



The Left Tail

Duration

Carry

The Ultimate Tourist Guide to Bondistan

Formerly titled 
"Beep Beep Trade Bonds Boop"

by
Efficient Market Hype

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For A.

Introduction

This is a primer of sorts, a haphazard manual of fixed income trading cobbled together from the things I have learned from teachers, mentors, bosses and of course the market. I can certainly tell you that the market is a tougher but better teacher than most and if you are careless and unknowledgeable, with the highest of fees. Yet there is no better classroom with a more objective grading system than financial markets.

The most valuable commodity in markets is knowledge, the rarest is time. I urge you to trade the rare for the valuable.

Equipped with knowledge, you are empowered with the ability but not the right to succeed. Knowledge is a universal option with no expiry and a strike that gets closer to being in the money the more of it you add. It's just a matter of applying it and hopefully this book can be a starting point. You won't find trade advice here, you won't find trade ideas, just some tools and examples on what trading fixed income involves.

This book started out as a thread on Twitter about a tiny portion of the Treasury futures market, but the reception was strong enough to warrant more threads on fixed income topics that not only told you what and how, but why. And the hungriest minds are always looking for the answers to the 'why'. The twitter threads (The Bond Basics with Bloomberg Series – "The BBB Series") continue to be free for all to access and will continue to be unless removed at no choice of my ownⁱ. This book is free as well. While the information in this book is much the same as the threads, this format allows me to add more information, emphasise key knowledge points that I think you should pay attention to, structure the material in a more cohesive manner and convey my thoughts more effectively. The biggest problem I've always found with most textbooks is that they're bound by theory, academic assumptions and focus on **the what but not the how and why**. I hope this book provides a practitioner's view on how the orderly theory of fixed income meets the chaos of actual markets. Any trading-related information contained herein is not financial advice, just opinions and educational examples.

In the following pages we will cover the basics of fixed income using examples and real-world applications with the Bloomberg terminal. The Bond Basics with Bloomberg Series – The BBB Series. Using market experience, education and the help of other professionals on twitter, we've put together a comprehensive but introductory primer on fixed income that explores the conventions, explains the mechanics and most importantly provides real world examples. The fixed income waters are as deep as they are wide, but the shallows can be just as fun. Jump in!

If you're looking for a resource that lays out the foundations from bond math to swaps, this will be what I hope is a good starting point. All you need is some time and a willingness to learn. Enjoy, and welcome to the world of bonds.

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ⁱ Do note, the material in this document was written throughout 2021 so examples, dates and relative timings ("4 years from now") are written in that context. Pay more attention to the core concepts in order to understand the material and less on the hard numbers. You should be able to replicate any result in this book with current data as long your grasp on the concepts is solid.

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1. Bond Math

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1.1 Discounting, Compounding and The Time Value of Money

The fundamental principle of financial valuation is rooted in determining the value of something today in exchange for the hope of something tomorrow.

"Higher risk [is required for the possibility of] higher reward."

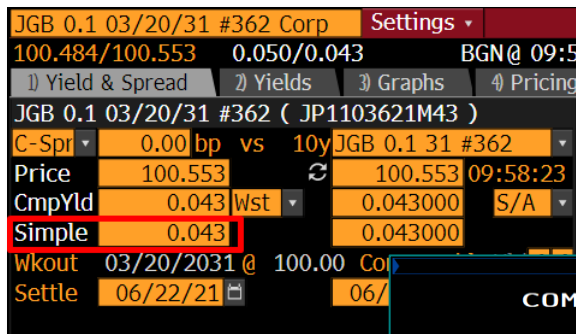
So, if I know the value of something today and with certainty its value the next day/month/year - without threat of that changing - that difference in value is "risk-free". And if the possibility of its value changing is high, that difference in value is "risky".

Bonds are great because right from the start they lay out the potential outcome. You buy at X price; it will pay you Y coupon and at the end you also receive Z principal back. If you are certain those are never in jeopardy, it's risk free. If not, it's risky. So how do we determine the rate at which that outcome plays out? Enter the concept of yield. The easiest to understand is the Simple Yield.

If you invested \$100 today and earned \$5 on that every year, after 5 years you would have \$125.

$$\text{FutureValue} = \text{PresentValue} * [1 + (y \times N)]$$

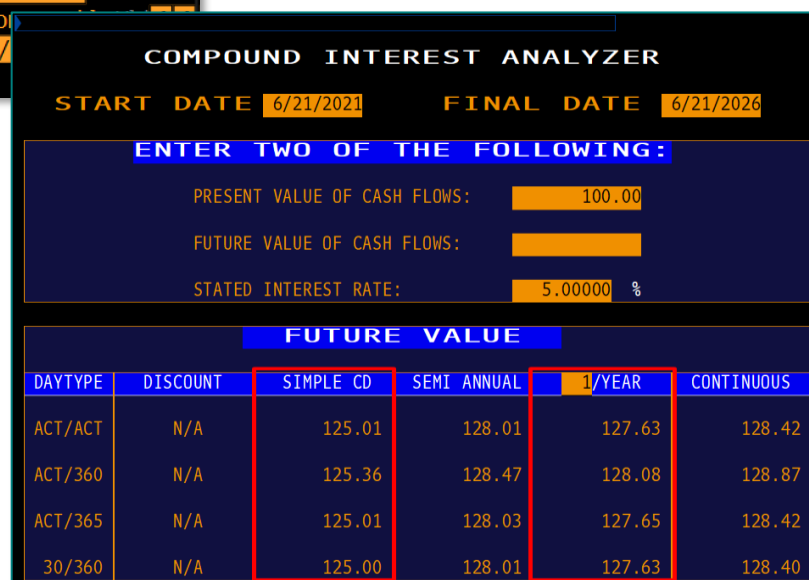
Before you say simple yield is dumb, just know that's the convention for how it is quoted in Japan, one of the largest fixed income markets in the world.



JGB 0.1 03/20/31 #362 Corp	Settings
100.484/100.553	0.050/0.043
Yield & Spread Yields Graphs Pricing	
JGB 0.1 03/20/31 #362 (JP1103621M43)	
C-Spr	0.00 bp vs 10y JGB 0.1 31 #362
Price	100.553
CmpYld	0.043
Simple	0.043
Wkout	03/20/2031 @ 100.00
Settle	06/22/21

But bond people are meant to be smart! That \$5 I get, I'm going to reinvest it! This is called compounding. In practice we ASSUME we can reinvest at the same original rate (5%)

On Bloomberg there's an ancient screen called **PFI<GO>** that lets you look at **compounded rates**.



COMPOUND INTEREST ANALYZER					
START DATE		6/21/2021	FINAL DATE		6/21/2026
ENTER TWO OF THE FOLLOWING:					
PRESENT VALUE OF CASH FLOWS:		100.00			
FUTURE VALUE OF CASH FLOWS:					
STATED INTEREST RATE:		5.00000 %			
FUTURE VALUE					
DAYTYPE	DISCOUNT	SIMPLE CD	SEMI ANNUAL	1/YEAR	CONTINUOUS
ACT/ACT	N/A	125.01	128.01	127.63	128.42
ACT/360	N/A	125.36	128.47	128.08	128.87
ACT/365	N/A	125.01	128.03	127.65	128.42
30/360	N/A	125.00	128.01	127.63	128.40

	A	B	C	D	E	F	G
1	Interest Rate	5%					
2	Principal	100					
3							
4							
5	Year	1	2	3	4	5	End Total
6	Coupon	\$ 5.00	\$ 5.00	\$ 5.00	\$ 5.00	\$ 5.00	\$ 25.00
7	Reinvested Coupon 1		\$ 0.25	\$ 0.26	\$ 0.28	\$ 0.29	\$ 1.08
8	Reinvested Coupon 2			\$ 0.25	\$ 0.26	\$ 0.28	\$ 0.79
9	Reinvested Coupon 3				\$ 0.25	\$ 0.26	\$ 0.51
0	Reinvested Coupon 4					\$ 0.25	\$ 0.25
1							\$ 27.63
2	Total Income + Principal						\$ 127.63
3							

Compounding means one cashflow is grown at an assumed rate for the remaining life of the investment.

$$FV = PV * [1 + (y / f)]^n$$

y = annual percentage yield

f = frequency of payouts (annual = 1, semi = 2, etc)

n = number of periods to reinvest. This is directly affected by f.

Note: The higher f is, the higher n is, meaning the compounding effect increases the higher the frequency. This is why in the previous screen Semi-Annual and continuous have higher FVs than 1Y. We'll come back to this formula later!

Now entertain 2 rules:

Rule 1: All money earned in an investment will be compounded

Rule 2: There is no free lunch

Combining these two gives us the underpinning of forward rates. **A forward rate is simply "the rate necessary in order to be indifferent between two investments"**

For example:

1. A 12-month investment (S₁) at 1% p.a.
2. 2 consecutive 6-month investments

Assuming the first 6-month rate (S_{0.5}) is 0.5% p.a., what is the 2nd 6-month rate (F_{0.5,1}) required for the two investments to be equivalent?ⁱⁱ

1. $S_1 = S_{0.5} * F_{0.5,1}$
2. 12month = 1.01
3. $2 \times 6\text{-month} = [(1 + (.005 / 2)) * (1 + F_{0.5,1} / 2)] \rightarrow 2 \times 6\text{-month} = [1.0025 * (1 + F_{0.5,1} / 2)]$

To be equivalent >> $(1 + F_{0.5,1} / 2) = 1.01 / 1.0025 = 1.00748$

ⁱⁱ Forward Rate notation can vary between F(start,end) or F(start,tenor) – here I use F(start,end) which follows the FRA convention for forward rate notation.
Tenor = (End minus Start). For example F_(0.5,1) is the 6 month rate (1 - 0.5) starting 6 months from now.

2nd 6-month rate = $0.00748 * 2$ (to make it a yearly figure)

2nd 6-month rate = 0.01496 or 1.49%

Any more or any less, and there's a free lunch.

The process of determining forward rates is called "gapping". On Bloomberg you can use the function **GA1<GO>** (another ancient screen) to conduct Gap breakeven analysis on money market rates.ⁱⁱⁱ

Separate but important to know - T-Bills (short term govt bills <1yr maturity) are quoted in *annualised discount*.

The price of a bill = $100 - [\text{Annualised discount} \times (\text{Days to maturity}/360)]$

Don't confuse this with "discounting", "discount factor" and the "discount rate" (discussed below).



Yields		Description		Cashflow Analysis	
Discount	0.02250	Settle	06/22/21	For	1,000 M Face Amount
Price	99.9946250	Issue	03/18/2021	Principal (Round)	N
Days to Maturity	86	Maturity	09/16/2021	Redemption	1,000,000.00
Yield Calculations		Taxed @	Profit		
US Treasury Convention	0.022814	28.00%	Repo Rate	0.04	
US Govt Bond Equivalent	0.023001	0.016426	Overnight Repo Equiv	0.023	
Simple Interest (Act/360)	0.022501	0.016561	Cost of Carry (pts)	-0.017	
Medium Term CD (Act/360)	0.022501	0.016201	Net P&L	-0.49	
US Treasury with Leap Year	0.022878	0.016471			
Risk					
Duration	0.236				
Modified Duration	0.236				
Risk	0.236				
Convexity	0.001				
DV - 01 on 1MM	23.56				
YV - 0.01 Dscnt	0.01014				

So now we've covered two key points:

1. **Compounding** - the idea of reinvesting cashflows from investments
2. **Forward rates** - the idea of finding investment rates between two differing opportunities such that they are equal in value.

Now, we turn the formula around. So far, we've looked at what my money *today* becomes in the *future*, but the question of "what is it worth?" is really "what is the future worth TODAY?"

This is the basis of all capital allocation decisions - where do I put my money today?

Let's first take the compounding formula and flip it around:

$FV = PV * [1 + (y / f)]^n$ flips around to become $PV = FV / [1 + (y / f)]^n$

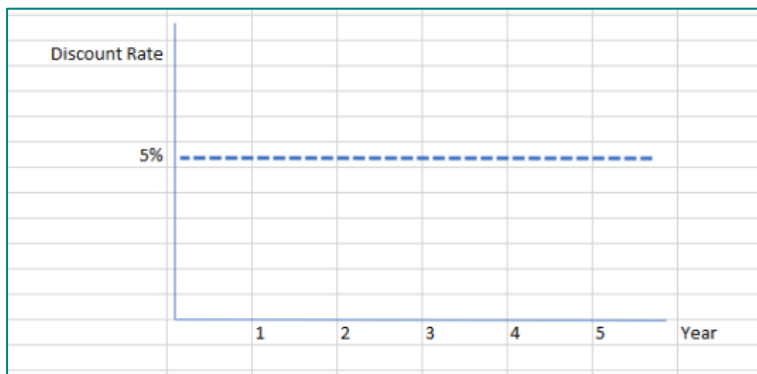
If I know a future cashflow amount (FV) and the rate I'm reinvesting my money in (y), I can figure out what that future cashflow is in today's terms. This is basically how you derive a bond's price based on yield.

The term $[1 + (y / f)]^n$ is what I am DISCOUNTING the future cashflows by.

If you assume the future cashflow is \$1, then discounting it to present gives me a **DISCOUNT FACTOR** for every future dollar. We can then easily use this DF to then discount whatever notional value of cashflows we have (i.e., quickly discount any number of bonds we have in a portfolio).

Discount Factor (DF) = $1 / [1 + (y / f)]^n$

ⁱⁱⁱ Note there are different day-count conventions for various parts of the market.



If you haven't realized by now, y is the discount rate and if you use that to determine bond price then by logic, a bond's **Yield to Maturity** (YTM) is simply the bond's internal rate of return (IRR) and Price is simply the NPV.

Yes, DCF experts are just wannabe bond guys. 🤖

Now let's bring these concepts together:

1. By assuming we reinvest cashflows at a certain CONSTANT rate...
2. we can use that rate to discount future cashflows to present, so...
3. this is how we determine the value of cashflows in today's terms.

1.2 Accrued Interest

I think it's worth including this small but important feature of bonds. Most theoretical material assume even cashflow periods out of convenience (no different in this handbook) but most of the time, you're not going to be buying or selling bonds on the 1st day of the accrual period, and when you don't there is something called accrued interest.

Let's say you buy a bond for 100.00 on Jan 1, and it pays a 4% coupon, semi-annually starting from 1st January each year. That's 4% split into 2 payments a year, once on Jan 1 and another time on July 1.

$4\% / 2 = 2\%$. If you bought \$250,000 face of bonds you would receive \$5,000 every 6 months.

Every day that you own that bond, you are accruing interest. Assuming 360 days in a year, that's \$27.78 a day in coupons you are entitled to. So, what happens if you sold the bond for 101.00 at the end of March? You would be entitled to 101% of 250,000 and the coupon you accrued from Jan 1 to Mar 31. That's 3 out of 6 months or 90 days.

$2\% \times (90 / 180) = 1\% \gg \$250,000 \times 1\% = 2,500$ in Accrued Interest.

The thing is, you're selling on Mar 31 while the coupon isn't paid till June 30 so there's no way for you to receive the coupon. Instead, the buyer of the bond will receive the full 2% coupon, even though 1% is owed to you. So, what happens? The buyer pays you for the bond (101.00) and then also pays you your share of the coupon earned – the accrued interest of 1%. In total, you will receive $101 + 1 = 102.00$ from the buyer of the bond.

101.00 is what is called the **Clean Price**.

102.00 is what is called the **Dirty Price**.

1.3 Topic Question

If YTM assumes a constant rate of investment, is the bond price derived from that methodology a true reflection of its value? Hint: think of the shape of the yield curve.

Because YTM assumes a constant discount rate while the yield curve is typically curved, the cashflows of a bond should actually be discounted at different discount rates implied by the yield curve. YTM provides you with a convenient and quick value of a bond but is not the most accurate.

2. Interest Rate Risk, Its Calculation and Application





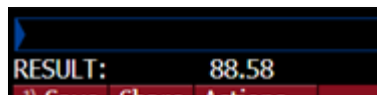
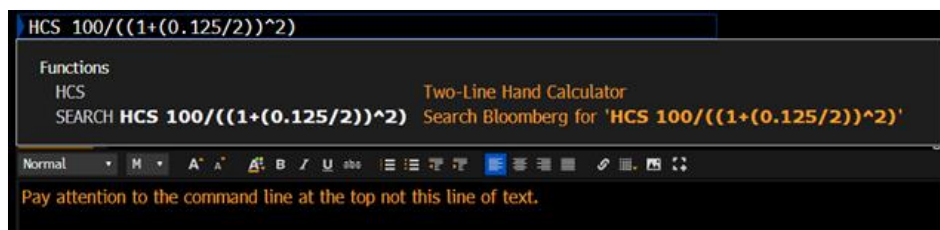
In this topic we discuss interest rate risk and how to measure it. **What is interest rate risk?**

Simply put, it is the risk of a change in the present value of a bond caused by the change in interest rates. In order to understand risk, we must first look at how a bond is valued. We just covered the PV formula and how to discount cashflows to present value.

$$PV = FV / [1 + (y / f)]^n$$

Because a bond is a series of future cashflows, the value is simply a sum of all cashflow PVs. So, let's use this approach and back out bond prices using the Yield to Maturity concept.

*Bonus tip: you can use **HCS<GO>** function on Bloomberg to quickly calc stuff!



We mentioned that YTM assumes reinvestment of the coupons at the same rate. But isn't YTM used to DISCOUNT the cashflows? Why is reinvestment of coupons a key assumption here? **Basically, to close a loop in the YTM formula.**

If I invest at 5% and discount at 5% the cashflow value at t=0 will remain consistent. This is why the part about forward rates is important – **any other rate results in a differing investment proposition.** Often, this logic is not mentioned in conjunction with the assumptions, but it should be a mandatory piece of bond math education.

Let's use an example:

1. Suppose a 2-year UST pays a 0.125% coupon and matures exactly 2y from now.
2. 2y yields trading in the market are at 0.25%.
3. Because USTs pay semi-annual coupons, we will receive 2 coupons a year >> $0.125\% / 2 = 0.0625\%$

We will receive a total of 4 payments >> $2 * 2 = 4$ with the final coupon coming with the principal.

Now, we can compute the value ourselves using the formulas and then we can also use a system like Bloomberg to calculate it for us and see that they are the same.

What is the value of the 2y UST using a formula?

$$1\text{st Cashflow} = 0.000625 / (1 + 0.00125)$$

$$2\text{nd Cashflow} = 0.000625 / (1 + 0.00125)^2$$

$$3\text{rd Cashflow} = 0.000625 / (1 + 0.00125)^3$$

$$4\text{th Cashflow} = (1+0.000625) / (1 + 0.00125)^4$$

Sum of Cashflows = 0.997508 which in percent terms is 99.7508

Using Bloomberg, on **PRPL<GO>** you can create your own custom bond. We set the maturity to be 2 years from today (in the screenshot the first settle date is 06/22/2021 and the maturity is 06/22/2023. Once done, just save the security.



Private Security Creation

Choose a Template OR Add Security without Template

Template Name: .T 0 3/8 06/22/2023 Corp

NOT CREATED BY BLOOMBERG

Pages: 1) Security Info, 2) Addtl Info, 3) Schedules, 4) Coupons, 5) Identifiers

Issuer Information: Name US TREASURE N/B, Industry

Privileging: Firm

Identifiers: ID, BB# PPEA2MF70, FIGI BBG011K9J4R6

Security Information (highlighted): Ticker, Cpn, Series, Maturity 06/22/2023, Restructure, Iss Type US Domestic, Ctry/Reg US, Curr USD

Coll Type US Govt Gtd, Cpn Type Fixed, Day Type ACT/ACT, Maturity Type Normal, Security Type Govt Natl

Calc Type (1) STREET CONVENTION

Announcement Date 06/22/2021, Interest Accrual Date 06/22/2021, 1st Settle Date 06/22/2021, 1st Coupon Date 12/22/2021

Issuance & Trading: Issue Amt 10000000.00 (M), Amt Out 10000000.00 (M), Par Amount 1000

Ratings: Est. Rating AAA

Pricing: Issue Price, Bid Price, Ask Price, Issue Yield

Left Sidebar: US Treasury Bonds & Notes (highlighted)

We can take the custom bond we created and pull it up on **YAS<GO>** to see the price is the same. So here we have a practical example of how real-world systems are built using the same bond math introduced to you thus far.



Yield and Spread Analysis

.T 0 3/8 06/22/23 Corp

Settings: 95 Buy, 90 Sell

Yield & Spread: Spread -0.45 bp vs 2yT 0 3/8 05/31/23

Price 99.750779 (highlighted)

Yield 0.250000 Mty (highlighted)

Wkout 06/22/2023 @ 100.00, Duration Yld 6.6

Settle 06/22/21 (highlighted)

Risk: M.Dur, Dur, Maturity, OAS, Risk, Convexity, DV, on 1MM, Benchmark Risk, Risk Hedge, Proceeds Hedge

Spreads: G-Sprd -1.7, I-Sprd -6.6, Z-Sprd -6.5, ASW -6.4, OAS -1.6

Yield Calculations: Street Convention 0.250000, Equiv 1 /Yr 0.250156, Mmkt (Act/360) 0.247038, True Yield 0.250000, Current Yield 0.125

Invoice: Face 1,000 M, Principal 997,507.79, Accrued (0 Days) 0.00, Total (USD) 997,507.79

After Tax (Inc 40.800 % CG 23.800 %) 0.169254

Issue Price = 0.000. Non OID Bond with Mkt Disc...

Now let's take a step further and see how the value of a bond *changes* if the yield changes. If I change the yield to 0.26%, I get a price of 99.730875; a difference of -0.019904. If I change it to 0.24%, I get a price of 99.770688; a +0.019909 difference.

Between a 1bp change up and down, there is a range of $(99.770688 - 99.730875) = 0.039813$

The range of 0.039813 over 2bps (1bp up, 1bp down) equates to a change of 0.0199065 per 1bp.


Using that rate of change per 1bp, if I change the yield to 0.22% (3bps lower) I should get a price of roughly **99.8105** $[99.750779 + (0.0199065 * 3)]$. Indeed, it matches what we see on Bloomberg!



Yield & Spread		Risk	
Spread	-3.45 bp vs 2y T 0 6/31/23	Maturity	OAS
Price	99.810521	1.996	1.997
Yield	0.220000 Mty	1.992	1.993
Wkout	06/22/2023 @ 100.00	Convexity	0.050
Settle	06/22/21	DV on 1MM	199
		Benchmark Risk	1.928
		Risk Hedge	1,033 M
		Proceeds Hedge	1,001 M

Spreads		Yield Calculations		Invoice	
1) G-Sprd	-4.7	Street Convention	0.220000	Face	1,000 M
2) I-Sprd	-9.6	Equiv 1 /Yr	0.220121	Principal	998,105.21
Basis	N.A.	Mmkt (Act/360)	0.217345	Accrued (0 Days)	0.00
4) Z-Sprd	-9.5	True Yield	0.220000	Total (USD)	998,105.21
13) ASW	-9.3	Current Yield	0.125		
14) OAS	-4.6				

Let's say I change the yield by +1% (i.e., 100bps) to 1.25%. Price should be roughly $[99.750779 - (0.0199065 * 100)] = 97.76013$ but in reality, we can see Bloomberg calculates it as 97.784722. We're off by 0.0247 now – our previous estimate on 3bps change in yield was only off by 0.000021. **What happened to cause our estimate to get less accurate?**

You see, when we discount the cashflows it's this sucker 

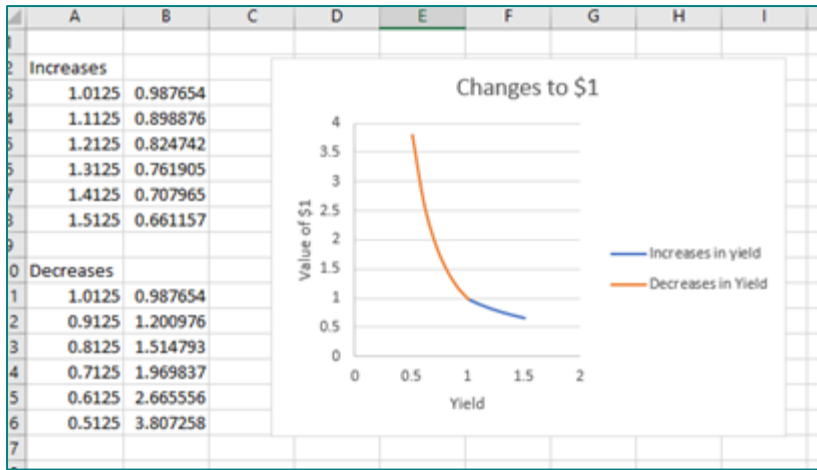
$$1 / (1 + y / f)^n$$

that plays a big part. The denominator (lower part of equation) is what changes the value but *increases in it have a marginally smaller impact on it than decreases in it*. **This is known as convexity**. You can see in the graph that the change in price does not have a linear relationship – it is curved.



Yield & Spread		Risk	
Spread	99.55 bp vs 2y T 0 6/31/23	Maturity	OAS
Price	97.784722	1.986	1.987
Yield	1.250000 Mty	1.942	1.943
Wkout	06/22/2023 @ 100.00	Convexity	0.049
Settle	06/22/21	DV on 0.01	0.00515
		Benchmark Risk	1.928
		Risk Hedge	1,007 M
		Proceeds Hedge	980 M

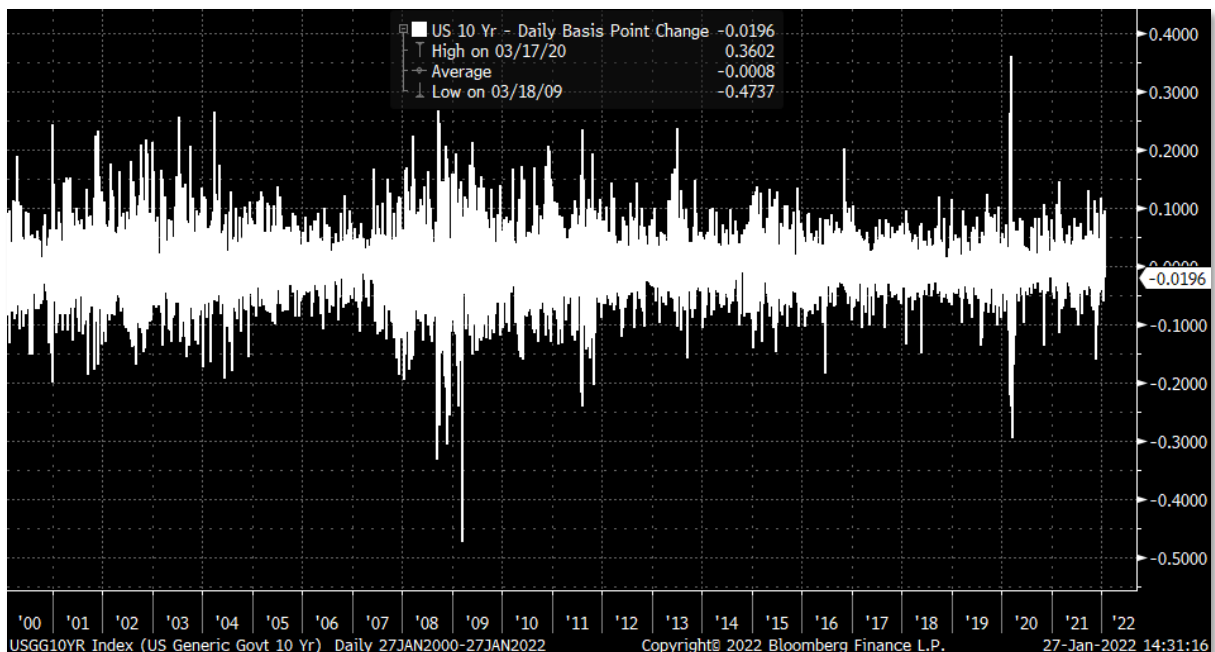
Spreads		Yield Calculations		Invoice	
1) G-Sprd	98.3	Street Convention	1.250000	Face	1,000 M
2) I-Sprd	93.4	Equiv 1 /Yr	1.253906	Principal	977,847.22
Basis	N.A.	Mmkt (Act/360)	1.244493	Accrued (0 Days)	0.00
4) Z-Sprd	93.5	True Yield	1.250000	Total (USD)	977,847.22
13) ASW	90.7	Current Yield	0.128		
14) OAS	98.5				



We'll touch on convexity later but for now just know that this curvature in the relationship of prices and yields is why the difference in estimates grows with a larger change in yield.

Something I observe in my career in finance is that market conventions are often built around maximum efficiency with acceptable accuracy, YTM is one example. Another is the concept of measuring IR risk through duration and PV01 or DV01.

The average daily change over the last 21 years in the US 10y yield is **-0.0844 BASIS POINTS**. My risk today, is largely confined to reasonably expected changes and is why linear approximations like **DV01 and duration** are market standard for day-to-day risk management despite the existence of convexity.



2.1 Duration

When we talk about duration, we really mean Modified Duration. **It's the percent change in Price for a 1% change in yield.** Macaulay duration is pretty much useless in everyday bond trading. However, you'll often hear people say something like "I'm running x number of years duration"

$$\text{Macauley Duration} = \frac{\sum_{t=1}^n \text{PV}(\text{CF}_t) \times t}{\text{Market Bond Price}} = \frac{\sum_{t=1}^n \frac{t \times C}{(1+Y)^t} + \frac{n \times M}{(1+Y)^n}}{\text{Market Bond Price}}$$

This is a general reference to the risk of your portfolio. The simplest (and still somewhat wrong) way I can describe Macaulay duration is "the number of years until your investment breaks even at current yields".

- Because you earn coupons that you reinvest, Mac. Dur. is always lower than maturity. (You breakeven sooner)
- And because zero coupon bonds give zero coupons, Mac.Dur is always equal to maturity.
- And because negative yielding debt means you LOSE money, negative yielding bonds have GREATER Mac.Dur than maturity!! 🤖

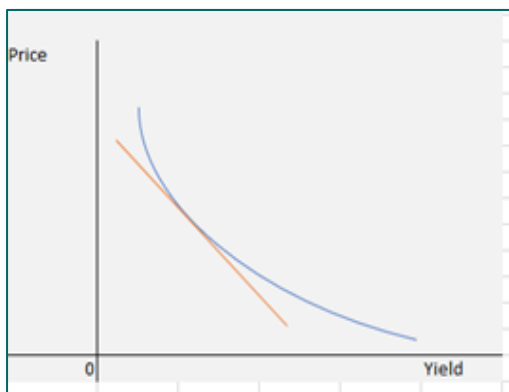
DBR 0 08/15/31 Corp		Settings ▾		Yield and Spread Analysis	
101.565/101.594	-0.153/-0.156	BGN@ 15:43	No Notes	95 Buy	96 Sell
1) Yield & Spread		2) Yields		3) Graphs	
4) Pricing		5) Description		6) Custom	
DBR 0 08/15/31 (DE0001102564)			Risk		
Spread	0.00 bp vs 10y DBR 0 08/15/31	Workout	OAS		
Price	101.594	101.594 15:43:21	<input checked="" type="radio"/> M.Dur	<input type="radio"/> Dur	10.158
Yield	-0.155800 Wst	-0.155800 Ann	Risk	10.520	
Wkout	08/15/2031 @ 100.00 Comparabl...	Yld 6 6	Convexity	1.134	
Settle	06/24/21	06/24/21	DV	01 on 1MM	1,032
			Benchmark Risk	10.320	
			Risk Hedge	1,000 M	
			Proceeds Hedge	1,000 M	

If you think about it this 'time to investment breakeven' perspective, it makes sense then that a higher coupon means lower duration, a higher yield (lower starting price) means lower duration and vice versa.

To get modified duration, you simply take the Macaulay duration and divide it by $(1 + y / f)$:

This is the derivative of P with respect to y: dP/dy

Modified duration is the delta of a bond. Graphically, it is the tangential line on the curve that represents that specific point's slope. It is an *approximation* of the rate at which a bond's price changes with a change in its yield.



But remember, bond yields typically move in basis points not percentages each day. If I know the % change I just multiply the Mod.Dur with Price and divide by 100 (1% = 100bps) to get the **PV01**.

PV01 stands for the **Price Value of 1 basis point change**. $PV01 = (\text{Price} \times \text{Mod. Dur}) / 100$. This is the *unit risk in bond price* for every 1bp change in yield.

Take the PV01 and multiply by the notional amount of your investment to get the **DV01** = PV01 x Face. DV01 stands for

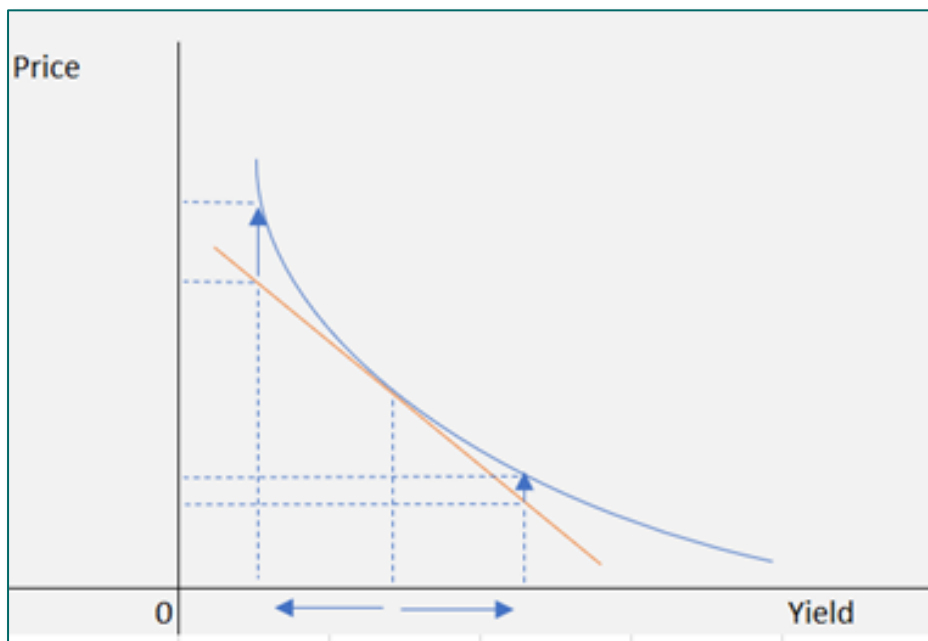
Dollar Value of 1 Basis Point Change. This is the *dollar unit risk in bond value* for every 1bp change in yield.

Face in the bond world means the notional amount of bonds you are buying. \$1million face at a price of 101 is equal to a principal value of \$1,010,000. So, a PV01 of 0.01942 results in a DV01 of \$194.2 per \$1million face. DV01 is useful because while the price may be 101.50 my actual investment could be \$250,000 worth. It's more meaningful to me to know that for my \$250k bond, I have \$48.55 at risk for every 1bp move in interest rates.

When you see a comment about DV01, know now that they're talking about how much money will be made or lost with each basis point change in rates.

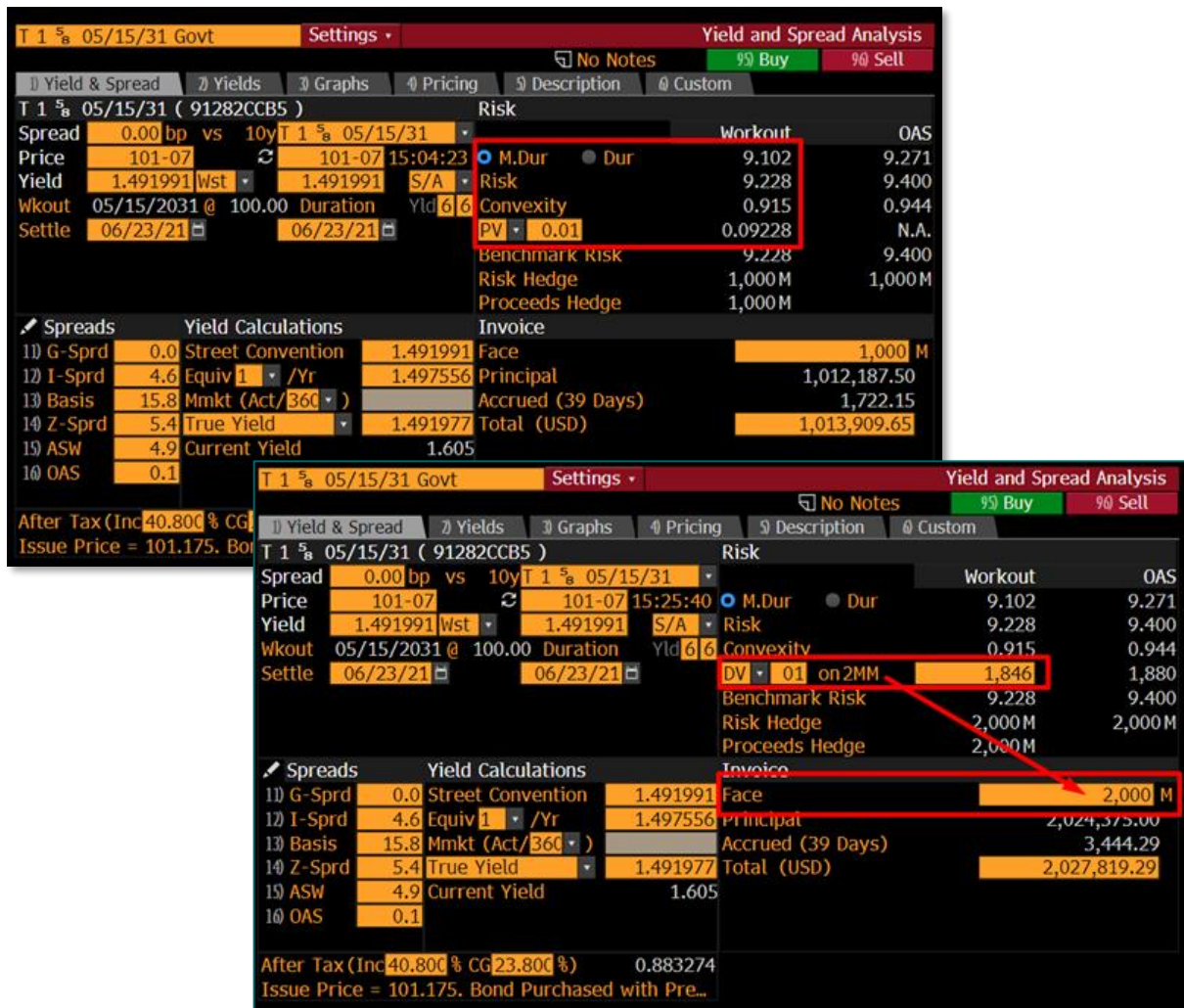
Convexity is the last part, and hardly touched on in everyday conversation about bonds. However, it is vastly important in portfolio management of a fixed income portfolio. In fact, convexity is a bond investor's BEST FRIEND (most of the time). Why? I covered earlier how the price to yield relationship is convex.

Recall: Increases in yield decreases price LESS than decreases in yield increases price. **This is why people "pay for convexity"**. In a large enough shock to rates, *duration will overestimate drops in price and underestimate gains due to convexity*. This is the reason why when running a bond portfolio, you need to **dynamically hedge** your interest rate exposure. As interest rates don't move a huge amount in short periods, day traders would be less concerned about convexity than someone running a fixed income portfolio.



The last point is that if you look at the payoff curve, the convexity effect results in higher yields with lower duration (the tangential line is less steep) and lower yields have higher duration. This is partially the reason why high yield bonds don't hurt as much as investment grade bonds do when rates shift violently (assuming spreads don't change a lot).

Lastly, let's wrap it up in the **YAS<GO>** screen where you can see a bond's risk characteristics. The PV01 field can be toggled to DV01 which will then display the DV01 per Face value denoted in the invoice section.



Top Screenshot (PV01):

Field	Value	Field	Value
Spread	0.00 bp vs 10y T 1 5/8 05/15/31	Workout	9.102
Price	101-07	OAS	9.271
Yield	1.491991	Risk	9.228
Wkout	05/15/2031 @ 100.00	Convexity	0.915
Settle	06/23/21	PV	0.01
		PV01	0.09228
		Benchmark Risk	9.228
		Risk Hedge	1,000 M
		Proceeds Hedge	1,000 M

Bottom Screenshot (DV01):

Field	Value	Field	Value
Spread	0.00 bp vs 10y T 1 5/8 05/15/31	Workout	9.102
Price	101-07	OAS	9.271
Yield	1.491991	Risk	9.228
Wkout	05/15/2031 @ 100.00	Convexity	0.915
Settle	06/23/21	DV	01 on 2MM
		DV01	1,846
		Benchmark Risk	9.228
		Risk Hedge	2,000 M
		Proceeds Hedge	2,000 M

Invoice Section (Bottom Screenshot):

Field	Value
Face	2,000 M
Principal	2,024,375.00
Accrued (39 Days)	3,444.29
Total (USD)	2,027,819.29

That's about it for Bond Math. It's one of the dryer parts but **knowing your bond math to the core is essential to understanding how things move in the bond market and why.** Once you understand how to price and quantify risk in bonds, the day-to-day movements as well as trade construction starts to make sense.

2.2 Topic Question

In the Bloomberg screen, what is the Risk value listed under Modified Duration and how is it calculated?

Risk = Modified Duration x Dirty Price. The important distinction here is to use Dirty Price. Yield to Maturity assumes dirty pricing which is Clean Price + Accrued Interest. So, the idea of Risk is to give you the \$risk to bond price of a 1% change in rates. In the simplest sense, it is PV01 x 100.



3. Money Markets and Forward Rates



Now that we're done with bond math, we can start moving into actual products that are traded in the market. Keep the math in your back pocket though because it's an essential part of understanding the mechanics involved.

Simply put, the money market is any instrument in the fixed income space that trades with a maturity of 1 year or less. Things like Treasury bills, commercial paper, certificate of deposits, banker's acceptances, Forward Rate Agreements and FinTwit's favourite – Repos.

United States of America				Browse		16:20:38											
Fed Funds FOMC »		Fed O/N Repo		US T-Bill		USD Deposit Rates		Rev Repo (Bid/Ask)									
FFDF	0.0900	0.1100	SOFR	0.05	4W	0.04	+0.00	0.05	0.04	O/N	0.0700	0.2200	O/N	0.04	0.03		
OBFR01		0.08	TGCR	0.05	2M	0.04	+0.00	0.05	0.04	1W	0.0900	0.1500	1W	0.05	0.00		
Commercial Paper			BGCR	0.05	3M	0.04	+0.00	0.05	0.04	2W	0.0800	0.2300	2W	0.05	0.01		
30D		0.100	AFX O/N Rate		6M	0.04	-0.01	0.06	0.04	1M	0.0900	0.2400	1M	0.05	0.01		
90D		0.110	AMERIBOR		1Y	0.07	+0.00	0.08	0.07								
Dow Jones		S&P 500 E-Mini Future		NASDAQ Composite Index		CRB Commodity Index											
DJIA	33874.24	-71.34	SPX Fut	4249.50	+18.00	CCMP	14271.73	+18.46	CRB	209.24	+1.36						
US Bonds FIT »		SOFR Future		90D EUR\$ FUT		BSBY Fix		LIBOR Fix									
T 0 1/8	06/30/23	0.268	99-22 3/4	99-22 7/8	-00 3/8	SFR1	99.915	SEP	99.8550	O/N	0.08627	O/N	0.08538				
T 0 1/4	06/15/24	0.473	99-10 3/4	99-11	-01	SFR2	99.840	DEC	99.7900	1M	0.07455	1W	0.08825				
T 0 7/8	06/30/26	0.912	99-26	99-26 1/4	-01 3/4	SFR3	99.745	MAR	99.7900	3M	0.09890	1M	0.09075				
T 1 1/4	05/31/28	1.252	99-31	99-31+	-03	SFR4	99.640	JUN	99.7150	6M	0.12303	2M	0.11675				
T 1 5/8	05/15/31	1.499	101-04+	101-05	-04	SFR5	99.520	SEP	99.6150	12M	0.17910	3M	0.13375				
T 2 1/4	05/15/41	2.051	103-05+	103-07+	-08+	SFR6	99.395	DEC	99.4600	Funds Future		6M	0.16063				
T 2 3/8	05/15/51	2.123	105-16	105-17+	-11	10Y Note Future		CBT		132-02	-04	JUN	99.905	1Y	0.24563		
Spot FX FXC »		Key Rates		Swaps		Commodities		30Y MBS BBTM »									
JPY	110.8700	Prime	3.25	3Y	0.5714	NYM WTI	73.43	+0.35	FNCL 2.5	103-08	103-09+	+00					
EUR	1.1937	BLR	2.00	5Y	0.9700	GOLD	1779.96	+1.28	G2SF 2.5	103-09+	103-11+	+00					
GBP	1.3983	FDTR	0.25	10Y	1.4757	Current Coupon		1.877									
CAD	1.2290	Discount	0.25	30Y	1.8067												

There are many other people that are massively more informed than me on money markets, any pro out there trading STIRs is already miles ahead as I am just a tourist.

Some names to follow on Twitter are @arishisays, @magnusmacro, @stirboi, @shortendtrader, @joegilster

3.1 T-Bills

Let's start with T-Bills. As previously mentioned, bills are quoted on a discount basis. So, 1% is not a 1% yield but it is an annualized discount:

$$P = 100 - [(Days\ to\ maturity / 360) * Discount]$$

On the current 3-month T-bill there are 90 days to maturity:

$$90/360 = 0.25$$

The discount quoted is 0.0325:

$$0.25 * 0.0325 = 0.008125$$

$$Price = 100 - 0.008125$$

$$= 99.991875$$

B 0 09/23/21 Govt		Settings	
0.05/0.0325	0.051/0.033	BGN@ 16:33	No Notes
Description		Cashflow Analysis	
B 0 09/23/21 (912796F53)		For	1,000 M Face Amount
Discount	0.03250	Settle	06/25/21
Price	99.9918750	Issue	03/25/2021
Days to Maturity	90	Maturity	09/23/2021
Yield Calculations		Taxed @	28.00 %
US Treasury Convention	0.032954	Repo Rate	0.04
US Govt Bond Equivalent	0.033225	Overnight Repo Equiv	0.033
Simple Interest (Act/360)	0.032503	Cost of Carry (pts)	-0.007
Medium Term CD (Act/360)	0.032503	Net P&L	-0.62
US Treasury with Leap Year	0.033044		
Risk			
Duration	0.247		
Modified Duration	0.247		
Risk	0.247		
Convexity	0.001		
DV	01 on 1MM	24.65	
YV	0.01 Dscnt	0.01014	



You may have noticed date conventions like 30/360, Act/360, ACT/ACT. What do they mean? They're date conventions for how you calculate yield and interest earned. The first part is how you count the days in a month (actual vs 30), the 2nd part is days in a year (actual vs 360).

Fun Fact: In general, commonwealth countries (UK, Singapore, Australia) follow ACT/365 while non-commonwealth countries like the US follow ACT/360 convention when it comes to bills.

25 Bond Description		26 Issuer Description	
Pages 11 Bond Info 12 Addtl Info 13 Reg/Tax 14 Covenants 15 Guarantors 16 Bond Ratings 17 Identifiers 18 Exchanges 19 Inv Parties 20 Fees, Restrict 21 Schedules 22 Coupons Quick Links 32 ALLQ Pricing 33 QRD Qt Recap 34 TDH Trade Hist 35 CACS Corp Action 36 CF Prospectus 37 CN Sec News 38 HDS Holders 60 Send Bond		Issuer Information Name AUSTRALIA F-BILL Industry Treasury (BCLASS) Security Information Mkt Iss AUSTRALIAN Ctry/Reg AU Currency AUD Rank Unsecured Series 2506 Coupon 0.000000 Type Zero Coup... Cpn Freq Day Cnt ACT/365 Iss Price Maturity 06/25/2021 BULLET Iss Yield .196 Calc Type (7)INTEREST@MTY Pricing Date 08/20/2020 Interest Accrual Date 1st Settle Date 08/21/2020 1st Coupon Date	
		Identifiers FIGI BBG00WP4P5M0 ISIN AU2CLT250615 ID Number BK9516521 Bond Ratings Issuance & Trading Amt Issued/Outstanding AUD 8,500,000.00 (M) / AUD 8,500,000.00 (M) Min Piece/Increment 5,000.00 / 5,000.00 Par Amount 5,000.00 Book Runner Exchange NOT LISTED	

Commercial paper is also quoted on discount, typically in lots of 100,000 USD. They can be dealer placed via banks or directly placed by the issuer themselves. Think: Ford issuing a CP where you lend money to them in return for interest. There is no collateral.

3.2 Short Term Interest Rates (STIR) and Risk

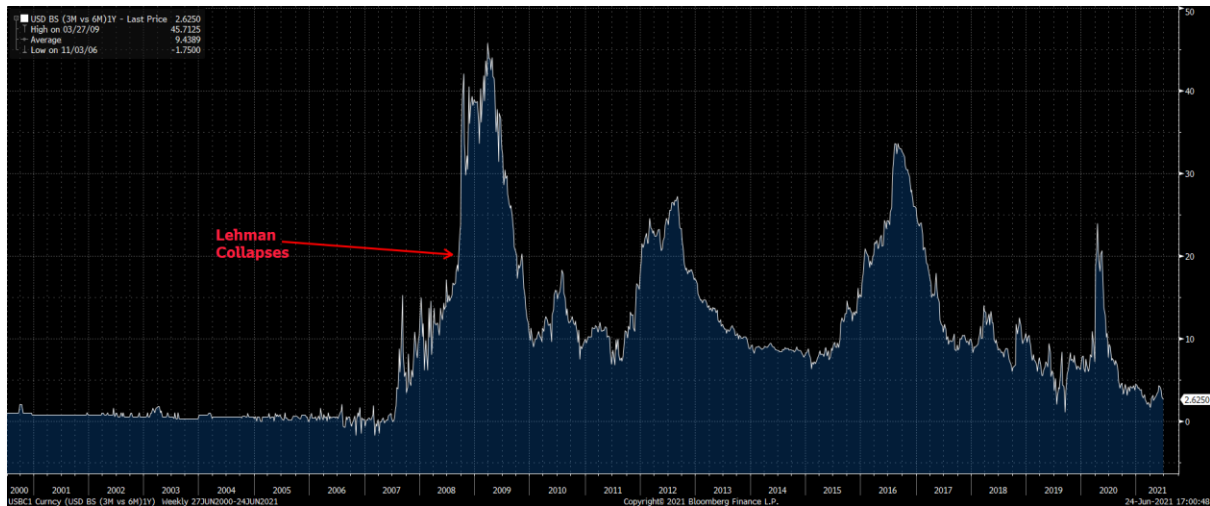
The Fed Funds Rate is **unsecured lending** costs between banks on excess reserves on an OVERNIGHT basis. The Target Rate is the Fed's objective, and the Effective rate comes from actual transactions between banks. As they're on reserves at the Fed and lent overnight – **they're super safe**.

The ECB has three traditional tools they use to set policy rates – the refinancing rate which are set via weekly auctions of 2-week repos, the deposit facility rate in which banks make overnight deposits with the central bank and the marginal lending facility which is somewhat equivalent to the Fed's discount window. You don't want to be seen anywhere near that window.

In the very first topic I defined the risk-to-reward relationship as "Higher risk [is required for the possibility of] higher reward." **Risk exists in many forms: interest rate, credit, reinvestment, liquidity, FX, inflation, political, etc.**

In just about every instance time increases each and every one of these risks. You don't worry about inflation tomorrow; you worry about its effects next year and onwards. You don't worry about rates rising enormously if your investment matures in a week, but you would if it had 10 years left. The shorter the maturity, generally the lower the potential risks. This is why money markets are considered "safe" and effectively cash or "cash-plus". *But what happens when they're not? That's where it gets interesting!*

Yeah, you know what I'm talking about. That day in September. Seems like it was just yesterday, right? Yeah, that's right I'm talking about- what? No, not repo madness. I'm talking about Lehman collapsing you idiot.



That is the 1-year basis swap between 3M LIBOR and 6M LIBOR. To me, it perfectly encapsulates how the financial industry has never been the same since GFC (admittedly, there a number of reasons and interbank risk is just one). What is it saying? Simply, banks were worried about lending to each other in '07 but once Lehman collapsed in September 2008 no one was safe.

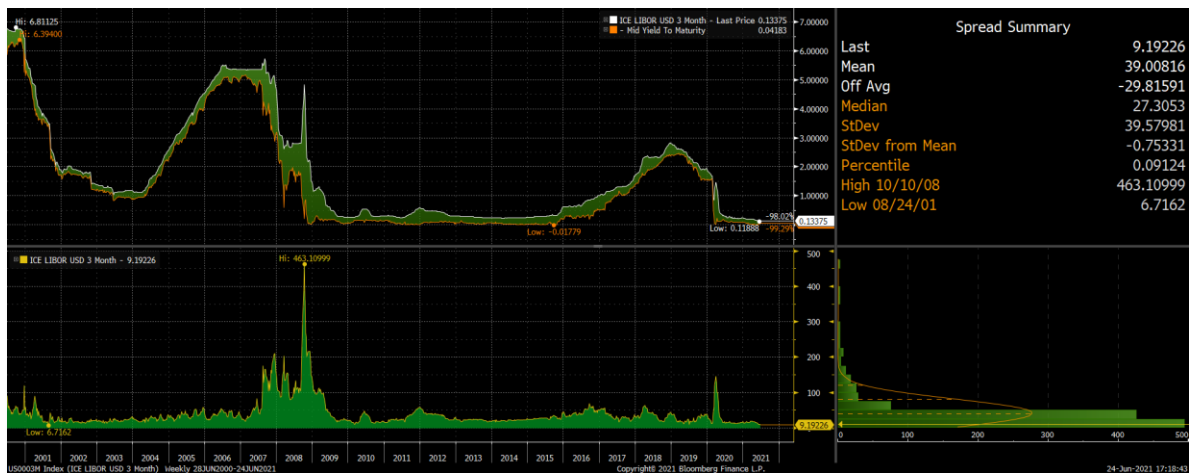
You see, in the past the probability of one bank surviving the next 6 months was the same as them surviving the next 3 months. In 2008, that was not the case. This meant a bank getting funding for 6 months suddenly became much more expensive than getting funding for 3 months.

What is LIBOR? The London InterBank Offer Rate (LIBOR) is basically derived from a racket-survey of reasonable rates that one bank would ~~collude with~~ lend to another on the London money market. It effectively captures interbank credit risk. The higher the risk, the higher the banks are going to quote the interest rate in the survey. This is what Eurodollars are based on. It is being replaced by other rates, such as SOFR in the U.S.

Why are they called Eurodollars? It has zero to do with euros & everything to do with USD. A Eurodollar is any USD debt instrument issued OUTSIDE the US. A USD bill in Japan is technically, a Eurodollar as is a USD bond issued in China that everyone is waiting for to default.

25 Bond Description		26 Issuer Description			
Pages 11) Bond Info 12) Addtl Info 13) Reg/Tax 14) Covenants 15) Guarantors 16) Bond Ratings 17) Identifiers 18) Exchanges 19) Inv Parties 20) Fees, Restrict 21) Schedules 22) Coupons Quick Links 32) ALLQ Pricing 33) QRD Qt Recap 34) TDH Trade Hist 35) CACS Corp Action 36) CF Prospectus 37) CN Sec News 38) HDS Holders 60) Send Bond		Issuer Information Name CHINA EVERGRANDE GROUP Industry Other Financial (BCLASS) Security Information Mkt Iss EURO-DOLLAR Ctry/Reg KY Rank Secured Coupon 8.250000 Cpn Freq S/A Day Cnt ISMA-30/360 Maturity 03/23/2022 CALL 07/26/21@102.06 Iss Yield 8.2500 Calc Type (1)STREET CONVENTION Pricing Date 03/17/2017 Interest Accrual Date 03/23/2017 1st Settle Date 03/23/2017 1st Coupon Date 09/23/2017		Identifiers FIGI BBG00G7BLS07 ISIN XS1580431143 ID Number AM9155384 Bond Ratings Moody's B2 Fitch B- Composite B- Issuance & Trading Amt Issued/Outstanding USD 2,025,000.00 (M) / USD 2,025,000.00 (M) Min Piece/Increment 200,000.00 / 1,000.00 Par Amount 1,000.00 Book Runner CSMHK,CS,HAITON Reporting TRACE	

So, if LIBOR captures interbank risk, we can look at its spread against a risk-free rate like the 3-month T-Bill. There's very little chance right now where the US collapses in the next 3 months. Assuming that, I can track the spread between Libor and T-Bills: [the TED Spread](#)



The TED spread still gets quoted but most of the market now quotes the LOIS, aka LIBOR-OIS spread & the FRA-OIS. What is the difference between the two? LIBOR-OIS is just the spread between current 3M LIBOR and current 3M OIS rates whereas FRA-OIS is traded via swap and is the spread over the OIS leg of the swap. Don't worry about mechanics now but essentially, it's *current* risk of the interbank market (LOIS) vs *expected* risk of the interbank market (FRA-OIS).

Remember in the first topic we talked about forward rates? That's what an FRA is – a Forward Rate Agreement.

Example: FRA_{3x6} = to borrow at 3months from now, maturing 6 months from today. So, 6-3 = 3 months. You are striking a deal for the 3-month rate, 3 months forward.

What is OIS? It stands for Overnight Index Swap. What is it based on? The Fed Funds Rate. Because Fed Funds is for unsecured overnight lending, you can enter into a swap agreement whereby you pay a fixed coupon in return for receiving the overnight rate. Because it's based on FF, which are overnight, it's very safe. The OIS swap also sees no exchange of notionals, so the counterparty risk is also very low. This is why OIS is considered risk-free, but we'll get into swaps at a later stage.

We covered how to calculate forward rates under a no-arbitrage scenario – if you have the 6-month lending rate and the 3-month lending rate, you can calculate the 3 month rate, 3 months forward such that investing for 6 months vs [3months X 3months] are equivalent.

Use `SWPM -FRA<GO>` to price an FRA on the terminal.



Deal	FRA	Counterparty	FRA CNTRPARTY
Side	Sell (Lend)	Bus Day Adj	ModifiedFollowing
Notional	10MM	Calendar	FD, EN
Currency	USD	Days Before Acrl	2
FRA Style	Regular	Index	3M US0003M
Type	2M X 5M	Reset Date	03/17/2022
Effective	03/21/2022	Settlement	03/21/2022
Maturity	06/21/2022	Bus Adj Maturity	06/21/2022
Rate	0.488905	Days	92
Day Count	ACT/360		

Projected Cashflow	0.00	Premium	0.00000	DV01	255.22
Discount (Settle)	0.99987	BP Value	0.00000	Gamma (1bp)	0.02
NPV	0.00	Market Rate (%)	0.48890		



Most of you would be more familiar with Eurodollar futures (ED). Eurodollar futures are futures contracts on LIBOR fixings for future dates. **The quote on an ED contract is 100 – yield.** So EDZ1 as of Friday June 25th, 2021, was 99.790, indicating a yield for Dec '21 LIBOR of 0.210%.

In this case, buying(selling) an ED contract means you think the yield will go down(up). Thus, buying an ED future is the same as to lend FRA and to sell ED is akin to borrowing on FRA. You are aiming to lock in future yields higher(lower) than you are lending(borrowing).

As EDs get phased out due to the retirement of LIBOR, the market will shift to SOFR futures. Perhaps in a future revision we will cover them more but for the most part, they are functionally the same as ED in design. The same goes for Fed Funds 30-day futures contracts; all three are quoted in price as 100 – yield.

1) Contract Information	2) Linked Instruments
SFRM3 Comdty	3 MONTH SOFR FUT Jun23
CME-Chicago Mercantile Exchange	
3) Notes	
** Product specifications link below **	
CME 3-Month SOFR Futures. ***Please refer to the contract specifications link below for more details.	
(COMB PIT ELEC) to accommodate sub-futures contracts.	
4) Contracts CT »	Jan-F Feb-G Mar-H Apr-J May-K Jun-M Jul-N Aug-Q Sep-U Oct-V Nov-X Dec-Z
Contract Specifications	
Underlying	3mo SOFR
Contract Size	2,500 \$ x IM...
Value of 1.0 pt	\$ 2,500
Tick Size	0.005
Tick Value	\$ 12.5
Price	96.225
Pt. Val x Price	\$ 240,562.5
Last Time	11:41:24
Exch Symbol	SR3
FIGI	BBG00LXRDBL5
Daily Price Limits	
Up Limit	N.A.
Down Limit	0.003

1) Contract Information	2) Linked Instruments
FFN2 Comdty	FED FUND 30DAY Jul22
CBT-Chicago Board of Trade	
3) Notes	
** Product specifications link below **	
30 Day Federal Funds Futures. **Effective November 17, 2018, CME amended Fed Fund Futures product rules to clarify that contract value is \$4,167 per price point. This amendment made no	
4) Contracts CT »	
Jan-F Feb-G Mar-H Apr-J May-K Jun-M Jul-N Aug-Q Sep-U Oct-V Nov-X Dec-Z	
Contract Specifications	
Underlying	FED FUND 30D...
Contract Size	5,000,000 US...
Value of 1.0 pt	\$ 4,167
Tick Size	0.005
Tick Value	\$ 20.835
Price	98.320
Pt. Val x Price	\$ 409,699.44
Last Time	11:43:15
Exch Symbol	ZQ
FIGI	BBG00PT37T87
Daily Price Limits	
Up Limit	N.A.
Down Limit	0.003

3.3 Repos

Repo is short for repurchase agreement. You give collateral in return for cash, agreeing to repurchase your collateral later on. It is, therefore, a SECURED lending rate.

Because it's a temporary arrangement, ownership is not transferred - repos are thus treated as loans.

The way it works is like this: You have \$1MM of US Treasury Bonds (UST) but you want cash instead. You go to the repo market and post your UST as collateral, receiving ~\$1MM of cash and 1wk later you buy back the UST but at a higher price. The %diff btw selling and buying back the UST is the repo rate.

The opposite way is a Reverse Repo (RRP) where you lend cash in return for collateral with the agreement to sell the collateral back to get cash in the future. They are two sides of the same coin.

Recent example? The Fed's reverse repo facility that you hear about so much about. In this scenario the Fed is counterparty and institutions like money market funds are the dealers in the RRP – they are lending cash for treasuries and selling them back to the Fed for a gain.

The Fed recently set the RRP rate at 5bps^{iv}. Why? So that the theoretical floor for short term rates is 0.05% - any lower than that and you would go to RRP. The lack of demand elsewhere should push up those rates to at least 0.05%.

^{iv} June 2021 FOMC

For a much better explanation on the Fed's RRP, look for Rishi Mishra's excellent breakdown.

<https://twitter.com/aRishisays/status/1392211076687667202>

When you need cash and go to repo, your counterparty could say your UST sucks. If you want \$1MM in cash, you need to give more than 1MM worth of UST. That is called over-collateralization. The other method is called a haircut, where the market value of your UST is discounted.

Over-collateralization and haircuts are the inverse of the other. 1% overcollateralization = 1/1.01 haircut on the collateral. So, a 1% haircut means 1MM all-in market value of UST gets you 990k of cash. If you wanted 1MM in cash, you would need to post 1.01MM market value of UST.

What is when a bond goes "special"? Remember, if you have UST and you want cash you have to pay interest on that loan. But what if there is HUGE demand for USTs? In that case, there is a ton of cash looking for bonds and are willing to receive a lower interest rate.

At some point the demand for UST gets to a stage where the interest rate become negative. You get give 1MM of UST, get 1MM of cash and later on buy back the bond for less than 1MM.

When the rate is negative, the bond used as collateral trades "special".

I don't want to go much further into money markets - Any deeper and it gets somewhat esoteric & there are better-equipped people than me that understand this market much better. I implore you to follow the twitter accounts I listed in the earlier part of this chapter.

Money markets are essential to financial markets and underpin everything from fed policy to the swaps market. Understanding how this area of the market works hopefully puts some context into a lot of what you read here on fintwit and the all-too-often doomsday headlines :)

3.4 Topic Question

If you are going to trade a view on LIBOR and have to choose between an FRA on 3M LIBOR or ED futures - what is the key difference you must factor in between the two? Hint: I'm looking for answers on VALUATION between the two, not technical (OTC vs Exchange)

You must consider the convexity (or lack thereof) between the two instruments. ED futures are linear instruments with a fixed DV01 of \$25 per bp. FRAs on the other hand are discounted cashflows and therefore subject to convexity as yield changes. Depending on your view of changes in rates and/or whether or not you are hedging using these two instruments, the convexity effect must be considered.



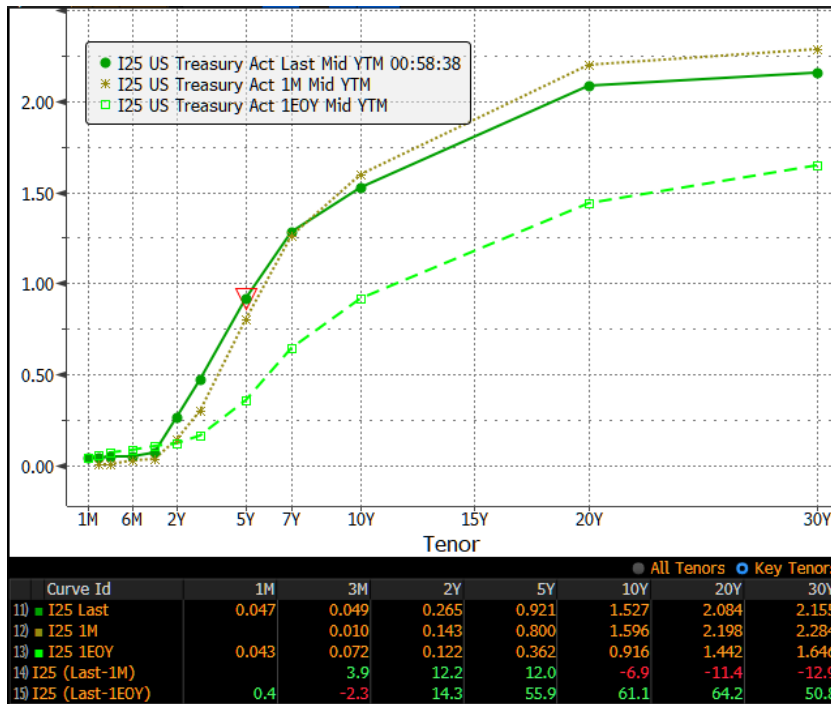
4. The Yield Curve (Authored by @macropotamus)



4.1 What is a Yield Curve?

We often hear people talk about the yield curve, and even more often when it is inverted. But why is it important? What does a normal yield curve look like? What drives the shape of the curve?

Simply, a yield curve is a line showing the yields of bonds of different maturities. The bonds used to construct the yield curve have the similar credit equality (e.g., BBB curve) or come from the same issuer (e.g., US Treasury). In Bloomberg, you can load the US treasury active curve with `GT10 Govt GC<GO>`. Typically, a yield curve is upward sloping. It can also be flat, inverted, or twisted (rare). We typically divide the yield curve by three major buckets: front-end (0-3y), belly (3-7y), and long-end (7y+).



The yield of a longer-term bond (e.g., 5y) reflects short-term spot and forward yields (1y, 1y1y, 2y1y, 3y1y, 4y1y) and thus the (market) expectations for the short-term interest rate path. Currently, interest rates are expected to increase over time which you can observe through forward implied rates on `FWCM<GO>`

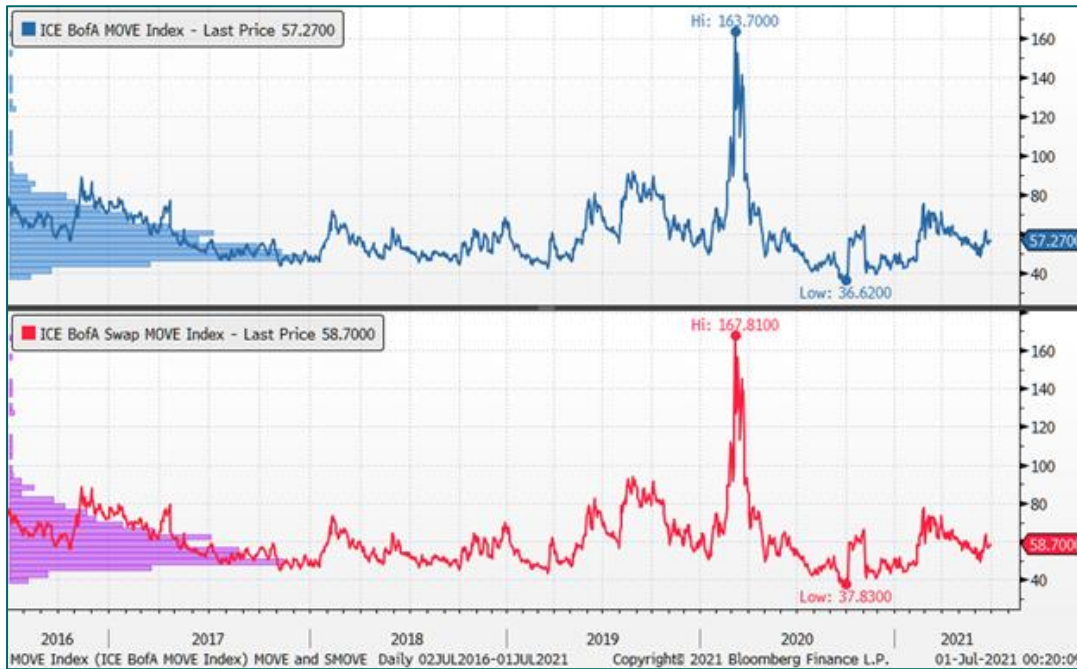
As maturity increases, interest rate (duration/volatility) risk increases as well. To compensate for the increasing risk, investors earn a risk premium (higher yields) by holding longer-term bonds. On the other hand, increasing positive convexity

(noncallable/make-whole), better investors demand for longer bonds (10y, 20y, 30y) lower the long-term bond yields. That is why a yield curve is typically steeper in the front and flatter in the back.

US Treasury Actives Curve		Export	Graph	Forward Curve Matrix								
US Treasury Actives Curve		Mid	Yield	Conventional								
Two Curve Spreads		Select a curve under "Curve List" for two curre...		Curve List								
Forward Curve Date		07/05/21		OIS Discounting								
Spot		Coupon		Zero								
Tenors	Zero	7/5/2021	3Mo	6Mo	1Yr	2Yr	3Yr	4Yr	5Yr	10Yr	15Yr	30Yr
1Mo	0.0469	0.0465	0.0591	0.1042	0.4417	0.8732	1.5833	1.5746	2.1806	2.7414	2.7566	2.3345
2Mo	0.0476	0.0489										
3Mo	0.0497	0.0504	0.0615	0.1025	0.4491	0.9095	1.5942	1.5941	2.2353	2.7781	2.7781	2.3779
6Mo	0.0533	0.0562	0.0816	0.1256	0.4469	0.9107	1.5971	1.6060	2.2327	2.8031	2.8031	2.3719
1Yr	0.0891	0.0967	0.1903	0.2861	0.4457	0.9373	1.5929	1.5929	2.2284	2.7878	2.7802	2.3719
2Yr	0.2640	0.2709	0.3751	0.4810	0.6905	1.2637	1.5929	1.9083	2.2323	2.7841	2.7802	2.3687
3Yr	0.4872	0.4966	0.6200	0.7462	0.9887	1.3713	1.8002	2.0153	2.2150	2.7828	2.7802	2.3677
5Yr	0.9256	0.9285	1.0312	1.1382	1.3468	1.7056	1.9583	2.0788	2.2155	2.7833	2.7717	2.3681
7Yr	1.2963	1.2876	1.3585	1.4339	1.5814	1.8341	2.0282	2.1972	2.3681	2.7825	2.6632	2.3674
10Yr	1.5674	1.5477	1.6087	1.6763	1.8097	2.0467	2.2358	2.3573	2.4815	2.7779	2.5821	2.3674
20Yr	2.1668	2.0940										
30Yr	2.2288	2.1637	2.1822	2.2069	2.2558	2.3419	2.4082	2.4461	2.4850	2.5392	2.4564	2.3672

If you are long bonds, positive convexity means you make more when interest rate decline by a certain amount (e.g., 20bps) than you would lose when rate goes up by the same amount. And you want to own convexity if you expect rate volatility to exceed market expectations.

To quickly gauge the market expectations for volatility, you can look at MOVE or SMOVE index, which is the curve-weighted *normalized* 1M implied volatility.



You can also enter `VCUB<GO>` to look at the ATM normalized implied volatility of the interest rate swaptions of different expiry (vertical) for different bond tenors (horizontal). As you can see, as bond maturity increases (left to right), volatility increases. And as the option maturity (up to down) increases, volatility increases up to a point before market expectations for mean-reversion kicks in.

97 Actions 93 Settings Interest Rate Volatility Cube

USD USD BVOL Cube (Default) Bid Date 06/28/21

Analyze Cube Market Data

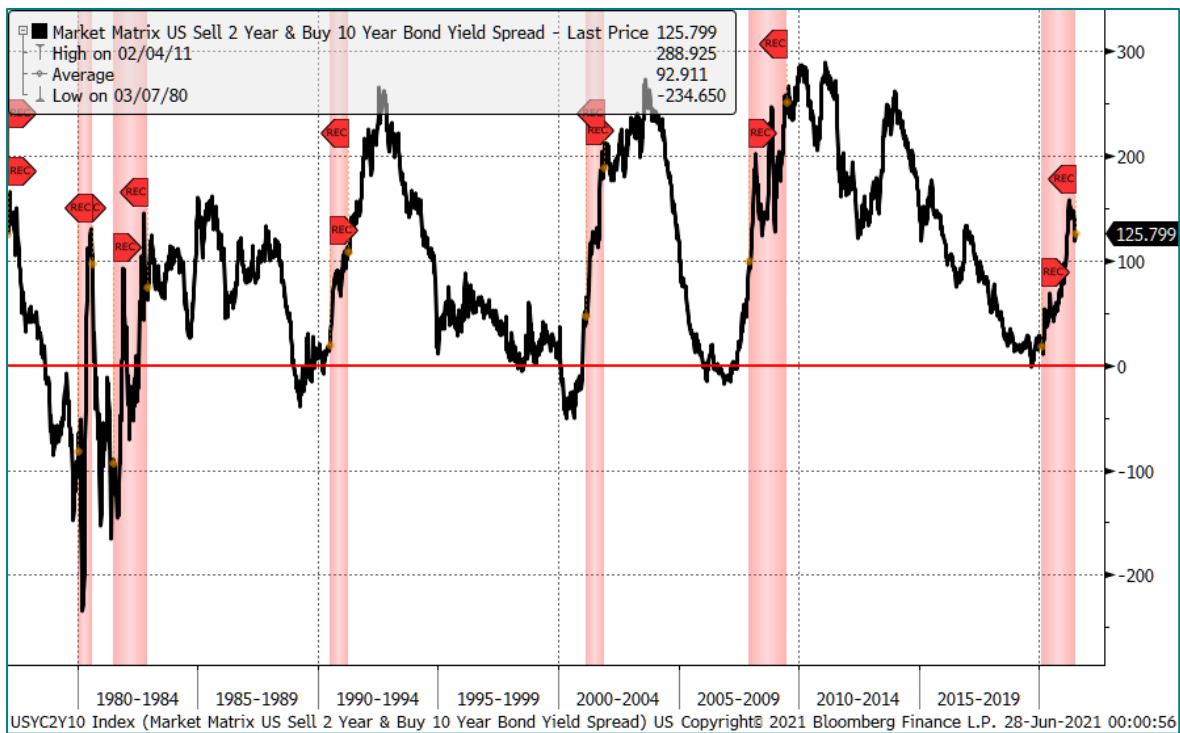
Swap Curve (23) US Dollar Index Tenor 3M Show Vol Normal

View Strike ATH Discounting IBOR Show Strikes

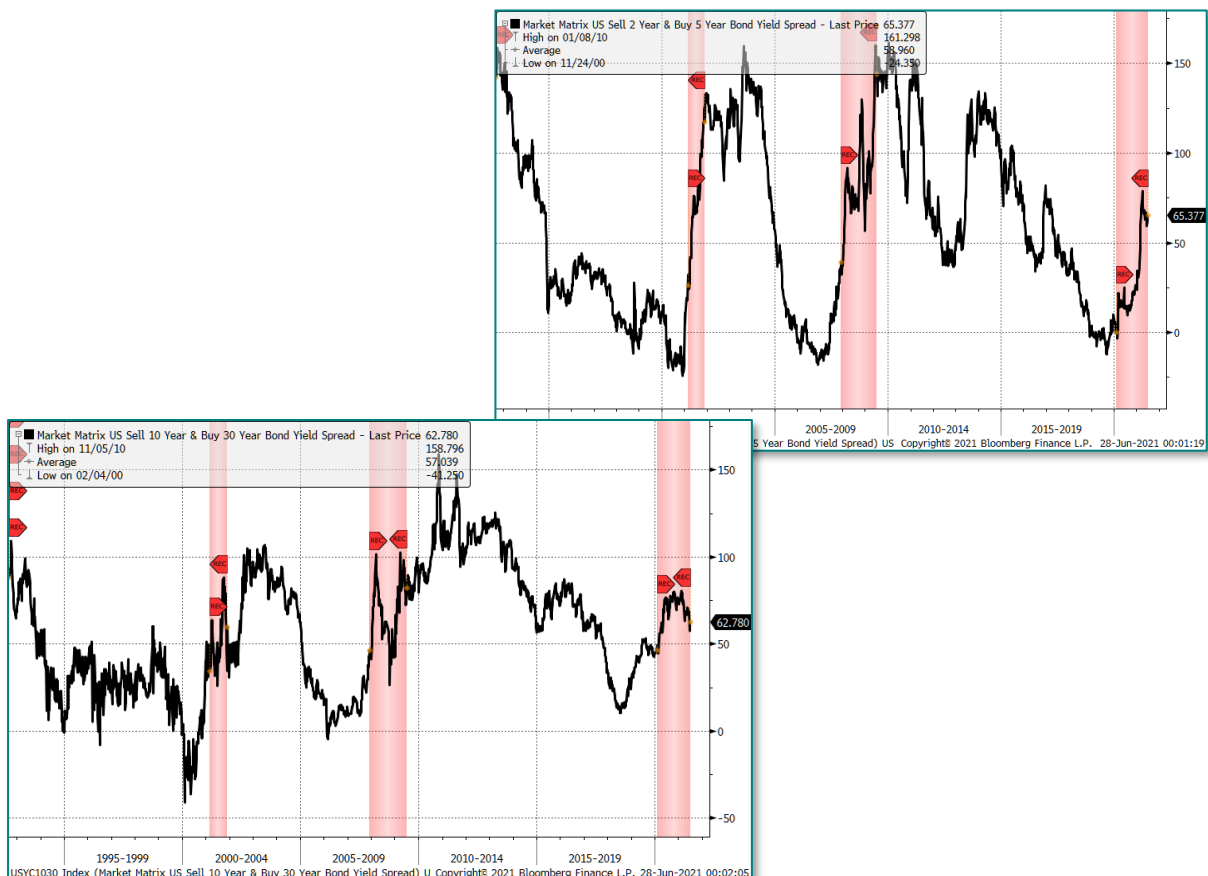
Expiry	1Yr	2Yr	3Yr	4Yr	5Yr	7Yr	10Yr	12Yr	15Yr	20Yr	25Yr	30Yr
1Mo	14.94	26.08	37.83	50.40	59.38	63.70	66.30	67.08	67.54	69.05	70.27	71.49
3Mo	21.30	35.42	47.85	58.44	65.22	69.27	72.35	72.92	73.13	73.99	75.13	75.99
6Mo	26.93	43.36	54.62	61.73	66.47	69.43	71.71	72.08	72.21	72.87	73.46	74.19
9Mo	33.00	48.64	58.41	64.40	66.61	69.61	71.12	71.30	71.23	71.43	72.03	72.49
1Yr	39.74	53.46	62.26	66.54	68.83	70.08	71.19	71.19	70.93	70.82	70.95	71.06
2Yr	63.84	69.32	70.99	72.17	72.38	72.30	72.28	71.77	70.92	70.38	70.15	70.08
3Yr	73.71	74.74	74.55	73.96	73.41	73.00	72.37	71.79	70.76	69.69	69.11	68.63
4Yr	75.21	75.55	74.70	74.11	73.54	73.06	72.36	71.58	70.38	69.15	68.35	67.80
5Yr	75.35	74.98	74.36	73.88	73.48	72.70	71.78	70.96	69.78	68.06	67.18	66.49
6Yr	74.58	74.35	73.90	73.36	72.87	71.99	70.70	69.80	68.44	66.83	65.94	65.29
7Yr	73.53	73.61	73.28	72.81	72.44	71.28	69.71	68.78	67.36	65.69	64.69	64.14
8Yr	72.96	72.78	72.46	71.98	71.67	70.27	68.77	67.78	66.22	64.61	63.42	63.08
9Yr	72.21	71.63	71.26	70.97	70.68	69.30	67.77	66.78	65.29	63.58	62.33	62.08
10Yr	70.87	70.23	70.06	69.86	69.72	68.26	66.72	65.74	64.28	62.37	61.04	60.98
12Yr	67.92	67.82	67.66	67.31	67.07	65.83	64.38	63.35	61.81	59.76	58.78	58.64
15Yr	63.69	64.16	63.67	63.45	63.17	62.09	60.84	59.74	58.10	55.83	55.38	55.12
20Yr	59.54	59.83	59.42	59.24	59.11	58.21	57.17	55.76	53.65	52.32	51.66	51.28
25Yr	56.71	57.36	57.20	56.10	56.27	55.67	54.94	53.72	51.88	50.83	50.14	49.79

Quick Pricer For Swaption Swap Manager (SWPM)

4.2 Breaking Down the Curve – Curve and Butterfly Spreads

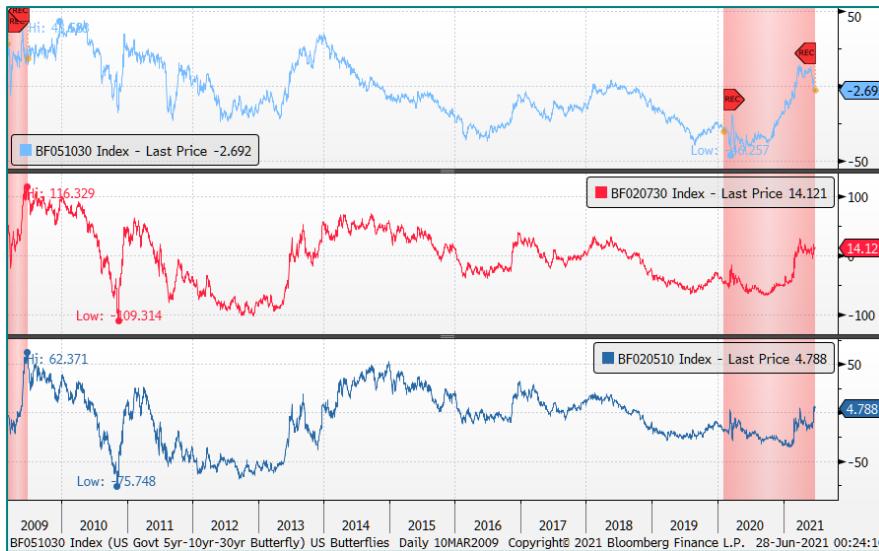


OK, so the yield curve is typically upward-sloping, so what? Well, investors love to look at the yield curve to understand (and sometimes predict) economic cycles. They typically look at different term spreads, for example, between 10y and



2y bonds (2s10s, BBG: USYC2Y10 Index), to look at economic cycles. You can see the reason why an inverted curve gets so much attention as inversion typically happened before a recession in the past.

Investors also evaluate the evolution of the yield curve by looking at the butterflies, which comprises of three maturities/tenors. For example, a 2y5y10y fly (BBG: BF020510 Index) is the yield spread of 5y (x2) – 2y – 10y. In this case, the 5y is the body, and 2y and 10y are the wings. The chart below shows 3 different butterflies. When the butterfly spread goes up, the body underperform the wings.



4.3 Carry & Roll-down – How the Curve Affects Your Investment

So, what does the shape of yield curve mean for your bond investment? When the yield curve is steep, long bonds are very attractive because of the carry and roll-down. **Carry is simply the income return of your long bonds over cash or short-term securities (T-Bills).** When the yield curve is steep, the financing or opportunity cost (LIBOR + spread, repo, T-Bills) is lower than the yields of longer bonds, and you can earn excess returns by “carrying” the longer bonds.

However, when we talk about carry in practice, we look at it as a **breakeven measure in yield terms.** It tells us how much yield can go up before we lose money on a financed bond position over our holding period, e.g., a year. In this



example, your 1Y carry is 21.7bps. This carry in yield term is the difference between the forward (1Y4Y) and settlement rates (“Yield Drop” in **FPA <GO>**), derived with arbitrage-free assumption.

T 0 7 _s 06/30/26 Govt		90 Manage Scenarios	97) Settings	Scenario Analysis	
Load CIX Save as CIX Swap Type Risk Settlement Security B/S Amt (M) Date Price Yield W Risk Rate T 0 7 _s 06/30/26 B 1,000 07/02/21 99-29 ¹ / ₄ 0.892629 W 4.87 Repo 0.056 <Add Security #2> <Add Security #3>		OAS Financing Reinvestment Rate 0.056% Horizon Date Multiple Horizon 07/05/2022 Carry 21.7 bp Rolldown 21.1 bp Total 42.8 bp		Scenario Results Scenario Name Total Return % HPR % Horizon Yield Net P&L (USD) B/E Yield Target Horizon Yields 10 +20 bps 0.064 0.064 1.093 643 1.109 +10 bps 0.449 0.453 0.993 4,523 1.109 0 bps 0.834 0.843 0.893 8,421 1.109 -10 bps 1.221 1.235 0.793 12,336 1.109 -20 bps 1.608 1.628 0.693 16,268 1.109 Historical Yield High (0.925%) 0.710 0.718 0.925 7,170 1.109 Average (0.897%) 0.816 0.824 0.897 8,234 1.109 Low (0.891%) 0.840 0.849 0.891 8,484 1.109 Curve Shifts (125) 3) Edit Benchmark Curves	

T 0 7 _s 06/30/26 Govt		Send (VCON)	Forward Pricing Analysis	
Type B/S	Trade Date 07/01/21	CUSIP 91282CCJ8	ISIN US91282CCJ80	
Trade Information				
Settlement Date	07/02/21	Settlement Price	99-29 ¹ / ₄	Settlement Yield 0.892629
Repo Rate (ACT/360)	0.056%	Face Amount	1000 M	Termination Date 07/05/22
B/E Repo Rate	0.05600	Term (# Days)	368	Invoice Payment
Profit/Loss Analysis		Settlement 999,188.18		
Spread	bp	Termination 991,008.86		
Net Profit/Loss		Net Change -8,179.32		
Forward Price	99.088997 99-02 ⁷ / ₈	Fwd Yld Street 1.109242		
Price Drop	0.825065 0-26 ³ / ₈	Yield Drop -21.6613 bp		
Notes				

The forward rate is your breakeven yield, assuming no shift in curves, and over the next year, the yield on your bond has to exceed the breakeven level (1.109%) in order for you to lose money.

T 0 7 _s 06/30/26		Settings	Fixed Income Horizon Analysis	
99-29 ¹ / ₄ / 99-29+ 0.893/0.891 BGN @ 02:02 Load CIX Save as CIX Swap Type Risk Settlement OAS Financing Dur/Cvx Tax Rates Security B/S Amt (M) Date Price Yield W Risk Horizon Price Yield W Rate T 0 7 _s 06/30/26 B 1,000 07/02/21 99-29 ¹ / ₄ 0.892629 W 4.87 99.088996 1.109242 W Repo 0.056 Add Security Add Security		Reinvestment Rate 0.056% Income Tax 0.000% Capital Gains Tax 0.000% View Cashflows Pre Tax After Tax Total Return % HPR % MMKT % Net P&L Total Return % HPR % MMKT % Net P&L T 0 7 _s 06/30/26 0.000 0.000 0.000 0 0.000 0.000 0.000 0		B/E 1.11



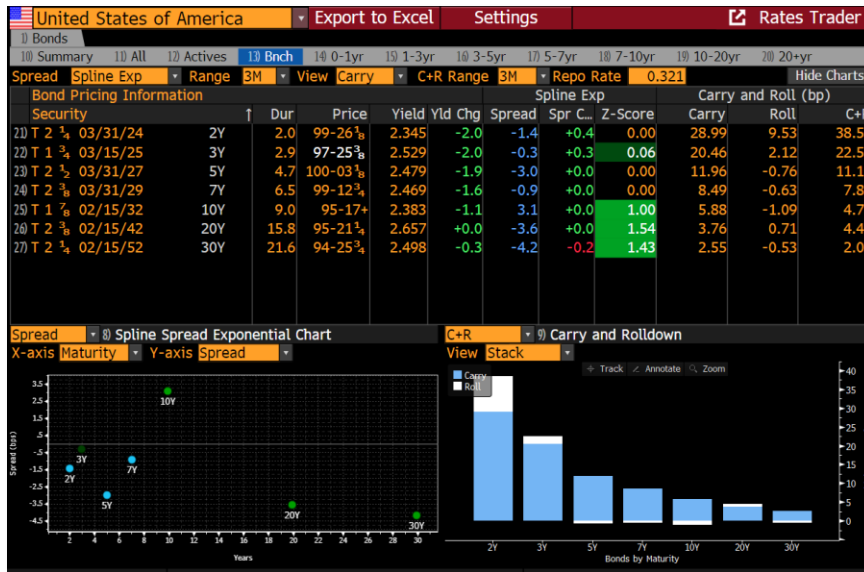
Rolldown is your return as your long bonds get shorter on an upward sloping yield curve. Here, a 5y bond yielding 0.893% will become a 4y bond in a year, and if the yield curve stays the same in a year, you can sell your bond at 0.682% (higher price) with a rolldown of 21.1bps.

T 0 7 _a 06/30/26 Govt										Settings		Fixed Income Horizon Analysis					
99-28+/99-28 ₄										0.897/0.896		BGN @ 02:14		Buy		Sell	
Swap Type Risk										Settlement		OAS		Horizon 07/05/22		Financing	
Security	B/S	Amt (M)	Date	Price	Yield	W	Risk	Price	Yield	W	Rate						
T 0 7 _a 06/30/26	B	1,000	07/02/21	99.914062	0.892629	W	4.87	100.75918	0.681629	W	Repo	0.056					
Add Security																	
Add Security																	
											B/E		1.11				
Return Analysis																	
Reinvestment Rate			0.056%			Income Tax			0.000%			Capital Gains Tax			0.000%		
View Cashflows																	
Pre Tax													After Tax				
	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L					
T 0 7 _a 06/30/26	1.651	1.672	1.635	16,702	1.651	1.672	1.635	16,702	1.651	1.672	1.635	16,702					

You are “rolling down” the curve as you sell the shorter bond at a higher price and reinvest the proceeds in a longer bond at a lower price. You can also think of rolldown as the rise in yields over the holding period that would eliminate the rolldown effect.

So, carry & rolldown are powerful. Where can we easily see them? We can use **CARY <GO>** to look at the swap curves. Typically, the levels and shapes are not meaningfully different from the govt curves, with differences (swap spreads) driven by demand for hedging, credit risks, etc.

Carry and Rolldown Analysis													
Single Currency		Currency USD		Type Fixed-Float Swap		Running		Upfront					
Multi Currency		Date 06/28/2021		Curve 23 - USD (30/360, S/A v...									
Spot Trade		Curve Spread Trade		Butterfly Spread Trade		Forward Trade		Custom Trade					
		Horizon 1YR				Horizon 1YR				Horizon 09/28/2021			
Trade	Spot Rate	Fwd	Carry	Roll	Total	Fwd	Carry	Roll	Total	Fwd	Carry	Roll	Total
1YR	0.183	--	--	--	--	--	--	--	--	0.194	1.1	1.3	2.5
2YR	0.336	0.490	15.4	15.3	30.8	0.490	15.4	15.3	30.8	0.363	2.7	5.2	7.9
3YR	0.578	0.778	20.0	24.0	44.0	0.778	20.0	24.0	44.0	0.617	3.9	6.1	10.1
4YR	0.802	1.011	20.9	22.4	43.3	1.011	20.9	22.4	43.3	0.846	4.4	5.5	9.9
5YR	0.981	1.184	20.4	17.9	38.2	1.184	20.4	17.9	38.2	1.025	4.5	4.5	8.9
7YR	1.251	1.436	18.5	12.0	30.5	1.436	18.5	12.0	30.5	1.294	4.2	3.0	7.2
10YR	1.487	1.641	15.5	6.6	22.0	1.641	15.5	6.6	22.0	1.523	3.6	1.5	5.1
12YR	1.592	1.731	13.9	4.9	18.8	1.731	13.9	4.9	18.8	1.625	3.3	1.1	4.5
15YR	1.695	1.816	12.1	3.3	15.4	1.816	12.1	3.3	15.4	1.725	2.9	0.7	3.7
20YR	1.787	1.887	9.9	1.8	11.7	1.887	9.9	1.8	11.7	1.812	2.4	0.4	2.8
25YR	1.817	1.901	8.4	0.6	9.0	1.901	8.4	0.6	9.0	1.838	2.1	0.1	2.1
30YR	1.825	1.898	7.3	0.1	7.5	1.898	7.3	0.1	7.5	1.843	1.8	-0.1	1.7

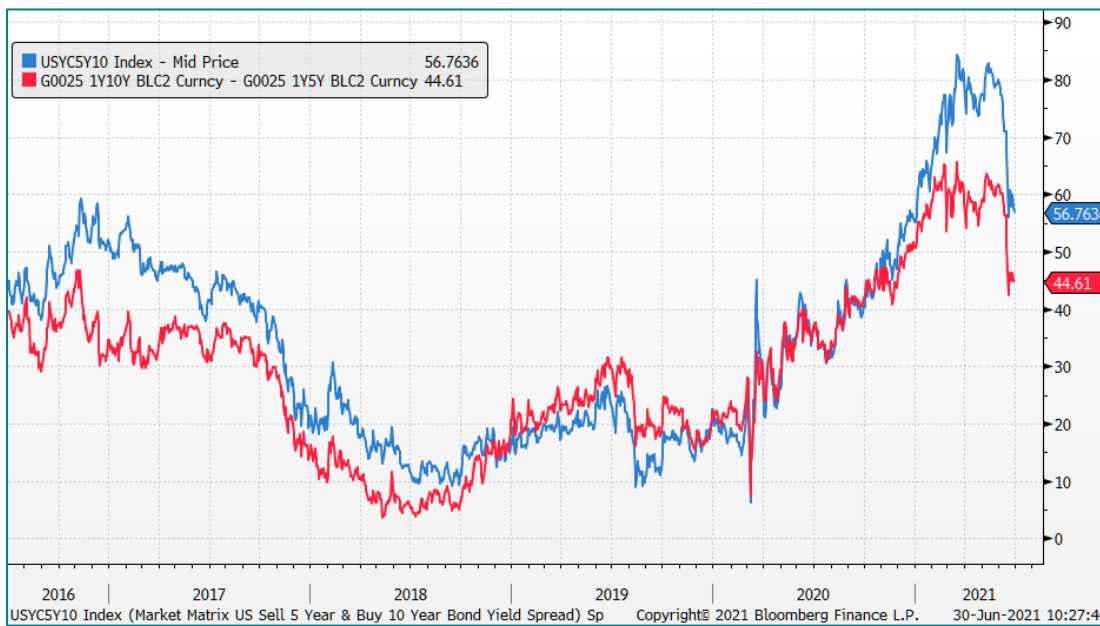


Additionally, you can see Carry and Roll of sovereign bonds through the **GOVY<GO>** function on Bloomberg

4.4 Trading the Yield Curve – Steepeners & Flatteners

So how do we trade the yield curve? Say if you think the 5s10s curve (56bps) is still too steep and expect it to flatten more than the

forwards (44bps). How do you structure the trade? You can be buying the 10-year and selling the 5-year, either with cash bonds or futures. And typically, we want to take out the interest rate risk (DVO1/duration neutral), and there is an easy Bloomberg function for this: **FIHG<GO>**.



Hedge Selection	Security	Price	Yield	Risk	BPV	Hdg Ratio	Hedge Amt	Repo	DCOH
Hedge Rate Risk	T 1 5/8 05/15/31	101-21+	1.443	9.26	9,255				
<input checked="" type="checkbox"/> Cash <input type="checkbox"/> Future	T 0 3/8 06/30/26	100-00	.875	4.88	9,255	1.90	18.97MM	.04	-428
	UXYU1 Comdty	147-06+	--	13.41	9,254	.69	69	.04	-393
Hedge Rate and Curve Risk	T 1 3/4 06/30/28	100-07	1.217	6.70	7,190	1.38	10.74MM	.04	-342
	T 2 1/4 05/15/41	104-08	1.990	16.75	2,065	.55	1.23MM	.04	-68
	UXYU1 Comdty	147-06+	--	13.41	8,852	.69	66	.04	-376
	USU1 Comdty	160-26	--	19.38	388	.48	2	.04	-14
	IRS (SWPH) Pay Fixed (05/15/31)	--	1.408	9.59	9,255	.97	9.65MM		-348
	Future Strip (TED) EDA Comdty	--	1.656	.25	9,250	37.02	370		-653
Hedge Credit Risk	US CDS EUR SR 5Y D14	--	7.1800	--		.00			

Here, say you want to buy 10MM Par of the OTR 10y, to hedge the duration, you will borrow and sell short about 18.97MM Par of the OTR 5y. Your spread DV01 (BPV) is about \$9,255. Or you can sell 5y futures (FV) instead.



In practice, I prefer using futures for short positions if there is no dislocation in basis (**DLV <GO>**) making futures unusually cheap compared to cash. The disadvantage is that you need to keep rolling your futures to maintain a position. We also consider capital efficiency.

Here is long cash 10y and short 5y (FV futures) – the BPV does not match perfectly (\$22/bps), you can match the futures DV01 by entering (9,277) in the BPV field, and it will show you the exact par amount for the cash 10y.

T 1 5/8 05/15/31 Govt		97) Settings		Fixed Income Hedging	
Trade Date	06/30/21	Par Amount	10MM (10,000,000 USD)	Hedge Analysis >>	
Settle Date	07/01/2021				
Hedge Selection					
	Security	Price	Yield	Risk	BPV
	T 1 5/8 05/15/31	101-21+	1.443	9.26	9,255
Hedge Rate Risk 97) (FIHR)					
	Cash	T 0 7/8 06/30/26	100-00	.875	4.88
	Future	FVU1 Comdty	123-14	--	5.39
Hedge Rate and Curve Risk					
	Cash-Barbell	T 1 1/4 06/30/28	100-07	1.217	6.70
		T 2 3/4 05/15/41	104-08	1.990	16.75
	Future-Barbell	UXYU1 Comdty	147-06+	--	13.41
		USU1 Comdty	160-26	--	19.38
	IRS 97) (SWPM)	Pay Fixed (05/15/31)	--	1.408	9.59
	Future Strip 97) (TED)	EDA Comdty	--	1.656	.25
Hedge Credit Risk					
	CDS 99) (CDSW)	US CDS EUR SR SY D14	--	7.1800	--
FX rates \$=1.000 €=0.843					

UXYU1 COMB Comdty		97) Settings		Fixed Income Hedging	
Trade Date	06/30/21	Number of Contracts	68	Contract Size	100,000 USD
Settle Date	06/30/2021				
Hedge Selection					
	Security	Price	Yield	Risk	BPV
	UXYU1 COMB	147-07+	13.41	9.122	
Hedge Rate Risk 97) (FIHR)					
	Cash	T 1 5/8 05/15/31	101-22	1.441	9.26
	Future	FVU1 Comdty	123-13 3/4	--	5.40
Hedge Rate and Curve Risk					
	Cash-Barbell	T 1 1/4 06/30/28	100-08	1.213	6.70
		T 1 5/8 05/15/31	101-22	1.441	9.26
	Future-Barbell	TYU1 Comdty	132-16+	--	8.39
		USU1 Comdty	160-27	--	19.38
	IRS 97) (SWPM)	Pay Fixed (02/15/31)	--	1.392	9.38

Here, we are trading the curve with futures only. I use the ultra 10y UXY futures instead of 10y TY futures because it better expresses my view (5s10s) instead of (5s7s). The CTD bond of UXY is a 2031 bond (10y). The CTD bond for TY is a 2028 bond (7y)

TYU1 ↓ 132-16+ + 08		ic132-16 / 132-16+		4015 x 23		Prev 132-08+		
At	11:45	Vol	789091	Op	132-09	Hi	132-17+	
		Lo	132-06	OpenInt	4296033			
TYU1 Comdty		Export		Settings		Cheapest-to-Deliver		
US 10YR NOTE (CBT) Sep21		Price	132-16+	Trade	06/30/21	Delivery	09/30/21	
Sort By		Implied Repo ↓ Decreasing		Settle	07/01/21	Cheapest IRP	-0.002	
				Prices	in Decimals	Days	91 Act / 360	
Cash Security	Price	Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)
Adjust Value								
1) T 2 7/8 05/15/28	111-06+	BGN	1.1733	0.8338	22.771	-0.002	0.061	0.572
2) T 2 7/8 08/15/28	111-10+	BGN	1.2105	0.8286	48.822	-2.865	0.061	26.436
3) T 1 1/4 05/31/28	100-11 1/4	BGN	1.1968	0.7474	41.900	-3.932	0.061	32.451
4) T 1 1/4 04/30/28	100-13 3/4	BGN	1.1843	0.7474	44.400	-4.239	0.061	35.006
5) T 1 1/4 03/31/28	100-16	BGN	1.1727	0.7474	46.650	-4.501	0.061	37.202
6) T 3 1/8 11/15/28	113-07+	BGN	1.2408	0.8376	71.657	-5.106	0.061	47.490
7) T 1 1/4 06/30/28	100-08 1/4	BGN	1.2115	0.7395	72.400	-7.708	0.061	63.004
8) T 2 5/8 02/15/29	109-25	BGN	1.2746	0.8039	104.062	-9.333	0.061	83.663
9) T 2 3/8 05/15/29	108-01+	BGN	1.2964	0.7836	134.644	-13.218	0.061	116.385
10) T 1 5/8 08/15/29	102-13	BGN	1.3117	0.7320	172.954	-19.277	0.061	160.496
11) T 1 3/4 11/15/29	103-11+	BGN	1.3247	0.7331	198.789	-22.073	0.061	185.453
12) T 1 1/2 02/15/30	101-04	BGN	1.3612	0.7105	223.125	-25.767	0.061	211.658
13) T 0 5/8 05/15/30	93-19+	BGN	1.3932	0.6462	255.289	-33.034	0.061	250.806
14) T 0 5/8 08/15/30	93-10	BGN	1.4086	0.6382	279.713	-36.368	0.061	275.188
15) T 0 7/8 11/15/30	95-07 3/4	BGN	1.4189	0.6476	301.602	-38.205	0.061	295.149
16) T 1 1/8 02/15/31	97-07+	BGN	1.4336	0.6577	322.523	-39.809	0.061	314.028



What happens now that you have initiated your trade, what would your PnL look like? Let's take a look at it. In **FISA<GO>**, we look at what happens in 3M, 6M and 12M. In the FISA chart, "Target Horizon Yields" assume a parallel shift in the yield curve. For example, in the -20bps scenario, it assumes your 10y and 5y bond yields decline by 20bps. The High/Average/Low "Historical Spreads" are calculated over the past year.

This is how your PnL look like if you put on a flattener over the next 3, 6, and 12M. Especially interesting is that if the spread stays about the same, you are going to lose money after 6M and a year as you can see under "Historical Spread" – Low Scenario.

The screenshot shows the FISA<GO> interface for a bond trade. The main window displays a trade for GT10 Govt and GT05 Govt with a yield spread of 56.924 bp. A 'Scenario Details' pop-up window is open, showing a 'Target Horizon Yield Scenario' of -20 bps as of 07/01/22. It lists the security descriptions, prices, and yields for both bonds.

Security Description	Price	Yield
GT10 Govt	103.202257	1.242634
GT05 Govt	100.793789	.673398

And in "Target Horizon Yield" scenario, you need the curve to flatten >16bps in a year to breakeven as your position becomes a 4s9s flattener. The whole curve is effectively flatter assuming little decline in yields in the front end.

Another important point is that when you put on a bond trade, you will have to be right on both your direction, magnitude, and timing because you have to overcome the carry and rolldown of your trade. In the case of 5s10s flattener over a one-year horizon, you have a negative carry of 4.2bps, and negative rolldown of 12.9bps.

The screenshot shows the 'Scenario Analysis' window in FISA<GO>. It displays the trade details and provides a summary of the OAS (9.26 Repo) and Financing (4.88 Rvrp) components. The total carry is -4.2 bp, and the total rolldown is -17.1 bp.

Component	Value
OAS	9.26 Repo
Financing	4.88 Rvrp
Carry	-4.2 bp
Rolldown	-12.9 bp
Total	-17.1 bp

Another function you can find your hedging need for your curve trade is **FIHR<GO>**. It gives the hedge amount you need to trade to match primary position. Here, we assume a yield beta of 1, that means you expect the movement between your primary and hedge positions to be 1:1.



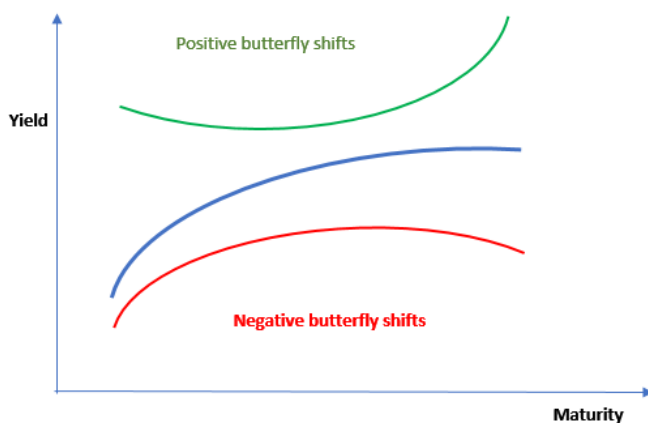
T 1 5/8 05/15/31 Govt		97 Settings		Fixed Income Hedge Ratios	
				99 Buy	90 Sell
Trade Date	06/30/21	Workout Date	05/15/31	Workout Price	100.000
Settle Date	07/01/21	Par Amount	10 MM (10,000,000 USD)	Yield Beta	1.00
<input type="radio"/> Cash <input checked="" type="radio"/> Future					
<input type="checkbox"/> Show Deferred Contracts <input type="checkbox"/> Edit Proxy Securities				Future Risk Type <input type="text"/> Current	
Security	Price	Hg Rat	# FutProxy Security	C Factor	Risk
T 1 5/8 05/15/31 Govt	101-22 1/4				9.258
11) EDZ1 90DAY EURO\$ FUTR Dec21	99.793	37.03	370		0.25
12) TUU1 US 2YR NOTE (CBT) Sep21	110-05 3/4	4.27	213	T 2 5/8 06/30/23	0.9447 2.17
13) FVU1 US 5YR NOTE (CBT) Sep21	123-14 3/4	1.72	172	T 0 3/8 11/30/25	0.7953 5.39
14) TYU1 US 10YR NOTE (CBT) Sep21	132-17+	1.10	110	T 2 7/8 05/15/28	0.8338 8.38
15) UXYU1 US 10yr Ultra Fut Sep21	147-08+	0.69	69	T 1 3/8 02/15/31	0.6577 13.42
16) USU1 US LONG BOND(CBT) Sep21	160-27	0.48	48	T 5 05/15/37	0.9000 19.39
17) WNU1 US ULTRA BOND CBT Sep21	193-00	0.26	26	T 3 02/15/47	0.6123 36.15

Assuming yield beta of 1 is typical when you are considering a curve trade. Here is the look at the cash bond hedges.

T 1 5/8 05/15/31 Govt		97 Settings		Fixed Income Hedge Ratios			
				99 Buy	90 Sell		
Trade Date	06/30/21	Workout Date	05/15/31	Workout Price	100.000		
Settle Date	07/01/21	Par Amount	10 MM (10,000,000 USD)				
<input type="radio"/> Cash <input checked="" type="radio"/> Future							
Security	Price	Yield	Hg Rat	Hedge Amount	Risk	M.Dur	Convexity
T 1 5/8 05/15/31 Govt	101-22 1/4	1.440			9.258	9.085	.912
11) B 0 07/27/21	0.036	.037	129.97	1.30MM	.071	.071	.000
12) B 0 08/24/21	0.038	.038	62.58	625.82MM	.148	.148	.000
13) B 0 09/30/21	0.042	.043	37.14	371.40MM	.249	.249	.001
14) B 0 12/30/21	0.050	.051	18.58	185.76MM	.498	.499	.005
15) B 0 06/16/22	0.068	.068	9.66	96.64MM	.958	.959	.014
16) T 0 1/8 06/30/23	99-24 1/4	.248	4.66	46.57MM	1.988	1.993	.050
17) T 0 1/4 06/15/24	99-12 5/8	.454	3.17	31.67MM	2.923	2.940	.101
18) T 0 7/8 06/30/26	100-01 1/8	.868	1.90	18.97MM	4.881	4.879	.265
19) T 1 1/4 06/30/28	100-08 3/4	1.209	1.38	13.82MM	6.700	6.682	.491
20) T 1 5/8 05/15/31	101-22 1/4	1.440	1.00	10.00MM	9.258	9.085	.912
21) T 2 1/4 05/15/41	104-08 1/4	1.989	.55	5.53MM	16.751	16.023	3.004
22) T 2 3/8 05/15/51	107-03 1/4	2.056	.40	3.99MM	23.201	21.602	5.778

4.5 Trading the Yield Curve – Butterflies

OK, now let's say you think the yield curve is going to twist and do a positive butterfly, i.e., you expect yield in the belly to outperform the front- and back- ends. For example, you believe the 5y to outperform 2y and 10y, and that 2y5y10y (BBG: BF020510) will decline, and you want to structure a trade to express a view, you can run **BFLY<GO>**. You can trade them with cash bonds or futures.





Here, you are buying \$10MM 5y and selling \$12.3MM 2y and \$2.6MM 10y at a yield spread of 5.2bps. Your DV01 is about \$4,880. Here are the PnL scenarios for parallel shifts and spread move. Because of carry and roll, you will be fine with parallel shifts with better PnL on the way down.

T 0 $\frac{7}{8}$ 06/30/26 Govt		98) Manage Scenarios	97) Settings	Scenario Analysis	
<div style="display: flex; justify-content: space-between;"> 1) Load CIX 2) Save as CIX </div>					
Security	Swap Type	Risk	Settlement	OAS	
T 0 $\frac{7}{8}$ 06/30/26	B	10,000	07/01/21	100.015624	
T 0 $\frac{3}{8}$ 06/30/23	S	12,275	07/01/21	99-24	
T 1 $\frac{5}{8}$ 05/15/31	S	2,636	07/01/21	101.687503	
Yield Spreads			Gross	5.209 bp	
Scenario Results					
Reinvestment Rate	0.040 %				
Horizon Date	Multiple	Horizon	08/01/2021	Carry 0.7 bp	
				Rolldown 1.4 bp	
				Total 2.0 bp	
Scenario Name	Total Return %	HPR %	Horizon Spread	Net P&L (USD)	B/E Spread
Target Horizon Yields					
+20 bps	0.060	0.005	5.209	761	5.529
+10 bps	0.098	0.008	5.209	1,234	5.726
0 bps	0.133	0.011	5.209	1,668	5.904
-10 bps	0.164	0.014	5.209	2,062	6.063
-20 bps	0.192	0.016	5.209	2,414	6.204
Historical Spread					
High (6.778bps)	-0.166	-0.014	6.778	-2,093	5.904
Average (5.863bps)	0.011	0.001	5.863	132	5.919
Low (5.360bps)	0.104	0.009	5.360	1,308	5.905
Curve Shifts (I25, I25, I25) 3) Edit Benchmark Curves					
Implied Fwd Curve	0.382	0.032	3.889	4,800	5.891
My Custom Scenarios					

Let's say the butterfly does a positive shift (more negative spreads), you will make money. Conversely, you lose money if there is a negative shift (more positive spreads).



T 0 ⁷ / ₈ 06/30/26 Govt										Settings		Fixed Income Horizon Analysis					
100-00+/100-00 ³ / ₄										0.872/0.870		BGN @ 12:41		95 Butterfly Ticket			
Load CIX										Save as CIX		Financing		Dur/Cvx		Tax Rates	
Swap Type		Risk		Settlement		OAS		Horizon		Financing							
Security	B/S	Amt (M)	Date	Price	Yield	W	Risk	Price	Yield	W	Rate						
T 0 ⁷ / ₈ 06/30/26	B	10,000	07/01/21	100-00+	0.871797	W	4.88	101.00419	0.670000	W							
T 0 ³ / ₈ 06/30/23	S	12,275	07/01/21	99-24	0.250562	W	1.99	99.950364	0.150000	W							
T 1 ⁵ / ₈ 05/15/31	S	2,636	07/01/21	101.68750	1.440946	W	9.26	102.71813	1.330000	W							
Yield Sprd				Gross		5.21 bp		-1.48		Yield Sprd		-14 bp					
												B/E		5.27			
Return Analysis																	
Reinvestment Rate				0.040 %				Income Tax				40.800 %		Capital Gains Tax		23.800 %	
View Cashflows				Pre Tax				After Tax									
Total	Return %	HPR %	MMKT %	Net P&L	Total	Return %	HPR %	MMKT %	Net P&L								
Total	38.900	0.317	38.054	47,347	29.611	0.241	28.967	36,035									
T 0 ⁷ / ₈ 06/30/26	167.193	0.996	119.463	99,571	117.696	0.757	90.886	75,751									
T 0 ³ / ₈ 06/30/23	-26.335	-0.202	-24.226	-24,719	-19.750	-0.154	-18.440	-18,815									
T 1 ⁵ / ₈ 05/15/31	-173.702	-1.024	-122.936	-27,521	-121.920	-0.779	-93.490	-20,911									

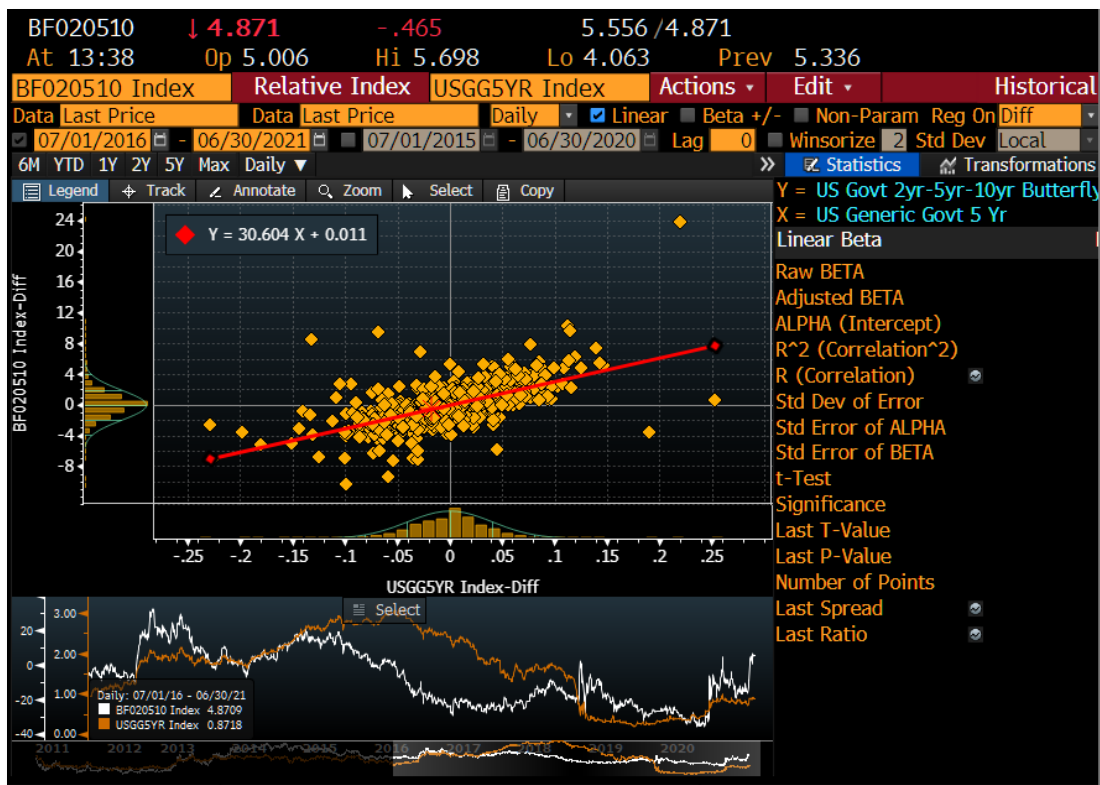
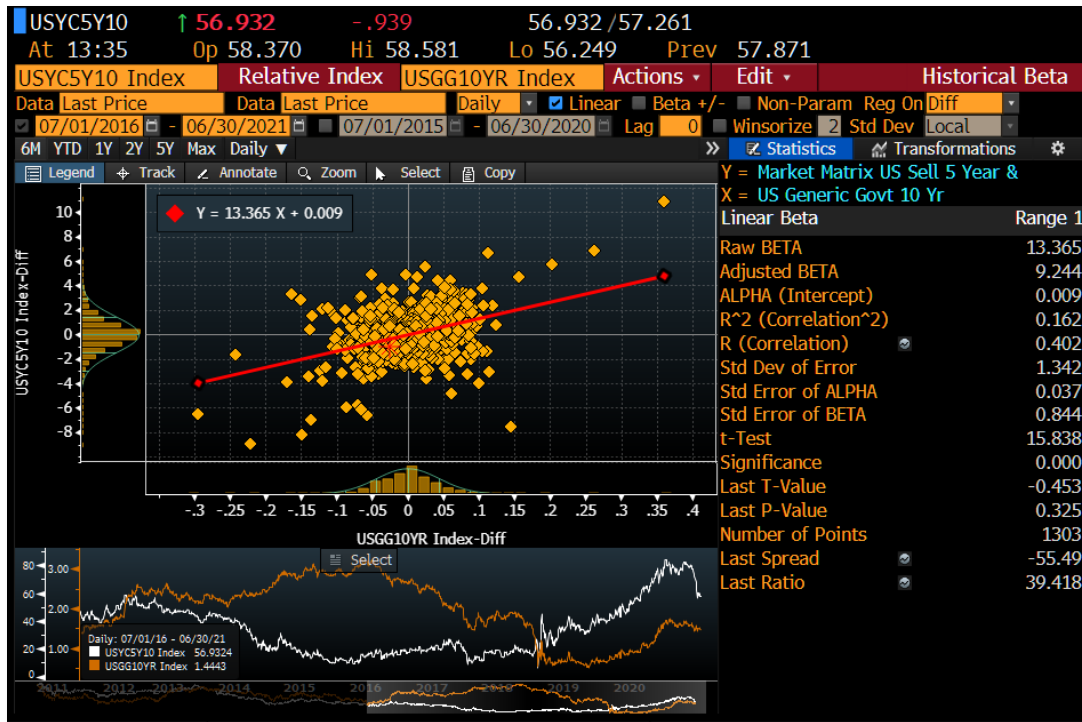
T 0 ⁷ / ₈ 06/30/26 Govt										Settings		Fixed Income Horizon Analysis					
100-00+/100-00 ³ / ₄										0.872/0.870		BGN @ 12:41		95 Butterfly Ticket			
Load CIX										Save as CIX		Financing		Dur/Cvx		Tax Rates	
Swap Type		Risk		Settlement		OAS		Horizon		Financing							
Security	B/S	Amt (M)	Date	Price	Yield	W	Risk	Price	Yield	W	Rate						
T 0 ⁷ / ₈ 06/30/26	B	10,000	07/01/21	100-00+	0.871797	W	4.88	99.055065	1.070000	W							
T 0 ³ / ₈ 06/30/23	S	12,275	07/01/21	99-24	0.250562	W	1.99	99.554387	0.350000	W							
T 1 ⁵ / ₈ 05/15/31	S	2,636	07/01/21	101.68750	1.440946	W	9.26	100.77449	1.540000	W							
Yield Sprd				Gross		5.21 bp		-1.48		Yield Sprd		25 bp					
												B/E		5.25			
Return Analysis																	
Reinvestment Rate				0.040 %				Income Tax				40.800 %		Capital Gains Tax		23.800 %	
View Cashflows				Pre Tax				After Tax									
Total	Return %	HPR %	MMKT %	Net P&L	Total	Return %	HPR %	MMKT %	Net P&L								
Total	-39.206	-0.320	-38.354	-47,720	-29.915	-0.244	-29.265	-36,406									
T 0 ⁷ / ₈ 06/30/26	-88.853	-0.953	-114.391	-95,343	-72.205	-0.728	-87.312	-72,772									
T 0 ³ / ₈ 06/30/23	22.574	0.195	23.410	23,886	17.460	0.149	17.859	18,222									
T 1 ⁵ / ₈ 05/15/31	83.915	0.883	105.963	23,721	68.037	0.676	81.076	18,135									

4.6 Recap

Why do we care about the yield curve? It tells you something about the economic cycles and central bank policy. It also gives you an idea about the carry and roll of the bonds. Buying a bond on the steepest part of the curve when the curve is also steep is a nice positive carry trade.

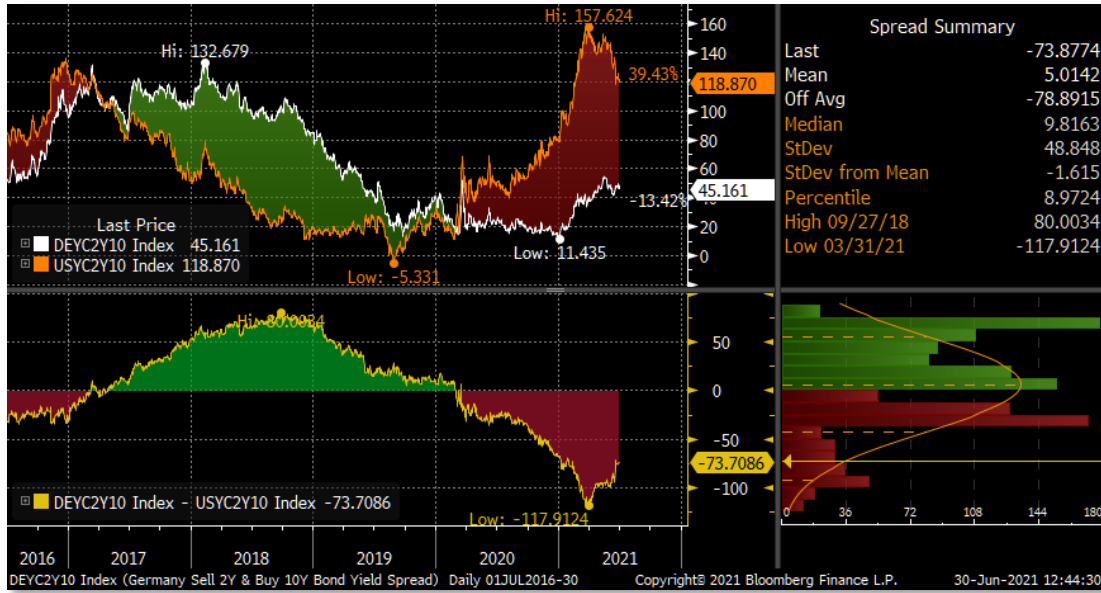
Why do we want to do all these curve trades? Mainly, because you have a view on the yield curve, or you have a higher confidence about the curve movement (relative to expectations) than the yield movement.

How do we want to do the curve trade properly? We want to keep interest rate risk to the minimum and take only curve risk. If you want a view on duration, consider it as a separate trade and manage its risk separately. You also want to check your duration trade against the curve trade, so you are not doubling on the same bet. Simply go to **BETA<GO>** to look at the relationship between your curve trade and the key rate (say 10y or 5y).



4.7 Topic Question

if you want to express on the relative steepness between the US and European curves, how would you structure the trade? What do you need to do to remove unintended risks? What macro scenarios will be favourable for your trades? Or conversely, when will your trade not work?





5. Futures (STIRs, Notes and Bonds)



5.1 Introduction to Interest Rate Futures

Interest rates futures extend from short term (money market futures or Short-Term Interest Rate Futures, STIR Futures for short) out to longer dated rates such as US treasuries, German bunds, Italian BTPs, Australian Govt bonds, etc.

They're a huge part of the fixed income space and by retail traders and large institutions alike. Like other derivatives, they're capital light and therefore provide a lot of leverage. In fact, leverage for a speculator on TY (CME ticker: ZN) is around 79x vs ES which is about 18x!

Our first stop is **WIR<GO>** and **WBF<GO>** where one can see a snapshot of global money market futures and bond futures respectively on the terminal.

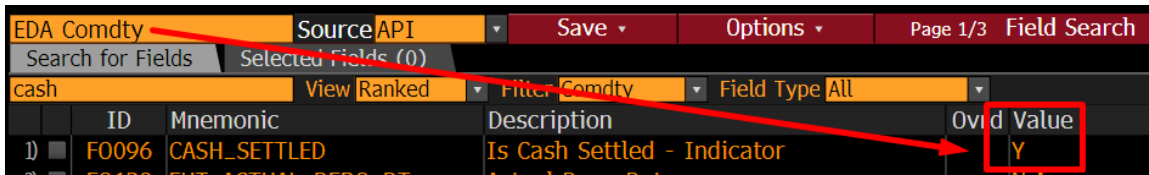
97) Settings		World Interest Rate Futures							
	Exch Ticker	Last	Change	Time	1-Day	High	Low	Volume	Open Int
1) North/Latin America									
10	90DAY EURO\$ FUTR Dec21	CME EDZ1	99.790	+0.00	16:53	99.795	99.785	16686	1032748
11	90DAY EURO\$ ICE Jul21	d ICF LEDN1	99.8650 y	-0.025	07/01			0	0
12	1MO EURO\$ FUTURE Jul21	CME EMN1	99.9000 y	+0.000	07/01			0	0
13	FED FUND 30DAY Jul21	CBT FFN1	99.90500	+0.00250	15:25	99.90500	99.90500	174	146797
14	BANK ACCEPT FUTR Mar22	d MSE BAH2	99.370	-0.005	16:31	99.370	99.365	139	269009
15	ONE-DAY BANK DEP Jan22	d BMF ODF22	5.720 y	+0.045	07/01	5.745	5.665	430195	6719256
16	MEXICAN TIE Apr21	d MDX DOJ21							
17	1 MONTH SOFR FUT Jul21	CME SERN1	99.9525 y	+0.000	07/01	99.9550	99.9500	6130	68782
18	3 MONTH SOFR FUT Dec21	CME SFRZ1	99.9450	+0.000	09:57	99.9450	99.9450	300	101692
2) Europe/Africa									
20	3MO EURO EURIBOR Dec21	d ICF ERZ1	100.535	+0.005	16:34	100.535	100.530	3662	461547
21	90DAY STERLING FU Sep21	d ICF L U1	99.905	-0.005	16:43	99.910	99.905	1646	562922
22	Euro CHF 3MO ICE Sep21	d ICF ESU1	100.750	+0.000	15:27	100.750	100.750	1	37376
23	OMX RIBA Futures Sep21	d PMI ORIU1	-0.015	-0.015	14:45	-0.013	-0.015		528000
24	ICE 3MTH SONIA FU Jun21	d ICF SFIM1	99.9450 y	+0.000	07/01			31	30428
3) Asia/Pacific									
30	3MO EUROYEN Dec21	d TFX YEZ1	100.080 s	+0.000	Close	100.080	100.080	3	2372
31	90-DAY BANK BILL Sep21	d SFE IRU1	99.96 y	+0.00	07/02	99.96	99.95	3	122491
32	3 MONTH KLIBOR Sep20	d MDE KKU0							
33	NEW ZEAL 3MO BILL Sep21	d SFE ZBU1	99.62 y	+0.01	07/02	99.62	99.60	759	37020

97) Settings		World Bond Futures							
	Exch Ticker	Last	Change	Time	1-Day	High	Low	Volume	Open Int
1) North/Latin America									
10	US ULTRA BOND Sep21	CBT WNU1	193-13	+1-12	16:54	193-20	192-19	13634	1189782
11	US LONG BOND Sep21	CBT USU1	160-27	+ 21	16:54	160-30	160-13	36508	1169023
12	US 10yr Ultra Fut Sep21	CBT UXYU1	147-06+	+ 14	16:54	147-08	146-29	28481	1544332
13	US 10YR NOTE Sep21	CBT TYU1	132-15	+ 06+	16:54	132-16	132-09+	157778	4298721
14	US 5YR NOTE Sep21	CBT FVU1	123-11	+ 01+	16:54	123-11+	123-08+	89399	3517771
15	US 2YR NOTE Sep21	CBT TUU1	110-04%	- 00%	16:53	110-04%	110-04%	52657	2102642
16	CAN 10YR BOND FUT Sep21	d MSE CNU1	145.68	+0.16	16:34	145.71	145.37	9232	673731
2) Europe/Africa									
20	EURO-BUXL 30Y BND Sep21	EUX UBU1	203.70	+0.90	16:54	203.80	202.52	18195	300338
21	EURO-BUND FUTURE Sep21	EUX RXU1	172.94	+0.40	16:54	172.98	172.54	175844	1371265
22	EURO-BOBL FUTURE Sep21	EUX OEU1	134.250	+0.90	16:54	134.270	134.150	86358	1191825
23	EURO-SCHATZ FUT Sep21	EUX DUU1	112.160	-0.000	16:54	112.170	112.155	34765	1176947
24	LONG GILT FUTURE Sep21	d ICF G U1	128.29	+0.27	16:44	128.32	128.03	34844	698020
25	Euro-BTP Future Sep21	EUX IKU1	151.78	+0.07	16:54	151.92	151.63	29239	308806
26	Euro-OAT Future Sep21	EUX OATU1	159.35	+0.28	16:54	159.41	159.09	41951	659176
27	Short Euro-BTP Fu Sep21	EUX BTSU1	113.20	+0.00	16:53	113.21	113.18	15720	208182
28	SWEDISH 5YR FUT Sep21	d PMI BTU1	-0.044	-0.008	16:30	0.003	-0.044		35964
3) Asia/Pacific									
30	JPN 10Y BOND Sep21	d OSE JBU1	152.00	+0.08	16:34	152.00	151.93	3256	87602
31	KOREA 10YR BND FU Sep21	d KFE KAAU1	125.66 s	-0.05	Close	126.05	125.66	55819	131986
32	KOREA 3YR BND FUT Sep21	d KFE KEU1	109.87 s	-0.04	Close	109.96	109.82	147310	365516
33	AUST 10Y BOND FUT Sep21	d SFE XMU1	98.5250	+0.0100	16:44	98.5300	98.5100	20275	1223710
34	AUST 3YR BOND FUT Sep21	d SFE YMU1	99.580	+0.010	16:43	99.580	99.565	13923	716188

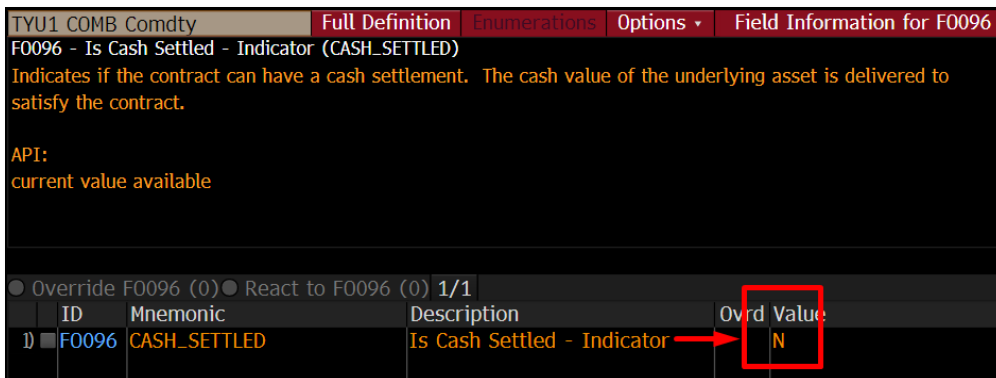
So quick recap – what are futures? Standardized contracts traded on an exchange between two parties for an agreed price and quantity of the underlying to be settled at a future date. Now, futures can either be physically or cash settled meaning if you held the contract until the last day, you will either have to receive/deliver the underlying or settle the difference in cash. **MAKE SURE YOU KNOW WHICH ONE THE FUTURE IS BASED ON.**

In general, money market futures are cash settled (such as Eurodollar futures) while notes and bond futures are physical.

I once nearly had to take delivery of physical gold because I forgot to roll. My brokers were not happy trying to unwind that shitshow. 😓



ID	Mnemonic	Description	Ovrld Value
1) FO096	CASH_SETTLED	Is Cash Settled - Indicator	Y



TYU1 COMB Comdty Full Definition Enumerations Options Field Information for FO096

FO096 - Is Cash Settled - Indicator (CASH_SETTLED)

Indicates if the contract can have a cash settlement. The cash value of the underlying asset is delivered to satisfy the contract.

API:
current value available

ID	Mnemonic	Description	Ovrld Value
1) FO096	CASH_SETTLED	Is Cash Settled - Indicator	N

For Bloomberg users, I'm sure many of you are aware that **FLDS<GO>** is an excellent source of “hidden” or hard to find info. I could probably do a whole extra topic on leveraging FLDS to its full extent (I might actually lol).

How do you find the right futures ticker? On CME's website you can find them, on Bloomberg you can go to **SECF<GO>** then sort by Fixed Income and go to the Futr tab.



R	Name	Ticker	So...	Last Trade	Instrument	Quote	Open Int	Volume
1)	US Treasury Note, 10Yr Active Contract	TYA	CBT U...	09/21/2021	Active Future	Price	4255169	1252104
2)	Euro Bund Active Contract	RXA	EUX E...	09/08/2021	Active Future	Price	1402975	181996
3)	US Treasury Long Bond Active Contract	USA	CBT U...	09/21/2021	Active Future	Price	1165306	353676
4)	US Treasury Note, 5Yr Active Contract	FVA	CBT U...	09/30/2021	Active Future	Price	3514889	739520
5)	US Treasury Ultra Bond Active Contract	WNA	CBT U...	09/21/2021	Active Future	Price	1183877	206360
6)	Japan Gov't Bond, 10Yr Active Contract	JBA	OSE J...	09/13/2021	Active Future	Price	84873	5641
7)	Generic 1st US Treasury Note, 10Yr	TY1	CBT U...		Generic Future	Price	4255169	1252104
8)	Generic 1st Euro Bund	RX1	EUX E...		Generic Future	Price	1402975	551487
9)	Euro BTP Future Active Contract	IKA	EUX E...	09/08/2021	Active Future	Price	303633	36409
10)	Australian Gov't Bond, 10Yr Active Contra...	XMA	SFE A...	09/15/2021	Active Future	Price	1235557	52482
11)	US Ultra Treasury Note, 10Yr Active Contr...	UXYA	CBT U...	09/21/2021	Active Future	Price	1515693	198165
12)	Long Gilt Active Contract	G A	ICF G...	09/28/2021	Active Future	Price	703792	157781
13)	Euro Bobl Active Contract	OEA	EUX E...	09/08/2021	Active Future	Price	1166325	83051
14)	US Treasury Note, 2Yr Active Contract	TUA	CBT U...	09/30/2021	Active Future	Price	2034292	283613
15)	Generic 1st Japan Gov't Bond, 10Yr	JB1	OSE J...		Generic Future	Price	84873	5641
16)	Euro Buxl Active Contract	UBA	EUX E...	09/08/2021	Active Future	Price	301107	18558
17)	Interbank Deposit, 1 Day Active Contract	ODA	BMF B...	12/30/2021	Active Future	Rate	6921612	321760
18)	Australian Gov't Bond, 3Y Future Active C...	YMA	SFE A...	09/15/2021	Active Future	Price	732487	23172
19)	Fed Fund, 30 Day Active Contract	FFA	CBT U...	07/30/2021	Active Future	Price	138302	27075



A better way, which I much prefer, especially when dealing with options is to use **CTM<GO>**

Search Page 1/1 Contract Table Menu

Show Categories Exchange Region

- Agriculture and Livestock
 - 1) CORN - Corn
 - 2) FIBR - Fibers
 - 3) FOOD - Foodstuff
 - 4) LSTK - Livestock
 - 5) OGRN - Other Grain
 - 6) SOY - Soy
 - 7) WHET - Wheat
- Energy and Environment
 - 8) COAL - Coal
 - 9) CRDO - Crude Oil
 - 10) ETCY - Electricity
 - 11) EMIS - Emissions
 - 12) NATG - Natural Gas
 - 13) REFP - Refined Products
 - 14) SHTP - Shipping
 - 15) WTHR - Weather
- Financial Contracts
 - 16) BOND - Bond
 - 17) CDS - Credit Derivatives
 - 18) XCUR - Cross Currency
- Index Contracts
 - 19) CIIR - Currency
 - 20) INTR - Interest Rate
 - 21) CURO - Spot Currency Options
 - 22) SWAP - Swap
 - 23) SYNS - Synthetic Interest Rate Strip
 - 24) WBON - Weekly Bond Options
 - 25) WCUR - Weekly Currency Options
- Metals and Industrials
 - 26) EQIX - Equity Index
 - 27) EIXO - Equity Index Spot Options
 - 28) VIXO - Equity Volatility Index Option
 - 29) HOUS - Housing Index
 - 30) NEIX - Non-Equity Index
 - 31) NEXO - Non-Equity Index Spot Options
 - 32) WIXO - Weekly Index Options
 - 33) BMTL - Base Metal
 - 34) IMAT - Industrial Material
 - 35) PMTL - Precious Metal

You can also sort the menu by exchange (e.g., CME) and see all futures contracts trading on that exchange (Ultras, e-minis, gold, etc). Once your future is loaded you can look at the entire strip of contracts going out via **CT<GO>**. This brings up the futures contract table. For those of you that follow STIR traders you will hear many of them talking about colours like reds, blues, etc. More often than not, they're talking about 3-month Eurodollar future contracts.

EDN1 Comdty Export Settings Futures Contract Table

3 Month Eurodollar Future As of 06/30/21

Source Chicago Mercantile Exchange Session COMB Display Quoted Value Type Specific

Exchange Symbol GE Currency USD

Aggr Vol 214,206 Aggr Open Int 12,202,358

Color Legend

Curve CCRV

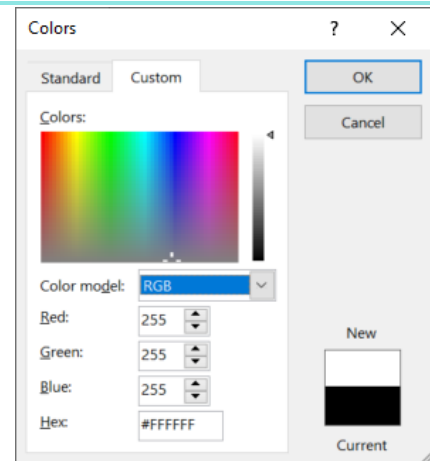
Description	Last	Chg	Settle	Time	Bid	Ask	Open Int	Volume	Yest Settle
1) Jul21	99.8675	+0.025	17:42	99.8675	99.8700	344459	2646	99.8650	
2) Aug21	99.865	+0.005	17:52	99.865	99.870	123045	1812	99.860	
3) Sep21	99.855	--	17:52	99.855	99.860	987688	15216	99.855	
4) Oct21	99.840	--	16:18	99.840	99.845	54543	2429	99.840	
5) Nov21	99.825s	--	17:52	99.825	99.830	10060	17	99.825	
6) Dec21	99.795	+0.005	17:52	99.795	99.800	1032374	20218	99.790	
7) Mar22	99.800	+0.005	17:52	99.800	99.805	879402	16710	99.795	
8) Jun22	99.730	+0.010	17:52	99.730	99.735	811369	23239	99.720	
9) Sep22	99.635	+0.010	17:57	99.635	99.640	674017	11676	99.625	
10) Dec22	99.485	+0.015	17:57	99.480	99.485	851289	19232	99.470	
11) Mar23	99.370	+0.015	17:57	99.365	99.370	955338	12493	99.355	
12) Jun23	99.230	+0.020	17:55	99.225	99.230	935522	15252	99.210	
13) Sep23	99.010	+0.020	17:57	99.005	99.010	773364	10150	98.990	
14) Dec23	98.875	+0.015	17:50	98.875	98.880	831935	20314	98.860	
15) Mar24	98.760	+0.020	17:52	98.760	98.765	341685	5599	98.740	
16) Jun24	98.645	+0.020	17:53	98.645	98.650	442993	6895	98.625	
17) Sep24	98.540	+0.020	17:57	98.535	98.540	513720	3526	98.520	
18) Dec24	98.445	+0.020	17:57	98.440	98.445	654676	12509	98.425	
19) Mar25	98.395	+0.025	17:54	98.390	98.395	255852	2410	98.370	
20) Jun25	98.335	+0.025	17:55	98.330	98.335	169703	3910	98.310	
21) Sep25	98.280	+0.020	17:57	98.275	98.285	206212	1233	98.260	
22) Dec25	98.220	+0.025	17:55	98.215	98.220	160637	2546	98.195	
23) Mar26	98.180	+0.020	17:51	98.180	98.185	86108	945	98.160	
24) Jun26	98.130	+0.020	17:51	98.130	98.135	47447	1387	98.110	

5.2 Eurodollar Futures

You can see they are colour coded in 12-month groups, called “packs”. Each pack contains the next 4 quarterly expirations.

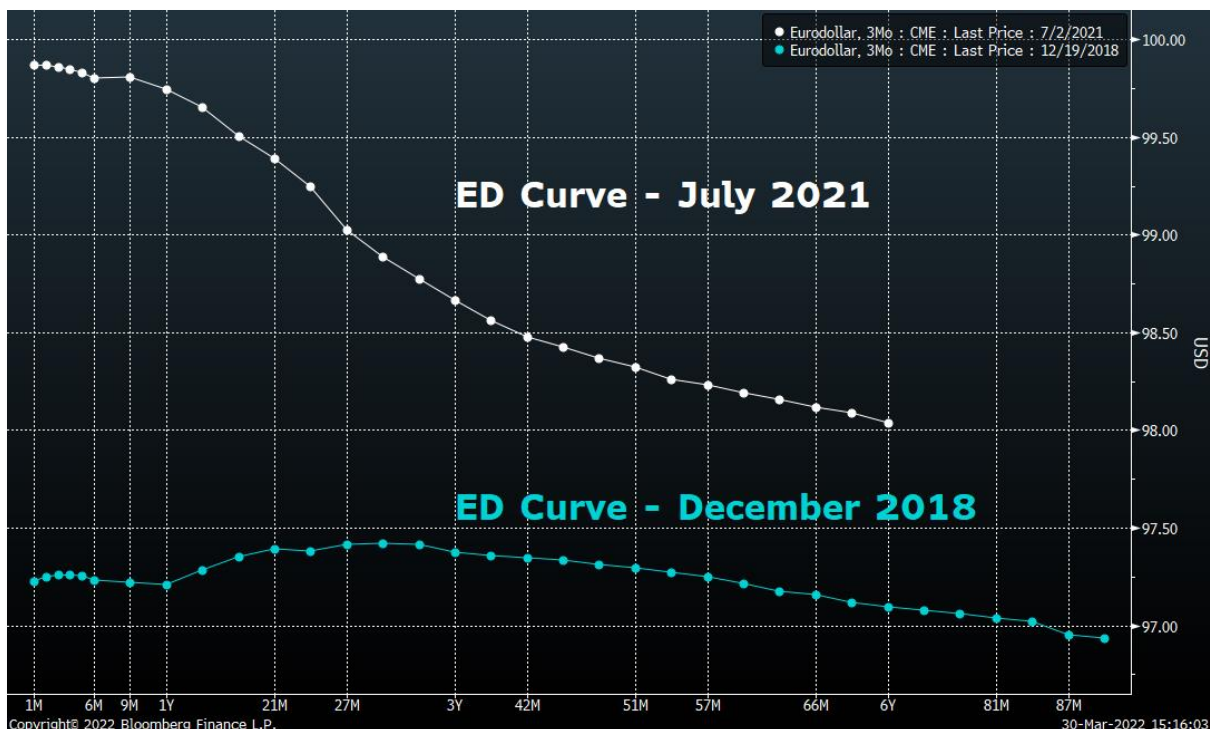
The easiest way to remember (for me) is to think of it like colours on a computer screen. White is everything, so it’s the first. Then we pick colours with RGB – red, green, blue. WRGB are the most common packs you’ll hear mentioned and sometimes the next pack (gold). Combining consecutive packs together you get a bundle. Red bundle = white and red packs combined.

This combination and length (EDs go out 10 years) is unique to money market futures - you do not see these many contracts trading with expiries that far away on note and bond futures.



You can view the entire term structure of ED’s (or any future) via **CCRV<GO>** to see the futures curve. An upward sloping curve is called “contango” while an inverted curve is “backwardation” and typically contango is the ‘normal’ shape of a futures curve (e.g., oil) but with EDs, because they are quoted as a function of 100-yield it results in an inverted curve because the yield curve is actually normally shaped (right now).

Take note, while the ED curve is inverted it’s actually just the inverse of the implied forward yield curve.



An ED future is an agreement to lend or borrow money at 3M LIBOR in the future but struck at a pre-agreed rate. So, if EDZ1 is BOUGHT at 99.80 you are agreeing to LEND money for 3 months at December 13th 2021 at a rate of 0.20%.

If you get to Dec 13th and 3M LIBOR is 0.15% you’ve made money Because you can borrow at 0.15% and lend at 0.20%. You earn a 0.05% spread. **ED futures are cash settled so you don’t actually lend out money you just collect or pay the difference.**

In futures, there's an 'active contract' – determined by the exchange. In practice, it is often the front month contract and is expected to have the most volume. On Bloomberg the ticker tail is "A" - TYA

However, in some cases the exchange has specific months which can be the active.

For the US 10-year Treasury future, because there's only Sep/Dec/Mar trading right now, the Sep is the nearest quarterly expiration and thus has the most volume and OI. That is the active contract.

If you were to look at Gold futures however, the active is determined by CME to be the nearest of the following months that isn't the current month:

April

June

August

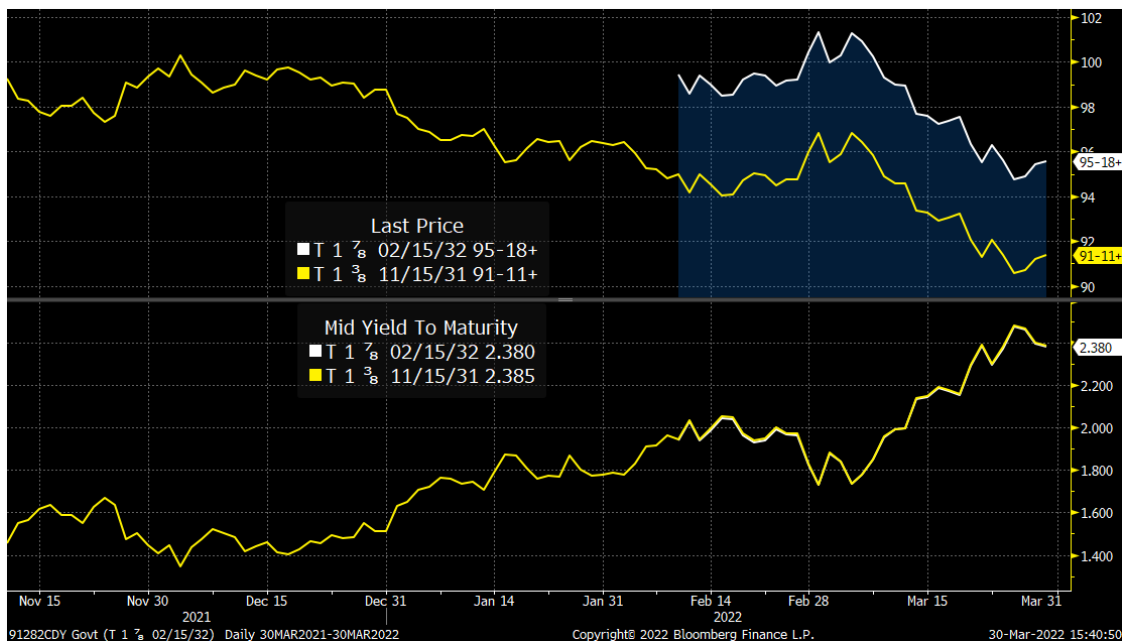
December

February

That's why the active for gold in late July is the August contract and not September like Treasury futures.

5.3 Futures Rolls and Generic/Continuous Contracts

This is important for understanding rolls & settings for a futures contract. You see, we look at **the yield not price on a chart for cash bonds** as each new on-the-run bond vs the old bond's (off-the-run) price will be different resulting in gaps in price that don't exist in yields.



When looking at a **future, we typically only look at its price** which is driven by the value of the deliverable. Because it is looking at the cheapest-to-deliver and the delivery is at the futures expiry, with each new futures contract that basket changes and so does the price.

If I have a position in the future and want to maintain that exposure going forward, I will have to close out the current future position and open a new one in the new active future. This is the roll.

TYM1 COMB Comdty Page 1/2 Security Description

1) Contract Information 2) Linked Instruments

TYM1 Comdty US 10YR NOTE (CBT)Jun21 CBT-Chicago Board of Trade

3) Notes

** Product specifications link below **
 10-Year US Treasury Note Futures
 ***Effective 2/29/2016, The Board of Trade of the City of Chicago, Inc. ("CBOT") will amend the

4) Contracts | CT » Jan-F Feb-G Mar-H Apr-J May-K Jun-M Jul-N Aug-Q Sep-U Oct-V Nov-X Dec-Z

Contract Specifications		Trading Hours	
Underlying	US 10yr 6%	Exchange	Local
Contract Size	100,000 USD	Electronic	06:00 - 05:00
Value of 1.0 pt	\$ 1,000		
Tick Size	0-00+ (64ths)		
Tick Value	\$ 15.625		
Price	0-00 points		
Contract Value	\$ 133,062.5		
Last Time			
Exch Symbol	ZN		
FIGI	BBG00X9DZQ76		

5) Price Chart | GP »

● Intraday ● History ● Curve



6) Related Dates | EXS »

First Trade	Tue	09/22/2020
Last Trade	Mon	06/21/2021
First Notice	Fri	05/28/2021
First Delivery	Tue	06/01/2021
Last Delivery	Wed	06/30/2021

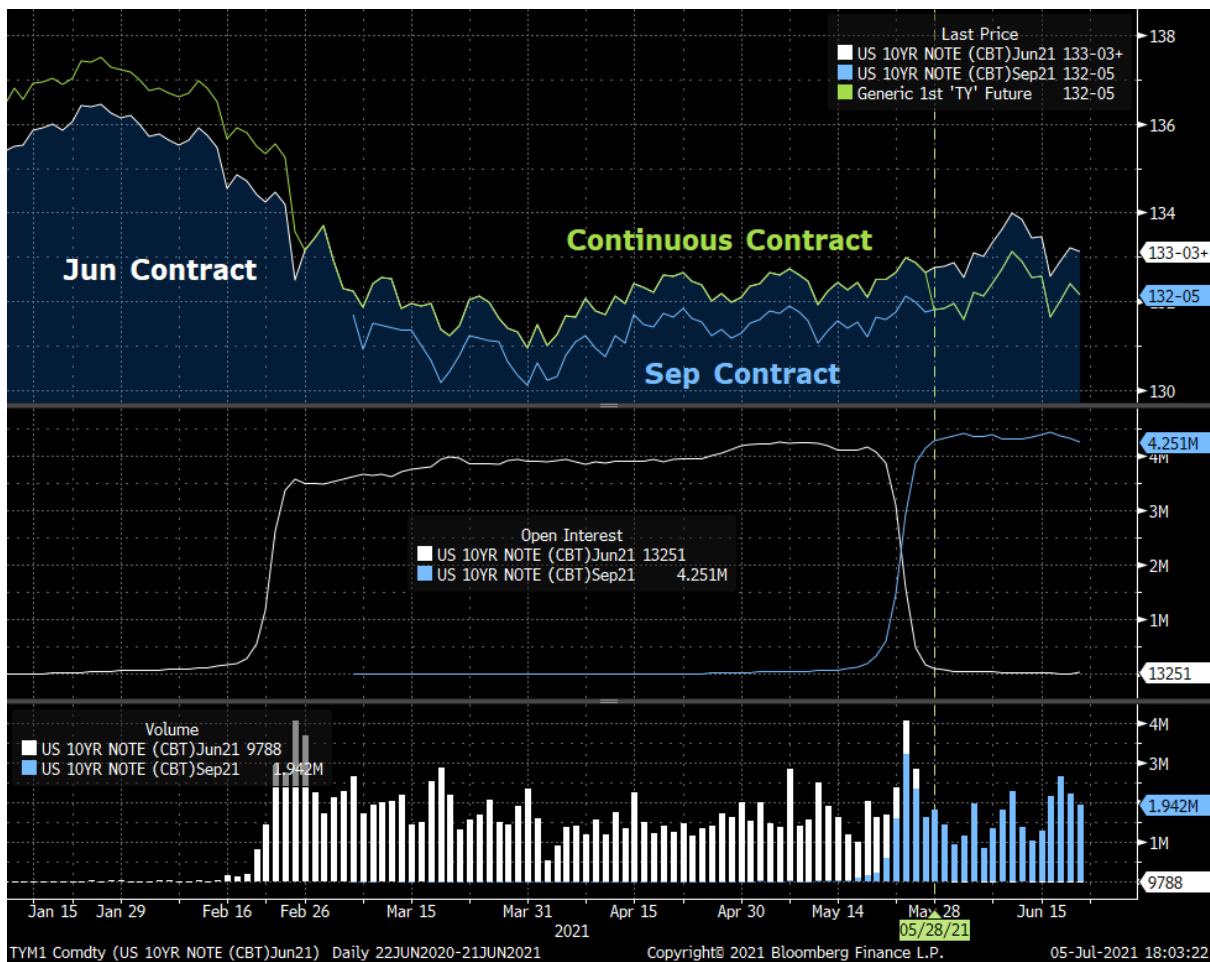
7) Holidays | CDR CB »

Margin Requirements

	Speculator	Hedger
Initial	1,677	1,525
Secondary	1,525	1,525

Daily Price Limits

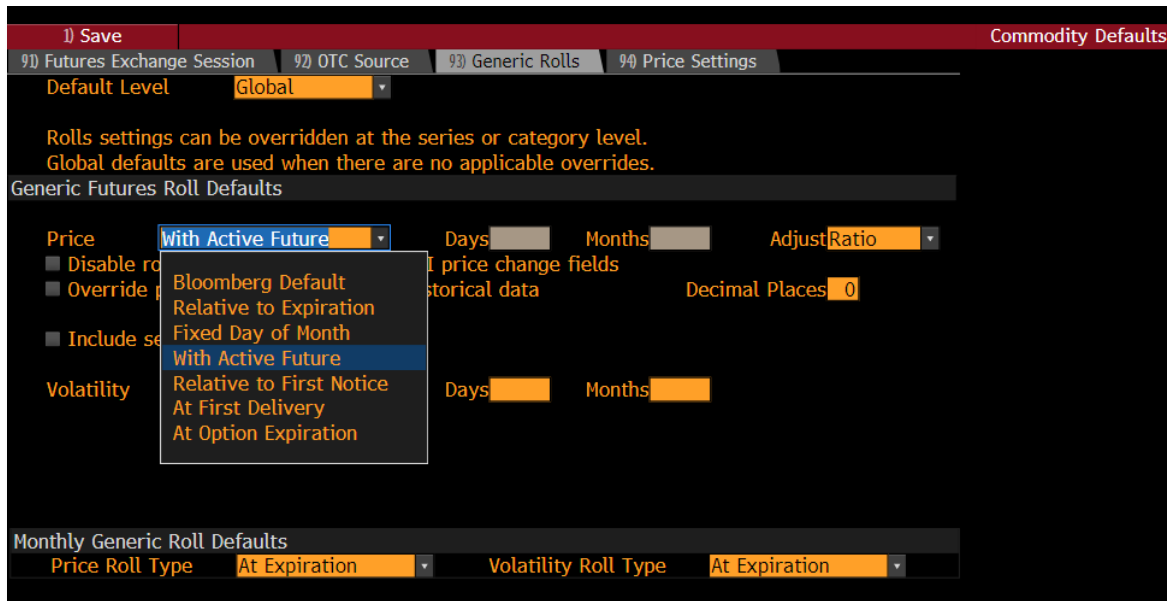
Up Limit	N.A.
Down Limit	0-00+



You can see that for the June contract M1, the first delivery was 06/01/2021 which means physical delivery of the cash bond for futures begins to take place even though the future can trade for another 3 weeks. In the lead up to this first delivery volume and open interest (OI) on the following expiry (Sep/U1) start to increase while OI falls on the June as positions are closed out and shifted to U1. By 05/25/2021 there is already more OI in U1 than M1 and by 05/27/2021 there's now more volume on U1 than M1.

In the chart with prices, the white line is M1, the blue line is U1, and the green line is the continuous chain of ACTIVE futures prices. You can see how on 06/01/2021 the active moved from M1 to U1, it ROLLED. This move, which was downward in price is referred to as having ROLLED-DOWN.

The continuous series of active futures is called the Generic contract on Bloomberg (with 1 as the ticker's tail – TY1). No matter which system you use, your treatment of continuous series of futures is vastly important especially when running backtests. go to **GFUT<GO>** to see your default settings.



I prefer to roll generics with the active contract so that my generic is tied to the volume traded. The other part is the roll adjustment, which I set to Ratio. There is no hard and fast rule but some things to note:

None = no changes to historical series relative to active. Price changes from roll down/up are displayed.

Difference = the nominal change in roll is applied to all historical roll periods. If a roll happens today of 0-15+ on TY, all prior prices will get adjusted by that amount.

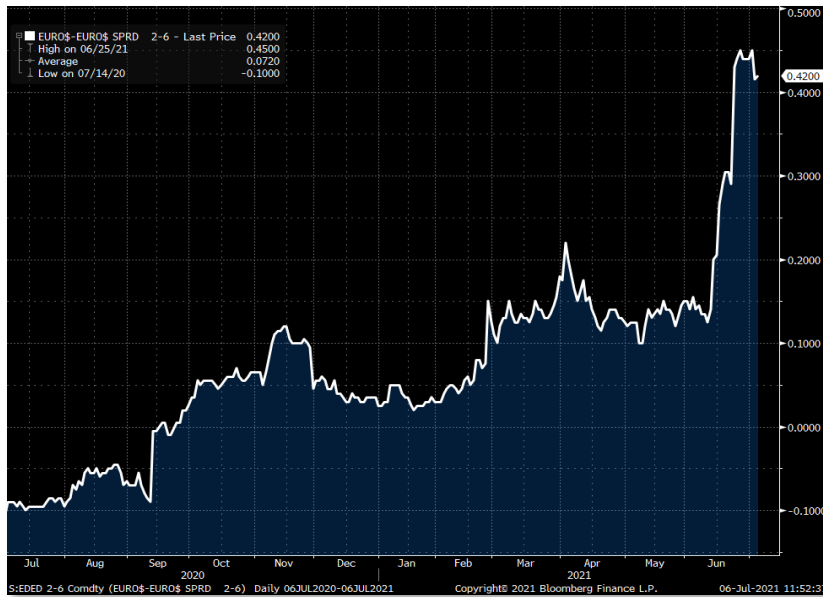
Ratio = instead of nominal change it takes the % change in roll and applies that to historical prices.

Average = weighted average price of front month & 2nd month with each weight changing according to the days btw front and 2nd month. Average is proactive while the rest are retroactive



I prefer to use RATIO adjustment as 1) current price is tradeable (Average is not) and 2) doing backtesting of a continuous series with NONE creates false PnL due to roll effects if you hold a position over the roll and Difference adjusts historical series but backward adjustments are non-relative, again screwing PnL.

For EDs what's typically looked at isn't so much the continuous contract but rather the spread between contracts – e.g. ED22ED23 Comdty is the spread between Dec 22 and Dec 23 Eurodollars. The generic contract actually has a 2nd generic, and a 3rd etc. Given the ED strip goes out 10 years you can actually track the generic spread quite far ahead.

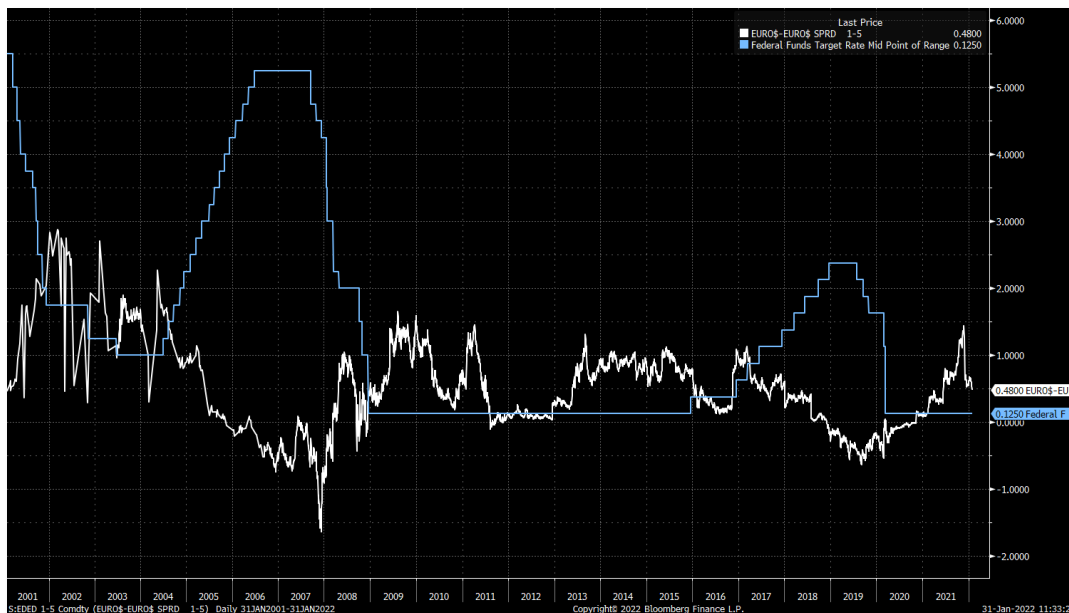


On BLOOMBERG the ticker format is S:EDED x-y Comdty where x and y are the two generic contracts you want to spread. Because the ED strip is in quarterlies, a spread of 4 contracts is a 1-year generic spread – S:EDED 2-6 Comdty is the 1 year ED spread from the 2nd quarterly expiry. The tricky part is, ED1 will be the active contract so ED2 will be the next quarterly expiry from the active. Eurodollar active contracts are not necessarily the nearest quarterly expiry.

The chart below for example tracks the 4-quarter spread against the active ED future compared to the Fed Funds Target Rate. You could probably observe a few things:

- 1) the spread widens ahead of Fed lift-off
- 2) it tightens shortly after
- 3) it widens as Fed begins cutting

Once you establish that the spread is simply “where are rates 1 year ahead?” it will make sense. The spread prices in the hike, then the front ED rolls into the hiked levels then eventually cuts get priced in.



5.4 Note and Bond Futures

Let’s turn to notes and bond futures now. When it comes to bond futures the quoting conventions are...all over the place. I love it. US bonds are quoted in fractions, euro bonds in percent of par and Aussie bonds are quoted in yield



with the decimal price being 100-yield. This means that while US bonds and Bunds are linear in the change of their contract value, Aussie bond future values exhibit convexity just like their underlying bond.

If you look at the Aussie 10y treasury bond, the value of 1pt says “Varies” and the value of 1 tick is A\$57.11 – if I change the price to 99.00 the value of 1 tick changes to A\$59.58 (second screenshot). But recall Eds are quoted as 100-yield as well with a tick value of \$25, so why are these two instruments different if quoted the same way? With EDs they are valued as \$25 per tick but with Aussie treasury futures they are valued in terms of yield of the underlying 6% bond. Therefore, the value will change with the effect of convexity.

The screenshots show the following contract specifications for XMU1 Comdty (AUST 10Y BOND FUT Sep21):

- Contract Size: 100,000 AUD
- Value of 1.0 pt: Varies
- Tick Size: 0.0050
- Tick Value: A\$ 57.11 (at price 98.5550) / A\$ 59.58 (at price 99.0000)
- Price: 98.5550 (100 - yield) / 99.0000 (100 - yield)
- Contract Value: A\$ 142,270... / A\$ 147,468...

For US bond futures, *generally* the longer the maturity of the underlying the larger the tick size. For US bond futures the tick size remains constant. For ex: TY (CME ticker ZN), 1 point is worth \$1000 (TAKE NOTE OF THIS).

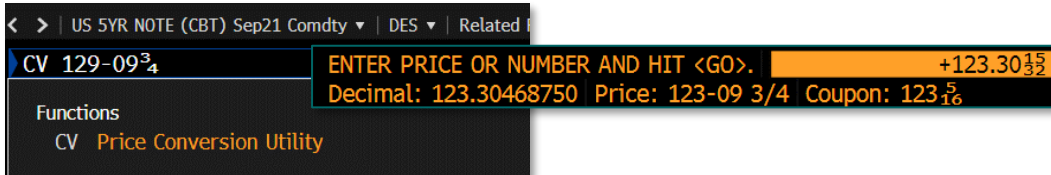
The price quote is in fractions of 32 with the smallest move (a tick) being half a 32nd – i.e., 1/64. This is commonly denoted as a '+'. To confuse you more when trading, you can receive the same quote in the following ways: 132-06+, 132.06+, 132.1875 or even 132-06.50

The screenshot shows the following contract specifications for TYU1 Comdty (US 10YR NOTE (CBT)Sep21):

- Contract Size: 100,000 USD
- Value of 1.0 pt: \$ 1,000
- Tick Size: 0-00+ (64ths)
- Tick Value: \$ 15.625
- Price: 132-06 points
- Contract Value: \$ 132,187.5

For 5y notes (FV / ZF) the minimum tick is 1/128 or 1/4 of a 32nd. Half the size of a TY tick. So, you could receive a quote like 123-09¾, 123.3046875, 123-09.75. You could even get fractions after a decimal like 123.09¾ which is just sadistic.

Thankfully, Bloomberg incorporates a conversion function using the command **CV<GO>** to help you convert fractions to decimals and vice versa.



The price of a treasury future (and bund) is percent of par, so 132.1875 = 132.1875%. Multiply this by the contract size and you have the contract value – \$100,000 * 1.321875 = \$132,187.50

Grade and Quality: U.S. Treasury notes maturing at least 6 1/2 years, but not more than 10 years, from the first day of the delivery month. The invoice price equals the futures settlement price times a conversion factor plus accrued interest. The conversion factor is the price of the delivered note (\$1 par value) to yield 6 percent.
 ETYA is no longer supported, you will be able to see the same data in TYA ELEC <COMDTY>.
 Exchange ticker: TY

US treasury futures trade with an assumed 6% coupon (Bunds & Aussie too). As futures

contracts are standardized a consistent coupon is necessary. This is confusing but the actual theoretical bond underlying the future is a bond issued at par yielding 6% which implies the coupon is 6%

As bond futures are **physically settled** it means that if you buy a bond future and hold to delivery you will receive an actual treasury bond and pay for it according to the futures price you transacted at. Obviously current yields are much lower than the theoretical 6% coupon that the future is based on so the price you paid on the future is not exactly the same as what you should pay for the real bond.

This is where the conversion factor (CF) comes in. CFs are calculated by the exchange to equate the future with its deliverable. While the future trades on a theoretical 6% coupon, all the deliverables trade at diff coupons and yields, meaning each has a diff CF.

TYU1 Comdty	Export	Settings	Cheapest-to-Deliver				
US 10YR NOTE (CBT)Sep21	Price 132-14	Trade 07/02/21	Delivery 09/30/21				
Sort By		Settle 07/06/21	Cheapest IRP 0.076				
Implied Repo	Decreasing	Prices in Decimals	Days 86	Act /	360		
Cash Security	Price Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)
Adjust Value							
1) T 2 7/8 05/15/28	111-02+ BGN	1.1882	0.8338	20.856	0.076	0.061	-0.125
2) T 2 7/8 08/15/28	111-06+ BGN	1.2249	0.8286	46.893	-2.958	0.061	25.748
3) T 1 3/4 05/31/28	100-08+ BGN	1.2097	0.7474	41.019	-4.120	0.061	32.088
4) T 1 3/4 04/30/28	100-10 3/4 BGN	1.1985	0.7474	43.269	-4.412	0.061	34.390
5) T 1 3/4 03/31/28	100-13 1/4 BGN	1.1858	0.7474	45.769	-4.722	0.061	36.840
6) T 3 1/8 11/15/28	113-03 3/4 BGN	1.2533	0.8376	70.001	-5.372	0.061	47.161
7) T 1 1/4 06/30/28	100-05 1/4 BGN	1.2254	0.7395	71.249	-8.083	0.061	62.368
8) T 2 5/8 02/15/29	109-21+ BGN	1.2867	0.8039	102.572	-9.846	0.061	83.303
9) T 2 3/8 05/15/29	107-30 BGN	1.3087	0.7836	133.103	-13.935	0.061	115.847
10) T 1 5/8 08/15/29	102-09 3/4 BGN	1.3243	0.7320	171.534	-20.328	0.061	159.766
11) T 1 3/4 11/15/29	103-08 1/4 BGN	1.3367	0.7331	197.372	-23.291	0.061	184.768
12) T 1 1/2 02/15/30	101-01 1/4 BGN	1.3716	0.7105	222.151	-27.249	0.061	211.319
13) T 0 5/8 05/15/30	93-17 BGN	1.4041	0.6462	254.404	-34.895	0.061	250.167
14) T 0 5/8 08/15/30	93-07+ BGN	1.4193	0.6382	278.808	-38.426	0.061	274.534
15) T 0 7/8 11/15/30	95-05 BGN	1.4298	0.6476	300.471	-40.355	0.061	294.372
16) T 1 1/8 02/15/31	97-05 BGN	1.4429	0.6577	321.667	-42.109	0.061	313.643

CME provides a link to calculate the conversion factor which if you try, will be like feeding a power-drill to your eyeballs but if you're into that thing, here you go:

https://www.cmegroup.com/trading/interest-rates/files/Calculating_U.S.Treasury_Futures_Conversion_Factors.pdf

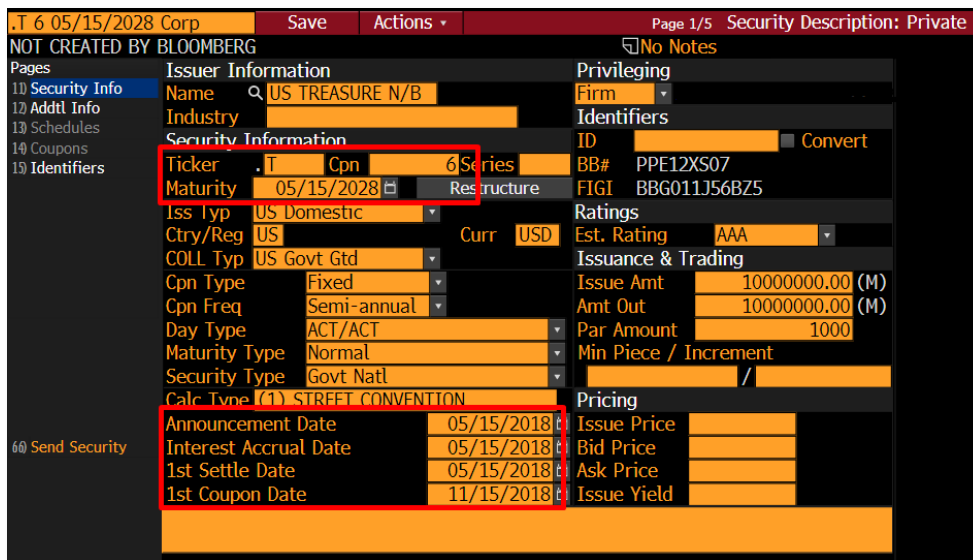
Here's how I like to think about CFs: Let's imagine the futures contract actually gave you a 6% coupon treasury at delivery date, meanwhile the actual deliverable bond has a 2 $\frac{7}{8}$ % coupon, with the same maturity – if you can get either one, which do you prefer? The 6% coupon bond of course! They're otherwise the same.

The 6% coupon bond should trade equal to the deliverable bond (T 2 $\frac{7}{8}$ 05/15/28) otherwise I'd just buy the future, sell the deliverable bond forward and get juicy free income till maturity. How do we select which bond to deliver? If there is a basket of bonds I can deliver, I will choose the one that costs me the least – what we call the Cheapest to Deliver bond (CTD). **How do we determine the CTD? Please see Appendix 1 for an in-depth breakdown.**

We need to equate the two – **“What is the price I need to pay for a 6% coupon bond at delivery such that I am indifferent between that and the real deliverable bond?”**

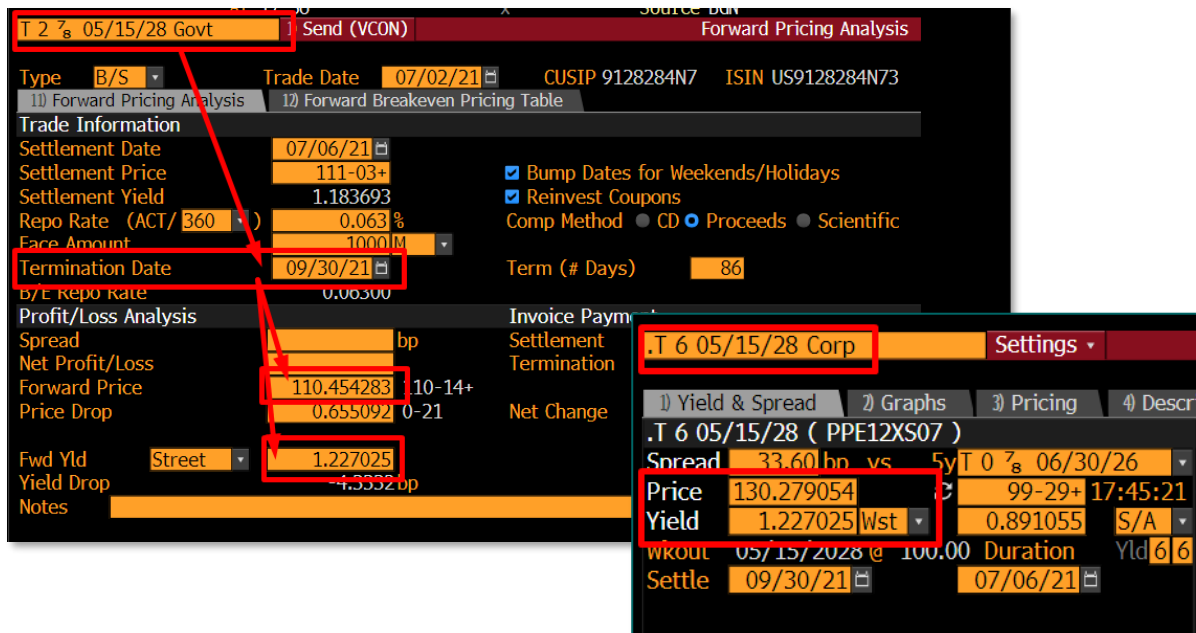
Remember, it's the yield you expect to earn that matters, not the price you pay.

Let's back it out. The CFs are set when the future is listed and doesn't change, so we won't get the exact figure, but we can get close. The current CTD bond matures on 05/15/28, so let's create a Treasury with the same maturity and cashflows but with a 6% coupon instead.



Security Information		Pricing	
Ticker	T	Issue Price	
Cpn	6	Bid Price	
Maturity	05/15/2028	Ask Price	
Series	6	Issue Yield	
Structure	Restructure		
BB#	PPE12XS07		
FIGI	BBG011J56BZ5		
Est. Rating	AAA		
Issue Amt	10000000.00 (M)		
Amt Out	10000000.00 (M)		
Par Amount	1000		
Min Piece / Increment			
Announcement Date	05/15/2018		
Interest Accrual Date	05/15/2018		
1st Settle Date	05/15/2018		
1st Coupon Date	11/15/2018		

Now, from our prior topics we know that from the yield curve, we can calculate the implied yield at forward dates, known as forward rates. Taking the deliverable bond, we can see what the curve implies is the forward yield for that bond at future delivery.

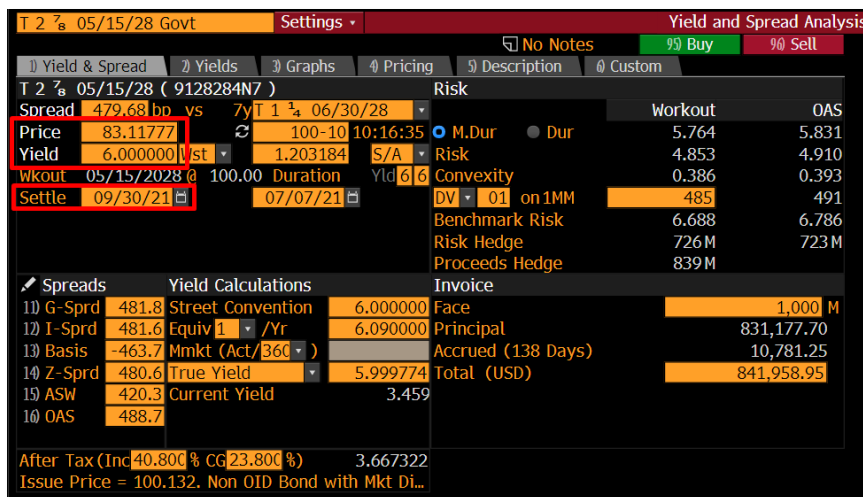


The screenshot shows a bond pricing application. The main window displays trade information for a bond with CUSIP 9128284N7 and ISIN US9128284N73. Key fields include Settlement Date (07/06/21), Settlement Price (111-03+), and Termination Date (09/30/21). A 'Forward Pricing Analysis' window is open, showing a forward price of 110.454283 and a yield of 1.227025. A secondary window shows a 'Yield & Spread' analysis for a 6% coupon bond (T 6 05/15/28 Corp) with a price of 130.279054 and a yield of 1.227025.

Today, if I sold forward the deliverable bond the market pricing would be 110.454283 clean for a 1.227025 yield on 09/30/21, about 3 months away. The fictional 6% coupon bond that underlies the futures contract, if we price it at a yield of 1.227025 on 9/30/21, that should imply a clean price of 130.279054

What is the ratio between the two? $110.454283 / 130.279054 = 0.8478$. The actual conversion factor is 0.8338 so we're fairly close! Get it now? The 6% coupon is more "valuable" than current coupons so you pay more, but the higher price results in a lower yield. The ratio of future to cash bond prices that results in the same deliverable yield is the conversion factor.

The other way to look at it is simply "what would the CTD price be at delivery to yield 6%?"



The screenshot shows a 'Yield and Spread Analysis' window for a 6% coupon bond (T 6 05/15/28 Corp). It displays various metrics including Spread (479.68 bp), Price (83.11777), and Yield (6.000000). The 'Invoice' section shows a Face value of 1,000 M and a Total (USD) of 841,958.95. The 'Yield Calculations' section shows a Current Yield of 3.459% and an After Tax yield of 3.667322%.

This gets us even closer to the CF, but the flow of logic doesn't fit as nice in my mind. That doesn't rationalize the future to cash price relationship as well, but your mileage may vary.

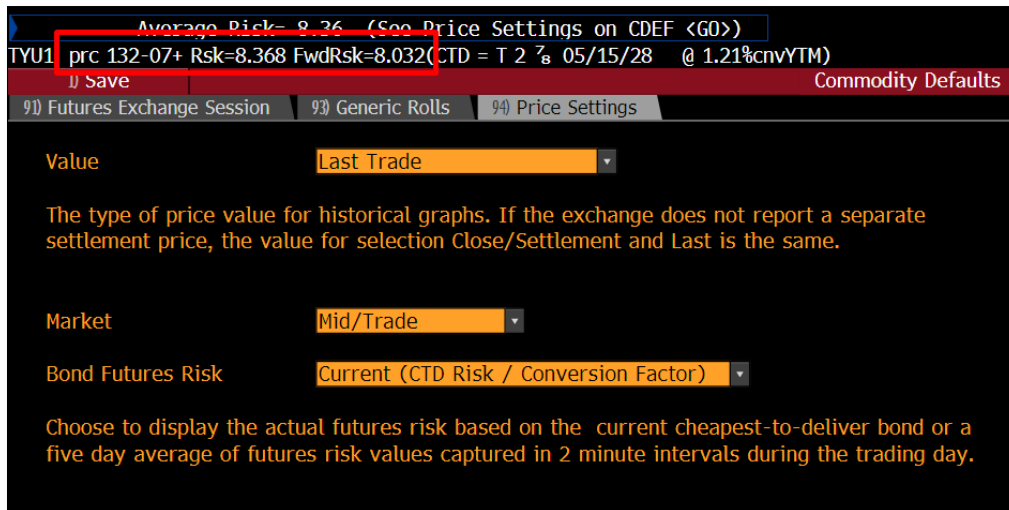
In any case, this in a nutshell, is the point of conversion factors: **equivalence**. This necessity for equivalence in light of the future-cash relationship therefore means that the conversion factor is a driving factor behind all of a bond future's risk analytics, which we will cover next.

5.5 Futures Risk

The key concept of bond futures is that an underlying bond gets delivered against it. Hence, when looking at future's risk, we look at the deliverable risk and how that translates to the future.

If you run the command **FRSK<GO>** for TYA, you will see its risk is around 8.365 and its forward risk is 8.030. What do these mean? First, risk is the risk to PRICE given a 1% shift in yields – the formula for a bond's risk is:

$$\text{RISK} = \text{DURATION} * \text{DIRTY PRICE.}$$



Average Risk= 8.36 (See Price Settings on CDEF <GO>)
 TYU1 prc 132-07+ Rsk=8.368 FwdRsk=8.032(CTD = T 2 7/8 05/15/28 @ 1.21%cnvWTM)
 Save Commodity Defaults
 91) Futures Exchange Session 93) Generic Rolls 94) Price Settings
 Value Last Trade
 The type of price value for historical graphs. If the exchange does not report a separate settlement price, the value for selection Close/Settlement and Last is the same.
 Market Mid/Trade
 Bond Futures Risk Current (CTD Risk / Conversion Factor)
 Choose to display the actual futures risk based on the current cheapest-to-deliver bond or a five day average of futures risk values captured in 2 minute intervals during the trading day.

To calculate risk for a future, first look at its cheapest to deliver contract, in this case T 2 7/8 05/15/28 Govt and look at its duration.

The duration is 6.266

The risk = 6.266 * 1.1133 = 6.976



T 2 7/8 05/15/28 Govt Settings Yield and Spread Analysis
 No Notes Buy Sell
 Yield & Spread Yields Graphs Pricing Description Custom
 T 2 7/8 05/15/28 (9128284N7)
 Spread -3.78bp vs 7yT 1 1/4 06/30/28
 Price 110-31 100-01 14:57:01
 Yield 1.207475 1.245324 S/A
 Wkout 05/15/2028 @ 100.00 Duration Yld 6.6
 Settle 06/30/21 06/30/21
 clean price
 Risk
 M.Dur 6.266
 Dur 6.351
 Risk 6.976
 Convexity 0.446
 PV 0.01 0.06976
 Benchmark Risk 6.685 6.786
 Risk Hedge N.A.M N.A.M
 Proceeds Hedge N.A.M
 Invoice
 Face 0.1 M
 Principal 110.97
 Accrued (46 Days) 0.36
 Total (USD) 111.33
 Dirty Price = Clean Price + Accrued Interest
 After Tax (Inc 40.800% CG 23.800%) 0.714869
 Issue Price = 100.132. Bond Purchased with Pre...

The CTD's risk value of 6.976 is then divided by the conversion factor 0.8338 to arrive at 8.367 which is the price risk of the future based on the underlying. Recall part 1's final point about equivalence between futures and cash and why we use the conversion factor.

TYU1 Comdty		Export		Settings		Cheapest-to-Deliver			
US 10YR NOTE (CBT)Sep21		Price	132-20	Trade	07/06/21	Delivery	09/30/21		
Sort By				Settle	07/07/21	Cheapest IRP	0.047		
Implied Repo		Decreasing		Prices in Decimals		Days	85 Act / 360		
Cash Security	Price Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)		
Adjust Value									
1) T 2 7/8 05/15/28	111-07+	BGN	1.1652	0.8338	20.853	0.047	0.061	0.117	
2) T 2 7/8 08/15/28	111-11+	BGN	1.2026	0.8286	46.922	-3.022	0.061	26.025	
3) T 1 3/4 05/31/28	100-12 3/4	BGN	1.1896	0.7474	40.784	-4.147	0.061	31.958	
4) T 1 3/4 04/30/28	100-15 3/4	BGN	1.1770	0.7474	43.284	-4.474	0.061	34.509	
5) T 1 3/4 03/31/28	100-17+	BGN	1.1652	0.7474	45.534	-4.755	0.061	36.710	
6) T 3 1/8 11/15/28	113-08 3/4	BGN	1.2340	0.8376	69.476	-5.398	0.061	46.902	
7) T 1 3/4 06/30/28	100-09 3/4	BGN	1.2044	0.7395	71.312	-8.189	0.061	62.535	
8) T 2 5/8 02/15/29	109-25 3/4	BGN	1.2688	0.8039	101.998	-9.909	0.061	82.956	
9) T 2 3/8 05/15/29	108-02 1/4	BGN	1.2913	0.7836	132.652	-14.051	0.061	115.597	
10) T 1 5/8 08/15/29	102-13+	BGN	1.3091	0.7320	170.892	-20.480	0.061	159.263	
11) T 1 3/4 11/15/29	103-11	BGN	1.3259	0.7331	195.724	-23.353	0.061	183.266	
12) T 1 1/2 02/15/30	101-03 3/4	BGN	1.3620	0.7105	220.388	-27.335	0.061	209.684	
13) T 0 5/8 05/15/30	93-19	BGN	1.3965	0.6462	252.527	-35.023	0.061	248.339	
14) T 0 5/8 08/15/30	93-10	BGN	1.4100	0.6382	277.479	-38.665	0.061	273.255	
15) T 0 7/8 11/15/30	95-07	BGN	1.4226	0.6476	298.586	-40.550	0.061	292.558	
16) T 1 1/8 02/15/31	97-07	BGN	1.4359	0.6577	319.721	-42.326	0.061	311.791	

The FwdRisk is the conventional forward risk value of the CTD. In plain English, if you bought the future and took delivery at the future's price adjusted for conversion factor, what is the risk of bond at delivery?

In practice, when trading futures I care more about the futures current risk rather than the forward risk as the movement of the underlying directly impacts the current price of the future. Forward risk is only really applicable when you are concerned about taking delivery.

5.6 Trading Strategies Using Futures

Now that you understand futures risk, you can start to construct **curve trades, butterfly trades or simply hedge** portfolios using futures. For example, if I wanted to put on a 5s30s steepener using futures, how would I do that?

Recall, a steepener involves buying the short end and selling the long end. E.g., Buy 5s, sell 30s. For futures I want to use the FV (ZF) and the WN (UB) contracts. Because the 30y has higher duration than the 5, if the curve moves equally across all points I can lose or make money without the curve shape actually changing – we want to eliminate that. So, we need to duration hedge the two legs.

In Bloomberg we can use the function **FIHG<GO>** to do this quickly. The WN contract has a risk of 36.22 while the FV contract has a risk of 5.38 >> the ratio is therefore 6.73. For every 100 lots of WN I sell I will have to Long 673 lots of FV.

WNU1 COMB Comdty		97) Settings		Fixed Income Hedging			
Trade Date		07/05/21		99) Buy 99) Sell			
Settle Date		07/06/2021		Number of Contracts		100	
Contract Size		100,000 USD		Hedge Analysis >>			
Hedge Selection							
	Security	Price	Yield	Risk	BPV	Hdg Ratio	Hedge Amt Repo DCOH
	WNU1 COMB	193-15		36.22	36,217		
Hedge Rate Risk 91) (FIHR)							
<input type="checkbox"/>	Cash	T 2 3/8 05/15/51	107-11+	2.044	23.26	36,217	1.56 15.57MM .07 -894
<input checked="" type="checkbox"/>	Future	FVU1 Comdty	123-17	5.38	36,202	6.73	673 .07 -2M
Hedge Rate and Curve Risk							
<input type="checkbox"/>	Cash-Barbell	T 2 1/4 05/15/41	104-13+	1.980	16.77	15,371	2.16 9.16MM .07 -495
<input type="checkbox"/>	Future-Barbell	T 2 3/8 05/15/51	107-11+	2.044	23.26	20,846	1.56 8.96MM .07 -515
<input type="checkbox"/>	IRS	92) (SWPM) Pay Fixed (02/15/47)	--	1.729	22.50	36,217	1.61 16.10MM .06 -725

Typically, I will construct a curve trade with DV01 in mind, on the screen it's BPV (Basis Point Value). So, if I want to put on a \$10,000 DV01 steepener on 5s30s using FV/WN futures I would have to do something like short 27 lots of WN and long 182 contracts of FV.

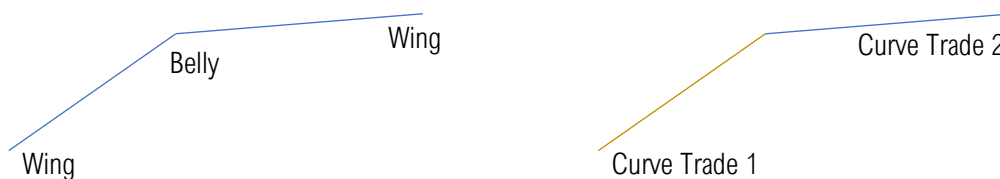
WNU1 COMB Comdty		97) Settings		Fixed Income Hedging			
Trade Date	07/05/21	Settle Date	07/06/2021	Number of Contracts	27	Contract Size	100,000 USD
Hedge Selection		Security	Price	Yield	Risk	BPV	Hdg Ratio
Hedge Rate Risk		WNU1 COMB	193-15		36.22	9,779	
<input type="checkbox"/> Cash	T 2 ³ / ₈ 05/15/51	107-11+	2.044	23.26	9,779	1.56	4.20MM .07 -241
<input checked="" type="checkbox"/> Future	FVU1 Comdty	123-17	--	5.38	9,790	6.73	182 .07 -426
Hedge Rate and Curve Risk		T 2 ¹ / ₄ 05/15/41	104-13+	1.980	16.77	4,150	2.16 2.47MM .07 -134
<input type="checkbox"/> Cash-Barbell	T 2 ³ / ₈ 05/15/51	107-11+	2.044	23.26	5,628	1.56	2.42MM .07 -139
<input type="checkbox"/> Future-Barbell							
<input type="checkbox"/> IRS	97) (SWPM) Pay Fixed (02/15/47)	--	1.729	22.50	9,779	1.61	4.35MM .06 -196

The manual way to do this is: take 10,000 (target DV01) then divide by $36.22 * 10$ (Risk * \$1000 per point per percent / 100 basis points) = 27.61 (round to 27) lots of WN.

Now, the FV Hedge = $27 * 6.73$ (hedge ratio of $36.22 / 5.38$ per contract) = 182 lots. If both legs saw yield rise/fall 1bp, their PnL performance should cancel each other out.

If 30s rise by 1bp and 5s stay the same, then I make 10k on WN and lose 0 on 5s. Likewise if 5s drop 1bp and 30s drop 0.5bps I make 10k on 5s and lose 5k on 30s. The opposite scenarios work against me. This way, my concern is not what each leg is doing on their own but how they are moving relative to one another.

A butterfly is just the belly and two wings – 3 legs of a trade. One in the middle and two on either side. **Broken down, it's actually two curve trades combined.** If you know how to construct a curve trade, you can construct a butterfly by adding two curve trades together with the belly being the pivot.



For example: long the 2s5s10s butterfly means you think it's going higher, and that means the yield of the belly (5s) goes up relative to the wings (2s and 10s) resulting in a more humped curve. The quote you will see is derived by taking $(2 * 5y \text{ yield}) - (2y \text{ yield} + 10y \text{ yield})$. If I think the curve becomes more humped then I want to SELL the belly (because yields up, price down) and buy the wings. If I think it becomes less humped, I want to BUY the belly (yields down, price up) and sell the wings.

A 10k DV01 trade that is long the fly could be a 5k DV01 2s5s steepener and a 5k DV01 5s10s flattener. Can you do 4k + 6k on each side of the belly? Sure. There are endless combinations and that's what makes it fun!

FVU1 COMB Comdty		97) Settings		Fixed Income Hedging					
Trade Date	07/05/21	Number of Contracts	185	Contract Size	100,000 USD	Hedge Analysis >>			
Settle Date	07/06/2021								
<input checked="" type="checkbox"/> Edit Mode									
Hedge Selection	Security	Price	Yield	Risk	BPV	Hdg Ratio	Hedge Amt	Repo	DCOH
Hedge Rate Risk	91) (FMRK)								
■ Cash	T 0 7/8 06/30/26	100-02+	.859	4.87	9,952	1.10	20.43MM	.07	-437
■ Future	FVU1 Comdty	123-17	--	5.38	9,952	1.00	185	.07	-433
Hedge Rate and Curve Risk									
■ Cash-Barbell	T 0 1/4 06/15/24	99-14 1/4	.440	2.91	2,832	1.85	9.73MM	.07	-97
	T 0 7/8 06/30/26	100-02+	.859	4.87	7,120	1.10	14.62MM	.07	-313
<input checked="" type="checkbox"/> Future-Barbell	TUU1 Comdty	10-05 3/4	--	2.16	5,000	2.50	116	.07	-107
	TYU1 Comdty	132-23+	--	8.38	4,942	.64	59	.07	-232
■ IRS	92) (SWPM) Pay Fixed (11/30/25)		.842	4.42	9,952	1.22	22.50MM		-453

The other consideration with butterfly combinations is the effect of convexity for longer-dated bonds. As the convexity increases, the larger convexity effect of the long-bond on the wing requires a smaller weighting. So for something like a 2s5s30s butterfly trade, you would typically end up with a weighting of 80:20 or even 90:10 between the 2s5s and 5s30s portions respectively.

Where possible, I prefer to hedge duration risk and/or trade the curve using futures as it is less capital intensive (i.e., you're using margin instead of cash) and is a very liquid market. This allows me to control the amount of duration present in my fixed income portfolio without having to commit large amounts of capital.

After FOMC (June 16, 2021), we saw huge moves on the long end of the curve. A lot of people pointed to positioning in steepeners being the cause and having to unwind them (covering the short long-bond position) was causing the rally. How did people "know" this? **Part of it was observing open interest.**

5.7 Observing Open Interest and Market Activity

Open interest usually confuses everyone including me. It's the total number of open contracts at a given time. Recall a future (and an option) is between two parties, a zero-sum game. Every contract I enter, I must exit at some point.

Imagine it's day 1 of futures trading, nothing has ever been done before. I short TYA and a rates maestro thinking I'm a sucker, buys the future. There now exists 1 futures contract and open interest is 1. Later, I sell another 5 contracts, so now open interest is 6. Volume for the day is 6.

Day 2. No one does anything. Volume is 0. Open interest is 6.

Day 3. TY pukes and I buy back all 6 of my contracts from a weeping counterparty and exit my position. Volume is 6, open interest is 0.

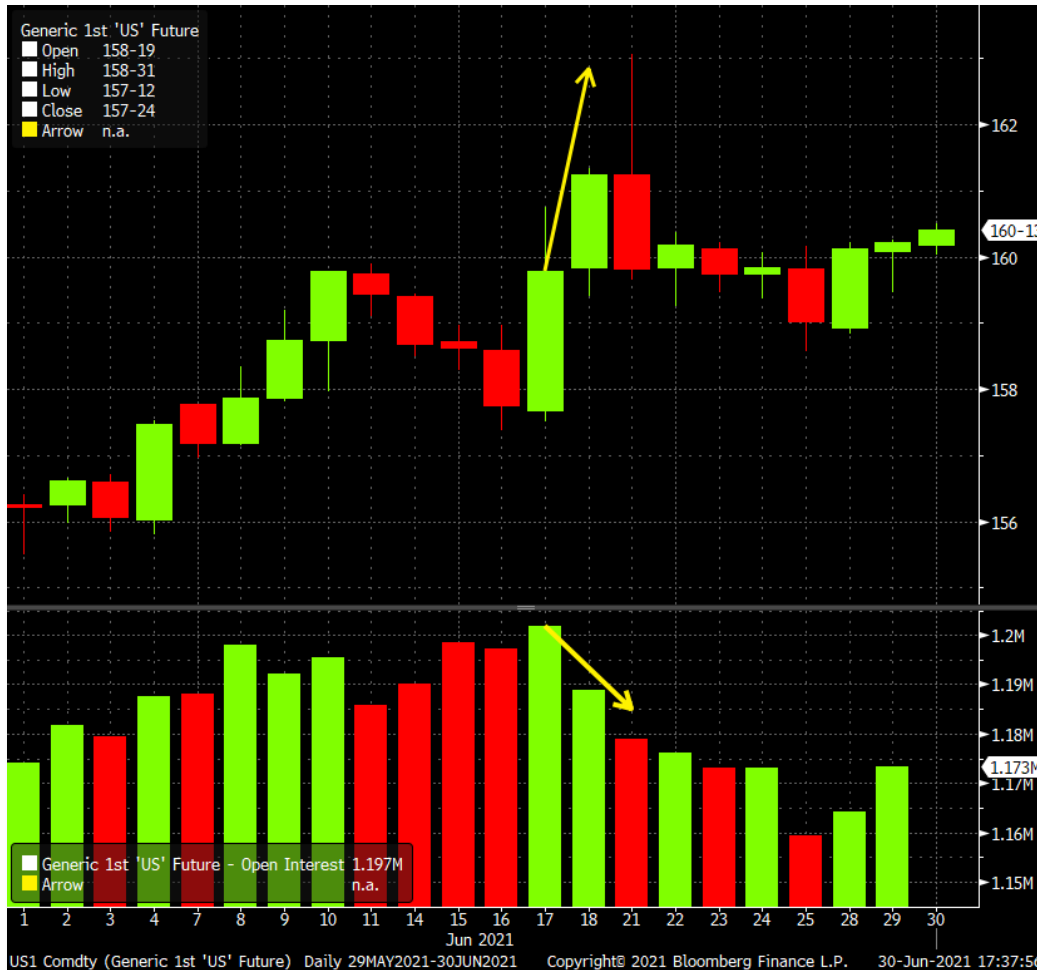
A noticeable drop in OI points to the closure of positions in a futures market. This is why people look at open interest during a strong rally to see if OI drops. If it does, it's an indication that the price going up involves people EXITING positions, likely meaning a short covering.

Post-FOMC, open interest in the US Long Bond future fell by 12,190 contracts on June 18 then 9,902 contracts the following day, while prices of the future were rallying hard.

Risk of the CTD around then was roughly 17.37, which converted to Futures was a risk of 19.3 (17.37 / 0.9) meaning for each contract, 1 basis point move in the underlying caused PnL to move by \$193 across the market. The 12,190 contracts that closed out on that Friday represented \$2.35million DV01 exiting positions. That day, that chunk of

contracts saw a change in value to the tune of \$22.35million (the 20y yield dropped 9.5bps that day). The prior day yields had already dropped 10bps. So back-to-back that's 19bps to account for, or in DV01 terms, about \$46million for that 12k block of contracts.

The best part is, another 9,902 dropped off the following day (21st June) while bonds saw a huge spike up which was CLASSIC STOP OUT action. Let's assume these poor guys were short since FOMC and just puked their guts out when the squeeze happened. At its worst, these 9.9k contracts experienced 27bps of yield tightening in the underlying for a DV01 effect of \$51.6million.



Now, not all of them covered at highs, some of that OI would have been longs taking profit, etc. But the next time you see on twitter something like JUMBO 30,000 BLOCK BUY IN 10YR TREASURIES EQUIV. \$2.5M DV01 at least now you kind of have an idea of what that means.



5.8 Topic Question

Here is the US 2y future and the US 10y future with their respective risk characteristics. If I wanted to construct a 2s10s curve flattener using these two instruments targeting a DV01 of \$5,000 how many contracts and what direction (long/short) do I need for each?

TUU1 COMB Comdty		97) Settings ▾	Fixed Income Hedging			
Trade Date	07/05/21 ↻					
Settle Date	07/06/2021 📅	Number of Contracts	100	Contract Size	200,000 USD	Hedge Analysis >>
<input checked="" type="checkbox"/> Edit Mode						
Hedge Selection	Security	Price	Yield	Risk	Hdg Ratio	Hedge Amt Repo DCOH
	TUU1 COMB	110-05 ³ / ₄		2.16		

TYU1 COMB Comdty		97) Settings ▾	Fixed Income Hedging			
Trade Date	07/05/21 ↻					
Settle Date	07/06/2021 📅	Number of Contracts	100	Contract Size	100,000 USD	Hedge Analysis >>
<input checked="" type="checkbox"/> Edit Mode						
Hedge Selection	Security	Price	Yield	Risk	Hdg Ratio	Hedge Amt Repo DCOH
	TYU1 COMB	132-23		8.38		

Because this is a flattener it implies positioning for the difference between short end yields and long end yields to narrow; hence we want to be short TUU1 (the short end) and long TYU1 (the long end). The risk ratio is $8.38 / 2.16 = 3.88$ so for every 1bp move the **price risk** on TYU1 is 3.88x greater.

Method 1: Calculating each leg individually

Risk on TUU1 is 2.16 so per contract, 1bp change equals $2.16 \times 2000 / 100 = \43.2 in DV01. \$5000 DV01 would require 115.74 contracts or rounded up, short 116 contracts of TUU1.

Risk on TYU1 is 8.38 so per contract 1bp change equals $8.38 \times 1000 / 100 = \83.8 in DV01. \$5000 DV01 would require 59.67 contracts or rounded up, long 60 contracts of TYU1.

Method 2: Calculating using hedge ratio

\$5000 DV01 on TUU1 requires 116 contracts, using the hedge ratio and contract values the hedged size on TYU1 required would be $116 / [3.88 \times (100,000/200,000)] = 59.79$ or 60 contracts

6. Options on Futures



6.1 What are Options?

The world of options in interest rate futures is exceptionally interesting and complex at the same time. The point of this part will just be to introduce options on rates futures and how they work from my perspective of managing a bond portfolio – I'm not a vol trader, much better guys out there for that stuff.

Full disclosure: I expect this part of the topic to have the most contention simply because everyone has their own style. This is mine. It may be stupid once you read it, but it's mine. Don't be too harsh.

What is an option? It's a right but not obligation to buy or sell the underlying at/by a certain time (expiry) at a certain price (strike). A right to buy is a call, a right to sell is a put.

The price you pay for an option is known as the premium. But what are you paying for? Well, the name says it all – options. **The fact that you have a RIGHT to choose to do something means it gives you flexibility.**

The value of flexibility in the world of options can be broken down into Time & Volatility. Together, they are known as time value. The value of having the time to decide with the various possible outcomes from now to option expiry.

An agreement to buy an orange for \$0.75 when they are selling for \$1 today is alone, worth \$0.25 right this very moment. That is known as intrinsic value. If I have the right to buy it anytime over the next week, well I have the flexibility to wait and see if the price rises further over time.

Therefore, **Option Value = Intrinsic Value + Time Value**

Every component is known in that equation except for the path that prices will take. I know the price now, I know the price I can sell at, I know the time I have available to do it, **but I don't know for sure what the final price will be.** I can only guess how far and which direction prices move. I can only guess volatility.

This is why option prices IMPLY volatility.

Like futures, options are a zero-sum game. Every buyer has a seller, every loss is the other's gain. You can buy a call/put or you can sell them – which if it is a new position is known as 'writing' a call/put (as opposed to selling the option you previously bought).

When it comes to options on futures, the futures have an expiry as well along with their underlying cash bond. So, in reality, an option on a rate future is a right to enter by a certain time an agreed price to deliver/receive a cash bond at a future date. Following this train of thought, if the risk of the future is tied to the cash bond, then the option's risk characteristics must be tied to the deliverable bond as well.

Cash Bond >> Bond Future >> Option on Future

6.2 Finding Options on Bloomberg

A future's list of available options is known as the options chain. It will typically look like a long list of expiries and their bid/ask for different strikes, with calls on one side and puts on the other.



EDA Comdty															Option Monitor														
90DAY EURO5 FUTR Dec21															99.805 / -0.05 / -0.05% 99.800 / 99.805 Hi 99.810 Lo 99.800 Volm 5943 HV .10														
Center 99.805 Strikes 5 Exp Oct-21 on EDZ1															Related Products EDA Comdty														
Calc Mode															Calc Mode														
Center Strike															Center Strike														
Calls															Puts														
Calls															Puts														
Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt	Strike	Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt									
Oct-21 (100d 10/15/21); CSize 1000000; EDZ1 99.805															Oct-21 (100d 10/15/21); CSize 1000000; EDZ1 99.805														
1) EDV1C 99.6875	.1100	.1250	.1275	.1275			12:00			99.6875	EDV1P 99.6875	.0075	.0050y	.0050				12:00											
2) EDV1C 99.75	.0550	.0700	.0675y	.0675			12:00			10670	99.7500	EDV1P 99.75	.0050	.0125	.0075y	.0075			12:00	1688									
3) EDV1C 99.8125	.0125	.0200	.0200y	.0200			12:00			12920	99.8125	EDV1P 99.8125	.0225	.0325	.0225y	.0225			12:00	2111									
4) EDV1C 99.875	.0075	.0075y	.0025	.0025			12:00			746	99.875	EDV1P 99.875	.0650	.0850	.0675y	.0675			12:00	670									
5) EDV1C 99.9375	.0050	.0025y	.0025	.1440	.03		12:00			160	99.9375	EDV1P 99.9375	1.300	1.450	.1275y	.1275			12:00										
Nov-21 (128d 11/12/21); CSize 1000000; EDZ1 99.805															Nov-21 (128d 11/12/21); CSize 1000000; EDZ1 99.805														
6) EDK1C 99.6875	.1150	.1300	.1300y	.1300			12:00			99.6875	EDK1P 99.6875	.0025	.0100	.0075y	.0075			12:00											
7) EDK1C 99.75	.0600	.0750	.0700y	.0700			12:00			99.7500	EDK1P 99.75	.0075	.0175	.0100y	.0100			12:00											
8) EDK1C 99.8125	.0150	.0250	.0225y	.0225			12:00			99.8125	EDK1P 99.8125	.0250	.0350	.0250y	.0250			12:00											
9) EDK1C 99.875	.0075	.0050y	.0050	.6904	.11		12:00			99.875	EDK1P 99.875	.0200	.1350	.0700y	.0700			12:00											
10) EDK1C 99.9375	.0050	.0025y	.0025	.1277	.03		12:00			135	99.9375	EDK1P 99.9375	.0800	.1950	.1300y	.1300			12:00										
Dec-21 (159d 12/13/21); CSize 1000000; EDZ1 99.805															Dec-21 (159d 12/13/21); CSize 1000000; EDZ1 99.805														
11) EDZ1C 99.6875	.1150	.1300	.1300y	.1300			12:00			799	99.6875	EDZ1P 99.6875	.0050	.0125	.0075y	.0075			12:00										
12) EDZ1C 99.75	.0600	.0750	.0700y	.0700			12:00			304600	99.7500	EDZ1P 99.75	.0125	.0200	.0150y	.0150			12:00	4304									
13) EDZ1C 99.8125	.0200	.0300	.0275y	.0275			12:00			163249	99.8125	EDZ1P 99.8125	.0300	.0400	.0300y	.0300			12:00	18445									
14) EDZ1C 99.875	.0025	.0100	.0075y	.0075			12:00			215053	99.875	EDZ1P 99.875	.0700	.0850	.0725y	.0725			12:00	77230									
15) EDZ1C 99.9375	.0050	.0050y	.0050	.1378	.05		12:00			139632	99.9375	EDZ1P 99.9375	1.300	1.450	.1325y	.1325			12:00	21276									
Mar-22 (250d 3/14/22); CSize 1000000; EDH2 99.815															Mar-22 (250d 3/14/22); CSize 1000000; EDH2 99.815														
16) EDH2C 99.6875	.1400	.1550	.1525y	.1525			12:00			99.6875	EDH2P 99.6875	.0150	.0250	.0200y	.0200			12:00											
17) EDH2C 99.75	.0850	.1000	.1000y	.1000			12:00			153816	99.7500	EDH2P 99.75	.0250	.0350	.0300y	.0300			12:00	9911									
18) EDH2C 99.8125	.0400	.0500	.0500y	.0500			12:00			149907	99.8125	EDH2P 99.8125	.0400	.0500	.0450	.0450			12:00	146766									
19) EDH2C 99.875	.0150	.0200	.0175y	.0175			12:00			229707	99.875	EDH2P 99.875	.0700	.0850	.0725y	.0725			12:00	250									
20) EDH2C 99.9375	.0025	.0100	.0075y	.0075			12:00			3411	99.9375	EDH2P 99.9375	1.250	1.400	.1250y	.1250			12:00	60446									
Jun-22 (341d 6/13/22); CSize 1000000; EDM2 99.750															Jun-22 (341d 6/13/22); CSize 1000000; EDM2 99.750														
21) EDM2C 99.625	.1650	.1800	.1775y	.1775			12:00			66737	99.625	EDM2P 99.625	.0400	.0550	.0425y	.0425			12:00	56156									
22) EDM2C 99.6875	.1150	.1300	.1275y	.1275			12:00			1173	99.6875	EDM2P 99.6875	.0500	.0650	.0550y	.0550			12:00	33384									
23) EDM2C 99.75	.0700	.0800	.0800y	.0800			12:00			115399	99.7500	EDM2P 99.75	.0650	.0800	.0700y	.0700			12:00	2621									
24) EDM2C 99.8125	.0300	.0400	.0400y	.0400			12:00			9177	99.8125	EDM2P 99.8125	.0900	.1050	.0925y	.0925			12:00	19735									
25) EDM2C 99.875	.0100	.0200	.0175y	.0175			12:00			64874	99.875	EDM2P 99.875	1.300	1.450	.1325y	.1325			12:00	134									
Sep-22 (439d 9/19/22); CSize 1000000; EDU2 99.660															Sep-22 (439d 9/19/22); CSize 1000000; EDU2 99.660														
26) EDU2C 99.375	.3350	.3600	.3600y	.3600			12:00			2608	99.375	EDU2P 99.375	.0500	.0700	.0600y	.0600			12:00	2058									
27) EDU2C 99.5	.2350	.2550					12:00												12:00	5820									
28) EDU2C 99.625	.1400	.1600					12:00												12:00										
29) EDU2C 99.75	.0600	.0800					12:00												12:00										
30) EDU2C 99.875	.0150	.0250					12:00												12:00										
Dec-22 (530d 12/19/22); CSize 1000000; TYU1 133-08															Dec-22 (530d 12/19/22); CSize 1000000; TYU1 133-08														
31) EDZ2C 99.25	.3650	.3900					12:00												12:00										
32) EDZ2C 99.375	.2700	.2950					12:00												12:00										
33) EDZ2C 99.5	.1800	.2050					12:00												12:00										
34) EDZ2C 99.625	.1050	.1250					12:00												12:00										
35) EDZ2C 99.75	.0400	.0650					12:00												12:00										
Mar-23 (614d 3/13/23); CSize 1000000; TYH3C 99.125															Mar-23 (614d 3/13/23); CSize 1000000; TYH3C 99.125														
36) EDH3C 99.125	.4200	.4650					12:00												12:00										
37) EDH3C 99.25	.2250	.2700					12:00												12:00										
38) EDH3C 99.375	.2450	.2700					12:00												12:00										
39) EDH3C 99.5	.1650	.1900					12:00												12:00										
TYU1 Comdty															Option Monitor														
US 10YR NOTE (CBT) Sep21															133-08 / 01 / -0.235% 133-08 / 133-08+ Hi 133-11+ Lo 133-07+ Volm 116656 HV 3.98														
Center 133-16 Strikes 5 Exp Aug-21 on TYU1															Exch														
Calc Mode															Calc Mode														
Center Strike															Center Strike														
Calls															Puts														
Calls															Puts														
Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt	Strike	Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt									
Aug-21 (16d 7/23/21); CSize 1000000; TYU1 133-08															Aug-21 (16d 7/23/21); CSize 1000000; TYU1 133-08														
1) TYQ1C 133	'36	'37	'39	'39	3.84	.61	10:42	2004	69466	133	20	TYQ1P 133	'20	'21	'21	'21	3.96	-.40	11:53	260	39140								
2) TYQ1C 133.25	'27	'28	'28	'28	3.73	.51	14:01	1760	12972	133.25	27	TYQ1P 133.25	'27	'28	'28y	'28	3.67	-.51	12:00	75	1577								
3) TYQ1C 133.5	'19	'21	'19y	'19	3.61	.39	12:00	403	72573	133.5	28	TYQ1P 133.5	'35	'37	'35	'35	3.77	-.58	11:09	26	1676								
4) TYQ1C 133.75	'13	'15	'16	'16	3.81	.35	10:20	500	7022	133.75	29	TYQ1P 133.75	'45	'47	'48y	'48	3.77	-.69	12:00		59								
5) TYQ1C 134	'09	'11	'10	'10	3.76	.25	14:08	2337	47016	134	30	TYQ1P 134	'57	'59	'59y	'59	3.66	-.77	12:00		550								
Sep-21 (51d 8/27/21); CSize 1000000; TYU1 133-08															Sep-21 (51d 8/27/21); CSize 1000000; TYU1 133-08														
6) TYU1C 132.5	1'18	1'19	1'16y	1'16	4.21	.64	12:00		23015	132.5	31	TYU1P 132.5	'34	'35	'34y	'34	4.21	-.36	12:00		34623								
7) TYU1C 133	'61	'63	'60y	'60	4.11	.55	12:00		53877	133	32	TYU1P 133	'45	'47	'46y	'46	4.11	-.45	12:00		1000								
8) TYU1C 133.5	'44	'46	'45	'45	4.07	.46	12:05		3	41070	133.5	33	TYU1P 133.5	'60	'61	'62y	'62	4.09	-.55	12:00		16907							
9) TYU1C 134	'30	'32	'33	'33	4.05	.37	09:41		389	84778	134	34	TYU1P 134	'14	'16	'16y	'16	3.97	-.65	12:00		901							
10) TYU1C 134.5	'20	'22	'20y	'20	3.94	.26	12:00		2	45470	134.5	35	TYU1P 134.5	'136	'138	'138y	'138	3.94	-.74	12:00		831							
Oct-21 (79d 9/24/21); CSize 1000000; TYZ1 132-19+															Oct-21 (79d 9/24/21); CSize 1000000; TYZ1 132-19+														
11) TYZ1C 132.5	1'07y	1'07	4.39	.51	12:00					132.5	36	TYZ1P 132.5	1'04y	1'04	4.39	-.49	12:00												
12) TYZ1C 133	2'32	'56y	'56	4.39	.44	12:00				133	37	TYZ1P 133	'15	1'21y	1'21	4.39	-.56	12:00											
13) TYZ1C 133.5	2'32	'43y	'43	4.36	.37	12:00				133.5	38	TYZ1P 133.5	1'40y	1'40	4.36	-.63	12:00												
14) TYZ1C 134	'33y	'33y	4.39	.30	12:00					134	39	TYZ1P 134	1'62y	1'62	4.39	-.70	12:00												
15) TYZ1C 134.5	'25y	'25	4.42	.24	12:00					134.5	40	TYZ1P 134.5	2'22y	2'22	4.43	-.76	12:00												
Nov-21 (107d 10/22/21); CSize 1000000; TYZ1 132-19+															Nov-21 (107d 10/22/21); CSize 1000000; TYZ1 132-19+														
16) TYZ1C 132.5	1'09y	1'09	3.89	.51	12:00					132.5	41	TYZ1P 132.5	1'06y	1'06	3.89	-.49	12:00												
17) TYZ1C 133	'59y	'59	3.94	.44	12:00					133	42	TYZ1P 133	1'24y	1'24	3.94	-.56	12:00												
18) TYZ1C 133.5	'46y	'46	3.92	.37	12:00					133.5	43	TYZ1P 133.5	1'43y	1'43	3.92	-.63	12:00												
19) TYZ1C 134	'36y	'36	3.9																										



Category: Weekly Bond Options

Ticker	Description	Exchange	Type	Options	Volu...	↓ Open I...
1) WNYA Comdty	US Treasury Ultra Bond, W...	Chicago Board of T...	Option	Yes	116373	773581
2) 1MA Comdty	US Treasury Note, 10Yr Wk...	Chicago Board of T...	Option	Yes	102996	185114
3) 3MA Comdty	US Treasury Note, 10Yr Wk...	Chicago Board of T...	Option	Yes	97215	43338
4) 5MA Comdty	US Treasury Note, 10Yr Wk...	Chicago Board of T...	Option	Yes	58426	0
5) 2MA Comdty	US Treasury Note, 10Yr Wk...	Chicago Board of T...	Option	Yes	55054	144795
6) 4MA Comdty	US Treasury Note, 10Yr Wk...	Chicago Board of T...	Option	Yes	52300	0

Take note of this when looking at options on rates futures on the terminal. Even platforms like ToS or IBKR incorporate everything easily. Pfft. Shame on you Bloomberg.

6.3 Breaking Down an Option

When looking at options, you need to check the underlying especially the farther out you go on the calendar. In this screenshot you can see that the underlying changes from U1 to Z1 once you go past September (naturally as U1 futures are Sep expiry)

US 5YR NOTE (CBT) Sep21

Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OI	Strike
4) FVQ1C 124.25	'00+	'07+	'07+y	'07+	1.90	'19	12:00	1	173	124.25
5) FVQ1C 124.25	'03	'03+	'03+y	'03+	2.00	'19	12:00	1	130	124.25
Sep-21 (51d 8/27/21); CSize 100000; FVU1 123-23+										
6) FVU1C 123.25	'47	'48	'48+y	'48+	2.41	'68	12:00	93	123.25	123.25
7) FVU1C 123.5	'36+	'37+	'37+y	'37+	2.34	'60	12:00	95	210	123.5
8) FVU1C 123.75	'26+	'27+	'27+y	'27+	2.24	'51	12:00	169	123.75	123.75
9) FVU1C 124	'18+	'19	'21	'21	2.23	'42	08:29	192	796	124
10) FVU1C 124.25	'12	'13	'12y	'12	2.03	'31	12:00	177	124.25	124.25
Oct-21 (79d 9/24/21); CSize 100000; FVZ1 123-07										
11) FVW1C 122.75			'50y	'50	2.23	'64	12:00			122.75
12) FVW1C 123			'40y	'40	2.21	'57	12:00			123
13) FVW1C 123.25			'32y	'32	2.24	'49	12:00			123.25
14) FVW1C 123.5			'25+y	'25+	2.29	'42	12:00			123.5
15) FVW1C 123.75			'20+y	'20+	2.36	'35	12:00			123.75



Let's look at the August '21 133.00 Calls for US 10y Note futures starting with the ticker on Bloomberg: TYQ1C 133.00 COMB Comdty

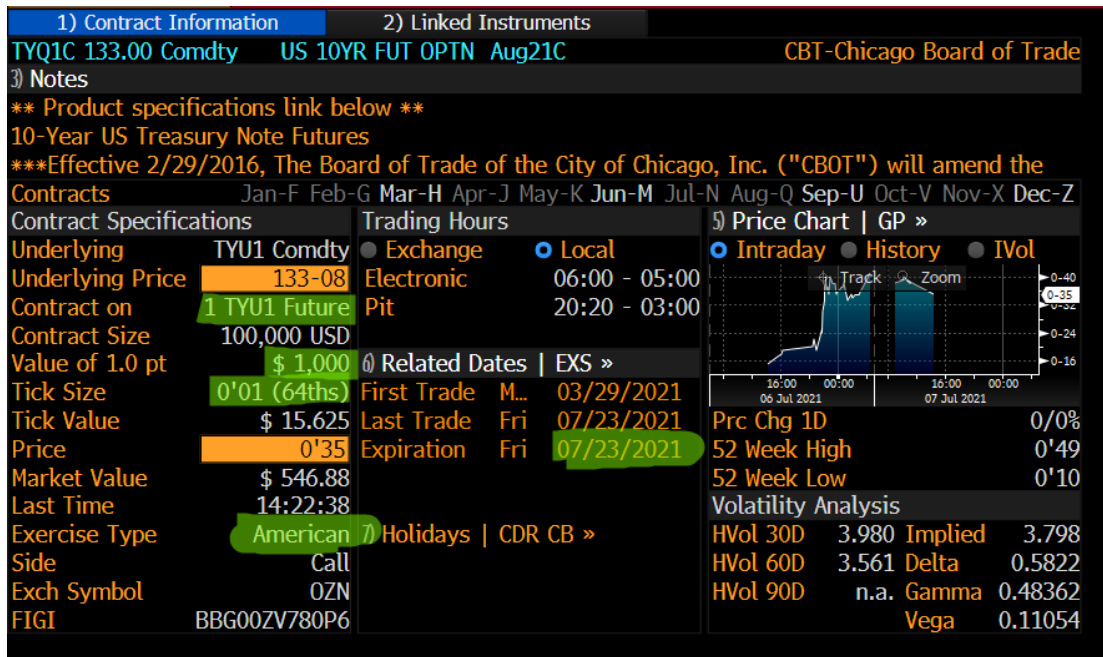
TY is the 10y futures ticker

Q1 is the option expiry month (Aug)

C is the option type – Call

133.00 is the strike

Going into the **DES<GO>** page we can see some more detail:



Firstly, the underlying is the TYU1 Future. Second because it is on 1 TY contract, 1 full point on the option is equal to 1 point on the future thus worth \$1000. The tick size of the option is expressed as 0'01 in 64ths – recall TY futures trade with a quotation of 0'01 as 32nds with the minimum tick being half (1/64th).

Simply, 0'01 on a TY option is **half the value** of 0'01 for a future. Don't get confused the next time you see TY options quoted as 0'48.

An American option means the option can be **exercised anytime** from now till the expiry date.

Options are on the price of the future, so buying a call means you are bullish on price and buying a put means you are bearish. If the strike of the call is less than the current price of the underlying, the option is In-the-money (ITM), same price it is At-the-money (ATM) and if more than current the option is Out-the-money (OTM). Flip it around for puts.

If a TY Call has a strike of 132-00 and the underlying future is 133-00 then the intrinsic value is 1'00. If all remains same, I can buy TY from the call seller at 132-00 and immediately sell it at market for 133-00 locking in 1-00 (\$1000). If the option is trading at a price of 1'48 (remember options are in 64^{ths}) then I am paying 48/64 (\$750) more than the intrinsic value – I am paying for flexibility.

6.4 Constructing a Trade

Now that we have the basic of the option on futures settled, lets dive into an example. As I write this, it is afternoon in Singapore on 7th July 2021. In about 11 hours the Fed minutes will get released. Suppose I'm wondering if they'll be a lot more hawkish than what the market expects, it might even show a more in-depth discussion about tapering.



Assuming the curve is going to bear flatten on that scenario and I know my portfolio's key rate risk is around 4.5 years I'll want to hedge out any adverse impact should 5y yield soar.

Indeed, 5s have been trading in a box the last 5 months, with a large flagpole pattern formed and currently at the base of the flag. Top of range could be 0.90% which is about 9bps away. Because I'm just worried about the impact from fed minutes, the weeklies for this Friday cover me – ticker 21A Comdty for 5y weeklies.

FVA Comdty Risk is 5.386, last traded 123-23¾ (123.7421875)

Average Risk= 5.38 (See Price Settings on CDEF <G0>)
 FVU1 prc 123-24 Rsk=5.386 FwdRsk=5.084(CTD = T 0 ¾ 11/30/25 @ .72%cnvYTM)



FVU1 123-23³/₄ - 01 123-23+ / 123-23³/₄ 1135 x 259 Prev 123-24³/₄
 At 14:57 Vol 66551 Op 123-26³/₄ Hi 123-26+ Lo 123-23³/₄ OpenInt 3488771

2IU1 Comdty 95 Actions 96 Export 97 Settings Option Monitor
 US 5YR NOTE 2nd W Sep21 123-23³/₄ - 01 -.0252% 123-23+ / 123-23³/₄ Hi 123-26+ Lo 123-23³/₄ Volm 66551 HV 2.33
 Center 123-23³/₄ Strikes 20 Exp Jul-21 on 2IU1 Exch

Calc Mode

Calls										Puts										
Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	Strike	Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	Strike	
1 2IN1C 121.5	2'15	2'16	2'17+y	2'17+	4.22	1.00	12:00		121.5	21 2IN1P 121.5	'00+		y	7.16		12:00			121.5	
2 2IN1C 121.75	1'63	2'00	2'01+y	2'01+	3.91	1.00	12:00		121.75	22 2IN1P 121.75	'00+		y	6.40		12:00			121.75	
3 2IN1C 122	1'47	1'48	1'49+y	1'49+	4.01	1.00	12:00		122	23 2IN1P 122	'00+		y	5.56		12:00			122	
4 2IN1C 122.25	1'31	1'32	1'33+y	1'33+	1.93	1.00	12:00		122.25	24 2IN1P 122.25	'00+		y	4.86		12:00			122.25	
5 2IN1C 122.5	1'15	1'16	1'17+y	1'17+	3.18	1.00	12:00		122.5	25 2IN1P 122.5	'00+		y	3.95		12:00			122.5	
6 2IN1C 122.75	'63	'00	'01+y	'01+	1.27	1.00	12:00		122.75	26 2IN1P 122.75	'00+		y	3.29	-.01	12:00			122.75	
7 2IN1C 123	'47	'48+	'49+y	'49+	1.93	1.00	12:00		123	27 2IN1P 123	'00+		y	2.24	-.01	12:00			123	
8 2IN1C 123.25	'31+	'32+	'34y	'34	2.87	.98	12:00		123.25	28 2IN1P 123.25	'00+	'01	'00+y	'00+	2.93	-.04	12:00			123.25
9 2IN1C 123.5	'17	'18	'19+y	'19+	2.74	.81	12:00		123.5	29 2IN1P 123.5	'02	'02+	'02y	'02	2.74	-.19	12:00			123.5
10 2IN1C 123.75	'06	'07	'08y	'08	2.43	.53	12:00		123.75	30 2IN1P 123.75	'07	'07+	'07+	'07+	3.06	-.52	14:26			123.75
11 2IN1C 124	'01+	'02	'02y	'02	2.43	.20	12:00		124	31 2IN1P 124	'18	'19	'16+y	'16+	2.43	-.80	12:00			124
12 2IN1C 124.25	'00+	'01	'00+y	'00+	2.72	.06	12:00		124.25	32 2IN1P 124.25	'32+	'34	'31y	'31	2.72	-.94	12:00			124.25
13 2IN1C 124.5	'00+		y		2.10	.01	12:00		124.5	33 2IN1P 124.5	'48	'49+	'46+y	'46+	1.80	-1.00	12:00			124.5
14 2IN1C 124.75	'00+		y		3.03	.01	12:00		124.75	34 2IN1P 124.75	1'00	1'01+	'62+y	'62+	2.41	-1.00	12:00			124.75
15 2IN1C 125	'00+		y		3.74		12:00		125	35 2IN1P 125	1'16	1'17+	1'14+y	1'14+	3.03	-1.00	12:00			125
16 2IN1C 125.25	'00+		y		4.56	.01	12:00		125.25	36 2IN1P 125.25	1'32	1'33+	1'30+y	1'30+	3.64	-1.00	12:00			125.25
17 2IN1C 125.5	'00+		y		5.35		12:00		125.5	37 2IN1P 125.5	1'48	1'49+	1'46+y	1'46+	2.60	-1.00	12:00			125.5
18 2IN1C 125.75	'00+		y		6.07		12:00		125.75	38 2IN1P 125.75	2'00	2'01	1'62+y	1'62+	4.67	-1.00	12:00			125.75
19 2IN1C 126	'00+		y		6.91		12:00		126	39 2IN1P 126	2'16	2'17	2'14+y	2'14+	3.21	-1.00	12:00			126
20 2IN1C 126.25	'00+		y		7.62		12:00		126.25	40 2IN1P 126.25	2'32	2'33	2'30+y	2'30+	5.25	-1.00	12:00			126.25

If I'm worried that minutes somehow shock rates 9bps higher then I want to be bearish 5s and therefore look at PUTS. From current, 9bps risk to FVA would be a decline of $(5.386 * 9)/100 = 0.4847$ >> $(123.7422 - 0.4847) = 123.2575$

2IU1 Comdty 95 Actions 96 Export 97 Settings Option Monitor
 US 5YR NOTE 2nd W Sep21 123-23+ - 01³/₄ -.0316% 123-23+ / 123-23³/₄ Hi 123-26+ Lo 123-23³/₄ Volm 69273 HV 2.33
 Center 123-23+ Strikes 20 Exp Jul-21 on 2IU1 Exch

Calc Mode

Puts										
Strike	Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt
20	Jul-21 (2d 7/9/21); CSize 100000; 2IU1 123-23+									
121.5	1 2IN1P 121.5		'00+	y		7.16		12:00		237
121.75	2 2IN1P 121.75		'00+	y		6.40		12:00		161
122	3 2IN1P 122		'00+	y		5.56		12:00		91
122.25	4 2IN1P 122.25		'00+	y		4.86		12:00		950
122.5	5 2IN1P 122.5		'00+	y		3.95		12:00		2349
122.75	6 2IN1P 122.75		'00+	y		3.29	-.01	12:00		4213
123	7 2IN1P 123		'00+	y		2.24	-.01	12:00		7726
123.25	8 2IN1P 123.25	'00+	'01	'00+y	'00+	2.93	-.04	12:00		2813
123.5	9 2IN1P 123.5	'02	'02+	'02y	'02	2.74	-.19	12:00		2350
123.75	10 2IN1P 123.75	'07	'08	'07+	'07+	3.06	-.52	14:26	52	11
124	11 2IN1P 124	'18	'19	'16+y	'16+	2.43	-.80	12:00		278
124.25	12 2IN1P 124.25	'32+	'34	'31y	'31	2.72	-.94	12:00		160
124.5	13 2IN1P 124.5	'48+	'49+	'46+y	'46+	1.80	-1.00	12:00		1
124.75	14 2IN1P 124.75	1'00+	1'01+	'62+y	'62+	2.41	-1.00	12:00		1
125	15 2IN1P 125	1'16	1'17+	1'14+y	1'14+	3.03	-1.00	12:00		
125.25	16 2IN1P 125.25	1'32	1'33+	1'30+y	1'30+	3.64	-1.00	12:00		
125.5	17 2IN1P 125.5	1'48	1'49+	1'46+y	1'46+	2.60	-1.00	12:00		
125.75	18 2IN1P 125.75	2'00	2'01+	1'62+y	1'62+	4.67	-1.00	12:00		
126	19 2IN1P 126	2'16	2'17+	2'14+y	2'14+	3.21	-1.00	12:00		
126.25	20 2IN1P 126.25	2'32	2'33+	2'30+y	2'30+	5.25	-1.00	12:00		

If I were to buy the P123.25 strike, that would only be ATM if 5s were to rise 9bps, so I wouldn't actually save myself much pain. To actually protect my portfolio, I would have to enter at higher strikes. Let's say I buy the current ATM put at 123.75 – it costs 0'08 which is 8/64ths = $0.125 * 1000 = \$125$ per option.

Simplistically, if 5y yields ripped 9bps tonight the FVA future would trade around 123.25 meaning the intrinsic value of the option is $123.75 - 123.25 = 0.50$

Less the cost of my option at 0.125 and I have a profit of 0.375 (\$375) if yields don't move after that till Friday. For me though, I am protecting a portfolio that will lose the 9bps of interest rates move so in reality it's just hedging out some risk. The \$375 I make will be lost in the portfolio but at least the top-level loss is mitigated.

What happens if yield don't move up? Then the options potentially expire worthless, and I lose \$125 per option. This is the cost of hedging, a.k.a. insurance. Let it be known, hedges should lose money and you should never be happy when they don't. **How does this translate into a portfolio allocation?** Firstly, look at the delta of the ATM option: -0.52



Strike	Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt
20	Jul-21 (2d 7/9/21); CSize 100000; 21U1 123-23%									
121.5	1) 2IN1P 121.5		'00+	y		7.16		12:00		237
121.75	2) 2IN1P 121.75		'00+	y		6.40		12:00		161
122	3) 2IN1P 122		'00+	y		5.56		12:00		91
122.25	4) 2IN1P 122.25		'00+	y		4.86		12:00		950
122.5	5) 2IN1P 122.5		'00+	y		3.95		12:00		2349
122.75	6) 2IN1P 122.75		'00+	y		3.29	-0.01	12:00		4213
123	7) 2IN1P 123		'00+	y		2.24	-0.01	12:00		7726
123.25	8) 2IN1P 123.25	'00+	'01	'00+y	'00+	2.93	-0.04	12:00		2813
123.5	9) 2IN1P 123.5	'01+	'02+	'02v	'02	2.74	-0.19	12:00		2350
123.75	10) 2IN1P 123.75	'06+	'07+	'07+	'07+	3.06	-0.52	14:26	52	11
124	11) 2IN1P 124	'17+	'18+	'16+y	'16+	2.43	-0.80	12:00		278
124.25	12) 2IN1P 124.25	'32+	'33+	'31y	'31	2.72	-0.94	12:00		160
124.5	13) 2IN1P 124.5	'48	'49+	'46+y	'46+	1.80	-1.00	12:00		1
124.75	14) 2IN1P 124.75	'1'00	'1'01	'62+y	'62+	2.41	-1.00	12:00		1
125	15) 2IN1P 125	'1'16	'1'17	'14+y	'14+	3.03	-1.00	12:00		
125.25	16) 2IN1P 125.25	'1'32	'1'33	'30+y	'30+	3.64	-1.00	12:00		
125.5	17) 2IN1P 125.5	'1'48	'1'49	'46+y	'46+	2.60	-1.00	12:00		
125.75	18) 2IN1P 125.75	'2'00	'2'01	'62+y	'62+	4.67	-1.00	12:00		
126	19) 2IN1P 126	'2'16	'2'17	'14+y	'14+	3.21	-1.00	12:00		
126.25	20) 2IN1P 126.25	'2'32	'2'33	'30+y	'30+	5.25	-1.00	12:00		

That means for every \$1 move in the underlying future the value of the option will move 52 cents right now – i.e., half. Why is this so? Well, in a basic sense the future trades at 123.75 right now and my put is for 123.75 – what are the odds (probability) that the future moves up or down respectively? Who knows?! In other words: 50/50

The expected value of the move is 50%. This is generally why ATM options trade with a delta around 50. As the spot move further ITM from strike the delta will increase (gamma).

In OVME we can model the option out. An instantaneous shift in underlying today from 123-23% to 123-16 (about 3.6bps move in 5y) would cause delta to increase from 52 to 92.5. The implication is that the more ITM the option gets, the higher the \$impact on PnL each bp move makes.



Asset	Actions	Products	Views	Settings
Fixed-float cross currency				
Deal 1	22 +	23 Load	24 Save	25 Trade
26 Pricing	27 Scenario	28 Matrix	29 Volatility	30 Backtest
Underlying	FVU1 Comdty	US 5YR NOTE (CBT)	Trade	07/07/2021 16:41
Und. Price	123-23%	USD	Settle	07/07/2021
Results				
Price (Total)	74.31	Currency	USD	Vega
Price (Share)	105	Delta (%)	-51.74	Theta
Price (%)	0.0600	Gamma (%)	279.7635	Rho
American Vanilla	Leg 1			
Style	Vanilla			
Exercise	American			
Call/Put	Put			
Direction	Buy			
Strike	123'48			
Strike % Money	0.01% ITM			
Shares	1,000.00			
Expiry	07/09/2021 05:00			
Time to Expiry	1 12:19			
Model	Black			
Vol	BVOL 2.213%			
USD Rate	MMkt 0.000%			

Asset	Actions	Products	Views	Settings
Fixed-float cross currency				
Deal 1	22 +	23 Load	24 Save	25 Trade
26 Pricing	27 Scenario	28 Matrix	29 Volatility	30 Backtest
Underlying	FVU1 Comdty	US 5YR NOTE (CBT)	Trade	07/07/2021 16:41
Und. Price	123-16	USD	Settle	07/07/2021
Results				
Price (Total)	255.77	Currency	USD	Vega
Price (Share)	164	Delta (%)	-92.54	Theta
Price (%)	0.2071	Gamma (%)	100.5766	Rho
American Vanilla	Leg 1			
Style	Vanilla			
Exercise	American			
Call/Put	Put			
Direction	Buy			
Strike	123'48			
Strike % Money	0.20% ITM			
Shares	1,000.00			
Expiry	07/09/2021 05:00			
Time to Expiry	1 12:19			
Model	Black			
Vol	BVOL 2.176%			
USD Rate	MMkt 0.000%			

So, putting these pieces together – right now if my portfolio key rate risk is ~5y and I want to hedge out 50% of it and the portfolio \$value is \$20MM with a portfolio DV01 of \$4,000 I would need to hedge out \$2,000 DV01 using options on 5s.

With a risk of 5.39, that equates to 37 lots of FVA. However, the option trades at a delta of -0.52 meaning the DV01 of 37 ATM options is currently $(1,993 * 0.52) = 1036.36$. In other words, I would currently have to buy 74 lots of ATM puts to reduce my portfolio DV01 by \$1000.



Hedge Selection	Security	Price	Yield	Risk	BPV	Hdg Ratio	Hedge Amt	Repo	DCOH
Hedge Rate Risk 9D (FIHR)									
■ Cash	T 0 7/8 06/30/26	100-10+	.808	4.88	1,993	1.10	4.08MM	.07	-82
■ Future	FVU1 Comdty	123-24 3/4	--	5.39	1,994	1.00	37	.07	-81
Hedge Rate and Curve Risk									
■ Cash-Barbell	T 0 1/4 06/15/24	99-16 3/4	.419	2.91	567	1.85	1.95MM	.07	-18
■ Future-Barbell	TU01 Comdty	110-06 3/4	--	2.15	990	2.50	23	.07	-21
■ IRS 9D (SWPM)	Pay Fixed (11/30/25)		.789	4.42	1,993	1.22	4.51MM		-84

This is important for a few reasons, the first of which is that the cost of hedging is affected by the delta of the option. The lower the delta the more you have to hedge and as that delta changes, the size of your hedge must also change.

6.5 Option Value Considerations – Delta and Implied Volatility

As delta increases, it increases the impact of your hedge. If you are maintaining a specific DV01 hedge you would have to reduce (i.e., sell) the puts as it moves further ITM in order to reduce the DV01 as gamma increases.

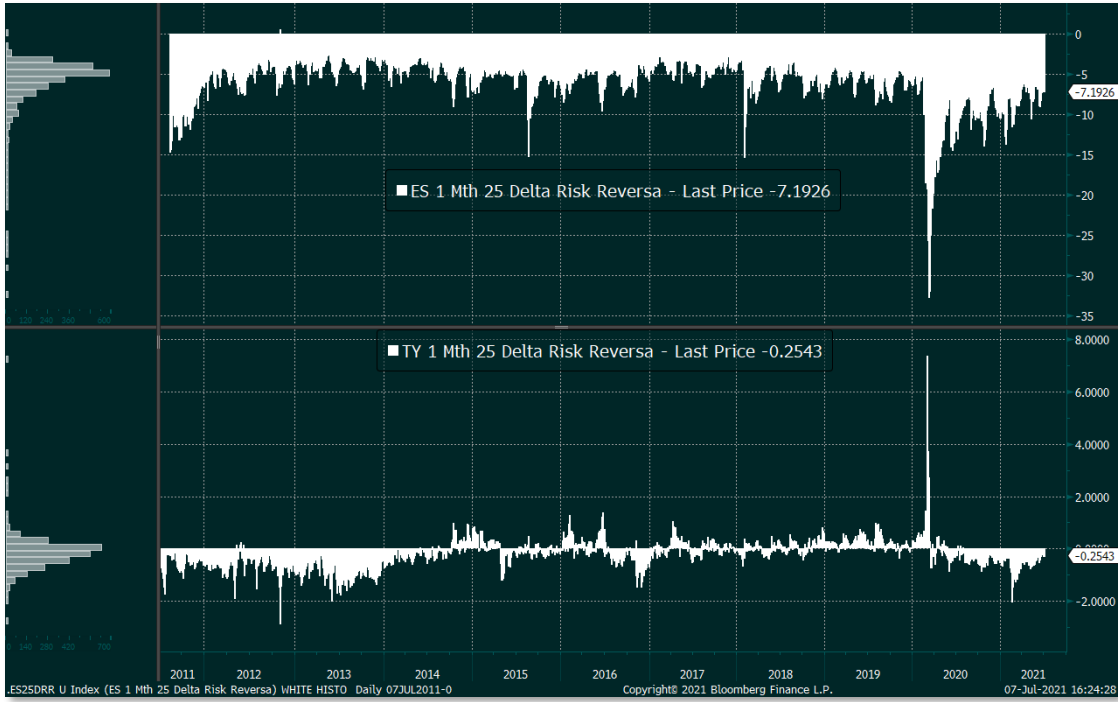
For me, I tend to focus on intrinsic value of the option strategy given the scenario I am positioning for, with the mentality that the premium I pay will burn away (hence it is an insurance premium). As a result, I must factor how much this insurance costs relative to my book value.

Very simply, if I did 37 lots that would cost me \$4,625 at a price of 0'08 per option. On a \$20MM book that is 2.3bps. Doesn't sound like much, but if I have a target return of 4% a year, I need to earn 1.6bps a day. So, you must weigh up the risk-to-reward of the option scenario but also the **risk-to-reward of the hedge as a cost to the portfolio.**

I tend not to run constant hedges via options due to the larger need to dynamically adjust for them. My preference is using futures for hedging portfolio duration and options for managing event risk. No hard and fast rule here. When looking at options, the other critical aspect to look at is Implied Volatility (IV) – based on the option's strike and expiry relative to the underlying and the option price, what is the implied move of the underlying?

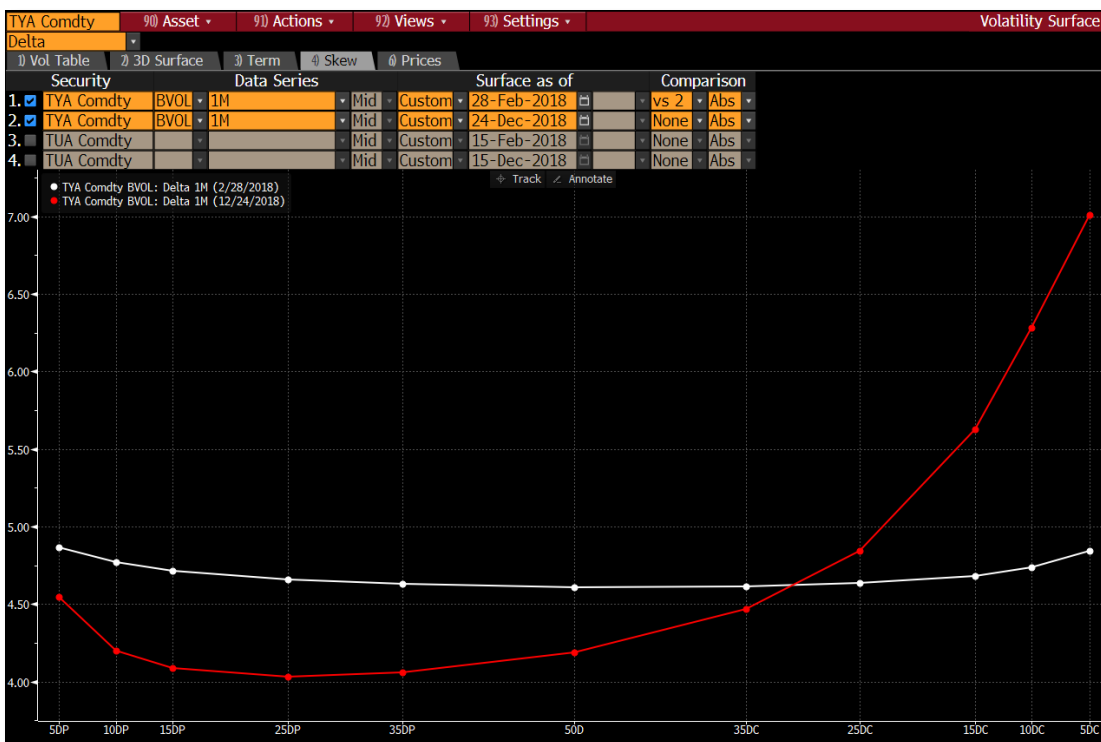
In other words, what's the probability that the underlying price moves to the option strike in the given time frame? The higher the likelihood, the higher the price should be. Pay to play. The more volatile, the larger the moves (in both directions).

Unlike equities, bond futures IVs tend to exhibit a slightly more even distribution of volatility skew. Basically, equities are typically worried about downside moves (and vol expands on down moves more than up moves) while in treasuries it more regime dependent. Below are the 1-month 25D skews for ES and TY compared. 25 delta skew just means you take the IV for 1M calls trading at 25 delta and minus the IV for 1M puts trading at -25 delta. A more negative number means the IV on puts is larger than the IV on comparative calls.



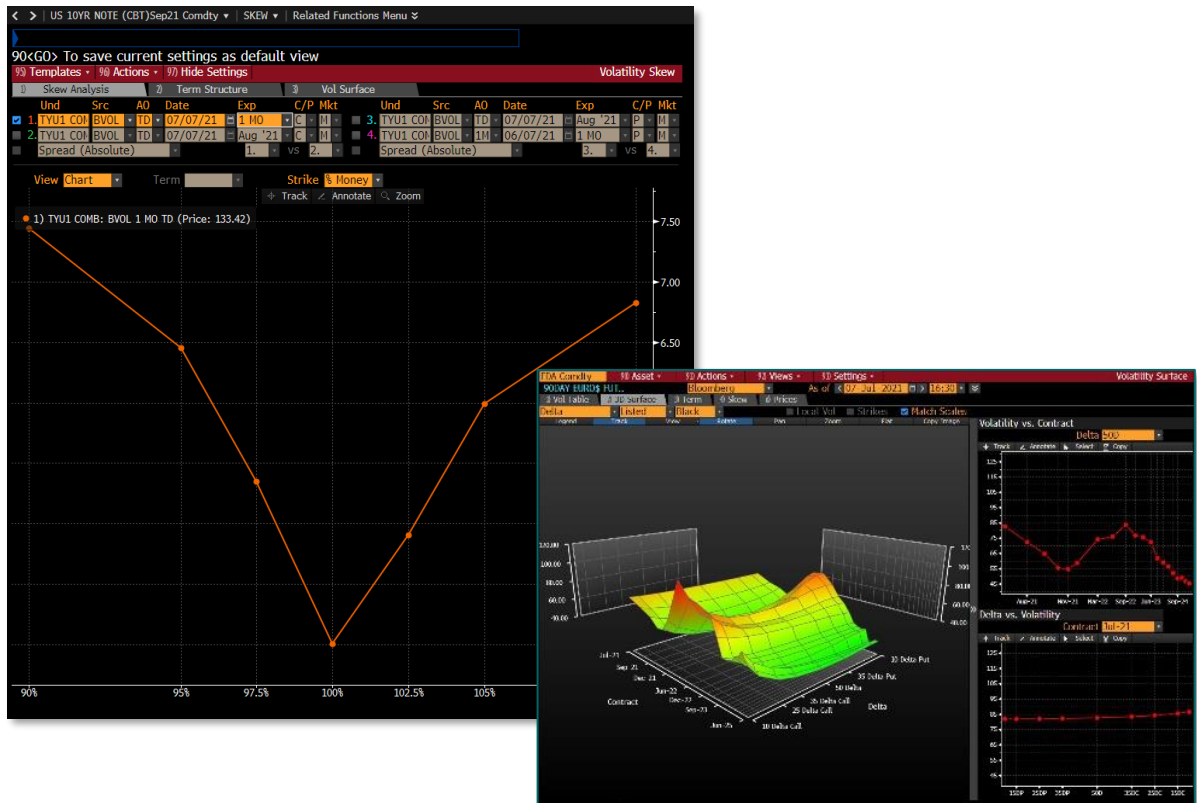
This makes looking at vol skews on rates futures interesting because there's a little more two-way than broad equity indices – **the rate cycle matters**.

To view the skew, you can go to `OVDV<GO>` on the terminal to see this. Here's an example of TY skew back in 2018 comparing February skew (red) when inflation worries were top of mind (and resulting Fed hikes) versus December that year when stocks were selling off massively on Fed autopilot.



Notice how the skew flips massively? In Feb the skew was much more symmetrical (a smile) while in Dec '18 it looked like Quasimodo got his bells rang the right way.

You can also use the **SKEW<GO>** function which will plot vol by moneyness as default. Moneyness is simply strike as % of spot. In **OVDV** there is a tab for the 3D Surface. This is a screen that was used in ancient times when we all worked in an office with other people and your boss showed clients around the trading floor.



6.6 Scenario Analysis

Finally, we can go through some option scenario analysis. On 4th Jan I tweeted: “...imo the path of lesser resistance is towards higher rates. 10s towards 1.50 with possible overshoot then a grind lower in 2H.”

Now let’s say I’m uber-bullish on bonds and think it’s no longer a grind – I think by the time Jackson Hole wraps up risk assets are on fire, HY spreads are blowing up and growth projections are getting cut. I think 10s will be 1%. I also think 1.50% is the high bar so I’d be happy to own bonds there.

How would I model look at this scenario with options? Firstly, I’ll use TYA – where the underlying is roughly 7y paper, not 10. But with 10s at 1.30% currently that’s 30bps to my lower target and 20bps to my upside target on yield. 7s trade roughly with a 0.9 beta to 10s so I’m looking at 27bps and 18bps downside/upside respectively.

TYA currently is 133-17+ with risk of 8.429. So, if yields drop to my target that’s 2.276 points (8.429×0.27) and if yield rise that’s -1.517 points (8.429×0.18). The price levels are 135.82 to the upside and 132.03 to the downside. I’ll model 2 scenarios:

Scenario 1: High long conviction to 1.00% yield target.

There are few things to look at now:

1. How much does it cost to gain long exposure and at what strike?
2. Is it worth selling calls at my target strike to cheapen the structure?

Firstly, I need to buy a strike below my target in order to have any reasonable chance of making money (I’m not trading vol here).



Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt	Strike	
20 TYU1C 129	4'37	4'39	4'38y	4'38	5.43	.96	12:00	319	129.120	129	
21 TYU1C 129.5	4'06	4'08	4'07y	4'07	5.22	.94	12:00	323	129.512	129.5	
22 TYU1C 130	3'39	3'41	3'40y	3'40	4.94	.93	12:00	338	130.120	130	
23 TYU1C 130.5	3'10	3'12	3'11y	3'11	4.96	.89	12:00	349	130.512	130.5	
24 TYU1C 131	2'45	2'47	2'46y	2'46	4.81	.86	12:00	9643	131.120	131	
25 TYU1C 131.5	2'18	2'20	2'19y	2'19	4.76	.81	12:00	12763	131.512	131.5	
26 TYU1C 132	1'56	1'58	1'61	1'61	4.59	.77	09:36	10	28539	132.120	132
27 TYU1C 132.5	1'32	1'34	1'34y	1'34	4.61	.68	12:00	23094	132.512	132.5	
28 TYU1C 133	1'11	1'12	1'13y	1'13	4.55	.60	12:00	48	53484	133.120	133
29 TYU1C 133.5	'55	'57	'58y	'58	4.43	.51	12:00	50	44330	133.512	133.5
30 TYU1C 134	'40	'41	'42	'42	4.21	.43	08:13	1048	88889	134.120	134
31 TYU1C 134.5	'28	'29	'30	'30	4.21	.34	08:38	49	46639	134.512	134.5
32 TYU1C 135	'19	'20	'20	'20	4.25	.25	10:50	57	81956	135.120	135
33 TYU1C 135.5	'13	'14	'14y	'14	4.32	.19	12:00	75	21246	135.512	135.5
34 TYU1C 136	'09	'10	'10y	'10	4.45	.14	12:00	28615	136.120	136	
35 TYU1C 136.5	'06	'07	'07y	'07	4.57	.10	12:00	9131	136.512	136.5	
36 TYU1C 137	'04	'05	'05y	'05	4.71	.07	12:00	10450	137.120	137	
37 TYU1C 137.5	'03	'04	'04	'04	4.97	.06	07:47	5	4470	137.512	137.5
38 TYU1C 138	'02	'03	'03	'03	5.14	.04	07:51	63	5572	138.120	138
39 TYU1C 138.5	'01	'03	'02y	'02	5.19	.03	12:00	5220	138.512	138.5	

If I were to buy an ATM Sep call it would cost me '57 (\$890 per contract). My upside target is 135.50 so under blue skies I'd make \$2k (135.5-133.5) less cost of option = \$1,110 profit per contract. Simple R:R is $1.110 / 0.89 = 1.25$

In my book, that sucks balls. You want something better than that. (Note that I assume price stops at my target)

What if I cheapen the structure by selling the strike at my upside target and make it a call spread? If prices rise my long call gets ITM and I make money. At the strike of the short call my exposure flattens out. The cost would be $(57-13) / 64 = 687.50$ per so my R:R is now 1.91 – sounds okay-ish.

ATM calls are just too expensive currently. The 134s are offered '41. If I do a 134-135.50 Sep call spread, it would cost me \$437.50 and my upside would be 1,062.50 with an R:R of 2.43 – let's keep that in the back pocket for now.

Scenario 2: I think the long play is fine, but I really think the market is going to retest 1.50% on 10s first. I'd LOVE to own them at those levels but for now bonds are overbought and will likely get sold up to my target yield of 1.50%.

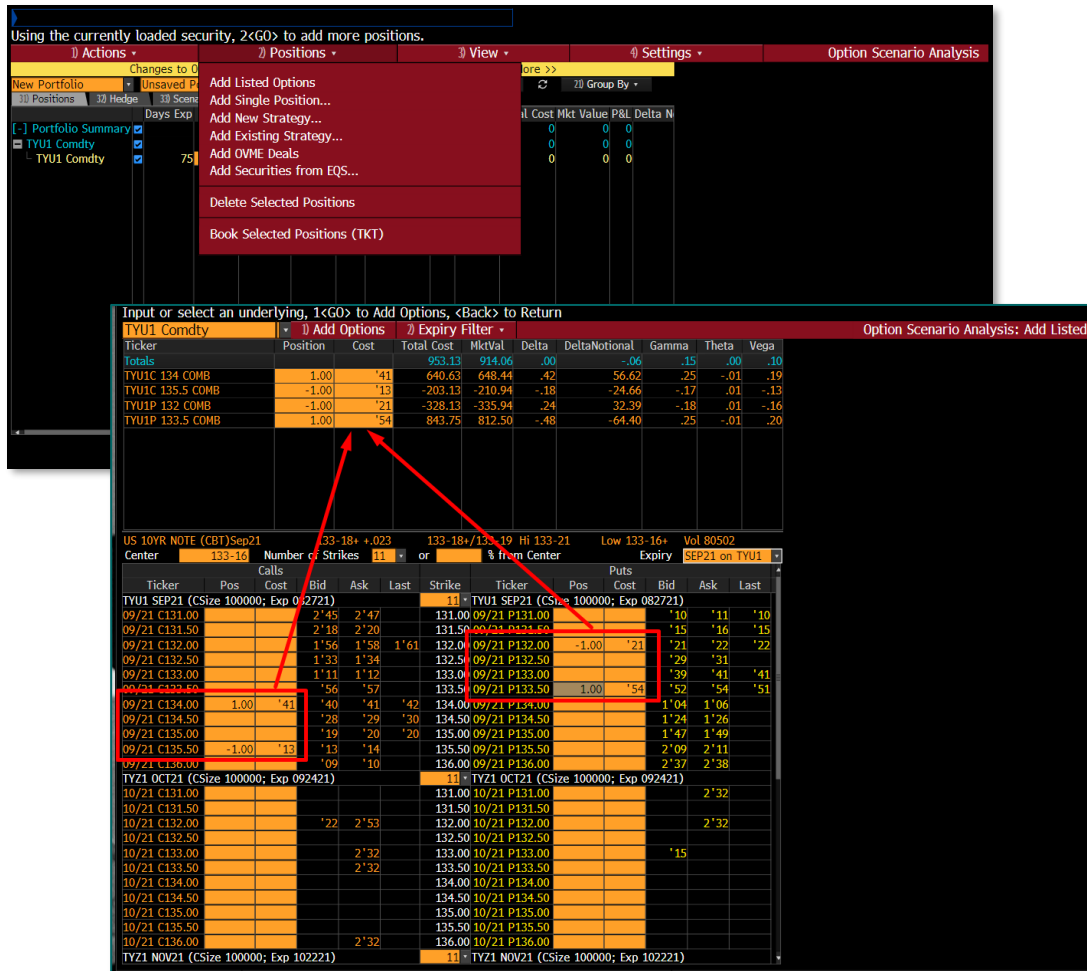
Ticker	Bid	Ask	Last	sEPx	IVL	DL	Time	Volm	OInt	Strike
20 TYU1P 129	'02	'03	'03y	'03	5.41	-.04	12:00	78742	129.120	129
21 TYU1P 129.5	'03	'04	'04y	'04	5.21	-.06	12:00	99545	129.512	129.5
22 TYU1P 130	'05	'06	'05	'05	4.95	-.07	12:17	903	112063	130
23 TYU1P 130.5	'07	'08	'08y	'08	4.96	-.10	12:00	46693	130.512	130.5
24 TYU1P 131	'10	'11	'10	'10	4.70	-.13	11:10	5	99018	131
25 TYU1P 131.5	'15	'16	'15	'15	4.66	-.18	12:17	878	54822	131.5
26 TYU1P 132	'21	'22	'22	'22	4.67	-.25	11:11	2	121945	132
27 TYU1P 132.5	'29	'30	'31y	'31	4.61	-.32	12:00	1	41398	132.5
28 TYU1P 133	'39	'41	'41	'41	4.48	-.40	12:17	310	27967	133
29 TYU1P 133.5	'52	'54	'51	'51	4.32	-.47	08:19	208	35977	133.5
30 TYU1P 134	1'04	1'06	1'07y	1'07	4.33	-.58	12:00	9434	134.120	134
31 TYU1P 134.5	1'24	1'26	1'27y	1'27	4.32	-.67	12:00	865	134.512	134.5
32 TYU1P 135	1'47	1'49	1'50y	1'50	4.34	-.75	12:00	766	135.120	135
33 TYU1P 135.5	2'09	2'11	2'11y	2'11	4.32	-.81	12:00	265	135.512	135.5
34 TYU1P 136	2'37	2'39	2'39y	2'39	4.46	-.86	12:00	151	136.120	136
35 TYU1P 136.5	3'02	3'04	3'04y	3'04	4.58	-.90	12:00	124	136.512	136.5
36 TYU1P 137	3'32	3'34	3'34y	3'34	4.72	-.92	12:00	138	137.120	137
37 TYU1P 137.5	3'63	4'01	4'01y	4'01	4.98	-.94	12:00	313	137.512	137.5
38 TYU1P 138	4'30	4'32	4'32y	4'32	5.15	-.95	12:00	384	138.120	138
39 TYU1P 138.5	4'61	4'63	4'63y	4'63	5.21	-.97	12:00	35	138.512	138.5

Same thing here, ATM puts cost me '54 while my target (132) is bid at '21. A put spread (buy closer strike Put, sell further away strike put) would cost me \$328 (21 / 64ths). My upside is 1.5k and after cost is 1.172k with an R:R of 3.57. So now I have an upside and a downside play. Let's plug them into the scenario analysis using **OSA<GO>**

PLEASE NOTE: Bloomberg reverted to their blood-sucking nature and made the key parts of OSA mentioned below into **ADDITIONALLY PAID** features of their MARS functionality. In other words, they made OSA useless

to everyday peasants that already pay US\$20k a year to use the terminal. Pathetic. Either way, just read the below section and take away the principles and approach I employ.

Click on listed options to see the options chain. Recall if you are doing this with weeklies, you'll need to load the weekly bond future ticker at the top left instead.



Using the currently loaded security, 2<G0> to add more positions.

1) Actions 2) Positions 3) View 4) Settings Option Scenario Analysis

Changes to OSA usage allowance will apply starting 31st July, 2021. See More >>

New Portfolio Unsaved Portfolio Add Position > USD 07/08/21 Group By

3) Positions 3) Hedge 3) Scenario Matrix 3) Scenario Chart 3) Multi-Asset Scenario

Days Exp Positi... Expiry Mkt Px M Intrinsic Px IVol Cost Total Cost Mkt Value P&L Delt

[-] Portfolio Summary

- TYU1 Comdty
 - TYU1 Comdty 75 0 09/21/21 133-26+ 1 438 563 125
 - TYU1C 135.50 Comdty 51 -1 09/28/21 '15 1 0.00 4.26 '13 -203 -234 -31
 - TYU1P 133.50 Comdty 51 0 08/28/21 '51 1 0.00 4.21 '54 0 0 0
 - TYU1C 134.00 Comdty 51 1 09/28/21 '51 1 0.00 4.43 '41 641 797 156
 - TYU1P 132.00 Comdty 51 0 08/28/21 '20 1 0.00 4.77 '23 0 0 0

Option Scenario Analysis: Add Listed

Ticker	Position	Cost	Total Cost	MktVal	Delta	DeltaNotional	Gamma	Theta	Vega
Totals			953.13	934.06	.00				
TYU1C 134 COMB	1.00	'41	640.63	648.44	.42	56.62	.25	-.01	.19
TYU1C 135.5 COMB	-1.00	'15	-203.13	-210.94	-.18	-24.66	-.17	.01	-.13
TYU1P 132 COMB	-1.00	'21	-328.13	-335.94	-.24	32.39	-.18	.01	-.16
TYU1P 133.5 COMB	1.00	'54	843.75	812.50	-.48	-64.40	.25	-.01	.20

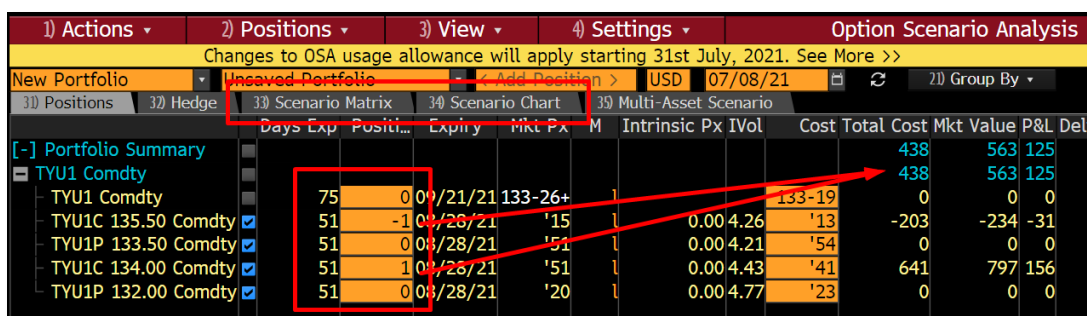
US 10YR NOTE (CBT)Sep21 133-18+ +.023 133-18+/133-19 Hi 133-21 Low 133-16+ Vol 80502

Center 133-16 Number of Strikes 11 or % from Center Expiry SEP21 on TYU1

Calls										Puts									
Ticker	Pos	Cost	Bid	Ask	Last	Strike	Ticker	Pos	Cost	Bid	Ask	Last							
TYU1 SEP21 (CSize 100000; Exp 082721)							TYU1 SEP21 (CSize 100000; Exp 082721)												
09/21 C131.00		2'45	2'47			131.00	09/21 P131.00		1'10			'11							
09/21 C131.50		2'18	2'20			131.50	09/21 P131.50		'15			'16							
09/21 C132.00		1'56	1'58	1'61		132.00	09/21 P132.00	-1.00	'21			'22							
09/21 C132.50		1'33	1'34			132.50	09/21 P132.50		'29			'31							
09/21 C133.00		1'11	1'12			133.00	09/21 P133.00		'39			'41							
09/21 C133.50		'56	'57			133.50	09/21 P133.50	1.00	'54			'54							
09/21 C134.00	1.00	'41	'40	'41	'42	134.00	09/21 P134.00		1'04			1'06							
09/21 C134.50		'28	'29	'30		134.50	09/21 P134.50		1'24			1'26							
09/21 C135.00		'19	'20	'20		135.00	09/21 P135.00		1'47			1'49							
09/21 C135.50	-1.00	'13	'14			135.50	09/21 P135.50		2'09			2'11							
09/21 C136.00		'09	'10			136.00	09/21 P136.00		2'37			2'38							
TYZ1 OCT21 (CSize 100000; Exp 092421)							TYZ1 OCT21 (CSize 100000; Exp 092421)												
10/21 C131.00						131.00	10/21 P131.00					2'32							
10/21 C131.50						131.50	10/21 P131.50												
10/21 C132.00		'22	2'53			132.00	10/21 P132.00					2'32							
10/21 C132.50						132.50	10/21 P132.50												
10/21 C133.00						133.00	10/21 P133.00					'15							
10/21 C133.50						133.50	10/21 P133.50												
10/21 C134.00						134.00	10/21 P134.00												
10/21 C134.50						134.50	10/21 P134.50												
10/21 C135.00						135.00	10/21 P135.00												
10/21 C135.50						135.50	10/21 P135.50												
10/21 C136.00						136.00	10/21 P136.00												
TYZ1 NOV21 (CSize 100000; Exp 102221)							TYZ1 NOV21 (CSize 100000; Exp 102221)												

1. For my upside scenario I want to buy the C134s and sell the C135.50s
2. For my downside scenario I want to buy the P133.50s and sell the P132s

Enter your quantity with direction. I put 1 for a long and -1 for a sell. The quantity doesn't matter for now, I can always scale to size as needed. Once done, click Add Options at the top. Start by zeroing the put positions so we just have the call spread loaded, you'll notice the cost associated with this. From here click on Scenario Matrix and later on, the Chart tab.



1) Actions 2) Positions 3) View 4) Settings Option Scenario Analysis

Changes to OSA usage allowance will apply starting 31st July, 2021. See More >>

New Portfolio Unsaved Portfolio Add Position > USD 07/08/21 Group By

3) Positions 3) Hedge 3) Scenario Matrix 3) Scenario Chart 3) Multi-Asset Scenario

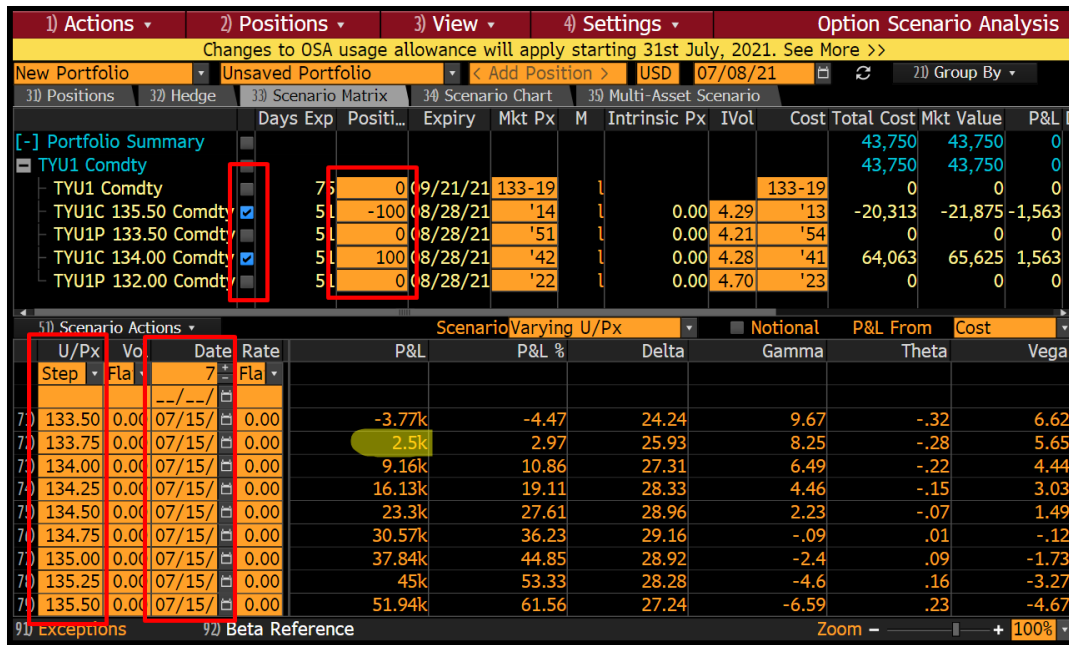
Days Exp Positi... Expiry Mkt Px M Intrinsic Px IVol Cost Total Cost Mkt Value P&L Delt

[-] Portfolio Summary

- TYU1 Comdty
 - TYU1 Comdty 75 0 09/21/21 133-26+ 1 438 563 125
 - TYU1C 135.50 Comdty 51 -1 09/28/21 '15 1 0.00 4.26 '13 -203 -234 -31
 - TYU1P 133.50 Comdty 51 0 08/28/21 '51 1 0.00 4.21 '54 0 0 0
 - TYU1C 134.00 Comdty 51 1 09/28/21 '51 1 0.00 4.43 '41 641 797 156
 - TYU1P 132.00 Comdty 51 0 08/28/21 '20 1 0.00 4.77 '23 0 0 0

Within scenario you can model a combination of scenarios from shifts in underlying price, vol, date and rates. To the right, you will be able to see how the greeks change.

Here, I've increased size of positions to 100 contracts and model 0.25 steps in price 1 week away with 0 shift in IV. The dropdown also allows you to choose Flat instead of Step which makes every scenario line the same input (e.g., all prices at 133.00)



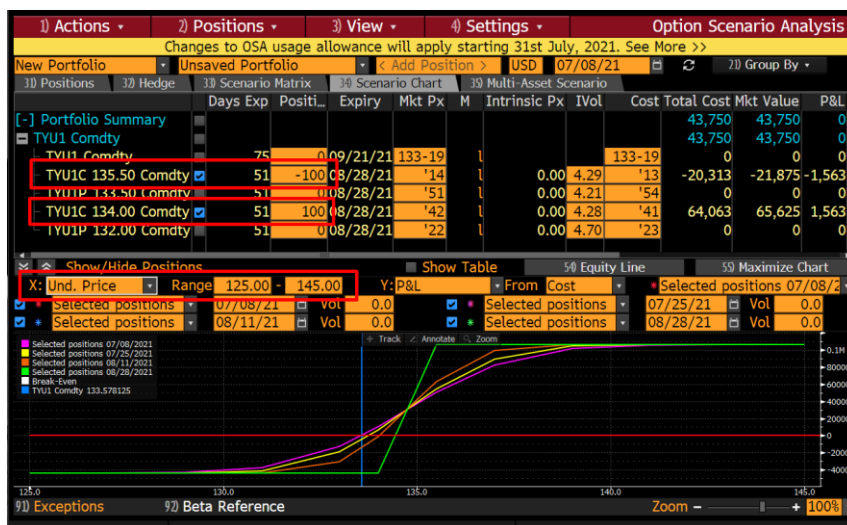
The screenshot shows the 'Option Scenario Analysis' interface. The top section displays a 'Portfolio Summary' table with columns for Days Exp, Positi..., Expiry, Mkt Px, M, Intrinsic Px, IVol, Cost Total, Cost Mkt Value, and P&L. The bottom section shows a 'Scenario Matrix' table with columns for U/Px, Vo, Date, Rate, P&L, P&L %, Delta, Gamma, Theta, and Vega. The 'Step' dropdown is set to 'Flat' and the 'Notional' box is checked.

U/Px	Vo	Date	Rate	P&L	P&L %	Delta	Gamma	Theta	Vega
Step	Flat	7	Flat						
133.50	0.00	07/15/21	0.00	-3.77k	-4.47	24.24	9.67	-0.32	6.62
133.75	0.00	07/15/21	0.00	2.5k	2.97	25.93	8.25	-0.28	5.65
134.00	0.00	07/15/21	0.00	9.16k	10.86	27.31	6.49	-0.22	4.44
134.25	0.00	07/15/21	0.00	16.13k	19.11	28.33	4.46	-0.15	3.03
134.50	0.00	07/15/21	0.00	23.3k	27.61	28.96	2.23	-0.07	1.49
134.75	0.00	07/15/21	0.00	30.57k	36.23	29.16	-0.09	0.01	-0.12
135.00	0.00	07/15/21	0.00	37.84k	44.85	28.92	-2.4	0.09	-1.73
135.25	0.00	07/15/21	0.00	45k	53.33	28.28	-4.6	0.16	-3.27
135.50	0.00	07/15/21	0.00	51.94k	61.56	27.24	-6.59	0.23	-4.67

Some takeaways:

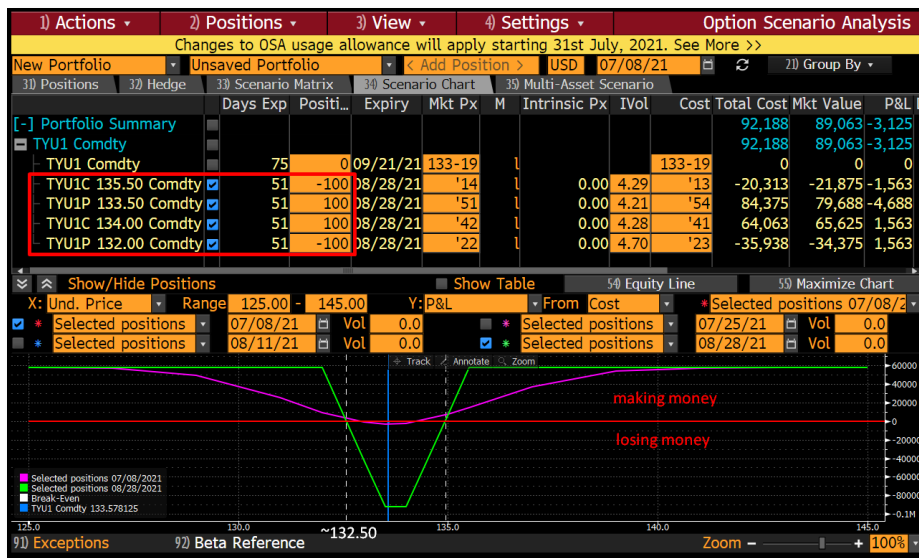
1. My breakeven a week away is at 133.75 even though I'm buying the 134-135.50 call spread
2. Delta remains constant because of the even-sized call spread, hence also why Theta is very minor (I'm not losing time value because I'm long and short options at same exp)
3. Greek values are expressed as contract points (1pt = \$1000) but you can tick the Notional box to change it to \$values

The chart tab graphically shows you the PnL performance of your options structure as underlying price changes for different time periods. You can change the x-axis from price to vol shift or other options.



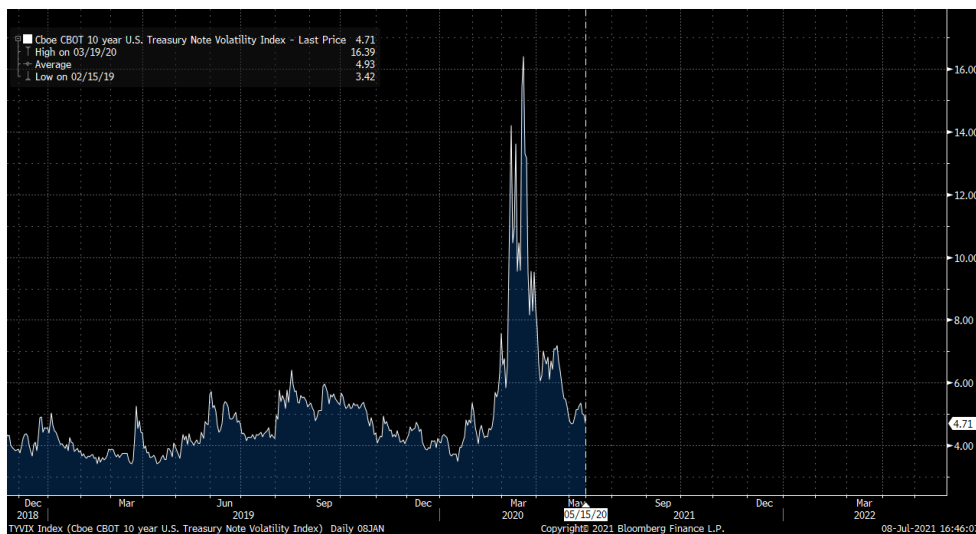
The put spread scenario is roughly similar but flipped around so there isn't really a need to go into that. What is more interesting is what if I decide that I want to be **long volatility**, but I don't know which direction bonds move? What happens if I combine the call spread and put spread together? This is known as a strangle (if the long call and long put strikes are the same then it's a straddle).

Immediately you should know that I am roughly doubling my cost but in reality, there's only one side that can win. So, the R:R must be lower (in this example it's negative!) This brings us back to the core tenet of options - **the price of flexibility**. The more flexibility you want, the more you have to pay for – there is no free lunch in this business.



The only things that are free tend to be bad opinions, and those can be costly.

The last part of this topic is just to wrap up the larger idea of options and implied volatility in interest rates. Plus, there's a juicy story involved. First, CBOE used to licence data from CME and produce TYVIX – treasury volatility based on TY implied vols. The index was based on the VIX methodology, looking at 1month implied vols across all strikes. Then one day in May 2020 it stopped publishing. RIP TYVIX.



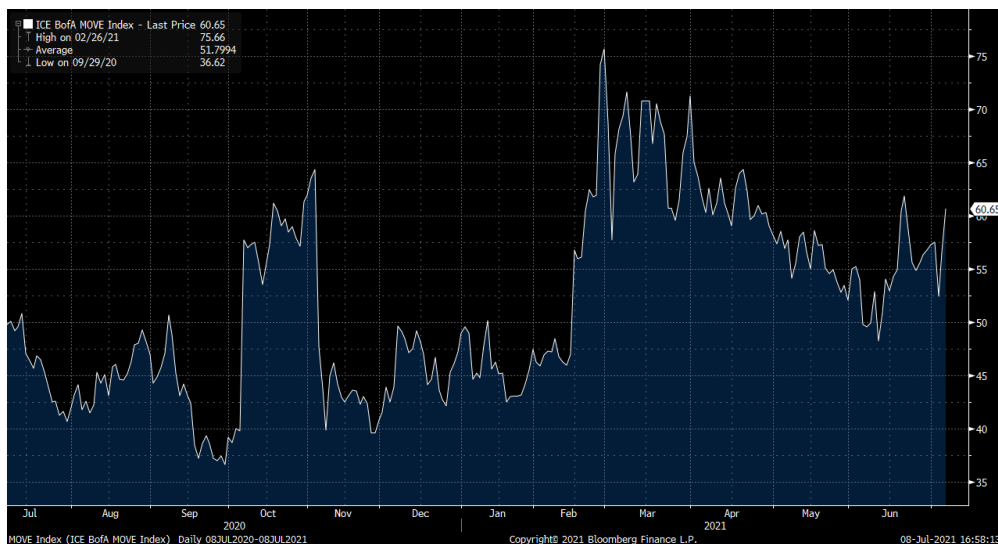
There are a few reasons we can dig into for why this happened:

First, in March 2020 when the pandemic hit, liquidity was so bad across the board that the TY options chain was EMPTY, devoid of quotes throughout large parts of the day. You can't calc a vol index using all strikes if there's nothing to price. Second, IVs on TY futures are price-based while bond volatility is conventionally expressed in basis points (remember convexity of price to yield and also why generic bonds are tracked via yield). Third is, CME was planning on releasing their suite of CVOL volatility indices for metals, other commodities and you guessed it, interest rates. They would go one step further; they would include both price and yield volatility measures.

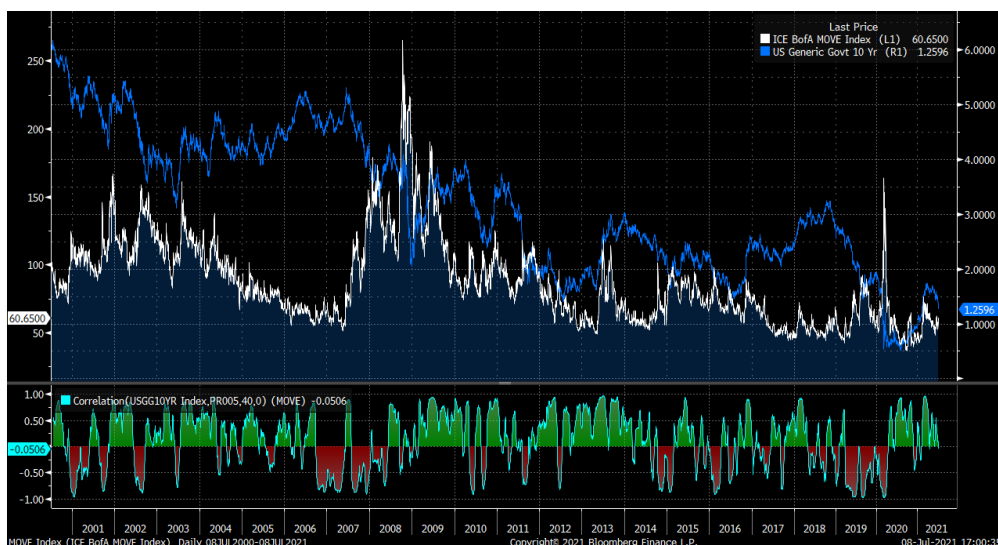
Our dear @beth_stanton covered the death of TYVIX in a brilliant story here. She is a must follow for fixed income.

https://twitter.com/beth_stanton/status/1275875134625189890

What other ways can we measure rate volatility? Well, there is one that has stood the test of time. The OG rate vol measure is the MOVE Index, created by Harley Bassman (what a rockstar name!), and is the normalized 1M implied volatility of the treasury curve weighted by 2-, 5-, 10- and 30-year vols. The weightings are 20%, 20%, 40% & 20% respectively. Why normalize? Because an implied 20bps move on 1% yield is very different than on 4%. Normalization equates the basis point move in terms of yield.



This is the MOVE index; you can see how it has climbed in recent days as bonds have rallied (yield down).



Running a correlation with implied vols and yields shows you that the relationship is not purely one-way and demand for volatility runs both directions. Simply – you can have high rate vol when the market is bullish bonds and also when they are bearish bonds, making rate volatility an extremely important tool in analysing the bond market.

6.7 Topic Question

How would you construct a 2s10s curve steepener with 10K DV01 using ATM options? Assume ATM strikes are both exactly 50D with 1 month to expiry and underlying risk is 2.0 and 8.0 respectively. Ignoring premiums paid, in what scenarios do you profit or lose over the month? What must you consider if you wish to maintain the DV01 exposure?

*Like the futures question, we first look at the curve trade itself – steepener means long end yields go up more than short end (or fall less than the short end) so **we want to have long exposure to 2s and short exposure to 10s.***

Method 1:

Simply, if using ATM options we can buy ATM calls on 2s and sell ATM calls on 10s. In the futures topic question \$5,000 DV01 of TUU1 required 116 contracts. So, \$10,000 would be 232 contracts BUT with if the call option only has 50 delta then I would need to double that. So, 464 contracts of ATM calls on TUU1. Likewise, for the TYU1 contract it was 60 contracts for \$5,000 DV01 so at 50D for \$10,000 DV01 it would require 240 contracts.

*My risk and considerations in this structure is **many-fold**:*

1. *10s rally more than 2s resulting in a flatter curve and I lose on the structure. The delta on 10s would also increase more than 2s resulting in an increasingly higher loss as my short exposure grows faster than my long exposure.*
2. *2s get sold while 10s rally, which is the same risk as before but even worse as the delta on 2s decreases, thus making the delta exposure increasingly negative*
3. *Throughout the month, I will have to buy/sell each leg to adjust for the changing deltas to maintain a DV01 neutral position. This will result in you crystalizing profits or losses on each leg.*

Method 2:

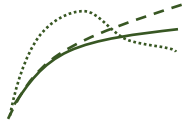
If I want to maintain long exposure on 2s and short exposure on 10s, I could also buy ATM calls on 2s and ATM puts on 10s. In this scenario, my risk is ultimately limited to the premium paid as I am long both legs. If the curve as a whole rallies, I will make money on 2s while the premium paid on 10s will burn away. Likewise, if the curve sells then the premium on the long calls on 2s burns away while the puts on 10s get ITM. This is a much safer way to express the trade than Method 1.

Method 3:

Sell ATM puts on 2s and long ATM puts on 10s. This is effectively the opposite of method 1. As I am short the ATM puts on 2s, (i.e. I am effectively long because I will get delivered the 2y note) my risk here is that 2s sell more than 10s resulting in an increasingly negative delta exposure and thus increasing losses as yields rise across the curve. My hope in this structure is that 10s sell off more than 2s within the 1-month time frame resulting in a positive PnL when the options expire.

The important thing to consider in this question is considering how you structure a directional trade using options determines the risks you undertake. Buying options caps your risk to the premium paid while shorting options results in open-ended exposure to losses. The trade-off between the two is whether you are paying or receiving the premium in the structure.

7. Bootstrapping the Yield Curve



This is a bootstrap. You pull on the tab and it helps getting your foot into the boot.



The idiom “pull oneself up by the bootstraps” is, if you think about it, literally impossible – lifting yourself up off the ground by pulling on your bootstraps. The idea of it though, came to mean bettering yourself on your own and as a modern-day extension of that idea, as a reference to a self-sustaining process without external input.

What does that have to do with the yield curve? Bootstrapping the yield curve is the process of sequentially deriving zero rates from the short to long end of the curve using only the existing yield curve.

Before we get into the guts of it, let’s talk about WHY you want to do this. Bootstrapping the yield curve will allow us to discount cashflows accurately, imply forward rates and project a forward curve. This has implications on pricing: forwards & futures, swaps, options, cash bonds and even credit risk. In the subsequent topics, you’ll see how bootstrapping the yield curve plays into each of them.

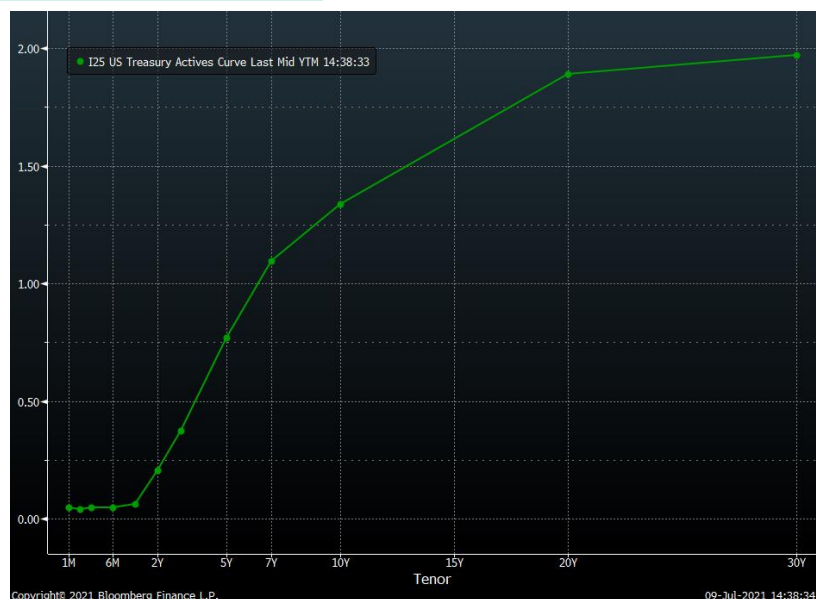
7.1 Meet the Curves – Par, Spot & Forward

Let me start off by introducing the various types of curves: **the par curve, the spot curve & the forward curve**. For this topic, we will use the US Treasury Curve and the USD 3M LIBOR Swaps Curve but the principles, which we are concerned with, are universally applicable to any curve.

We start with the par curve. This is the curve that everyone is familiar with, whether you realize it or not. The 10-year yield, the 5s30s spread, the 2s10s30s butterfly, etc. are all referencing the par curve. It is called the par curve because it contains the yields for all bonds priced at par along the curve. At par, it means the coupon = yield and price = 100.

THIS IS CRUCIAL TO THE CONCEPT OF BOOTSTRAPPING.

Now importantly, remember we learned in [Topic 1: Bond Math](#) that the yield to maturity of the bond is the yield necessary to discount all the cashflows to arrive at its price; The IRR of the cashflows. That means that the yield contains compounding effects on multiple cashflows. **They are compounded yields.**



7.2 Stripping the Yield Curve

If I have a single cashflow and I want to discount it today's value, I want a rate that is specifically for that one single cashflow. **A zero-coupon bond is structurally the same** - a single cashflow (the principal) paid at maturity which you discount to today's value. Technically, using a compounded yield isn't appropriate.

If you look at \$1000 par value of a US Treasury 2-year bond paying a 1% coupon, its cashflows can be decomposed as:

Year 0.5 = Coupon 1 = \$5 ($\$1000 * 0.01/2$)

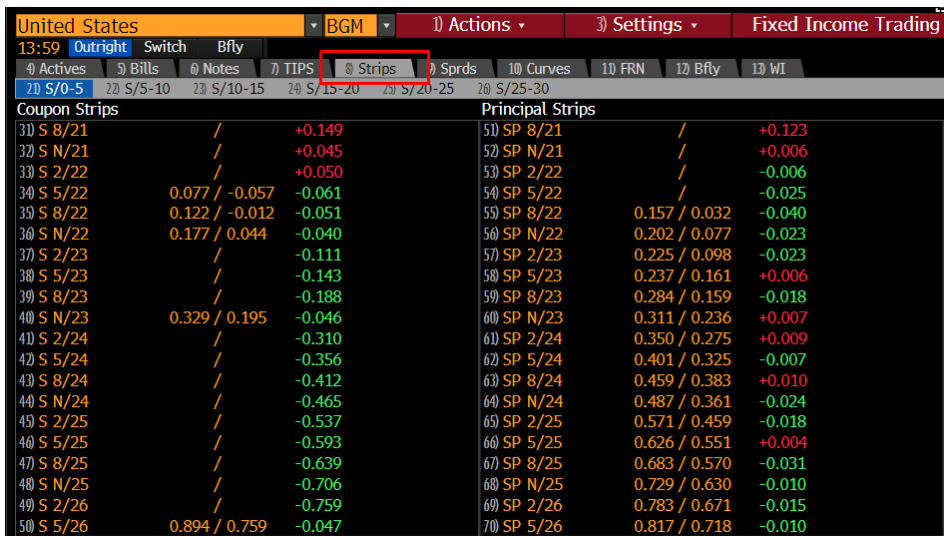
Year 1.0 = Coupon 2 = \$5

Year 1.5 = Coupon 3 = \$5

Year 2.0 = Coupon 4 + Principal = \$5 + \$1000 = \$1005

If you were to 'strip' each cashflow out and buy/sell them separately (which you actually can do), each cashflow is in itself, a zero-coupon bond. The idea of stripping out the coupons from the par curve and discounting them is referred to as 'stripping the yield curve'.

On **FIT<GO>** you'll find a tab for Strips where you can trade coupons and principals that are stripped out of a treasury and actively tradeable.



Coupon Strips		Principal Strips			
31) S 8/21	/	+0.149	51) SP 8/21	/	+0.123
32) S N/21	/	+0.045	52) SP N/21	/	+0.006
33) S 2/22	/	+0.050	53) SP 2/22	/	-0.006
34) S 5/22	0.077 / -0.057	-0.061	54) SP 5/22	/	-0.025
35) S 8/22	0.122 / -0.012	-0.051	55) SP 8/22	0.157 / 0.032	-0.040
36) S N/22	0.177 / 0.044	-0.040	56) SP N/22	0.202 / 0.077	-0.023
37) S 2/23	/	-0.111	57) SP 2/23	0.225 / 0.098	-0.023
38) S 5/23	/	-0.143	58) SP 5/23	0.237 / 0.161	+0.006
39) S 8/23	/	-0.188	59) SP 8/23	0.284 / 0.159	-0.018
40) S N/23	0.329 / 0.195	-0.046	60) SP N/23	0.311 / 0.236	+0.007
41) S 2/24	/	-0.310	61) SP 2/24	0.350 / 0.275	+0.009
42) S 5/24	/	-0.356	62) SP 5/24	0.401 / 0.325	-0.007
43) S 8/24	/	-0.412	63) SP 8/24	0.459 / 0.383	+0.010
44) S N/24	/	-0.465	64) SP N/24	0.487 / 0.361	-0.024
45) S 2/25	/	-0.537	65) SP 2/25	0.571 / 0.459	-0.018
46) S 5/25	/	-0.593	66) SP 5/25	0.626 / 0.551	+0.004
47) S 8/25	/	-0.639	67) SP 8/25	0.683 / 0.570	-0.031
48) S N/25	/	-0.706	68) SP N/25	0.729 / 0.630	-0.010
49) S 2/26	/	-0.759	69) SP 2/26	0.783 / 0.671	-0.015
50) S 5/26	0.894 / 0.759	-0.047	70) SP 5/26	0.817 / 0.718	-0.010

By finding the yields on zero coupon bonds at each tenor (year) of the par curve, we will build the ZERO RATE curve, commonly (and slightly confusingly but I will explain why later) known as the SPOT CURVE.

Let's establish the first concept: a Par Curve has yields with compounded cashflows and a Spot Curve has yields with zero coupons.

How do we bootstrap the spot curve from scratch? A self-sustaining process needs a starting point. As it happens, the par curve does have zero rates! At the very front of the curve, we have money markets instruments; US Treasury bills are discount-quoted debt of up to 1 year and importantly...they have no coupons.



Now for the sake of simplicity, let's assume all bonds pay annual coupons. Take a deep breath, we're going to strip an imaginary par curve. Remember, **Par implies yield = coupon and price = 100!!!** Also, remember that bills are discount-quoted but, you can easily find their bond yield equivalent

Yields		Description	
B 0 06/16/22 Govt			
0.0775/0-02	0.079/0.063	BGN@ 15:24	No Notes
B 0 06/16/22 (912796142)			
Discount	0.06250	Settle	07/14/21
Price	99.9414931	Issue	06/17/2021
Days to Maturity	337	Maturity	06/16/2022
Yield Calculations		Taxed @	
US Treasury Convention	0.063394	28.00	%
US Govt Bond Equivalent	0.063382	0.045647	
Simple Interest (Act/360)	0.062537	0.045026	
Medium Term CD (Act/B60)	0.062527	0.045022	
US Treasury with Leap Year	0.063570	0.045772	

So, here's how the concept of bootstrapping goes. Let's assume the following:

The 1-year Treasury bill yields 1%, **pays no coupon** – that means it's basically a zero-coupon bond.

The 2-year Treasury note yields 2%, **pays annual coupon**

Tenor	Par Yield	Year 1 Cashflow	Year 2 Cashflow	Zero Rate
1-year	1%	100	-	1%
2-year	2%	2	102	?

That means that the 2-year note's 1st cashflow can be discounted using the 1-year zero rate:

$$[\$2 / (1 + 0.01)] = \$1.9802$$

Because we're looking at bonds on the Par Curve, it means the 2-year note is priced at par = \$100. So that means the pricing of a 2-year note trading at par is composed of:

$$\$100 = [\text{Discounted Year 1 Cashflow}] + [\text{Discounted Year 2 Cashflow}]$$

$$\$100 = [\$2 / (1 + Z_1)] + [\$102 / (1 + Z_2)^2]$$

$$\$100 = \$1.9802 + [\$102 / (1 + Z_2)^2]$$

$$\text{Therefore } [102 / (1 + Z_2)^2] = (100 - 1.9802) = 98.0198$$

That means: $98.0198 = 102 / [(1 + Z_2)^2]$ where Z_2 is the 2-year zero rate.

$$Z_2 = \sqrt{(102 / 98.0198)} - 1 = 2.01\%$$

Tenor	Yield	Zero Rate
1Y	1.00%	1.00%
2Y	2.00%	2.01%

If the 3-year note trading at par yields 4% then we know that:

$$100 = (4 / 1.01) + (4 / 1.0201^2) + [104 / (1 + Z_3)^3]$$

Thus $Z_3 = 4.098\%$

Tenor	Yield	Zero Rate
1Y	1.00%	1.000%
2Y	2.00%	2.010%
3Y	4.00%	4.098%

With a zero rate, we can discount cashflows to their present value which is actually what we've been doing to find each new zero rate. So, we can transform the zero rate into a discount factor as introduced first in Bond Math; "For every \$1 of cashflow, what is its present value?"

$$DF = 1 / (1 + Z_n)^n$$

Discount factors are convenient to use because they easily translate cashflow from present values.

Tenor	Yield	Zero Rate	Discount Factor
1Y	1.00%	1.000%	0.990099
2Y	2.00%	2.010%	0.960980
3Y	4.00%	4.098%	0.886488

With the 3y, you can then do the 4, then 5, then 6...all the way up to 30yr zero-rates or for as far as you have an observable rate. This is the self-sustaining process of bootstrapping.

You'll notice from the table above that zero rates are higher than par rates. This makes sense - without coupons, an investment must have a higher rate of return in order to generate the same terminal return. This brings us back to 'gapping' forward rates that [we covered in bond math](#).

7.3 Implying Forward Rates

If I put \$1 into a 1-year zero rate investment, I would receive $1 * 1.0100 = \$1.01$ at the end of 1 year.

If I put \$1 into a 2-year zero rate investment, I would receive $1 * 1.0201^2 = \$1.0406$ at the end of 2 years.

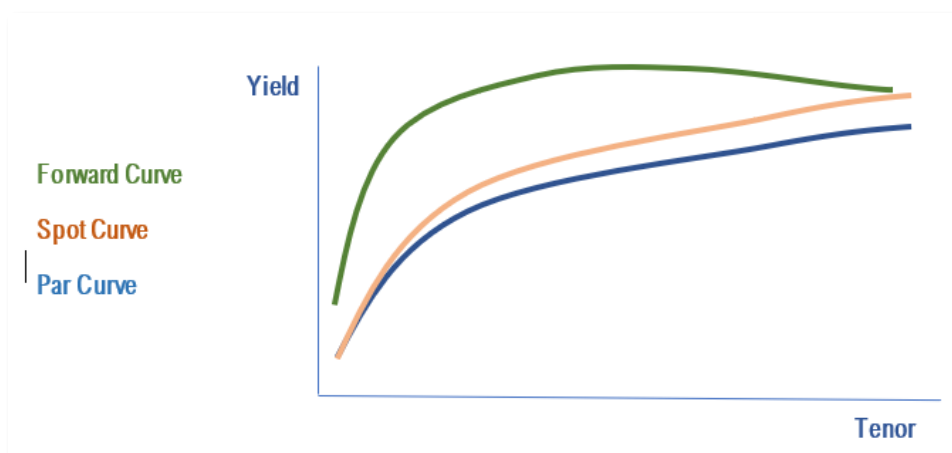
What is the rate that I should earn for a 1 year zero coupon investment, 1 year from now? In order for there to be no-free-lunch, it should be such that investing for 1 year and rolling it into the 1y1y rate the same as if I just put it into the 2y rate from day 0.

$$1.0201^2 = 1.01 * (1 + F_{1y1y})$$

$$F_{1y1y} = 3.0301\%$$

Tenor	Yield	Zero Rate	Discount Factor	1y Implied Fwd
1Y	1.00%	1.000%	0.990099	3.0301%
2Y	2.00%	2.010%	0.960980	5.6687%
3Y	4.00%	4.098%	0.886488	

If we stripped the entire curve then implied forwards, the three curves would look like the following:



^v Here we use the forward notation F_{1y1y} where we denote the yield as F(Forward Period, Forward tenor) i.e The rate 1-year forward, for a 1-year tenor. This is different from FRA notation, be careful!

Now, let's say the 4y rate is 4.50%, only 50bps higher than the 3y rate, what would the 1y3y forward rate look like?

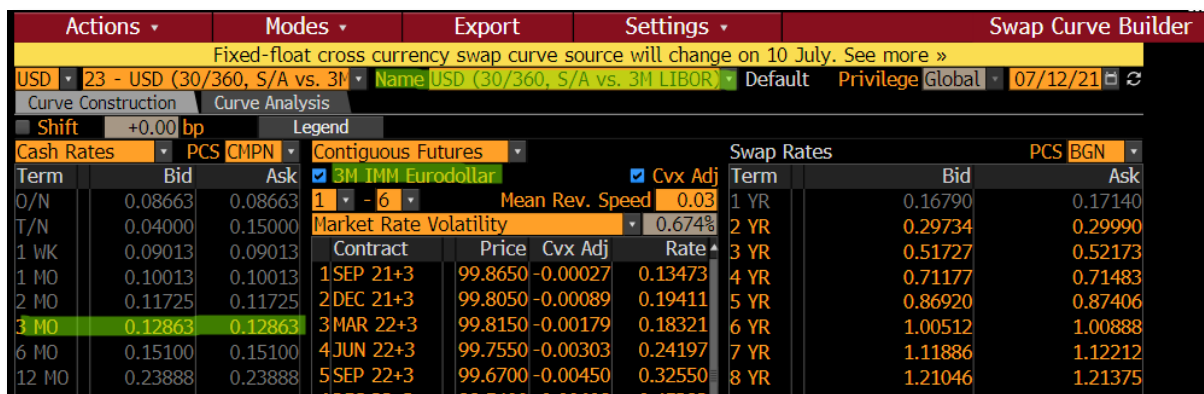
Tenor	Yield	Zero Rate	Discount Factor	1y Implied Forward
1Y	1.00%	1.000%	0.990099	3.0301%
2Y	2.00%	2.010%	0.960980	5.6687%
3Y	4.00%	4.098%	0.886488	5.8542%
4Y	4.50%	4.619%	0.834746	

Important to note, the forward curve rates are the implied forward ZERO rates based on the zero rates at spot (today). This is why the zero-rate curve is called the SPOT curve. Spot zero rates vs Forward zero rates.

One important implication of this is that the steeper the par curve the higher the implied forward rates.

If my starting rate is much lower than the rates further out the curve, any compounding I do needs to be at a much higher rate to “catch up”.

Suppose we took the USD Swaps curve, which consists of multiple tenors of fixed-float swaps using 3M LIBOR as the reference index for the floating leg:

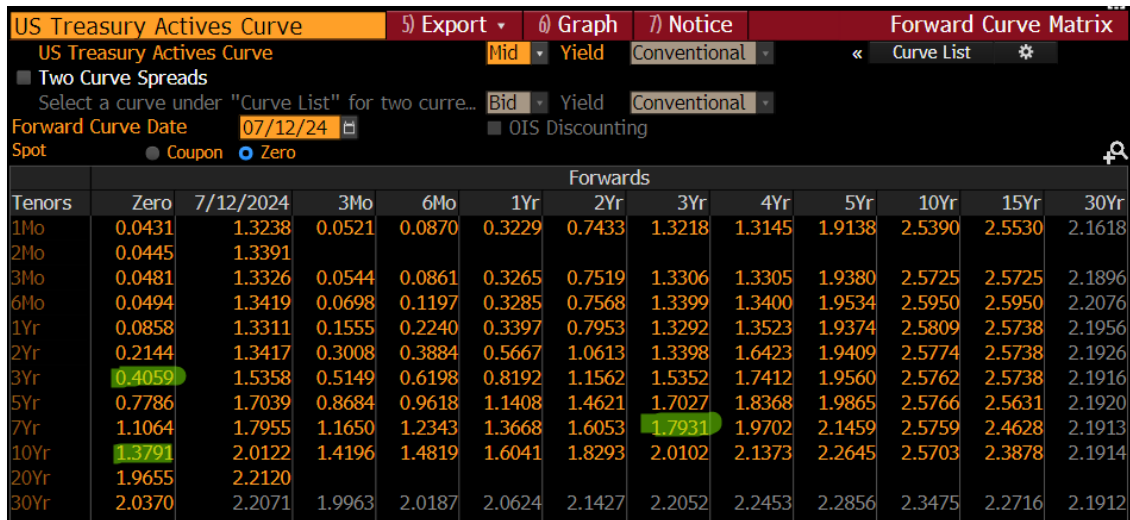


Cash Rates		Swap Rates	
Term	Bid	Term	Bid
0/N	0.08663	1 YR	0.16790
T/N	0.04000	2 YR	0.29734
1 WK	0.09013	3 YR	0.51727
1 MO	0.10013	4 YR	0.71177
2 MO	0.11725	5 YR	0.86920
3 MO	0.12863	6 YR	1.00512
6 MO	0.15100	7 YR	1.11886
12 MO	0.23888	8 YR	1.21046

If we can extract zero rates all along the curve, we can find out the implied 3M forwards that are embedded in this curve. While all the observable rates on the curve are not spaced out in 3M intervals, the process of interpolation (finding one point between two others) allows us to determine the necessary spot rates and thereby, the implied forward.

The specific methodology is somewhat more intense for this series but know that you can either draw straight lines to connect the rates or draw a smooth curve between a series of rates. Understandably, whichever you choose affects the spot rates you derive. On the terminal, you can view the settings to derive them at **SWDF DLFT<GO>** which are global settings (i.e., affects all swap curves).

To view see spot and forward rates, you can go to **FWCM<GO>** which is a forward rate matrix.



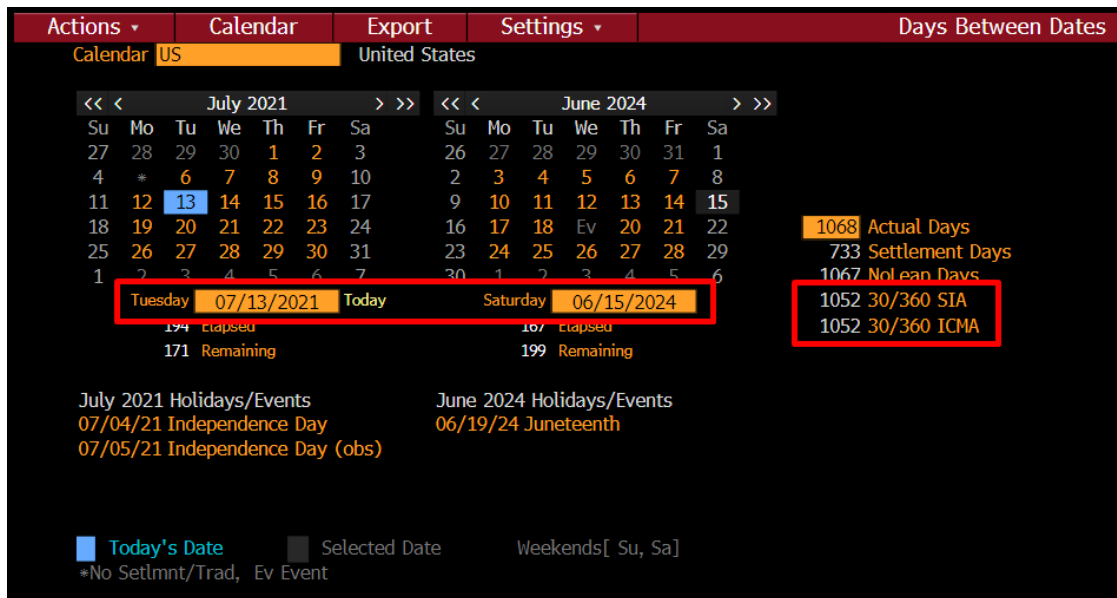
Tenors	Zero	7/12/2024	3Mo	6Mo	1Yr	2Yr	3Yr	4Yr	5Yr	10Yr	15Yr	30Yr
1Mo	0.0431	1.3238	0.0521	0.0870	0.3229	0.7433	1.3218	1.3145	1.9138	2.5390	2.5530	2.1618
2Mo	0.0445	1.3391										
3Mo	0.0481	1.3326	0.0544	0.0861	0.3265	0.7519	1.3306	1.3305	1.9380	2.5725	2.5725	2.1896
6Mo	0.0494	1.3419	0.0698	0.1197	0.3285	0.7568	1.3399	1.3400	1.9534	2.5950	2.5950	2.2076
1Yr	0.0858	1.3311	0.1555	0.2240	0.3397	0.7953	1.3292	1.3523	1.9374	2.5809	2.5738	2.1956
2Yr	0.2144	1.3417	0.3008	0.3884	0.5667	1.0613	1.3398	1.6423	1.9409	2.5774	2.5738	2.1926
3Yr	0.4059	1.5358	0.5149	0.6198	0.8192	1.1562	1.5352	1.7412	1.9560	2.5762	2.5738	2.1916
5Yr	0.7786	1.7039	0.8684	0.9618	1.1408	1.4621	1.7027	1.8368	1.9865	2.5766	2.5631	2.1920
7Yr	1.1064	1.7955	1.1650	1.2343	1.3668	1.6053	1.7931	1.9702	2.1459	2.5759	2.4628	2.1913
10Yr	1.3791	2.0122	1.4196	1.4819	1.6041	1.8293	2.0102	2.1373	2.2645	2.5703	2.3878	2.1914
20Yr	1.9655	2.2120										
30Yr	2.0370	2.2071	1.9963	2.0187	2.0624	2.1427	2.2052	2.2453	2.2856	2.3475	2.2716	2.1912

The left column are the tenors of the curve, and the top row is the forward date. So, the 7-year forward rate implied 3 years from now is 1.7931%

If you look at the market observed rates, you can see the spot rate for 3y is 0.4059 and for the 10y it is 1.3791. Using what we've learned we know that 3y7y should be close to $[(1.013791^{10} / 1.004059^3)]^{(1/7)} - 1 = 1.799\%$. In the screenshot you can see it is 1.7931% so while it's close, it's slightly off.

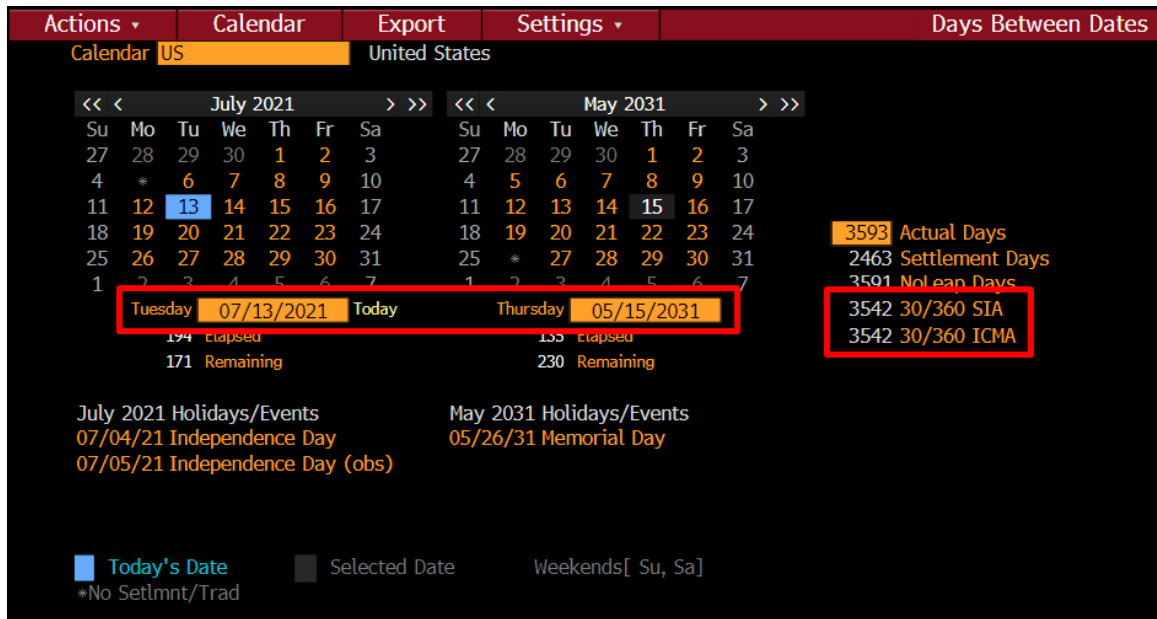
The reason for this is due to daycount conventions and properly counting dates (in the above I just assumed a perfect 3y, 10 and 7y timeframe). Treasuries follow ACT/ACT daycount conventions BUT FWCM is actually built using swap conventions, so it uses 30/360. Let's back it out:

The 3y rate is taken from T 0 ¼ 06/15/24. From today's settlement (t+1) that is 07/13/21 – 06/15/24 = 1052 Days



Calendar	United States																																																																																																																
<table border="1"> <tr><th colspan="7">July 2021</th></tr> <tr><td>Su</td><td>Mo</td><td>Tu</td><td>We</td><td>Th</td><td>Fr</td><td>Sa</td></tr> <tr><td>27</td><td>28</td><td>29</td><td>30</td><td>1</td><td>2</td><td>3</td></tr> <tr><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr> <tr><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td></tr> <tr><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td></tr> <tr><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td></tr> <tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr> </table>	July 2021							Su	Mo	Tu	We	Th	Fr	Sa	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	<table border="1"> <tr><th colspan="7">June 2024</th></tr> <tr><td>Su</td><td>Mo</td><td>Tu</td><td>We</td><td>Th</td><td>Fr</td><td>Sa</td></tr> <tr><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td><td>1</td></tr> <tr><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr> <tr><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td></tr> <tr><td>16</td><td>17</td><td>18</td><td>Ev</td><td>20</td><td>21</td><td>22</td></tr> <tr><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td></tr> <tr><td>30</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr> </table>	June 2024							Su	Mo	Tu	We	Th	Fr	Sa	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Ev	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6
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<p>July 2021 Holidays/Events</p> <p>07/04/21 Independence Day</p> <p>07/05/21 Independence Day (obs)</p>	<p>June 2024 Holidays/Events</p> <p>06/19/24 Juneteenth</p>																																																																																																																
<p>1068 Actual Days</p> <p>733 Settlement Days</p> <p>1067 No Leap Days</p> <p>1052 30/360 SIA</p> <p>1052 30/360 ICMA</p>																																																																																																																	

The 10y rate is taken from T 1 ½ 05/15/31 (hover over the 10y spot value). That is 07/13/21 - 05/15/31 = 3542 days



Calendar US United States

July 2021 << >> May 2031 << >>

Tuesday 07/13/2021 Today Thursday 05/15/2031

194 Elapsed 171 Remaining 155 Elapsed 230 Remaining

July 2021 Holidays/Events
07/04/21 Independence Day
07/05/21 Independence Day (obs)

May 2031 Holidays/Events
05/26/31 Memorial Day

3593 Actual Days
2463 Settlement Days
3591 No Leap Days
3542 30/360 SIA
3542 30/360 ICMA

Today's Date Selected Date Weekends[Su, Sa]
*No Setlmt/Trad

The number of days in between is $(3542 - 1052) = 2490$ days. This is how many days the forward rate must compound by.

So, the 3y7y forward rate = $[(1.013791^{(3542/360)} / 1.004059^{(1052/360)})]^{(360/2490)} - 1 = 1.793096\%$

A similar screen to FWCM is **FWCV<GO>**, which also lets you see a horizon curve for forward rates as well as a tab for the implied forwards for specific tenors. Here we'll use the USD Swaps curve and in particular, we'll focus on the Implied Forwards tab.



US Dollar Swaps (30/360, S/A) Curve (REF)

Tenor	Spot	1 Mo (P)	3 Mo (P)	02/12/2022 (P)
1 Mo	0.13265	0.13290	0.13413	0.19572
2 Mo	0.13292	0.13076	0.13242	0.19103
3 Mo	0.13149	0.13197	0.14907	0.18831
6 Mo	0.14031	0.15241	0.17169	0.20630
9 Mo				
1 Yr				
2 Yr				
3 Yr				
4 Yr				
5 Yr				
7 Yr				
9 Yr				
10 Yr				
12 Yr				
15 Yr				
20 Yr				
30 Yr				
50 Yr				

US Dollar Swaps (30/360, S/A) Curve

Date	Spot	Projection
07/14/2021		0.1286
10/14/2021	0.1304	0.1458
01/14/2022	0.1391	0.1942
04/14/2022	0.1581	0.1997
07/14/2022	0.1691	0.2601
10/14/2022	0.1882	0.3500
01/17/2023	0.2168	0.4781
04/14/2023	0.2530	0.5698
07/14/2023	0.2934	0.7740
10/16/2023	0.3494	0.8818
01/16/2024	0.4040	0.9872
04/15/2024	0.4572	1.0901
07/15/2024	0.5109	1.1370
10/15/2024	0.5604	1.2320
01/14/2025	0.6092	1.3240
04/14/2025	0.6572	1.4157
07/14/2025	0.7055	1.3687
10/14/2025	0.7458	1.4445
01/14/2026	0.7858	1.5187
04/14/2026	0.8248	1.5916

The implied forward tab allows you to imply the forward rates for a specific tenor into the future based on spot rates. In the screenshot, we are looking at the implied 3M rate, every 3 months for the next 5 years.

Spot is the current zero rate at every 3-month interval while projection is the implied 3-month rate at that date. Confused? Yep. Second row, 10/14/21 – that’s 3 months from now. The zero-rate curve says that to invest from now to 10/14/21 you should earn 0.1304%. When it comes to maturity, i.e., 10/14/21, you should be able to invest for another 3 months at 0.1458%.

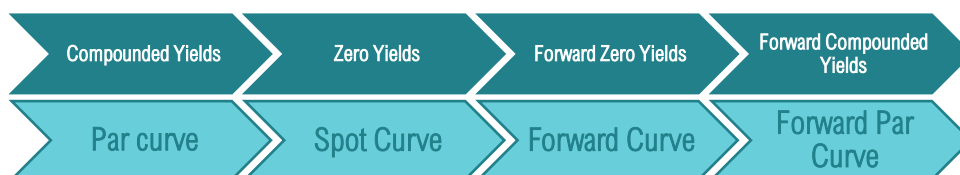
So why do we need all of these different curves? What purpose do they have? Well in the coming topics you will see that they underpin everything in fixed income beyond the basic concept of YTM and bullet bonds. As this is just a basic series, we won’t go too deep into all the calcs (that’s what you have systems for anyway). The more important part to me, is to understand why and how they are valued the way they are. Knowing how we derive spot and forward rates from par curves is extremely important in understanding what is happening in fixed income markets as it ties everything together from curve steepness to swap rates to the value of a floater.

Want to value a bond properly? You need discount rates/factors. Want to find out the credit risk of a callable bond? You need discount rates. Want to price a forward rate agreement? You need forward rates. Want to price an interest rate swap? You need forward rates AND discount rates.

Buckle up.

7.4 Topic Question

1. If the par curve is inverted up to the 10y tenor, what would the spot curve look like relative to the par curve?
2. Given a par curve, could you project a FORWARD par curve? If yes, how?
 1. *An inverted curve means that short-dated yields are higher than longer dated yields. This means that zero rates get lower the longer the tenor gets as the fair value of compounded cashflows is a lower target yield. An easy example is that if the 1-year rate is 1% and the 2-year rate is 0.5% then $100 = (0.5 / 1.01) + (100.5 / (1+y)^2)$ results in $y = 0.499%$*
 2. *Yes you could. The logic is simple and applies everything covered so far: From par curves (compounded yields) we can strip the curve and find zero rates. From zero rates we can imply forward rates. The forward rates are forward zero rates. So if a single compounded yield is made from a series of zero rates we can thus use a series of forward zero rates to imply forward par rates.*





8. Credit – Introduction to Corporate Bonds



8.1 Key Characteristics of a Bond

Let's start to define some terms that get loosely thrown around in bondtwit. Bonds are just fixed income instruments like sovereign and corporate bonds. Corporate bonds or debt instruments with corporate credit as the underlying are what we mean by 'credit'.

Typically, on a bank's trading floor you'll find that rates are lumped with currencies, while credit is separate. So even though rates and credit are both dealing with bonds, there must be something different about the way you look at them. So today, we'll introduce the credit complex. What is a complex? It's when you persistently apply technical analysis to VIX charts or divide a series by the Fed balance sheet. More importantly, it's also a term in finance for an interrelated set of financial instruments and measures, which is what we'll focus on today. The credit complex would encompass all areas of corporate bonds from the yields they trade at, spreads, credit ETFs, CDS, and so forth.

As much as rates are talked about on fintwit, credit is really where we look to quantify the most risk. It's where corporate funding and market risk sentiment translate into yield. Often macro-observers look to credit markets for indications of stress before equity markets do (debatable but does present some use-cases). Even for sovereign nations, their bonds are benchmarked against a risk-free counterpart and trade at a spread that reflects their credit risk such as EM sovereigns in USD or say Italian BTPs against German bunds. Don't short BTPs btw. JUST. DON'T.

Remember, bonds are basically loans. Issuers are borrowers and investors are lenders. So, if you are lending money to someone, you want to be picky about who you lend to. The riskier the borrower, the higher the chance they can't repay you later on.

As a credit investor, your typical investment objective is return of capital with capped return – i.e., the yield (let's ignore distressed debt). This translates into an overriding concern and analysis on the downside – the risk. So rather than judging how much risk you need to take to earn a certain reward, try to flip your thinking around to **"is this reward enough for the risk I have to take?"**

By now you've gathered that credit risk is really at the forefront of concerns here but before we dive into that, let's look at the types of bonds you may encounter. First, let's consider different ways a bond can be structured:

First of all, what are some the key things to look at with a bond? Take this fairly standard bond as an example:

1. The country it's issued in
2. Ranking
3. Coupon and Type
4. Frequency
5. Maturity
6. Currency
7. Bond's rating
8. Amount issued/outstanding
9. Minimum piece/increment
10. Par amount



25 Bond Description	20 Issuer Description	94 No Notes		95 Buy	96 Sell
Pages		Page 1/12 Security Description: Bond			
25 Bond Description		20 Issuer Description			
11 Bond Info		Issuer Information		Identifiers	
12 Addtl Info		Name MICROSOFT CORP		FIGI BBG00DJ1B6J2	
13 Reg/Tax		Industry Technology (BCLASS)		CUSIP 594918BR4	
14 Covenants		Security Information		ISIN US594918BR43	
15 Guarantors		Mkt Iss GLOBAL		Bond Ratings 7	
16 Bond Ratings		1 Ctry/Reg US		Moody's Aaa	
17 Identifiers		2 Rank Sr Unsecured		S&P AAA	
18 Exchanges		3 Coupon 2.400000		Fitch AA+u	
19 Inv Parties		4 Cpn Freq S/A		Composite AAA	
20 Fees, Restrict		5 Maturity 08/08/2026		Issuance & Trading	
21 Schedules		6 Currency USD		Amt Issued/Outstanding 8	
22 Coupons		7 Iss Price 99.81400		USD 4,000,000.00 (M) /	
23 Quick Links		8 Type Fixed		USD 4,000,000.00 (M)	
24 ALLQ Pricing		9 Iss Sprd +90.00bp vs T 1 5/8 05/15/26		Min Piece/Increment 9	
25 QRD Qt Recap		10 Calc Type (1)STREET CONVENTION		2,000.00 / 1,000.00	
26 TDH Trade Hist		11 Pricing Date 08/01/2016		Par Amount 10 1,000.00	
27 CACS Corp Action		12 Interest Accrual Date 08/08/2016		Book Runner JOINT LEADS	
28 CF Prospectus		13 1st Settle Date 08/08/2016		Reporting TRACE	
29 CN Sec News		14 1st Coupon Date 02/08/2017			
30 HDS Holders					
46 Send Bond					



Country – As bonds are OTC they can trade anywhere in the world. They can also be issued anywhere in the world (within that market's regulations). So, when it comes to bonds there are two main “countries” to take note of: the country of incorporation and the country of risk. If GE issues a bond out of its subsidiary in Ireland but the ultimate parent is based in the US, the *country of incorporation* is Ireland and the *country of risk* is US.

Ranking – the bond's ranking in the issuer's capital structure. The higher the ranking the safer the bond. Secured means it has collateral placed against it, unsecured ranks lower. Senior is higher than Junior/Subordinated. This hierarchy determines who gets paid out in the case of liquidation. Equity is at the bottom. Collateralization always takes priority over seniority, so Secured debt is 'safer' than Senior Unsecured.

Coupon and Type – The ANNUAL coupon rate and its type. fixed, floating, variable, zero, etc.

Frequency – how often the bond pays a coupon. E.g., semi-annual = 2 thus Coupon Payment = Annual coupon / 2

Maturity – when the bond pays out its final coupon and returns the principal

Currency of the bond – what currency a bond trades in. Some bonds can be dual currency – e.g., the principal and coupon are paid in USD while the notional value of the bond is priced in a local currency. Indian masala bonds are one such type of dual currency bonds.

Bond's rating – what an agency got paid to put there by the issuer. Kidding. Sort of. It's a credit rating agency's judgement on the quality of the credit. Do note that there are credit ratings for the bond AND credit ratings for the issuer.

Amount issued/outstanding – original size of the issue / what's remaining in the market

Minimum piece/increment – minimum amount per purchase / minimum increment of purchase size. So 250,000/1,000 means the smallest amount you can buy is 250,000 and you can increase the piece in 1,000s.

Par amount – Never have I ever seen a more poorly communicated concept in finance classes. Think of it as the benchmark value of principal when first issued. The biggest confusion people get is when they see par is 1,000 and the price is 100 and both are called 'par'. The price of 100 is actually 'percent of par' that the bond trades at. 101 = 101% of 1,000, so 1,000 face value = \$1,010. What is face value? Sometimes just called 'face' is the same as par value, so you may also hear it referred at 'par amount': "I am buying \$250k par amount of MSFT 26s".

8.2 Trade terms

When you trade a bond, corporate or sovereign, there are a couple of conventions to take note of. Remember, bonds are mostly traded over the counter (OTC) so there isn't one central place to see the last traded price like with stocks. This lack of transparency means some feeling in the dark is necessary.

Imagine a farmer's market with 100 stalls. 2 of them on opposite ends are selling apples. If you buy 1 apple for \$1 from stall A, you have no idea at that moment what stall B is selling an apple for. If you want, you'll have to walk over and ask first. If A sells for \$1 and B sells for \$2, what's the fair price? \$1.50? Now imagine out of the 100 stalls, 50 of them sell apples. It's much easier to find out a fair price with the larger sample size AND there're many more apples available.

This is how the bond market works: more participants = more liquidity = more inventory = more transparency and the only way to find out a real price is to ask around one by one.

On Bloomberg you can go to **ALLQ<GO>** to see all the quotes available on a bond. The more brokers you have, the more quotes you'll see. (I've blacked out my broker's names on this screenshot for privacy). The ones at the top are



called “composites” created by Bloomberg to capture an ‘average’ quote for a bond. This is analogous to an exchange price.

PCS	Firm Name	Bid Px / Ask Px	Bid Yld / Ask Yld	BSz(M) x ASz(M)	Time
CBBT	FIT COMPOSITE ...	53.873 / 55.882	137.846 / 128.335	x	17:15
TRAC	FINRA - TRACE	54.500 / Last Trd	134.139 / Last Trd	x Last Trd	d07/29
BVAL	BVAL (Score: 9)	54.027 / 55.111	137.096 / 131.912	x	16:00
BMRK	BBG REALTIME EVA...	54.307 / 55.114	135.743 / 131.899	500 x Indic Sz	07/29
BGN	BLOOMBERG GENER...	54.000 / 56.000	137.229 / 127.796	x	17:15
	Last Trade	54.500	134.139	1000	07/29
		54.000 / 55.000	137.229 / 132.437	1000 x 1000	17:15
		52.330 / 56.735	145.591 / 124.477	500 x 500	17:15
		54.500 / 55.500	134.813 / 130.098	1000 x 1000	16:57
		53.000 / 54.000	142.180 / 137.229	1000 x 1000	15:34
		52.000 / 54.000	147.300 / 137.229	502 x	15:20
		56.250 / 56.750	126.658 / 124.410	1000 x 1000	07/29

If you’re buying, you’re concerned with the prices on the right side, the ask. How much the broker is asking you to pay for the bond. If you are selling you are looking at the left-hand side. Based on the price the second column shows you the annualized yield to worst/convention that you would be selling/buying at. What is yield to convention? It’s basically the type of yield (to call/reset/maturity) that the market is pricing the bond to. This will make more sense later on.

Next is the bid and ask size. This is how much is available in 1,000s. 1,000 = \$1 million face bid/offered. A lot of these prices and sizes will be ‘indicative’ meaning it’s just a price the broker is indicating they’d be *likely* to transact at.

You may see or hear something called ‘axes’. Every day, a broker will have a list of bond inventory they have or want to get which they will work throughout the day to sell or buy. If they are ‘axed’ it means they have an intent to fulfill that position. That gives you an idea that this price they are displaying is a truer reflection of their intent and price to transact.



Now when you buy a bond, there is the clean price and the dirty price (we introduced this at the end of bond math). The **CLEAN PRICE** is the percent value of the bond’s face as of the settlement date (typically t+2). Because coupons are paid intermittently throughout the year, every day you hold a bond you earn some of that coupon. This interest that accrues up to the settlement date belongs the original owner (who is now selling). But the new buyer will receive the full coupon when it gets paid out later on – so he has to pay the seller their accrued interest. The clean price plus accrued interest is the **DIRTY PRICE**. The majority of bonds are quoted ‘clean’ but what you’ll actually pay to the seller is the dirty price.

Yield & Spread		Risk		Workout	OAS
Price	56.001 <small>clean</small>	M.Dur		0.371	0.181
Yield	127.791325 Wst	Risk		0.219	0.107
Wkout	03/23/2022 @ 100.00	Convexity		0.003	-0.720
Settle	08/03/21	DV	01 on 1MM	21.89	10.67
		Benchmark Risk		1.905	1.905
		Risk Hedge		115 M	56 M
		Proceeds Hedge		590 M	
Spreads		Invoice		Face	1,000 M
1) G-Sprd	12774. Street Convention	127.791325	Principal		560,010.00
2) I-Sprd	12764. Equiv 1 /Yr	168.617881	Accrued (130 Days)		29,791.67
Basis	N.A. Mmkt (Act/360)	137.106364	Total (USD)		dirty 589,801.67
14) Z-Sprd	12764. True Yield	127.791325			

If you are comparing bond prices on a system and trying to back it out on Excel using the PRICE or YIELD formula 99.99% of the time the reason why you can't match is because you're comparing clean prices to Excel's dirty price.

Now, the price you negotiate is tied to a yield and also a spread to its benchmark. That spread has two variables – the bond and its benchmark. **Corporate Bond Yield = Benchmark Yield + Spread to Benchmark**. So, a bond's yield/price could stay the same while the benchmark could move around. If you were to hedge out the duration risk of the bond, then it's just the spread you're buying – this is why bonds are also quoted in spread terms. Rather than "2MM at 101.50" you might hear "2MM at +135" meaning you are buying the bond at the price where it is 135 basis points over the benchmark treasury. **In this case, you need to make sure you're looking at the same benchmark as the broker!**

As the bond market is opaque, finding out prices is a key part of the game here. You don't wanna be buying way over market or selling way lower, and neither does the broker. So, once the trade is complete, the broker may ask **"can I get a cover?"**. This means they want you to sign the cover page of their desk calendar as a show of gratitude for taking the piece of shit MSTR convert off their books. Kidding. A 'cover' means the next best price you were quoted for that transaction (as you were likely shopping the trade around to multiple brokers). That way, your broker has a better idea if they're off-market or not. There is zero obligation to give them a cover (or an accurate one) but it's best to remember that in opaque markets, it's relationships that drive information and transactions.

How do you even trade bonds? Well, there's 'voice' and there's electronic trading. The bond world is slowly moving over to electronic trading but it's not all there yet. Personally, the majority of my bond trading still by voice actually! We call it voice but that includes the chat function on the Bloomberg terminal. It goes something like this:

Hi EMH

Hi Steve, what's up

Well today is your lucky day, my pain is your gain. Those Evergrande bonds you wanted last month? I'm axed to sell and I already emptied nana's retirement account on them so the surplus has gotta find a home, which sounds like your house.

For a steak dinner at wolfgang's and a bottle of '85 chateau margaux it's a deal

Haha you're a funny man EMH

I'm funny to you? Funny how? Do I amuse you? Am I a clown? Do I amuse you?

End Scene. Jokes aside, in reality it goes something like the following:

Hi EMH, have seller with \$2MM of MSFT 2.4 8/26, I can offer 107.00

Hi Steve. Sec.

Can you do 106.75 for 1MM?

Lemme check with my trader

We can do 106.75 but it has to be the full \$2MM

ok I can do that

Done. Sold to you at 106.75. VCONs coming your way shortly

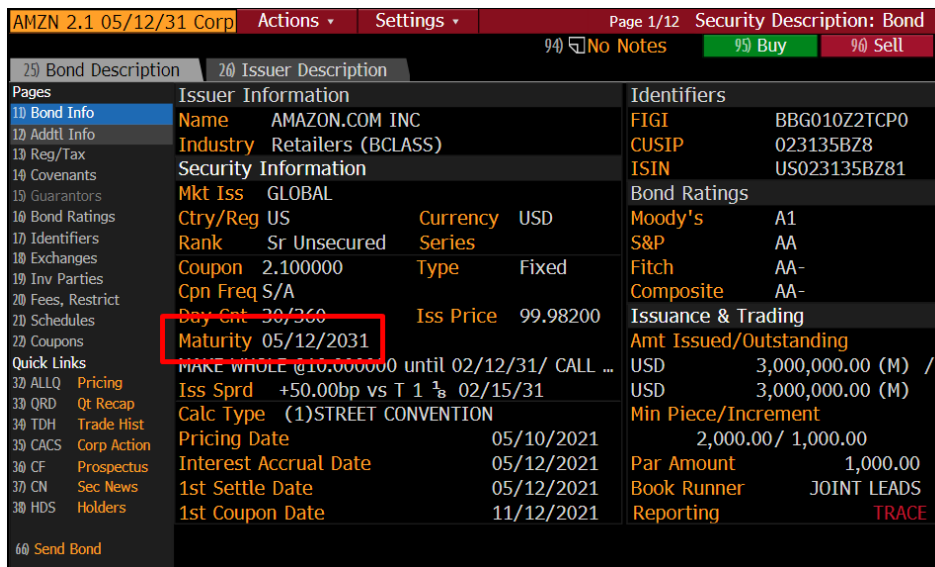
Simple as that. I get a trade recap which gets sent to my back office. They match the recap with the trade confirmation sent by the broker's back office. The trade gets booked with the custodian and they enter the trade details into the clearing system (e.g., DTCC in the U.S. and Euroclear outside of U.S.) whereby the broker's back office will do the same. This is called 'facing' each other. Once the details for both counterparties match, the trade gets settled (meaning the central clearing house receives cash and bond from either side, then releases both to the respective parties).

So now that we're familiar with bonds in general, let's take a look at the types of bonds you could trade.

8.3 Bond Structures

Bullet

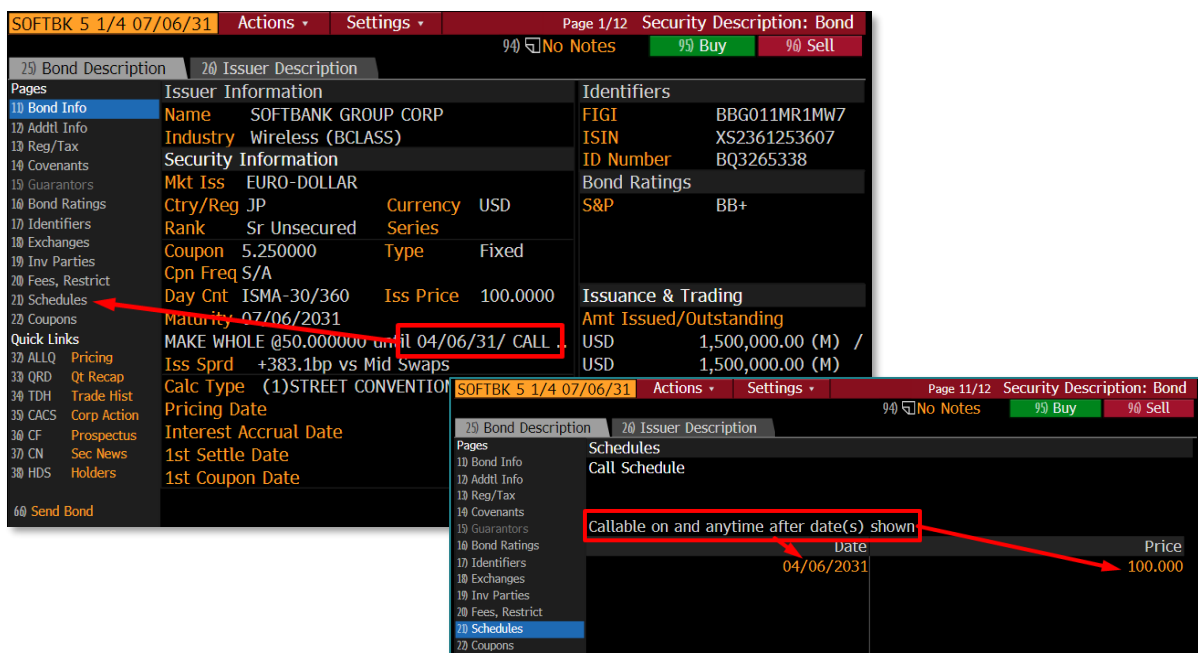
Probably the most common bond you'll encounter. It has a specific maturity where the principal is repaid. Imagine a bullet being fired in a straight line until it hits its target and stops. The bond math we covered in Topic 1 explains the calculations of this bond's value



25 Bond Description		20 Issuer Description		Identifiers	
Name		AMAZON.COM INC		FIGI	BBG010Z2TCP0
Industry		Retailers (BCLASS)		CUSIP	023135BZ8
Security Information		Mkt Iss GLOBAL		ISIN	US023135BZ81
Ctry/Reg	US	Currency	USD	Bond Ratings	
Rank	Sr Unsecured	Series		Moody's	A1
Coupon	2.100000	Type	Fixed	S&P	AA
Cpn Freq	S/A			Fitch	AA-
Day Cnt	30/360	Iss Price	99.98200	Composite	AA-
Maturity	05/12/2031	MAKE WHOLE @10.000000 until 02/12/31/ CALL ...		Issuance & Trading	
Iss Sprd	+50.00bp vs T 1 1/8 02/15/31	Iss Sprd +50.00bp vs T 1 1/8 02/15/31		USD	3,000,000.00 (M) /
Calc Type	(1)STREET CONVENTION	Calc Type (1)STREET CONVENTION		USD	3,000,000.00 (M)
Pricing Date	05/10/2021	Pricing Date 05/10/2021		Min Piece/Increment	
Interest Accrual Date	05/12/2021	Interest Accrual Date 05/12/2021		2,000.00/ 1,000.00	
1st Settle Date	05/12/2021	1st Settle Date 05/12/2021		Par Amount	1,000.00
1st Coupon Date	11/12/2021	1st Coupon Date 11/12/2021		Book Runner	JOINT LEADS
				Reporting	TRACE

Callable

- Has a maturity date AND a date where it can be called
- This is when the issuer CHOOSES to buy the bond back from people who own it
- It can be called on specific dates or any time after a certain date
- Special type is the make whole call



25 Bond Description		20 Issuer Description		Identifiers	
Name		SOFTBANK GROUP CORP		FIGI	BBG011MR1MW7
Industry		wireless (BCLASS)		ISIN	XS2361253607
Security Information		Mkt Iss EURO-DOLLAR		ID Number	BQ3265338
Ctry/Reg	JP	Currency	USD	Bond Ratings	
Rank	Sr Unsecured	Series		S&P	BB+
Coupon	5.250000	Type	Fixed	Issuance & Trading	
Cpn Freq	S/A			Amt Issued/Outstanding	
Day Cnt	ISMA-30/360	Iss Price	100.0000	USD	1,500,000.00 (M) /
Maturity	07/06/2031	MAKE WHOLE @50.000000 until 04/06/31/ CALL ...		USD	1,500,000.00 (M)
Iss Sprd	+383.1bp vs Mid Swaps	Iss Sprd +383.1bp vs Mid Swaps		Min Piece/Increment	
Calc Type	(1)STREET CONVENTION	Calc Type (1)STREET CONVENTION		2,000.00/ 1,000.00	
Pricing Date		Pricing Date		Par Amount	1,000.00
Interest Accrual Date		Interest Accrual Date		Book Runner	JOINT LEADS
1st Settle Date		1st Settle Date		Reporting	TRACE
1st Coupon Date		1st Coupon Date			

25 Bond Description		20 Issuer Description	
Schedules		Call Schedule	
Callable on and anytime after date(s) shown		Date	Price
		04/06/2031	100.000

Puttable

- Like a callable but the option is flipped in the investor’s favour.
- The investors are given an option to SELL the bond back to the issuer on/after a certain date

Sinkable

- Where a bond amortizes over its life by getting the principal repaid by a sinking fund set up for it
- With each payment date, the amount paid to investors is the coupon + part of principal that slowly reduces the principal until maturity
- Coupon rate stays the same, but because the principal reduces the coupon \$ reduces over time

AAL 5 1/2 04/20/26 Corp | Actions | Settings | Page 11/12 | Security Description: Bond

94 No Notes 95 Buy 96 Sell

25 Bond Description 26 Issuer Description

Pages

Schedules

52 Sink 53 Factor Hist

Type	Level	Amount Issued	3,500,000.00 (M)
Frequency	Quarterly	Schd Amt Outstanding	3,500,000.00 (M)
Voluntary	None	Next Mandatory Sink	07/20/2023
Avg Life	3.33 (12/01/24)	Shortest	3.34 (12/04/24)
		Longest	3.34 (12/04/24)

Table View Chart View

Date	Amount	Total Sunk		Remaining Balance	
		Cash (M)	%	Cash (M)	%
10/20/2023	291666.66	583333.31	16.6667	2916666.69	83.3333
01/20/2024	291666.66	874999.97	25.0000	2625000.04	75.0000
04/20/2024	291666.66	1166666.62	33.3333	2333333.38	66.6667
07/20/2024	291666.66	1458333.28	41.6667	2041666.73	58.3333
10/20/2024	291666.66	1749999.93	50.0000	1750000.07	50.0000
01/20/2025	291666.66	2041666.59	58.3333	1458333.41	41.6667
04/20/2025	291666.66	2333333.24	66.6667	1166666.76	33.3333
07/20/2025	291666.66	2624999.90	75.0000	875000.10	25.0000
10/20/2025	291666.66	2916666.55	83.3333	583333.45	16.6667
01/20/2026	291666.66	3208333.21	91.6667	291666.79	8.3333

Convertible

- A bond with an equity call option embedded that allows you to convert the bond into the issuer’s equity instead.
- The conversion price is typically quite a bit higher than the spot equity price meaning that while the equity is trading below the conversion price, the convertible acts more like a bond. This is important because a bond has a fixed payout over its life. **A stock does not, but it allows for capital appreciation.**

TSLA 2 05/15/24 Corp | Actions | Settings | 94 No Notes 95 Buy 96 Sell

25 Convertible Bond 26 Underlying Description

Pages

Issuer Information

Identifiers

Name	TESLA INC	FIGI	BBG00P2DPCT8
Industry	Automotive (BCLASS)	CUSIP	88160RAG6
Convertible Information		ISIN	US88160RAG65
Mkt of Issue	US DOMEST... Convertible	Bond Ratings	
Ctry/Reg	US Currency USD	S&P	BB
Bank	Cr Unsecured Series	Issuance & Trading	
Conv Ratio	16.1380	Conv Price	61.9655
Stock Trkr	TSLA US	Stock Price	710.9199...
Parity	1147.2827	Premium	-.1295
Coupon	2.000000	Init Prem	27.500
Type	Fixed	Freq	S/A

Calc Type (49) CONVERTIBLE

Pricing Date 05/02/2019

1st Coupon Date 11/15/2019

Convertible Until 05/13/2024

Maturity 05/15/2024

\$240MM GREENSHOE EXERCISED IN FULL EFFECTIVE 5/3/19.

Amt Issued/Outstanding

USD	1,840,000.00 (M)
USD	167,333.00 (M)

Min Piece/Increment 1,000.00 / 1,000.00

Par Amount 1,000.00

Book Runner JOINT LEADS

Reporting TRACE



So, if the market believes the stock price will move above the conversion price, the behaviour of the convertible begins to act like a stock rather than a bond. When this Tesla bond was issued, the stock was trading at around \$48 with a conversion price of 61.9655 – while the bond did move in line with the stock there was still some basis.

It wasn't until later november that the stock moved past \$62. Now look at how the convert and stock traded alongside one another throughout 2021.

As mentioned, the convertible is basically a bond with an equity call option embedded. This is why once the equity option is ITM enough the delta of the option becomes 1.00 and the convertible begins to trade as an equity.



Perpetual

Rather than a specific maturity, the bond never matures. I.e., you never get your principal back. You lend the money forever. Only way to get your money back is to sell it to someone else. Sounds bad? Then don't buy blue chip dividend stocks. Preferred equity shares are treated the same as they are functionally equivalent for the most part – you buy a preferred and in return get regular dividends in perpetuity, often with no voting rights.

There is a *special type of perpetual bond*, which are the designed to be Basel III compliant and absorb losses and fall under what are called TLAC (total loss absorbing capacity) bonds. These bonds are issued by financial institutions as part of raising additional capital for their balance sheets.



Most of these TLACs are Perpetual bonds with an option to call the bonds. A popular call date is 3, 5 or 7 years away. The coupons are typically fixed but reset to a floating rate at the call date. If you see the term **PerpNC7** the NC stands for Non-Call (until) meaning the bond is a perpetual until 7 years later when the call schedule begins.

Date	Issuer/Headline	Coupon	Maturity	Spread	Curr	Outst	Book Mgr	Note
110 08/04	PRICED: Summit Digital \$500m 10Y at 98.459 to Yield 3.055%							
111 08/04	RAYTHEON TECH	1.900	09/01/31	+73	USD	1000	JOINT LEADS	10C CONT
112 08/04	RAYTHEON TECH	2.820	09/01/51	+98	USD	1000	JOINT LEADS	30C CONT
113 08/04	PRICED: Raytheon Technologies \$2h Debt Offering in 2 Parts							
114 08/04	PRICED: Barclays Plc \$1.5bn PerpNC7 AT1 4.375%							Perpetual bond not callable till 7yrs time
115 08/04	BARCLAYS PLC	VAR	PERPETUAL		USD	1.5B	BARCS-sole	10C 3MBERM
116 08/04	PRICED: Ares Capital \$400m 2.875% 2028 Tap +147							
117 08/04	PRICED: Rexford Industrial Realty \$400m 10Y Green +108							
118 08/04	ARES CAPITAL COR	2.875	06/15/28	+165	USD	1.25B	JOINT LEADS	INCREASE

A subset of these TLAC bonds is a special breed known as CoCos which stands for **Contingent Convertible bonds**.

CoCos – Hybrid Bonds

In the wake of GFC, regulators required banks to shore up capital in order to withstand financial distress. Recall the classic accounting equation: **Assets = Liabilities + Equity**. Because impairments of assets hit the value of equity, enough impairments can make equity go to zero and results in Lehmanism. So, under Basel III rules, banks must hold a certain amount of core capital in the form of equity and retained earnings against risk-weighted assets. This ratio of equity to RWA is known as the Common Equity Tier 1 Ratio – CET1 Ratio. The minimum they must hold is currently 7%.

What banks were allowed to start doing was to issue a bond that in times of stress could do two things:

1. Stop paying coupons
2. Convert into equity or become completely written off

UBS 5 1/8 05/15/24 Cor		Actions	Settings
Bond Description		Issuer Description	
Name		UBS AG	
Industry		Banking (BCLASS)	
Mkt Iss		EURO-DOLLAR	
Ctry/Reg		CH	
Rank		Subordinated	
Coupon		5.125000	
Cpn Freq		Annual	
Day Cnt		ISMA-30/360	
Maturity		05/15/2024	
Quick Links		BULLET	
Identifiers		Capital Type CoCo	
Bond Ratings		Currency USD	
S&P		BBB+	
Fitch		A-	
Composite		BBB+	
Scope		RS	
Issuance & Trading		Iss Price 99.90500	
Amt Issued/Outstanding		Reoffer 99.905	
		USD 2,500,000.00 (M) /	

UBS 5 1/8 05/15/24 Cor		Actions	Settings
Bond Description		Issuer Description	
Additional Information		Loss Absorption Information	
Capital Type CoCo		Yes	
Basel III		Tier 2	
Trigger		Common Equity Tier 1 Ratio	
Action		Permanent Write Down	
Trigger Type		Mechanical	
Trigger Level		5.000000	

The halting of coupons would reduce cashflow issues and lower expenses, raising equity through retained earnings but the kicker is really #2. If the CET1 ratio drops below a trigger point, the whole bond either converts into equity or gets written off.

This either boosts the equity portion or reduces the liability, either of which helps the balance sheet.

A conversion contingent on a trigger, which is a pre-determined regulatory level – the CET1 ratio. It is a mechanical trigger, meaning there is no discretion involved. It happens when it happens. Since their introduction, no CoCo has ever triggered its conversion however there were widespread fears about DB and its CoCos back in 2016.

You will also NOT FIND any U.S. bank with a CoCo. This is because U.S. banking regulations prohibit their banks from issuing CoCos to meet their additional capital requirements. Instead of CoCos, U.S. banks issue preferred shares of equity. A key difference between these preferreds and CoCos is that in order to stop dividend payments on the preferred, common equity dividends must also be stopped, with CoCos the coupon stoppage is independent.

That wraps up the basic introduction to credit! Now you're familiar with some of the bonds available and some of the nuances involved. In the next part, we start to look at how to quantify credit risk in bonds (please re-read the special topic on bootstrapping if you haven't done so).

8.4 Topic Question

1. For a callable bond, when would an issuer be likely to call the bond back from the market and how does that impact the convexity of the Price/Yield chart?
2. If a Samurai Bond is a yen-denominated bond, issued by a non-Japanese corporation for the Japanese domestic market, and a Bulldog bond is a British-pound bond issued in the UK by a non-UK entity, what is a USD-denominated bond issued by an Australian corporate in Europe called? What if it was issued in the US?

1. *An issuer is likely to call back a bond when interest rates are low. This is because they can then re-issue the bond at a lower coupon, particularly when the bond can be called at par (100). This affects the convexity of the price/yield chart by making it negatively convex at yields at or lower than where the call price is. Above the respective yield, there is no incentive to call the bond and it trades like a normal bond. The shape of the curve is therefore in an "s-curve"*
2. *USD-denominated issued by Australian issuer in Europe = Eurodollar bond.
USD-denominated issued by an Australian issuer in the U.S. would make it a Yankee Bond (I'm not kidding).*



25) Bond Description		20) Issuer Description	
Pages			
11) Bond Info	Issuer Information		
12) Addtl Info	Name	BHP BILLITON FINANCE	
13) Reg/Tax	Industry	Metals and Mining (BCLASS)	
14) Covenants	Security Information		
15) Guarantors	Mkt Iss	YANKEE	Yankee
16) Bond Ratings	Ctry/Reg	AU	Currency USD
17) Identifiers	Rank	Sr Unsecured	Series
18) Exchanges	Coupon	6.420000	Type Fixed
19) Inv Parties	Cpn Freq	S/A	
20) Fees, Restrict			

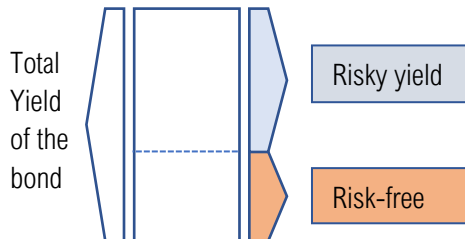
9. Credit Risk



Today we'll learn ways to quantify credit risk, namely through various spreads that are often quoted, what they measure, how/when to apply them and their differences. **This is the backbone of credit analysis.** Let's begin.

9.1 What is Credit Risk?

First let's start with the basic concept of yield. A bond's yield is the annualized return you'll earn if held from now until the principal is repaid. If there exists a risk-free yield, then a corporate bond's yield must be the risk-free yield plus compensation for added risk.



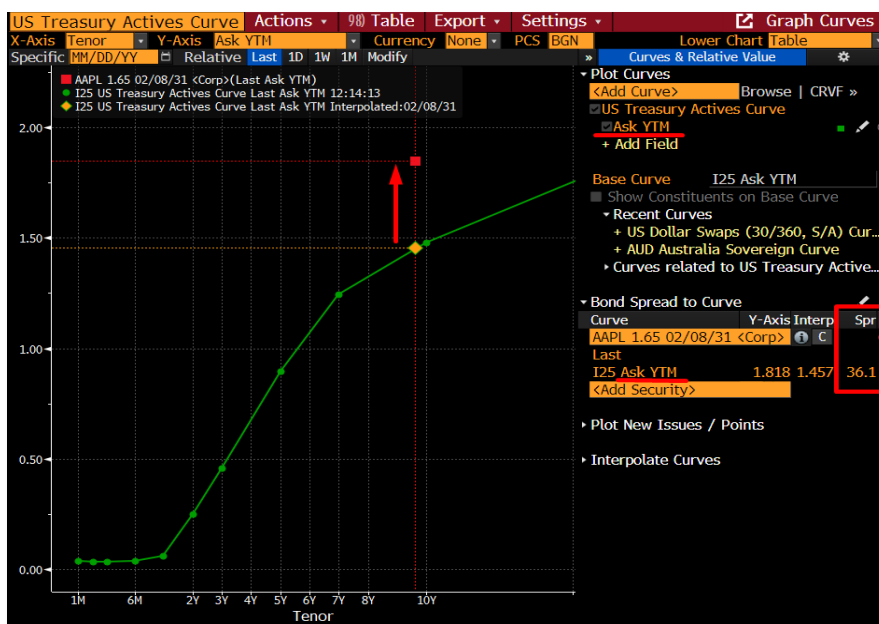
This is the resounding principal of any credit risk measure; the extra reward you get for taking on added risk. In practice, we've already seen a basic example from the money markets topic: LIBOR-OIS – the interbank lending rate over OIS is a measure of interbank credit risk.

In credit, a similar measure is the **Spread to Benchmark**: AAPL 10y bond pays 1.818025% yield while the 10y UST pays 1.476495, a spread of 34.15bps. That is a form of a credit spread.

But the 10y UST matures in 05/15/2031 while the AAPL bond matures in 02/08/31. That's not exactly the same maturity – the AAPL bond matures 3 months earlier. What if I wanted the spread exactly to the 02/08/31 point?

AAPL 1.65 02/08/31 Corp		Settings ▾	
97.993/98.525	1.879/1.818	BGN@ 04:59	
1 Yield & Spread 2 Graphs 3 Pricing 4 Descri			
AAPL 1.65 02/08/31 (037833FD8)			
Spread	34.15 bp	vs	10y T 1 5 05/15/31 ▾
Price	98.525		101-11+ 12:05:25
Yield	1.818025 Wst ▾		1.476495 S/A ▾
Wkout	02/08/2031 @ 100.00	Consensus	Yld 6.6
Settle	07/01/21		06/30/21

That's the **G-Spread** (G for Government). You interpolate the exact point on the yield curve (linear interpolation) to match the maturity of the credit and find the spread there. In this **GC<GO>** chart the yellow marker is the interpolated benchmark yield while the red marker is the AAPL bond's yield. The gap between the two is the G-Spread.

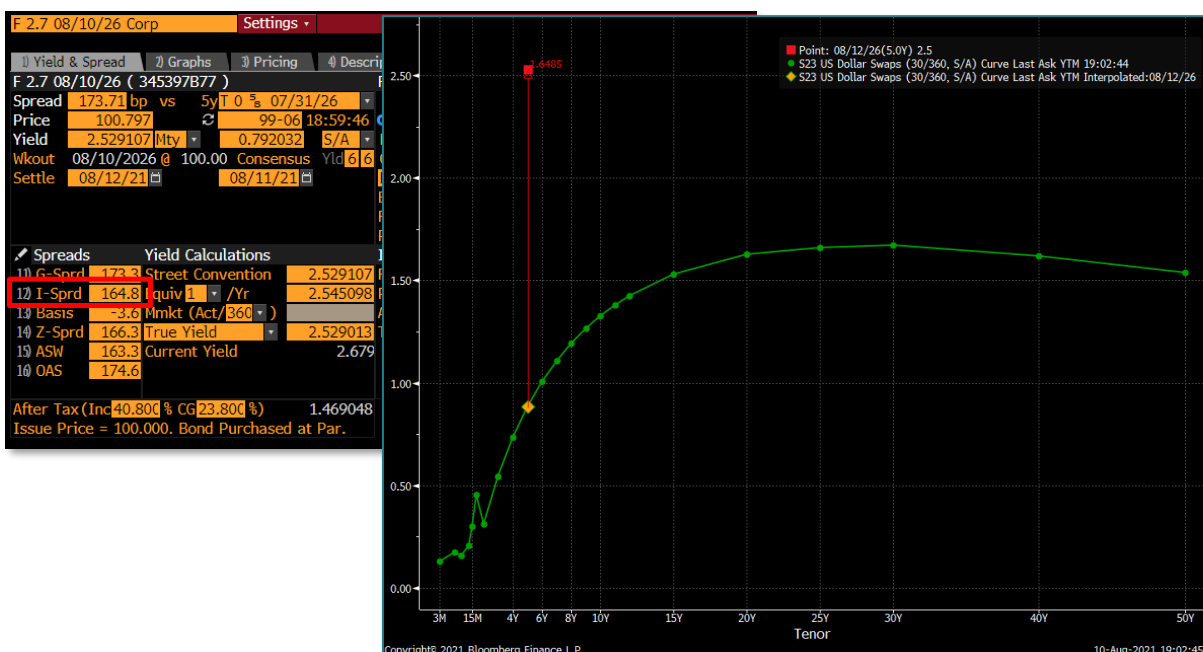




If you want to match your YAS screen with the GC screen you must make sure you have commonality between pricing settings. This is why in GC I underlined YTM ASK. On **YAS<GO>** the default setting should be to price on Ask. Why? Because you generally buy on the ask and sell on the bid and Bloomberg typically defaults to buyer's perspective. This is often a HUGE reason why brokers and clients will mismatch on pricing when referring to Bloomberg screens. Pricing defaults are a headache but also massively important.



Now, comparing to the govvie curve gives an idea about excess yield over a risk-free rate but in the real world it's not like many of us get funding at the government rate. If you're a bank, you're financing at the swap rate. Which brings us into another category of credit spreads. The **I-Spread** is just like the G-spread but instead of using the government





curve, you are using the relevant swaps curve. For example, this Ford bond matures on Aug 10, 2026 and yields 2.53% to maturity giving it an I-spread of 164.8

Those are the relatively easier spreads to think about. Now it gets a bit more complicated, but I'll be gentle and not go too deep. Basically, just the tip.

ANYWAY.

Did you remember to read the special topic on bootstrapping a yield curve? No? That's a shame. What does this series look like to you? Free? In the bootstrapping topic we looked at how to strip a yield curve so we can discount future cashflows by their appropriate discount rate. Recall: A bond's yield assumption is that reinvestment/discounting rate are constant – **a convenient assumption but not entirely accurate.**

First – understand that yields and price are inversely related to one another. Second – sear it into your brain that price is what you PAY, yield is what you ASSUME. So, in all the ways that you can then proceed to analyze a bond, it starts with the price paid. **Here's the key idea: If we derive risk-free discount rates, it means for a given price of a RISKY bond, its cashflows must be discounted at rates that are higher than the risk-free rate.**

Intuitively this is the same as the spread to benchmark but instead of one single benchmark yield, we are using zero-coupon yields from across the maturity of the bond. So we're going to use the whole curve to discount cashflows.

9.2 Z-Spread

The first example is the **Z-spread**. The Z in the name stands for “zero-volatility”. This is an important point which I'll come back to later. For this spread, we use the swaps curve. Firstly, we strip the swaps par curve and use that to discount the bond. The Z-Spread is the **CONSTANT** spread that is added on to each of the discount rates so that the NPV of the cashflows match the price.

It makes the risk-free discount rate a risky discount rate.

DAL 7 05/01/25 Corp		Settings		No Notes		Buy		Sell	
DAL 7 05/01/25 (247361ZX9)									
Spread	126.03 bp	vs	5yT 0 % 07/31/26	Risk		Workout	OAS		
Price	117.7475		99.30469	<input checked="" type="radio"/> M.Dur	<input type="radio"/> Dur	3.292	3.302		
Yield	2.028016	Wst	0.767694	S/A	Risk	3.940	3.952		
Wkout	05/01/2025 @ 100.00		Yld 6.6	Convexity		0.133	0.134		
Settle	08/10/21		08/09/21	DV	01 on 1MM	394	395		
Trade	08/06/21	Retro (Using hist price)		Benchmark Risk		4.854	4.888		
				Risk Hedge		812M	808M		
				Proceeds Hedge		1,205M			
Spreads		Yield Calculations		Invoice					
11) G-Spr	148.1	Street Convention	2.028016	Face		1,000	M		
12) I-Spr	135.7	Equiv 1 /Yr	2.038298	Principal		1,177,475.00			
13) Basis	93.0	Mmkt (Act/360)		Accrued (99 Days)		19,250.00			
14) Z-Spr	138.6	True Yield	2.027967	Total (USD)		1,196,725.00			
15) ASW	151.4	Current Yield	5.945						
16) OAS	150.5								
After Tax (Inc 40.800 % CG 23.800 %)		0.458704							
Issue Price = 100.000. OID Bond with Market Dis...									

Take this Delta Airlines bond as an example. It is a bullet bond maturing in about 4 years (from writing) and trades with a Z-spread of about 138bps. Let's try to back it out ourselves.

Now we need to find (through iteration) what the constant spread over each zero-coupon swap rate is that discounts the bond's cashflows to an NPV that matches the price. We are looking at the dirty price here: 119.6725 on a \$1mm face = \$1,196,725.00 (bottom right).

First, we strip the swaps curve, making sure to match the trade and curve dates. On 8/6/21 the settle date is 8/10/21. In Excel using Bloomberg add-ins (Curve Toolkit) we can pull in the curve and strip it, then using the bond's cashflow dates, interpolate what the zero-coupon rate is for those dates.

Each of these discount rates will have the Z-spread added to it to discount the cashflows.

Curve ID	S23	USD 3M LIBOR SWAPS CURVE (30/360)			
Stripped Curve ID	USD.3M:BLOOMBERG DC 501658				
Maturity	ZC Ask Rate	Payment Date	Interpolated ZC Rate	ZC Swap Rate + Z-Spread	
11/10/2021	0.130	11/1/2021	0.130	?	
12/15/2021	0.128	5/1/2022	0.150	?	
3/16/2022	0.148	11/1/2022	0.177	?	
6/15/2022	0.152	5/1/2023	0.253	?	
9/21/2022	0.166	11/1/2023	0.358	?	
12/21/2022	0.190	5/1/2024	0.472	?	
3/15/2023	0.229	11/1/2024	0.577	?	
8/10/2023	0.306	5/1/2025	0.669	?	
8/12/2024	0.536				
8/11/2025	0.720				
8/10/2026	0.868				
8/10/2027	0.996				
8/10/2028	1.103				
8/10/2029	1.194				
8/12/2030	1.270				
8/11/2031	1.337				
8/10/2032	1.395				
8/10/2033	1.443				
8/11/2036	1.553				
8/12/2041	1.663				
8/10/2046	1.698				
8/10/2051	1.707				
8/10/2061	1.629				
8/10/2071	1.518				

Now, let's pull in the bond information including its cashflows. Using goal seek, we can find out what the Z-Spread is, that results in a set of discount rates that makes the bond's NPV of its cashflows match the dirty price.

	A	B	C	D	E	F
1	US247361ZX93 Corp	DAL 7 05/01/25				
2	Trade Date	8/6/2021				
3	Settle Date	8/10/2021				
4	Face	\$ 1,000,000.00				
5	Price (Clean)	117.748	\$ 1,177,480.00			
6	Price (Dirty)	119.673	\$ 1,196,730.00			
7	Coupon	7				
8	Accrued Interest	1.925	\$ 19,250.00			
9	Day Count	30/360				
10	Z-Spread	?	bps	<< Iterated through Goal Seek		
11						
12	Cashflows					
	Payment Date	Coupon Amount	Principal Amount	Total	Days	Discounted Cashflow
14	11/1/2021	\$ 35,000.00	\$ -	\$ 35,000.00	81	?
15	5/1/2022	\$ 35,000.00	\$ -	\$ 35,000.00	261	?
16	11/1/2022	\$ 35,000.00	\$ -	\$ 35,000.00	441	?
17	5/1/2023	\$ 35,000.00	\$ -	\$ 35,000.00	621	?
18	11/1/2023	\$ 35,000.00	\$ -	\$ 35,000.00	801	?
19	5/1/2024	\$ 35,000.00	\$ -	\$ 35,000.00	981	?
20	11/1/2024	\$ 35,000.00	\$ -	\$ 35,000.00	1161	?
21	5/1/2025	\$ 35,000.00	\$ 1,000,000.00	\$ 1,035,000.00	1341	?
22					NPV	\$ -

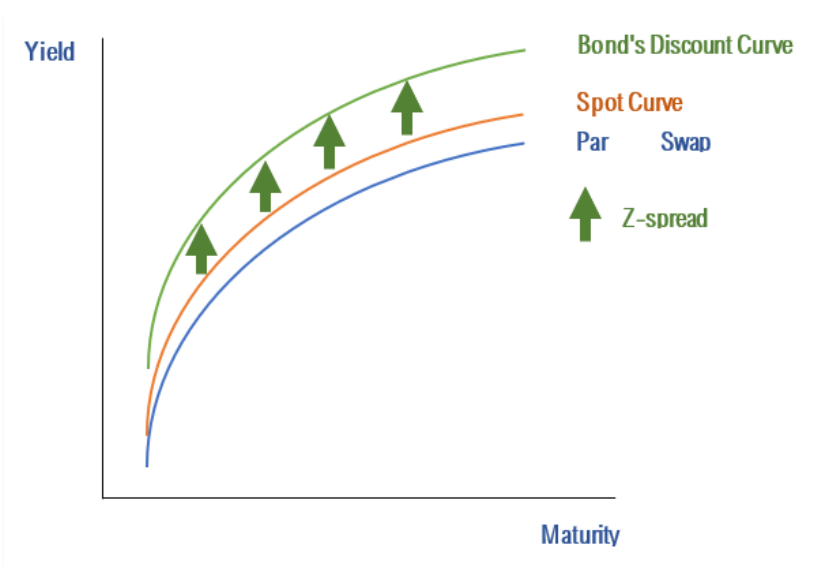


The result is

	A	B	C	D	E	F	G
1	US247361ZX93 Corp	DAL 7 05/01/25					
2	Trade Date	8/6/2021					
3	Settle Date	8/10/2021					
4	Face	\$ 1,000,000.00					
5	Price (Clean)	117.748	\$ 1,177,480.00				
6	Price (Dirty)	119.673	\$ 1,196,730.00				
7	Coupon	7					
8	Accrued Interest	1.925	\$ 19,250.00				
9	Day Count	30/360					
10	Z-Spread	138.7	bps	<< Iterated through Goal Seek			
11							
12	Cashflows						
13	Payment Date	Coupon Amount	Principal Amount	Total	Days	ZC Swap Rate + Z-Spread	Discounted Cashflow
14	11/1/2021	\$ 35,000.00	\$ -	\$ 35,000.00	81	1.518%	\$ 34,881.14
15	5/1/2022	\$ 35,000.00	\$ -	\$ 35,000.00	261	1.537%	\$ 34,613.52
16	11/1/2022	\$ 35,000.00	\$ -	\$ 35,000.00	441	1.564%	\$ 34,338.24
17	5/1/2023	\$ 35,000.00	\$ -	\$ 35,000.00	621	1.641%	\$ 34,027.33
18	11/1/2023	\$ 35,000.00	\$ -	\$ 35,000.00	801	1.745%	\$ 33,672.57
19	5/1/2024	\$ 35,000.00	\$ -	\$ 35,000.00	981	1.859%	\$ 33,278.83
20	11/1/2024	\$ 35,000.00	\$ -	\$ 35,000.00	1161	1.965%	\$ 32,861.48
21	5/1/2025	\$ 35,000.00	\$ 1,000,000.00	\$ 1,035,000.00	1341	2.056%	\$ 959,051.89
22						NPV	\$ 1,196,725.00

Spreads		Yield Calculation	
1) G-Sprd	148.1	Street Convnt	
12) I-Sprd	135.7	Equiv 1	/Yr
13) Basis	93.0	Mmkt (Act/B60	
14) Z-Sprd	138.6	True Yield	
15) ASW	151.4	Current Yield	
16) OAS	150.5		

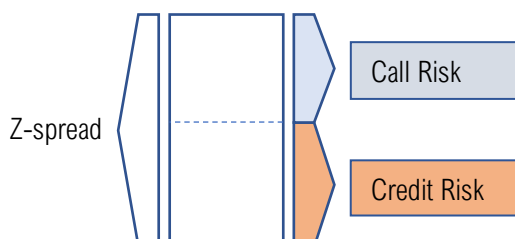
138.7bps, pretty much spot on with the BLOOMBERG screen (minor rounding adjustments). But this is how you derive the Z-Spread! Graphically it looks like this:



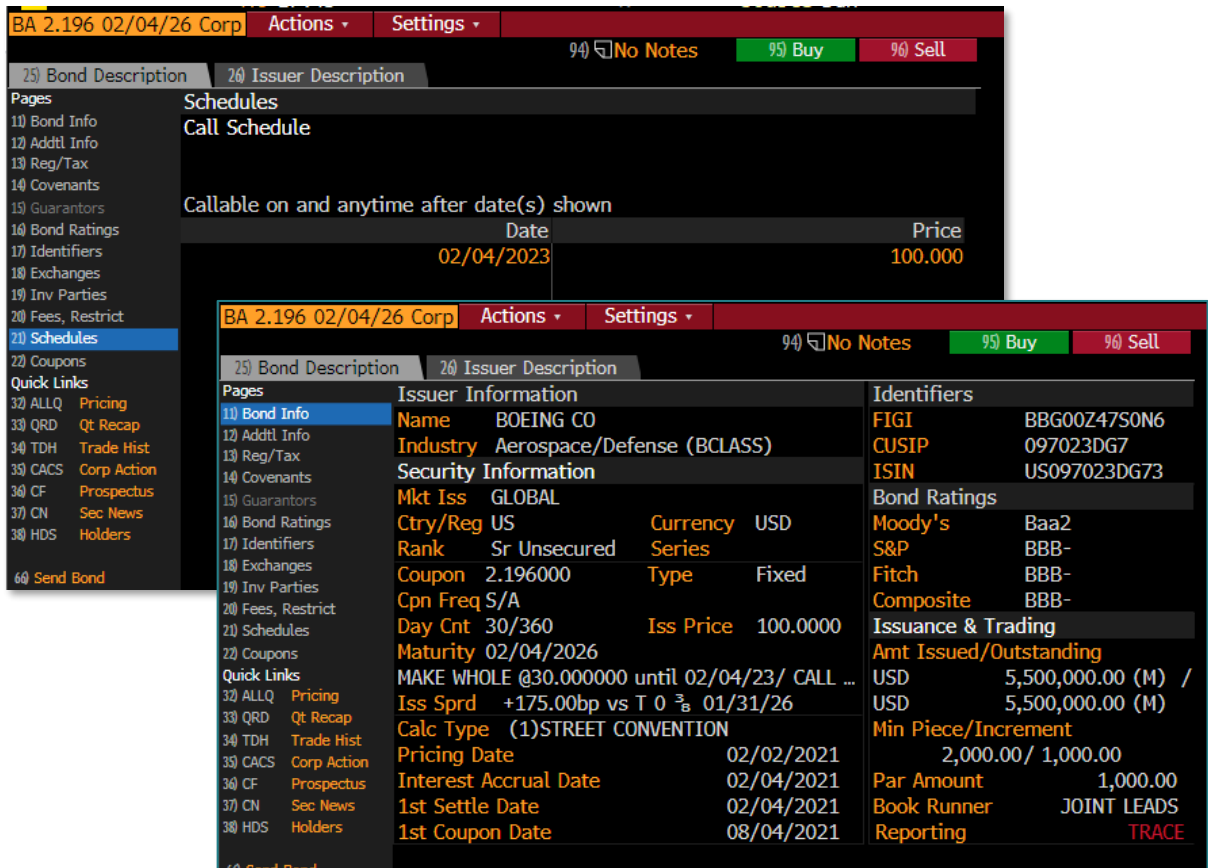
9.3 Callable Bond Risk – Option Adjusted Spread (OAS)

Now let's turn our heads to callable bonds. A callable is a bullet bond with a call option attached to it. Because the call option belongs to the issuer, the investor is SHORT the call option. That means the **bond possesses call risk** on top of the credit risk. If we are focused on credit risk, we must find a way to strip out call risk leaving only the credit risk.

For a callable bond, the Z-spread is calculating the extra spread in totality, but that Z-spread contains credit risk and call risk: i.e., all things equal a callable bond with 100bps Z-spread has a different credit risk than a bullet with 100bps Z-spread.

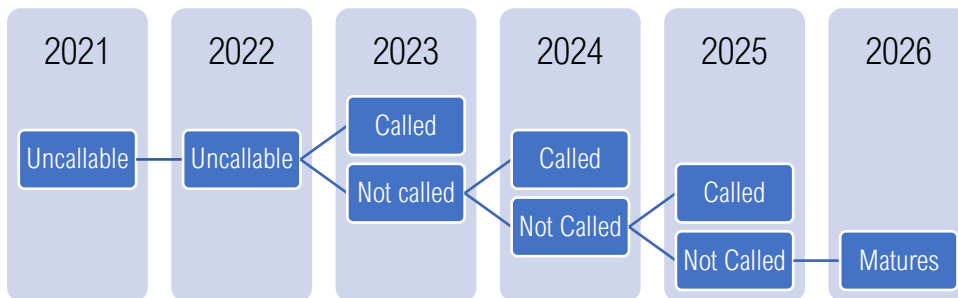


Welcome to the **OAS - Option-Adjusted Spread**. This is the process of removing the call risk (or put risk) in order to derive the credit risk of the bond. How do we do that? Let's look at a real example to understand better.



The screenshot shows two overlapping windows from a bond trading platform. The top window displays the 'Call Schedule' for the bond 'BA 2.196 02/04/26 Corp', indicating it is callable on and anytime after 02/04/2023 at a price of 100.000. The bottom window provides detailed issuer information for Boeing CO, including industry (Aerospace/Defense), security (Sr Unsecured), coupon (2.196000), maturity (02/04/2026), and various identifiers like FIGI, CUSIP, and ISIN. It also lists bond ratings (Moody's Baa2, S&P BBB-, Fitch BBB-) and issuance details.

This Boeing bond matures in 2026 but is callable at any time from 02/2023 at par. If we look at its potential path in yearly snapshots it would look something like this:



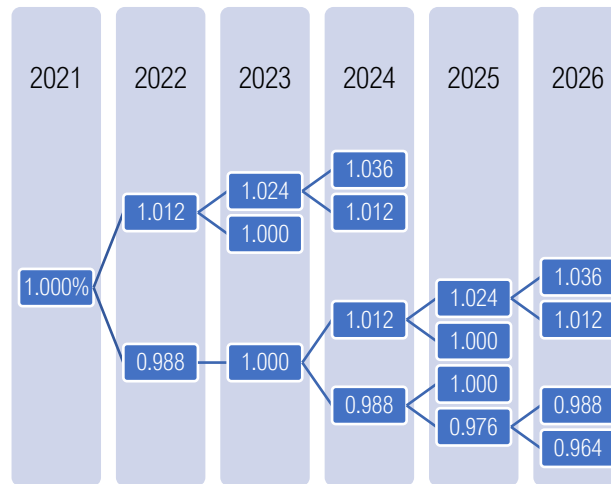
Now, the conventional way to think about the potential path of option-embedded bonds is through a stochastic process. Simply – it is a collection of random variables indexed by time. Even simpler - at each point in time there's an unknown path that could be taken.

For a callable bond, when would the issuer consider calling the bond? Intuitively, it would be when the bond's yields are lower than what the bond's coupon. Why? Because if they bought the bond back, they could re-issue a new bond at the lower yields and pay lower coupons. But the call schedule has a specific price it can be called at. So strictly, it would be called if the market price is more than the call price, as that would make the call option in-the-money. So, there's an unknown path at each time interval and we know that if yields are low enough the issuer would call.

What are we sure of? The present. **Everything in the future is a child of probability: yields can go up or down. And what goes with probability in finance? Volatility.**

If we can look back at how rates have moved in the past (its vol), we can apply that to each time interval. For example: if 1y swap rates have an annualized volatility of 1.2bps over the last year it means starting today I can map a fork in the road at each future point in time:

Example: Possible path of swap rates



So now we have a path of swap rates with each fork having an equal marginal probability of occurring with the magnitude of the move determined by volatility (OAS assumes constant volatility but there are alternative methods). Like with Z-spread, what is the constant spread required over each of the zero rates at each potential path that results in a NPV of each potential cashflow stream to equal the current price?

Z-spread has a single path, OAS has multiple paths determined by volatility of interest rates. [This is why the Z-spread stands for ZERO VOLATILITY spread.](#) If you set vol to 0 and assume the bond does not get called the OAS and Z-

OPTION-ADJUSTED SPREAD ANALYSIS

BOEING CO BA2.196 02/04/26 100.668/100.825 (1.733/1.624) BGN @ 4:59

Calculate Price OAS (bp) Volatility
(P,0,V) P) 100.8370 0) +119.6 v) 0.00

Cusip / ID# 097023DG7 Option Px Value: 0.00
Settle 8/16/2021 Bench settle 8/16/2021 Vega: 0.00
Spread 155.3bp vs 3Y T 0 3/8 08/15/24 Govt @ 99-25 4 (0.446)

{NUM}<GO> for:	OAS	Option	To Call on	To
3) Call Schedule	Method	Free	2/ 4/2023	Mty
Make whole	Yld	1.999	1.616	1.999
provision	Sprd	119.0	134.5	119.0
ignored	M Dur	2.64	1.44	4.24
	Risk	2.66	1.45	4.27
	Cnvx	-6.30	0.03	0.21

Model L=Lognormal
Exercise Premium 0.00

2) Customize
Curve S23 Semi
Swap: US Dollar
Dated 8/12/2021

BA 2.196 02/04/26 Corp Settings

Yield & Spread Graphs Pricing Descri

BA 2.196 02/04/26 (097023DG7)
Spread 119.72 bp vs 5y T 0 5/8 07/31/26
Price 100.837 99-04+ 13:22:17
Yield 1.999107 Mty 0.801905 S/A
Wkout 02/04/2026 @ 100.00 Consensus Yld 6/6
Settle 08/16/21 08/13/21

Spreads	Yield Calculations
1) G-Sprd 128.4	Street Convention 1.999107
2) I-Sprd 118.7	Equiv 1 /Yr 2.009098
3) Basis -11.5	Mmkt (Act/360)
4) Z-Sprd 119.7	True Yield 1.999053
5) ASW 117.6	Current Yield 2.178
6) OAS 55.2	

After Tax (Inc 40.800 % CG 23.800 %) 1.150811
Issue Price = 100.000. OID Bond with Market Dis...

spread will be the same for a callable as you can see with the Boeing bond below. The Delta Airlines bond on the other hand is a bullet bond, so its Z-Spread and OAS are always the same.

DAL 7 05/01/25 Corp		Settings ▾	
117.465/117.640		2.081/2.036 BMRK @ 06:4	
1) Yield & Spread 2) Graphs 3) Pricing 4) Descr			
DAL 7 05/01/25 (247361ZX9)			
Spread	123.24 bp vs	5yT 0 ⁵ / ₈	07/31/26 ▾
Price	117.64	↻	99-04 ¹ / ₄ 13:27:11
Yield	2.035945 Wst ▾	0.803521	S/A ▾
Wkout	05/01/2025 @ 100.00	Consensus	Yld 6.6
Settle	08/16/21		08/13/21
BULLET BONDS HAVE ONLY ONE PATH THEREFORE OAS = Z-SPREAD			
Spreads		Yield Calculations	
1) G-Sprd	146.0	Street Convention	2.035945
2) I-Sprd	135.1	Equiv 1 ▾ /Yr	2.046307
3) Basis	89.0	Mmkt (Act/360 ▾)	
4) Z-Sprd	138.0	True Yield ▾	2.035895
5) ASW	150.6	Current Yield	5.950
6) OAS	138.1		
After Tax (Inc 40.800% CG 23.800%)		0.464144	
Issue Price = 100.000. OID Bond with Market Dis...			

The math to back out the OAS is too intensive for this series (it is basics after all) but I want you to **take away the core principles** behind each of these metrics, so you know why we quote them on a daily basis.

So, the OAS removes call risk from the Z-spread by calculating the probability-weighted risk over the bond's life. This is important because you can now compare credit risk on callable bonds with bullet bonds and have a consistent credit risk measure applicable to an index or portfolio. This is why index spreads use OAS.

What is call risk? Break it down simply – say the Boeing callable at issue trades at 100. If never called, you will earn an annualized yield of 2.196%. If it gets called in 2023 then you will suddenly lose 2 years of compounded yield and need to reinvest it. That is call risk.

This risk must be compensated to the investor and is captured in the difference between Z-spread and OAS. Important things for BLOOMBERG: Check your model parameters – curve (Tsy vs Swaps), model type (lognormal, normal, with or without mean reversion).

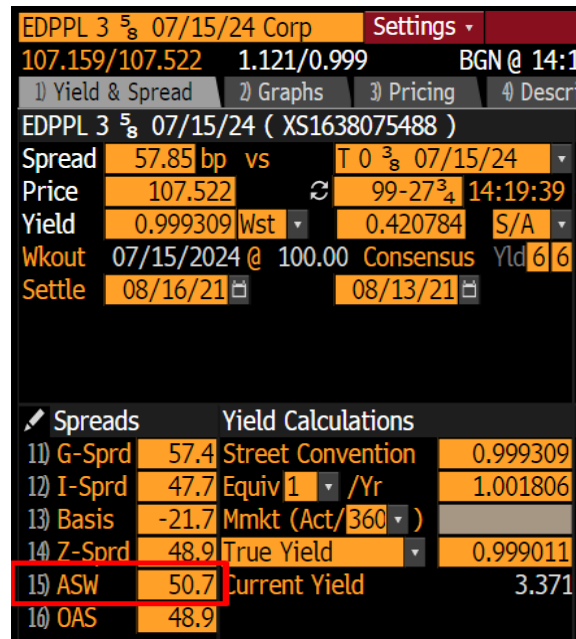
The flipside of this risk is extension risk. The market assumes the Boeing bond gets called hence the price is 100.837 for a yield to call of 1.616%. If not called the market must re-adjust the credit to price in line with 2yrs extra maturity risk (longer end yields + spread). One infamous example of this is a Standard Chartered PerpNC10. Issued in 2006, it paid a 6.409% coupon until Jan '17 when it would switch to a floating rate of 3M LIBOR+151bps.

STANLN Float PERP Corp		Actions ▾		Settings ▾		Page 1/12 Security Description: Bond	
		94 No Notes		95 Buy		96 Sell	
25 Bond Description		26 Issuer Description					
Pages		Issuer Information		Identifiers			
1) Bond Info	Name	STANDARD CHARTERED PLC		FIGI	BBG0000FM643		
2) Addtl Info	Industry	Banking (BCLASS)		ISIN	USG84228AT58		
3) Reg/Tax	Security Information			ID Number	EF9431190		
4) Covenants	Mkt Iss	EURO-DOLLAR	Depository Receipt	Bond Ratings			
5) Guarantors	Ctry/Reg	GB	Currency	USD	Moody's	Ba1	
6) Bond Ratings	Rank	Jr Subordinated	Series	REGS	S&P	BB	
7) Identifiers	Coupon	1.638500	Type	Variable	Fitch	BBB-	
8) Exchanges	Formula	QUARTLY US LIBOR +151.00000	Iss Price	100.0000	Composite	BB+	
9) Inv Parties	Day Cnt	ACT/360 NON-...	Issuance & Trading				
10) Fees, Restrict	Maturity	PERPETUAL	Aggregated Amount Issued/Out				
11) Schedules	PERPETUAL CALL	01/30/27@100.00	USD 750,000.00 (M) /				
12) Coupons	Iss Sprd	+198.00bp vs T 4 ⁵ / ₈ 11/15/16	USD 750,000.00 (M)				
13) Quick Links	Calc Type	(21)FLOAT RATE NOTE	Min Piece/Increment				
14) ALLQ Pricing	Pricing Date	12/01/2006	100,000.00/ 100,000.00				
15) QRD Qt Recap	Interest Accrual Date	12/08/2006	Par Amount 100,000.00				
16) TDH Trade Hist	1st Settle Date	12/08/2006	Book Runner JPM,ML,SCB				
17) CACS Corp Action	1st Coupon Date	07/30/2007	Reporting TRACE				
18) CF Prospectus	CPN=6.409% TO 1/2017 S/A (30/360); THEREAFTER 3MO US\$LIBOR +151BP						
19) CN Sec News	QTRLY (ACT/360). Basel III Grandfathered NON-CUMULATIVE REDEEMABLE PREF						
20) HDS Holders							
21) Send Bond							

9.4 Asset Swap Spread (ASW)

And for the last of the spreads we will cover today, we have the **ASW spread – the Asset Swap Spread**. When we cover interest rate swaps this will make more sense, but we'll jump in a little bit. A swap simply exchanges one thing for another or from one place to another. There are many types that exist in and out of finance; an interest-rate-swap swaps types of coupons (fixed to floating), a home swap switches locations of your dwelling with another and a wife-swap is...ahem.

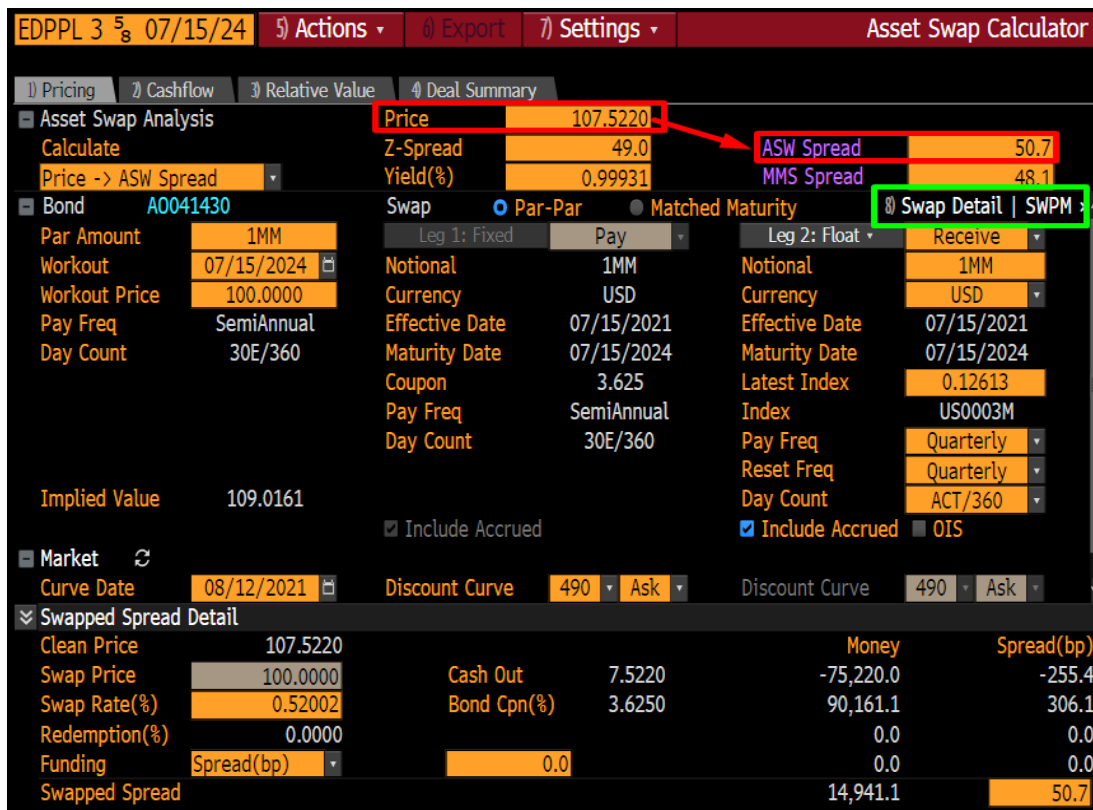
An ASW takes a credit and swaps its cashflows into another form. An easy example is swapping a fixed coupon bullet into floating-rate coupons. Take a look at this energy bond trading with an ASW of 50.7bps.



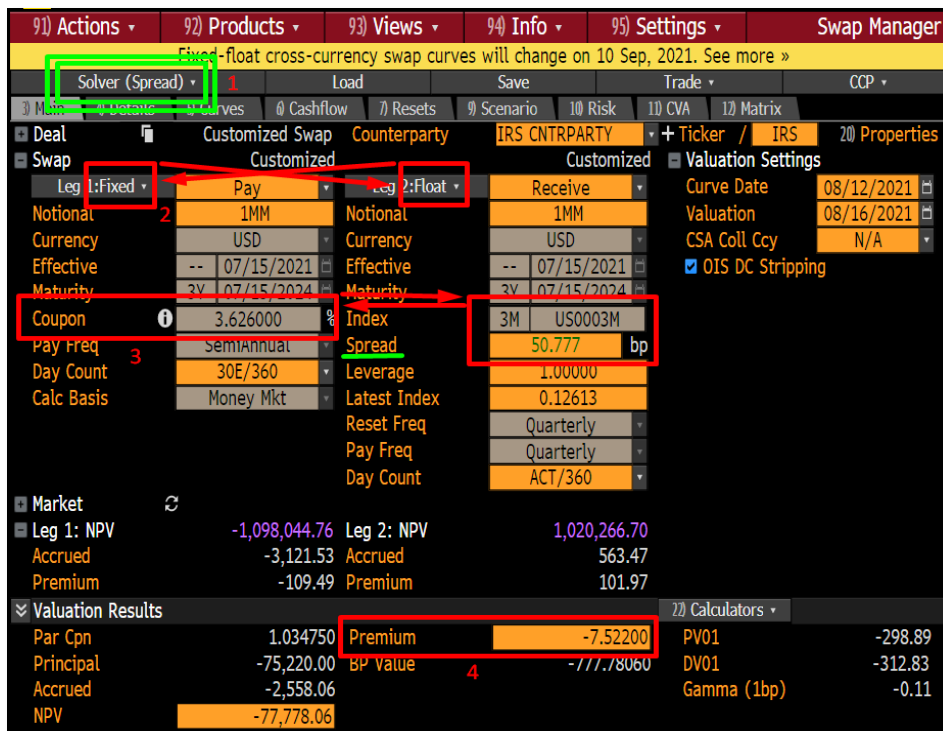
EDPPL 3 5s 07/15/24 Corp			
107.159/107.522	1.121/0.999	BGN @ 14:1	
EDPPL 3 5s 07/15/24 (XS1638075488)			
Spread	57.85 bp vs	T 0 3s 07/15/24	
Price	107.522	99-27 ³ / ₄	14:19:39
Yield	0.999309 Wst	0.420784	S/A
Wkout	07/15/2024 @ 100.00	Consensus	Yld 6.6
Settle	08/16/21	08/13/21	

Spreads				Yield Calculations	
11) G-Sprd	57.4	Street Convention		0.999309	
12) I-Sprd	47.7	Equiv 1 /Yr		1.001806	
13) Basis	-21.7	Mmkt (Act/360)			
14) Z-Sprd	48.9	True Yield		0.999011	
15) ASW	50.7	Current Yield		3.371	
16) OAS	48.9				

Clicking the ASW field brings you to this page that makes your eyes spasm but what we want to see are the details of the swap in SWPM (we'll go deeper in the IRS topic). Remember a swap is exchanging one bond type for one another. Here: 1 fixed coupon bond and 1 floating rate bond.



EDPPL 3 5s 07/15/24			
Asset Swap Analysis		Price	107.5220
Calculate		Z-Spread	49.0
Price -> ASW Spread		Yield(%)	0.99931
Bond A0041430		ASW Spread	50.7
Par Amount 1MM		MMS Spread	48.1
Workout 07/15/2024		Swap Detail SWPM	
Workout Price 100.0000		Swap Detail SWPM	
Pay Freq SemiAnnual		Swap Detail SWPM	
Day Count 30E/360		Swap Detail SWPM	
Implied Value 109.0161		Swap Detail SWPM	
Market		Swap Detail SWPM	
Curve Date 08/12/2021		Swap Detail SWPM	
Discount Curve 490 Ask		Swap Detail SWPM	
Swapped Spread Detail			
Clean Price	107.5220	Money	Spread(bp)
Swap Price	100.0000	Cash Out	-255.4
Swap Rate(%)	0.52002	Bond Cpn(%)	306.1
Redemption(%)	0.0000		0.0
Funding	Spread(bp)		0.0
Swapped Spread		14,941.1	50.7



Deal	Customized Swap	Counterparty	IRS CNTRPARTY	+ Ticker / IRS	20 Properties
Swap	Customized	Customized	Customized	Valuation Settings	
Leg 1: Fixed	Pay	Leg 2: Float	Receive	Curve Date	08/12/2021
Notional	1MM	Notional	1MM	Valuation	08/16/2021
Currency	USD	Currency	USD	CSA Coll Ccy	N/A
Effective	-- 07/15/2021	Effective	-- 07/15/2021	<input checked="" type="checkbox"/> OIS DC Stripping	
Maturity	3Y 07/15/2024	Maturity	3Y 07/15/2024		
Coupon	3.626000	Index	3M US0003M		
Pay Freq	SemiAnnual	Spread	50.777		
Day Count	30E/360	Leverage	1.00000		
Calc Basis	Money Mkt	Latest Index	0.12613		
		Reset Freq	Quarterly		
		Pay Freq	Quarterly		
		Day Count	ACT/360		
Market					
Leg 1: NPV	-1,098,044.76	Leg 2: NPV	1,020,266.70		
Accrued	-3,121.53	Accrued	563.47		
Premium	-109.49	Premium	101.97		
Valuation Results				Calculators	
Par Cpn	1.034750	Premium	-7.52200	PV01	-298.89
Principal	-75,220.00	BP value	-777.78060	DV01	-312.83
Accrued	-2,558.06			Gamma (1bp)	-0.11
NPV	-77,778.06				

1. We are solving for the Spread – how much on top of the floating rate (which is determined by the swap curve) should the floating rate be?
2. We are going to pay the fixed coupon (that we receive Because we own the bond) to our counterparty and receive the floating coupon instead
3. We swap the bond's coupon of 3.626% for the floating coupon (rate + spread)
4. Because the bond trades at 107.522 it has a 7.522% premium over par. This premium is factored into the difference in NPVs between the fixed and floating leg.

Recall: Using on zero rates, you can imply forward rates at varying tenors through “gapping”. This is what the ASW is doing on the floating leg – taking the swap curve and implying 3M LIBOR rates at every quarter in the life of the swap. Then we iterate for the spread on top to make the deal of swapping cashflows “fair”.

So, the Asset Swap spread is simply the excess risk over the implied forward swap rates as of today's curve such that the NPV of the floating leg = the NPV of the bond.

One major difference between these spreads is that ASW spread itself is tradeable while Z-spread and OAS are theoretical spreads. OAS allows apples to apples comparisons across various bond types isolating credit risk while ASW and Z-spread just assume 1 single path to principal repayment. So, there you have it, credit risk. These measures are crucially important in the world of credit and understanding the market risk sentiment. It's not about what you can gain, it's about what you can lose and putting a price to that risk of loss.

9.5 Topic Question

Why should the ASW account for a premium at inception?

A bit of a trick question. But since you are taking a bond from the market and swapping it, the price is often not going to be 100, you're likely paying a different price. That difference is either going to be a premium (above 100) or a discount (under 100). That premium/discount should get accounted for in the swap because you are going to swap for floating cashflows that discount to par. So by accounting for premium/discount you can now swap par for par.

10. Floating Rate Notes



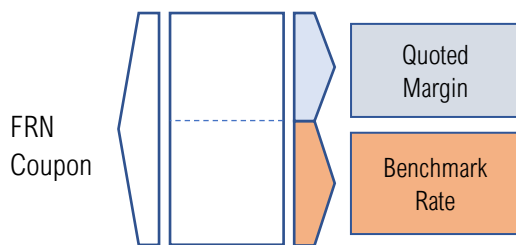
Why do Floating Rate Notes (FRNs) get their own topic? Because they are underdiscussed despite being a valuable allocation in a bond portfolio.

There are a few types of coupons for a bond – zero, fixed, variable and floating. We covered this briefly in Topic 5. Today we'll focus on the floating type. The most familiar floating rate to most of us? Our mortgage. We pay a benchmark rate + spread the bank charges us.

In a low interest rate period, it's great for us to BORROW money – which is why many of us refinance during these periods. But we are always worried about rates rising later on. Also, the worse your credit score, the larger the spread you'll pay on top of the benchmark rate.

All of this logic flows through to floating rate bonds. As an INVESTOR, you are lending the money which in a low-rate environment means your coupon is lower but resets to a higher coupon as rates rise. The benchmark rate changes, the spread stays the same.

10.1 Characteristics of FRNs



At issuance the spread over the benchmark rate is called a Quoted Margin – and determines the coupon. A FRN's coupon reset can be In Advance or In Arrears. In Advance means the rate is set BEFORE the coupon period starts. In Arrears means the rate is set at the END of the period.

In Advance:

t = 0 (Coupon Period Start)		t = 1 (Coupon Period End)
Benchmark rate = 1.00%	>	
Quoted Margin = 150bps		
Coupon Rate = 2.50%		

You know from t=0 to t=1 that you will earn 2.50% and receive it at t=1

In Arrears:

t = 0 (Coupon Period Start)		t = 1 (Coupon Period End)
	>	Benchmark rate = 1.50%
		Quoted Margin = 150bps
		Coupon Rate = 3.00%

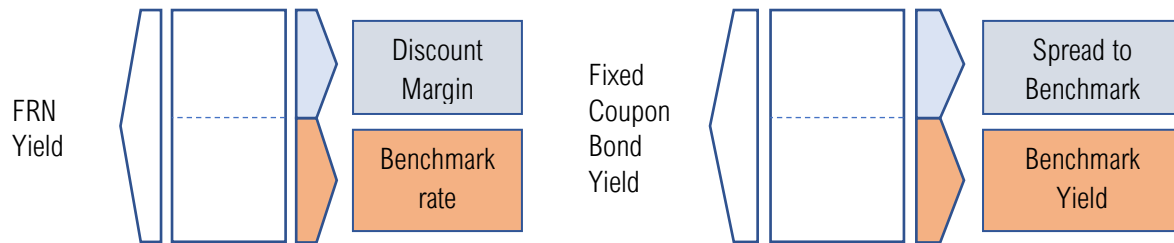
You know only at t=1 you earned 3.00% and receive it at t=1.

The majority of FRNs that exist, reset In Advance. We will focus on these types of FRNs for the rest of the topic. Once a FRN starts trading in the secondary market, the market determines the spread that it trades at (similar to a fixed coupon's spread to benchmark) – this is called the Discount Margin.

Quoted Margin >> Coupon

Discount Margin >> Yield

Remember, like any borrower, the credit risk of the issuer is what largely determines the quoted margin at issuance. Once the FRN starts trading in the market it changes into the discount margin. This is why FRNs are a play on credit.



10.2 Valuation of FRNs

So how do we value FRNs? Well, it's quite simple really – recall an axiom I put forward in [Topic 1](#): “market conventions are built around maximum efficiency with acceptable accuracy”

FRNs are another great example of this at play – the market convention is to treat the FRN as a fixed coupon bond. LOL. What do I mean? Simply, we assume that the current rate for the reset rate will not change going forward. That simple. But there are some quirks to this... So let's take a look at an actual FRN – here we have a Huarong FRN due April 22 (at a juicy yield).

HRINTH Float 04/27/22		Actions	Settings	Page 1/12	Security Description: Bond
Keepwell Agreement					
25 Bond Description 70 Issuer Description 94 No Notes 95 Buy 96 Sell					
Pages	Issuer Information		Identifiers		
11 Bond Info	Name	HUARONG FINANCE 2017 CO	FIGI	BBG00GH3W021	
12 Addtl. Info	Industry	Government Owned, No Guarantee (B...	ISIN	XS1596795192	
13 Reg/Tax	Security Information		ID Number	AN2893922	
14 Covenants	Mkt Iss	EURO-DOLLAR	Bond Ratings		
15 Guarantors	Ctry/Reg	VG	Currency	Moody's	Baa2 *-
16 Bond Ratings	Rank	Sr Unsecured	Series	Fitch	BBB *-
17 Identifiers	1 Coupon	1.978880	Type	Composite	BBB
18 Exchanges	2 Formula	QUARTLY US LIBOR +185.00000	Issuance & Trading		
19 Inv Parties	3 Day Cnt	ACT/360	Iss Price	100.0000	
20 Fees, Restrict	Maturity	04/27/2022	Amt Issued/Outstanding		
21 Schedules	BULLET		USD	1,000,000.00 (M) /	
22 Coupons	Iss Sprd		USD	1,000,000.00 (M)	
Quick Links	Calc Type	(21)FLOAT RATE NOTE	Min Piece/Increment		
32 ALLQ Pricing	Pricing Date	04/20/2017	200,000.00/ 1,000.00		
33 QRD Qt Recap	Interest Accrual Date	04/27/2017	Par Amount	1,000.00	
34 TDH Trade Hist	1st Settle Date	04/27/2017	Book Runner	JOINT LEADS	
35 CACS Corp Action	1st Coupon Date	07/27/2017	Reporting	TRACE	
36 CF Prospectus					
37 CN Sec News					
38 HDS Holders					
66 Send Bond					

1. We can see it's a floating coupon type but there is a coupon value – what is that? It's the **latest coupon** for the current accrual period
2. The coupon formula is 3M LIBOR + 185bps (Annual)
3. Day Count

To derive the price of any bond you need to know: all future cashflows and a discount rate. Whether it's a fixed coupon, floating, callable or perpetual, it is a matter of modelling cashflows and discounting them.

The simplest and quickest way to do this for a FRN is to gather three facts and assumptions:

1. The most recent reset rate for the current coupon
2. The current reset rate that will apply for the next fix
3. The discount rate to discount all the current and future coupons

For this Huarong bond:

1. Most recent coupon period was 7/27. (This was written on 8/24/2021) - coupon is calculated using the 7/27 3MLIBOR+QM
2. Next coupon period starts on 10/27 – all future coupons assume today's 3MLIBOR+QM
3. Pays quarterly = Coupon/4 (need to account for daycount)



51) Coupons 57) Bmrk Fallback

Benchmark	US0003M	Benchmark Freq	QUARTLY
Fix Frequency	Quarterly	2 Next Coupon Date	10/27/2021
Paying Agent		1 Prev Coupon Date	07/27/2021
Pay Calendars	US EN HK	Cap	Floor
Refix Calendars	EN	Margin	+185
First Irreg Cpn	Normal	Reset Days Prior	2
Last Irreg Cpn	Normal	Current Coupon	Lockout
		Cpn Conv Mod-Adj	3
		Cpn Freq	Quarterly

Accrual Start	Rate	Date	Margin
10/27/2021			
07/27/2021	1.978880		
04/27/2021	2.031380		
01/27/2021	2.062880		
10/27/2020	2.066500		
07/27/2020	2.094500		
04/27/2020	2.841380		

So, the first coupon is $0.12888 + 185\text{bps} = 1.97888\%$. Why 0.12888 from 07/23? If you look back at the coupon description, there is another field showing the coupon is Reset 2 days prior to the reset date. So, if the new coupon starts from 07/27, it fixes using the 07/23 rate.



Date	Last Px	Actual Ec...	Date	Last Px	Actual Ec...	Date	Last Px	Actual Ec...
Fr 08/20/21	.12838		Fr 07/30/21	.11775		Fr 07/09/21	.12863	
Th 08/19/21	.13075		Th 07/29/21	.12575		Th 07/08/21	.11900	
We 08/18/21	.13088		We 07/28/21	.12850		We 07/07/21	.12388	
Tu 08/17/21	.12725		Tu 07/27/21	.12963		Tu 07/06/21	.13488	
Mo 08/16/21	.12450		Mo 07/26/21	.13163		Mo 07/05/21	.13800	
Fr 08/13/21	.12425		Fr 07/23/21	.12888		Fr 07/02/21	.13788	
Th 08/12/21	.12475		Th 07/22/21	.12825		Th 07/01/21	.14475	
We 08/11/21	.12125		We 07/21/21	.13788		We 06/30/21	.14575	
Tu 08/10/21	.12275		Tu 07/20/21	.13825		Tu 06/29/21	.14488	
Mo 08/09/21	.12725		Mo 07/19/21	.13425		Mo 06/28/21	.14725	
Fr 08/06/21	.12838		Fr 07/16/21	.13425		Fr 06/25/21	.14600	
Th 08/05/21	.12538		Th 07/15/21	.13388		Th 06/24/21	.14600	
We 08/04/21	.12175		We 07/14/21	.12638		We 06/23/21	.14725	
Tu 08/03/21	.12138		Tu 07/13/21	.12613		Tu 06/22/21	.13375	
Mo 08/02/21	.12375		Mo 07/12/21	.13288		Mo 06/21/21	.13788	

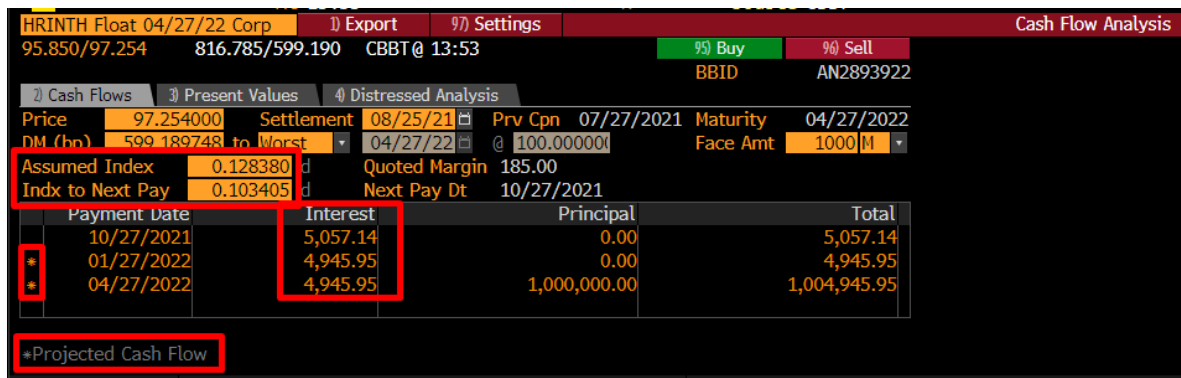


51) Coupons 57) Bmrk Fallback

Benchmark	US0003M	Benchmark Freq	QUARTLY
Fix Frequency	Quarterly	Next Coupon Date	10/27/2021
Paying Agent		Prev Coupon Date	07/27/2021
Pay Calendars	US EN HK	Cap	Floor
Refix Calendars	EN	Margin	+185
First Irreg Cpn	Normal	Reset Days Prior	2
Last Irreg Cpn	Normal	Current Coupon	Lockout
		Cpn Conv Mod-Adj	3
		Cpn Freq	Quarterly

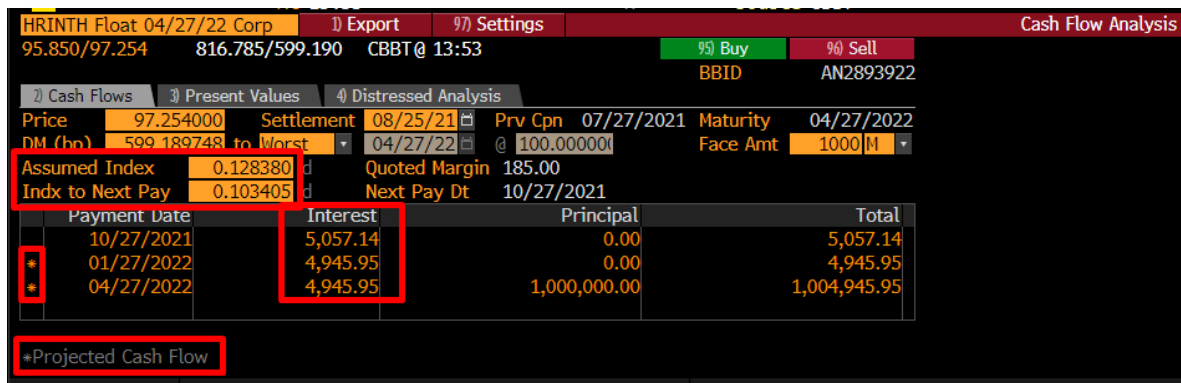
Meaning the 10/25 3ML will be the benchmark rate for the next coupon. For now, the market assumes current 3ML will be that rate. Here's the cashflow projection for the bond - notice how all the forward cashflows are the same?

$$(0.128380 + 1.85) / 4 = 0.494595 \gg \text{on 1mm face} = \$4,945.95 \text{ coupon}$$



Payment Date	Interest	Principal	Total
10/27/2021	5,057.14	0.00	5,057.14
* 01/27/2022	4,945.95	0.00	4,945.95
* 04/27/2022	4,945.95	1,000,000.00	1,004,945.95

How about the current coupon? Easy. $(0.12888+1.85) / 4 = 0.494720$ on 1mm face = 4,97-wait. What the freak? The screenshot says 5057.14!!!!



Payment Date	Interest	Principal	Total
10/27/2021	5,057.14	0.00	5,057.14
* 01/27/2022	4,945.95	0.00	4,945.95
* 04/27/2022	4,945.95	1,000,000.00	1,004,945.95

You stop and 🤔...I know! **<HELP HELP>**

You get an automated message. Finally, a message sounding like a real person typed it. You ask about the first cashflow for the floater and it not matching. They say, 'one moment please'

You wait 15 mins. You contemplate switching to eikon.

There's chaos at the helpdesk. The freaking cashflows don't match. The rep helping you is trying to figure out how to pass this question over to the data team. They ask you random questions to look like they're figuring it out

"Can I have the ticker please? Can you send me a screenshot? Is this the case for all floaters?"

"can you try resetting your terminal defaults, logging out and back in then trying again?"

"could it be due to central bank balance sheets?"

You're busy trying to figure out yourself and didn't see their most recent asinine question.

"it seems you're busy, please come back when you have time with the reference number H#1800GFY, k thx bye"



You mutter to yourself 20fckingKferstupidcollegeidiotsdontknowsht. Then you **IB EMH<GO>** and ask me what's up with the first coupon.

I say, "simple. I told you right at the start: day count convention."

You reply "Ah. But you never covered accrued interest in bond math" – I go "oh but I included it in the edits".

ACT/360 on this bond means from settlement to next coupon is 92 ACTUAL days (7/27 to 10/27). 1 year is assumed to be 360 days. $(0.12888 + 1.85) * (92 / 360) = 0.505714 \rightarrow \$5,057.14$ on 1mm face.

So, with

1. Current coupon
2. Assumed constant future coupons &
3. DM

you can discount all cashflows to arrive at price. The coupons are market derived so the only variable at YOUR discretion is the DM – more risk you see = larger the DM you ask for hence higher yield and lower price

10.3 Risk

Within this concept lies another key aspect of FRNs – interest rate risk or rather, **lack of**. Because FRN coupons reset regularly, they exhibit low but non-zero duration. A FRN possesses duration due to the current coupon being fixed while rates fluctuate until the next fixing.



R	Issuer Name	Ticker	A A Y	Mod Dur (Ask)	Bid Wkout Dt Yrs frm Tdy	Cpn	Issue Date
	Average		4.10	0.08	1.56	0.608	<10
1)	International Bank for R...	IBRD	...	--	9.48	0.420	02/11/2022
2)	Principal Financial Globa...	PFG	...	0.13	9.39	0.639	01/10/2000
3)	BPCE SA	BPCEGP	...	0.09	8.85	1.284	06/24/2021
4)	Goldman Sachs Group In...	GS	...	0.32	8.82	1.253	12/17/2000
5)	Allfirst Preferred Capital...	MTB	...	0.15	7.90	1.626	12/27/1999
6)	Fort Benning Family Com...	BENFAM	...	0.05	7.90	0.446	01/26/2000
7)	Fort Benning Family Com...	BENFAM	...	0.05	7.90	0.446	01/26/2000
8)	Citigroup Global Markets ...	C	...	0.16	7.67	0.131	04/20/2011
9)	Royal Bank of Canada	RY	...	0.10	7.61	0.866	03/29/2011
10)	Barclays Bank PLC	BACR	...	--	7.01	0.751	08/25/2022
11)	JPMorgan Chase & Co	JPM	...	0.19	6.95	0.751	12/18/2011
12)	KeyCorp Capital I	KEY	...	0.10	6.87	0.885	06/25/1999
13)	Huntington Capital II	HBAN	...	0.06	6.82	0.744	06/12/1999
14)	PNC Capital Trust C	PNC	...	0.02	6.78	0.705	06/09/1999
15)	European Investment Ba...	EIB	...	--	6.75	1.037	05/21/2022
16)	European Investment Ba...	EIB	...	--	6.75	1.037	05/21/2022

Can you workout the value of a FRN using the curve rather than assuming constant coupons? Certainly.

The principle is the same as in the OAS topic. By stripping the curve you can imply forward reset rates for each of the fixing dates and discount the cashflows accordingly. This is why for FRNs on Bloomberg the function **YASN** for advanced Yield analysis is the same page as **OAS1** for OAS analysis. Based on price you can derive the constant spread over the entire term structure rather than a static rate and/or vice versa.

HRINTH Float 04/27/22		Settings		Advanced Yield & Spread Analysis	
Bond HUARONG FINANCE 2017 CO		Type Floater		ID AN289392	
Maturity 04/27/2022		Currency USD			
1) Pricing	2) Cashflow	3) IR Risk	4) Coupons	5) Option	6) Sinking
Pricing Analysis					
Calculate	Price	OAS	Workout OAS		
Price -> OAS	97.22400	628.9994	628.9994		
Valuation					
Settle Date	08/25/21	Curves/Cubes	Curve Date	08/23/21	Workout Date
Dirty Price	97.38	Discount Curve	S490	USD SOFR (vs. FIXED RATE)	
Fixed Equivalent Yields		Forward Curve	S23	USD (30/360, S/A vs. 3M LIBOR)	
To Next Call	04/27/22 6.350	Curve Shift (bps)	0.0		
To Workout	04/27/22 6.350	Models			
To Maturity	04/27/22 6.350	Credit Model	Option Adjusted Spread		
Supplementary Analysis					
Option Premium (Price/100 Par)		Stochastic Risk		Risk to Workout	
Option Premium	--	OAS	Market	OAS	Market
Cap Floor Premium	--	Delta	-0.6300 -0.1501	-0.6300	-0.1501
DM Analysis to Workout		Gamma	0.0071 0.0032	0.0071	0.0032
DM (bps)	603.8	Modified Duration	0.6469 0.1541	0.6469	0.1541
Assumed Rate (%)	0.1284	Convexity	0.0073 0.0033	0.0073	0.0033
Yield (%)	6.1664	Vega	0.0000		

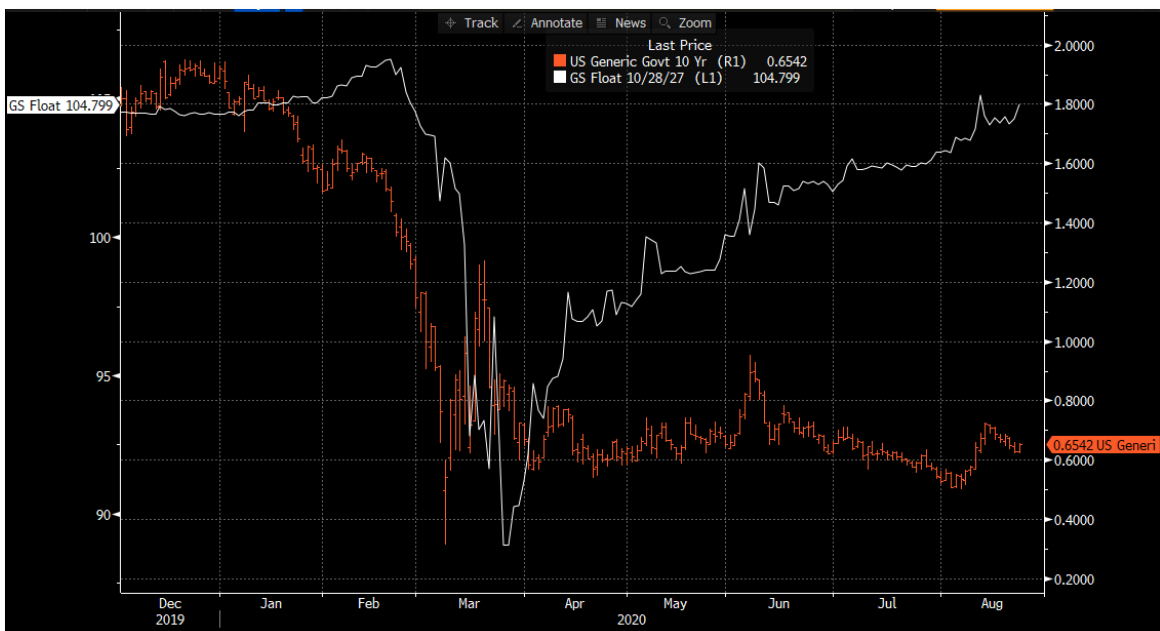
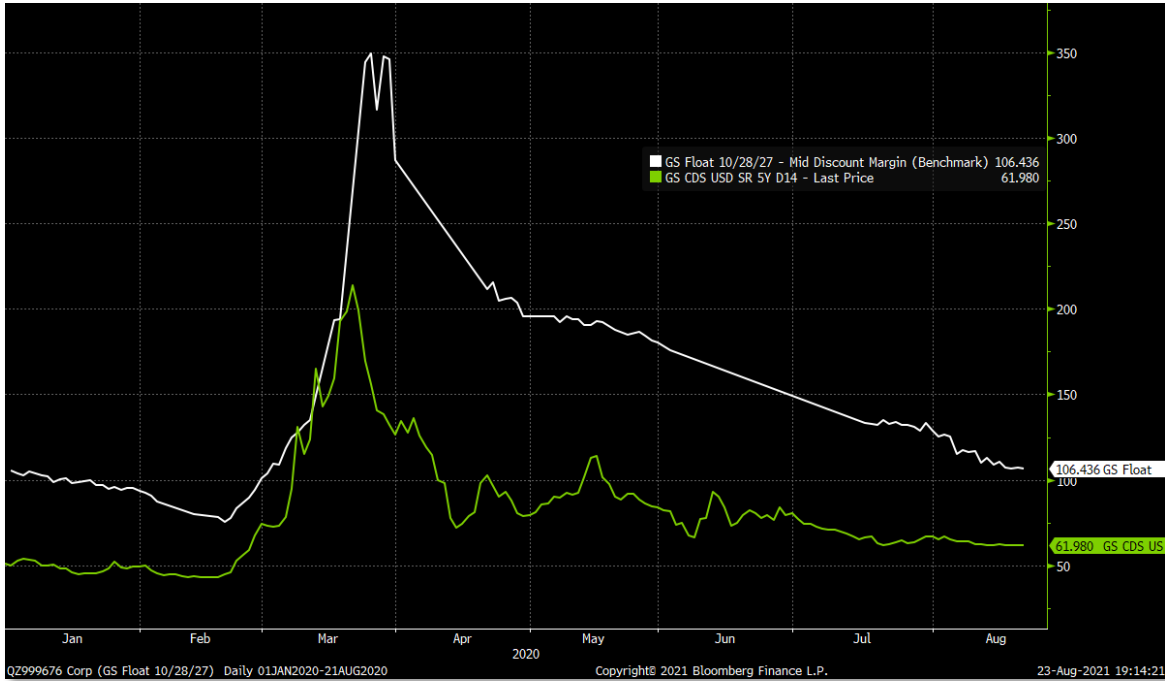
10.4 One of the Few Times I Made Money

One of the best trades I had with FRNs was during the March 2020 pandemic and was actually through the use of ETFs. One thing you should know with FRNs is that they aren't as plentiful and hence not as liquid as fixed coupon bonds and also, banks are heavy issuers of FRNs.

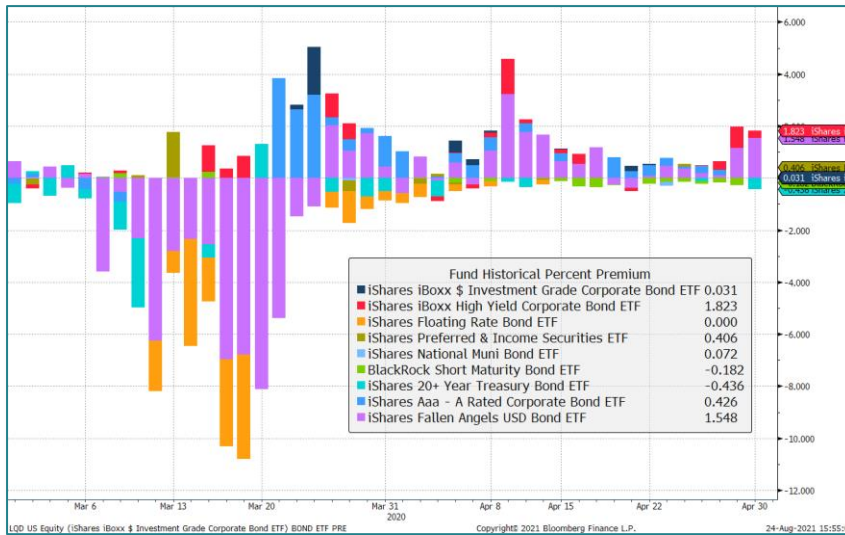
Come March 2020 I was sitting on a handful of GS, JPM and BAC floaters and as we've established, FRNs being a play on credit, meant the DMs on these looked like a priest in a nudist colony daycare. Bursting.

The play was on the credit – there were a few elements to this thesis:

1. I had figured that support would have to come in soon and taking the GFC playbook, Fed would look to prop up the banking sector at the start to ensure the transmission mechanism remained intact.
2. Rates had already plummeted to record lows (10s touched 31bps) and liquidity issues reared their ugly head. Also, a recovery in sentiment likely meant some pullback in rates.
3. Floaters seemed like a good way to capture credit spreads while hedging out duration. I wanted more.



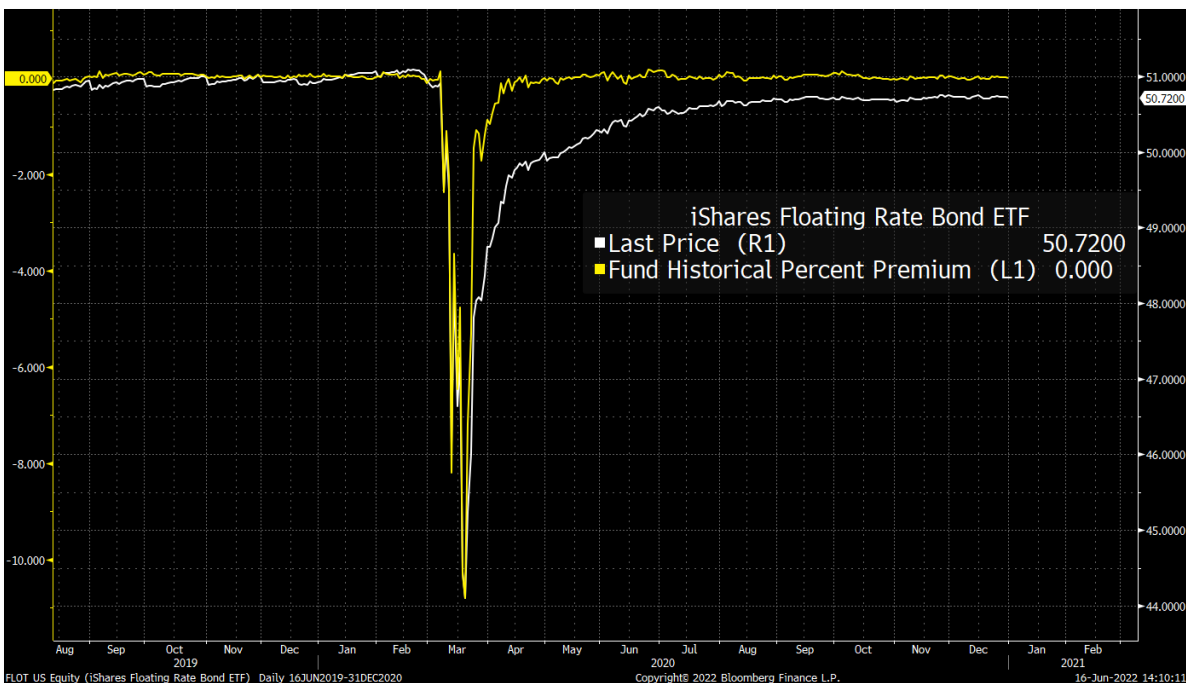
But something else was interesting – in a discussion with legendary @TayTayLLP, he asked if I had thoughts on FLOT just as I was looking at floaters.



FLOT, being an ETF was more “liquid” so the market was selling ETFs hard and in fact FLOT was the most discounted bond ETF amid the turmoil.

As FLOT was plunging the discount to NAV was accelerating to the tune of a 10%+ discount. This was a great opportunity for my idea – I want to buy FRNs to capture a ton of spread widening and ETFs allowed

me a more liquid way to grab them at a further discount while diversifying.



I bought them at 43.8015 and scaled out above 48-49.50. I owe a large part of it to TayTayLLP.

10.5 Topic Question

Which has higher duration, a FRN with coupons In Advance or In Arrears? Why?

In Advance. Fixing before the accrual period leaves you exposed to rate fluctuations for that specific period before fixing to the new rate. It also means all else equal, FRNs that fix the coupon In Advance will price at par on each fix.



11. Treasury Inflation Protected Securities (TIPS)



Let's start with the nomenclature – Treasury Inflation Protected Securities. Plural. TIPS.

Singular = Treasury Inflation Protected Security. TIPS.

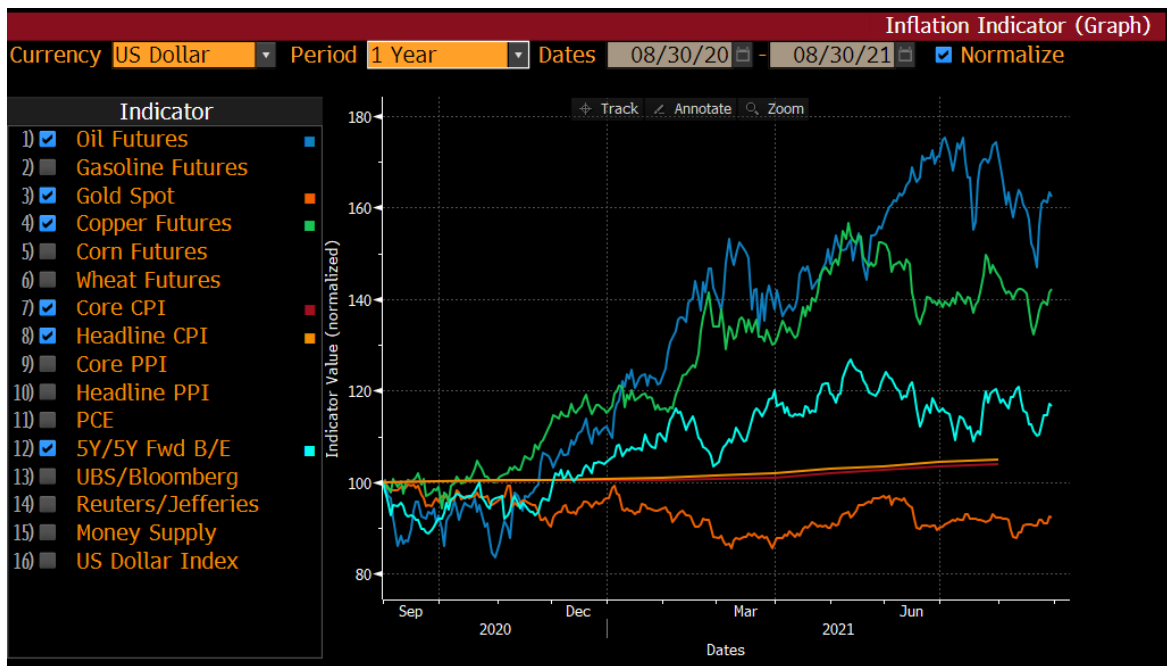
There is no TIP unless it's your one lucky day in 6 months and the kids are at grandma's. It's TIPS no matter what.

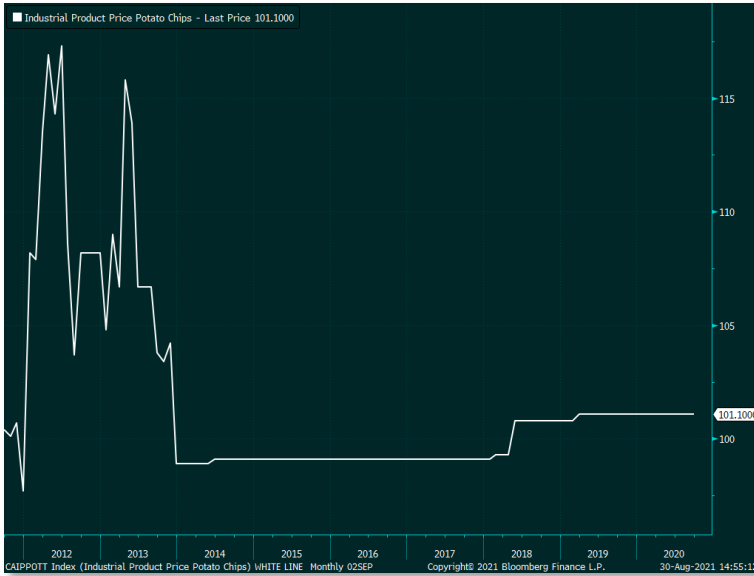
In March 1981, the UK became the first major country to issue inflation-indexed bonds, or "linkers" as they're commonly known due to being 'linked to inflation'. With all the attention being paid to inflation, now's a great time to dig into these instruments a bit more.

Settings												World Inflation Bonds			
Inflation-Linked Bond												Breakeven Index			
Region	Price	Chg	Yld	Chg	Low	Range	High	3M C...	B/E	Low	Range	High	3M C...		
1) Australia	163.409	+0.218	-0.877	-1.6	-0.980	●	-0.555	-27	1.987	1.938	●	2.200	-21		
2) Canada	148.539	-0.587			-0.651	●	-0.385	-15	1.725	1.675	●	1.878	-15		
3) Chile	104.520	1.478			0.848	●	1.985	+43							
4) Germany	123.768	-1.998			-2.053	●	-1.580	-33	1.454	1.274	●	1.467	+10		
5) Israel	112.280	-0.830			-0.831	●	-0.501	-26	1.808	1.601	●	1.931	+6		
6) Italy	121.716	-0.644			-0.740	●	-0.229	-31	1.394	1.204	●	1.408	+5		
7) Japan	101.983	+0.072	-0.199	-7	-0.360	●	-0.104	+10	0.196	.091	●	.371	-9		
8) Mexico	99.646	2.789			2.665	●	2.814	+3							
9) Spain	122.748	-1.298			-1.386	●	-0.952	-24	1.446	1.290	●	1.474	+3		
10) Sweden	133.648	-1.696			-1.770	●	-1.388	-28	1.883	1.779	●	1.893	+4		
11) United Kingdo	136.195	-2.976			-3.006	●	-2.573	-31	3.647	3.430	●	3.647	+9		
12) United States	112-20+	-1.084			-1.201	●	-0.755	-22	2.391	2.237	●	2.474	-5		

11.1 What is Inflation and Why Does It Matter?

First, let's look at the concept of inflation, nominal yields, real yields and how they all interact with one another. Inflation is the phenomenon of nominal prices increasing over a certain period of time. A loaf of bread that cost \$2 last year but now costs \$3 has seen price inflation of 50% YoY. Flipped around, your \$2 from last year can only buy 66% of a loaf of bread today. Inflation has eroded the value of your nominal dollar.





Here’s another example. I looooooove potato chips. Kettle’s honey Dijon flavour is my jam. Also, the bag is 50% air. I swear 5 years ago it was 75% full but nowadays I am getting less and less. That is commonly called ‘stealth inflation’ where the price stays the same but what you REALLY get is less than before.

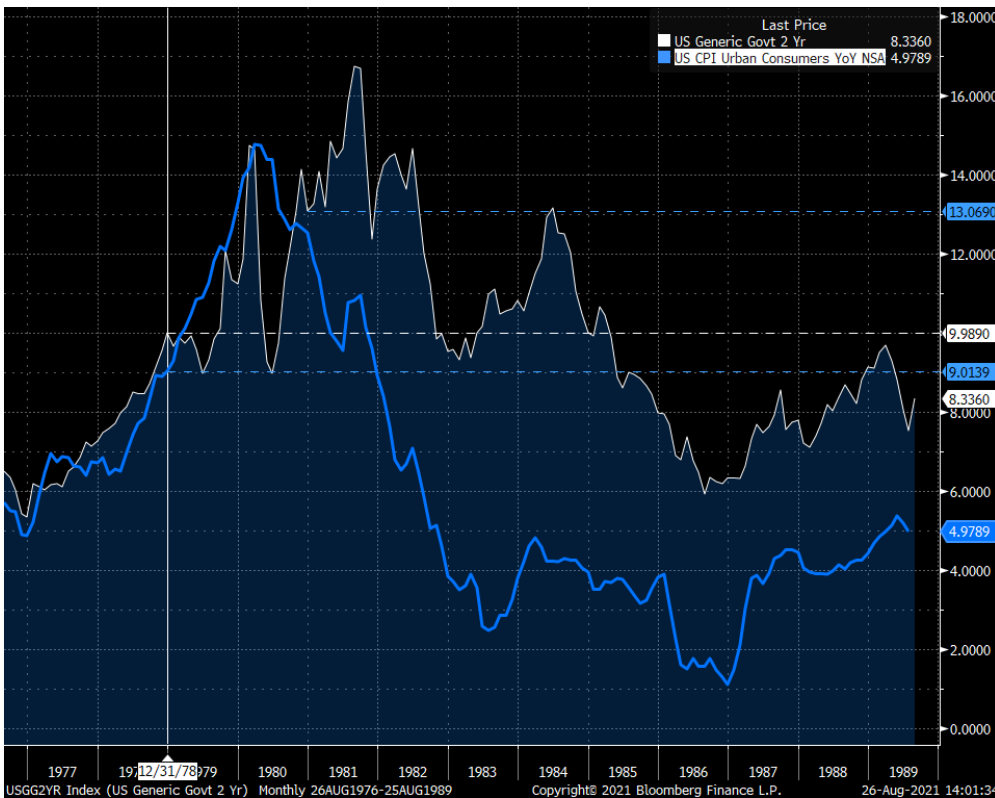
Get it now? Our world transacts in nominal values, but inflation affects what the REAL value is. This is what purchasing power means – the power of \$1 to purchase a unit of goods/services.

Thus, **Real Rate = Nominal Rate minus Inflation Rate**

Every year that prices rise by 1%, 1 nominal dollar loses its value by ~1%, so in order for you to not lose purchasing power, you want to grow your \$1 by an equal rate.

11.2 Inflation vs Nominal Bonds

This poses a problem for many bonds which are fixed coupon bonds – the coupons do not have the ability to adapt to the changing rate of inflation and as a result are exposed to inflation risk. This is where inflation-linked bonds come in. Recall, a bond’s yield must account for a number of risks: credit, reinvestment, liquidity and inflation. If fairly priced at issue, it should account for inflation risk but it cannot account for the CHANGE in the level of inflation risk.





The late '70s and early '80s were known for extremely high inflation, which was factored into yields. If you bought a 2 year UST at the end of 1978, you would have locked in a YTM of 9.989% while inflation was 9.014%. Logically, the real growth of your investment is 0.975% per annum. But there's an issue. On its own, a \$100 investment in the 2yr govvie would be have generated \$21 in returns over the 2 years. The first year you earned about \$10 in coupons, reinvested them, then received another \$10 coupon plus your \$100 back. But inflation didn't stay at 9.014%

Over the first year you received the coupon, prices actually rose 13.30%, and when you finally collect your principal, that year saw prices rise a further 12.51%. So in effect, the purchasing power of every dollar you invested eroded by $[(1.1330 * 1.1251) - 1] = 27.16\%$

Your bond investment actually LOST about 6% over 2 years in a "risk-free" 10% government bond. That's freaking nuts.^{vi}

So as I mentioned earlier, the UK introduced the linker - a bond product that would adjust itself according to inflation. Like everything in UK's history, they introduced something to the world that someone else would soon be better than them at. The only thing they still have the crown on is taking over a country and then abandoning it leaving the local population in a worse sta- oh wait nvm, guess they lost that one too.

11.3 Just the TIPS

You see, if you can adjust a bond's coupon to the level of inflation then your cashflows are...protected against inflation (to an extent). Currently the largest market for linkers globally is the US, where the bonds are called TIPS. And when you're in an environment where the risk is things growing too big too fast...you want just the TIP. 😊

So let's break down a Treasury Inflation Protected Security issued by the US government.

TII 0 1s 07/15/31 Govt		Actions ▾	Settings ▾	Page 1/11	Security Description: Bond
				95 Buy	96 Sell
25 Bond Description	26 Issuer Description				
Pages	Issuer Information		Identifiers		
11) Bond Info	Name	TSY INFL IX N/B	ID Number	91282CCM1	
12) Addtl Info	Industry	Treasury (BCLASS)	CUSIP	91282CCM1	
13) Covenants	Security Information		ISIN	US91282CCM10	
14) Guarantors	Issue Date	07/30/2021	SEDOL 1	BNW0365	
15) Bond Ratings	Interest Accrues	07/15/2021	FIGI	BBG011VCW48	
16) Identifiers	1st Coupon Date	01/15/2022	Issuance & Trading		
17) Exchanges	Maturity Date	07/15/2031	Issue Price	111.990248	
18) Inv Parties	Floater Formula	N.A.	Risk Factor	5.582	
19) Fees, Restrict	Workout Date	07/15/2031	Amount Issued	16000 (MM)	
20) Schedules	Coupon	.125	Security Type	USN	
21) Coupons	Cpn Frequency	S/A	Type	FIXED	
Quick Links	Mty/Refund Type	NORMAL	Series		
32) ALLQ Pricing	Calc Type	U.S. I/L REAL YLD	Amount Outstanding	16000 (MM)	
33) QRD Quote Recap	Day Count	ACT/ACT	Minimum Piece	100	
34) CACS Corp Action	Market Sector	US GOVT	Minimum Increment	100	
35) CN Sec News	Country/Region	US	Currency	USD	
36) HDS Holders	TENDERS ACCEPTED: \$16000MM.		SEE CPIRJL21 Index FOR INDEX RATIO.		
66) Send Bond	CALCULATIONS OF PRINCIPAL VALUE AND INTEREST PAYMENTS ARE NOT ADJUSTED IF PREVIOUSLY REPORTED CPI FIGURES ARE REVISED.				

^{vi} This was written in 2021 and I'm reviewing it now in 2022 with 8.6% CPI YoY and laughing my butt off.



Inflation ratio = The ratio of CPI used to calculate the accreted value for index-linked securities. This is calculated by **dividing the Reference CPI by the Base CPI value.**

It gets a little tricky here but the **Reference CPI has a 3 month lag** – so the reference CPI on 1st September 2021 is the CPI shown for June 2021.

CPURNSA 273.003 For Jul		Next Release 14 Sep 20:30		Survey --				
US CPI Urban Consumers NSA		Bureau of Labor Statistics						
CPURNSA Index	Export	Settings	Page 1/7 Historical Price Table					
US CPI Urban Consumers NSA	High	273.003 on	07/31/21					
Range 08/31/2001 - 07/31/2021	Period Monthly	Low	176.700 on 12/31/01					
Market Last Price Actual Line	Currency	Average	222.331 222.331					
View Price Table		Net Chg	95.503 53.80%					
Date	Last Price	Actual Line	Date	Last Price	Actual Line	Date	Last Price	Actual Line
12/31/21			12/31/20	260.474	260.474	12/31/19	256.974	256.974
11/30/21			11/30/20	260.229	260.229	11/30/19	257.208	257.208
10/31/21			10/31/20	260.388	260.388	10/31/19	257.346	257.346
09/30/21			09/30/20	260.280	260.280	09/30/19	256.759	256.759
08/31/21			08/31/20	259.918	259.918	08/31/19	256.558	256.558
07/31/21	273.003	273.003	07/31/20	259.101	259.101	07/31/19	256.571	256.571
06/30/21	271.696	271.696	06/30/20	257.797	257.797	06/30/19	256.143	256.143
05/31/21	269.195	269.195	05/31/20	256.394	256.394	05/31/19	256.092	256.092
04/30/21	267.054	267.054	04/30/20	256.389	256.389	04/30/19	255.548	255.548
03/31/21	264.877	264.877	03/31/20	258.115	258.115	03/31/19	254.202	254.202
02/28/21	263.014	263.014	02/29/20	258.678	258.678	02/28/19	252.776	252.776
01/31/21	261.582	261.582	01/31/20	257.971	257.971	01/31/19	251.712	251.712

The reference CPI for 1st Sept 2021

For any date in between, you take the linear interpolated reference CPI using the number of days based on settlement. Let's back it out.

On 08/27/2021, the settle date (T+1) which is 08/30/21 – from 08/01/21 that is 29 Actual Days.

The 08/01/21 reference CPI is 3 months prior which is 269.195 and the following month is 271.696. We need to find the interpolated CPI

between these two based on the actual days we just counted. August has 31 days so we are looking at 29 days / 31 days = 0.935483871

The difference between the two months' CPI is (271.696 – 269.195) = 2.501 which means that the interpolated CPI = 269.195 + (2.501 * 0.935483871) = 271.534645 as of trade date 08/27/21

That equates to an index ratio of 271.534645 / 268.0209 = 1.01311 (Reference CPI / Base CPI value)



TII 0 3/8 07/15/31		↑ 111-21 1/4 - 01 3/4		111-19 / 111-21 1/4		-0.990 / -0.996		
At 21:44		-- X --		Source BGN				
91282CCM Govt		Export		Settings		Page 1/6 Historical Price Table		
TII 0 3/8 07/15/31		Range 08/27/2020 - 08/30/2021		Period Daily		High 114-00 3/8 on 08/03/21		
Market Mid Line		Ratio		Currency USD		Low 111-19 3/4 on 08/27/21		
View Price Table		Source		BGN		Average 112-21 3/8 1.004253		
						Net Chg -07 3/8 -0.20%		
Date	Mid Line	Ratio	Date	Mid Line	Ratio	Date	Mid Line	Ratio
Fr 09/03/21			We 08/18/21	112-13 1/4	1.009500	Mo 08/02/21	113-26 3/4	1.004680
Th 09/02/21			Tu 08/17/21	112-15	1.009200			
We 09/01/21			Mo 08/16/21	112-29 7/8	1.008900	Su 08/01/21		
Tu 08/31/21			Sa 08/14/21			Sa 07/31/21		
Mo 08/30/21		1.013110	Su 08/15/21			Fr 07/30/21	113-25	1.003870
Su 08/29/21			Sa 08/13/21	112-29 1/8	1.007990	Th 07/29/21	113-15 1/4	1.003870
Sa 08/28/21			Fr 08/12/21	112-13 5/8	1.007690	We 07/28/21	113-25 3/8	1.003870
Fr 08/27/21	L 111-19 3/4	1.012210	Th 08/11/21	112-18 3/8	1.007390	Tu 07/27/21	113-08 1/8	1.003870
Th 08/26/21	111-21 7/8	1.011910	We 08/10/21	112-06 7/8	1.007090	Mo 07/26/21	112-30 3/4	1.003870
We 08/25/21	111-27 3/8	1.011600	Tu 08/09/21	112-06 7/8	1.006790	Su 07/25/21		
Tu 08/24/21	111-30 3/8	1.011300	Mo 08/08/21			Sa 07/24/21		
Mo 08/23/21	112-00 3/4	1.011000	Sa 08/07/21			Fr 07/23/21	112-18 1/4	1.003870
Su 08/22/21			Fr 08/06/21	112-15 7/8	1.005890	Th 07/22/21	111-26 3/8	1.003870
Sa 08/21/21			Th 08/05/21	112-31 1/4	1.005580	We 07/21/21		1.003870
Fr 08/20/21	111-26 3/8	1.010100	We 08/04/21	113-19 3/4	1.005280	Tu 07/20/21		1.003870
Th 08/19/21	112-09 3/8	1.009800	Tu 08/03/21	H 114-00 3/8	1.004980	Mo 07/19/21		1.003870

So how does the index ratio actually factor into the pricing of a linker? Well, **TIPS have the unique property of a fixed coupon rate with a floating principal**. Because the principal floats according to the inflation index, the fixed coupon RATE results in a \$coupon that floats with inflation.

Coupon = 0.25%, principal = 1,000,000, index ratio = 1.00 >> CPN\$ = 250

Coupon = 0.25%, principal = 1,000,000, index ratio = 1.25 >> CPN\$ = 1mm x 1.25 x 0.0025 = 3,125

The current 10y TIPS on Friday traded at 112.5967 clean, which on \$1MM face is 1,125,976 but the index ratio is 1.013311 meaning the principal value is actually 1,125,976 * 1.013311 = 1,140,738

Yield & Spread		Yields		Graphs		Pricing		Description		Custom	
TII 0 7/15/31 Govt (91282CCM1)											
Spread	-238.75 bp	vs	10yT 1 08/15/31	Risk		Workout	OAS				
Price	112.597656		99-15	11:52:22	M.Dur	4.935	9.997				
Yield	-1.080419	Wst	1.307061	S/A	Risk	5.631	11.405				
Wkout	07/15/2031	@	100.00	Comparab...	Yld	6/6	Convexity	0.257	1.099		
Settle	08/30/21		08/31/21		DV	01 on 1MM	563	1,141			
Spreads		Yield Calculations		Invoice		Index Ratio		1.01311000			
1) G-Spr	-238.1	Street Convention	-1.080419	Face		1,000 M					
2) I-Spr	-240.2	Equiv 1	-1.077501	Principal		1,140,738.11					
3) Basis	8.5			Accrued (46 Days)		158.30					
4) Z-Spr	13.2			Total (USD)		1,140,896.41					
5) ASW	15.3										
6) OAS	31.7										

Now there are some key things to take note of here. The first is that because the inflation ratio is lagged 3 months, that also means your inflation index is lagged and by definition BACKWARD looking.

In a period where inflation is moving higher your principal+coupon adjustments will lag spot inflation. Once inflation begins falling, the lag will benefit your index adjustments. So as inflation continues to rise, demand for TIPS generally increases, even as inflation plateaus. Which brings it back to the point of a floating rate – it is double edged, you're protected on upside changes and exposed to downside changes. If inflation craters so will a TIPS' index ratio.

But here's the next point about TIPS that is special and unique – they have a floor. The principal is floored at par (100) meaning not only are they inflation protected, they're deflation protected too. Essentially a floating rate bond with a series of rate puts attached. So what does trading TIPS actually involve? In the purest sense, you buy TIPS when you think that inflation is going higher and you want to protect the value of your capital. **Important caveat – they do not BENEFIT from higher inflation scenarios, only protect the real value of your capital.**

If you look at the cashflow (CSHF) for the 10y TIPS, you can see that all of the cashflows are adjusted for an inflation ASSUMPTION of 5.3786% annualized. How is this derived first of all? Earlier, we looked at how to find the interpolated index ratio – the same logic applies here. The inflation assumption is the YoY rate of inflation on the interpolated CPI index values based on the 3-month lag. Therefore, the cashflows which are 6 months apart are then projected with the index ratio adjusted for the assumed inflation growth rate.

$$07/15/2022 \text{ projected coupon} = 646.29 * [1.05378656 ^ (6 / 12)] = 663.44$$

Cash Flows		Present Values		Distressed Analysis		Cash Flow Analysis	
Price		112-19 ³ / ₄		Settlement		08/31/21	
Yield		-1.082505 to Worst		Issue		07/30/2021	
Yld w/Inflation Asmp		4.203880		Maturity		07/15/2031	
Inflation Asmp		5.378656 %		Face Amt		1000M	
*Payment Date	Interest	Principal	Total				
01/15/2022	646.29	0.00	646.29				
07/15/2022	663.44	0.00	663.44				
01/15/2023	681.04	0.00	681.04				
07/15/2023	699.13	0.00	699.13				
01/15/2024	717.68	0.00	717.68				
07/15/2024	736.73	0.00	736.73				
01/15/2025	756.28	0.00	756.28				
07/15/2025	776.35	0.00	776.35				
01/15/2026	796.96	0.00	796.96				
07/15/2026	818.11	0.00	818.11				
01/15/2027	839.83	0.00	839.83				
07/15/2027	862.11	0.00	862.11				
01/15/2028	884.99	0.00	884.99				
07/15/2028	908.48	0.00	908.48				
01/15/2029	932.59	0.00	932.59				
07/15/2029	957.34	0.00	957.34				
01/15/2030	982.76	0.00	982.76				
07/15/2030	1,008.84	0.00	1,008.84				
01/15/2031	1,035.61	0.00	1,035.61				
07/15/2031	1,063.10	1,700,960.00	1,702,023.10				



To look at the projected inflation rates, you can run **SWIL<GO>** on BLOOMBERG then go to the Bonds tab to see inflation projections. If you wish to make your own inflation assumptions then change the Contributor field from default to User.

Date	Index Value
Aug-2021	274.195
Sep-2021	275.391
Oct-2021	276.593
Nov-2021	277.800
Dec-2021	279.013
Jan-2022	280.231
Feb-2022	281.454
Mar-2022	282.682
Apr-2022	283.916
May-2022	285.155
Jun-2022	286.400
Jul-2022	287.650
Aug-2022	288.905
Sep-2022	290.166
Oct-2022	291.432
Nov-2022	292.704

Like with FRNs, the logic applied by default is that the latest rate is the constant rate. Inflation will not change into the future and remain at the current level. CAREFUL: constant inflation \neq zero inflation. A hedge, by definition, only makes up what is lost.

11.4 The P&L of TIPS

So why do I say that TIPS protect you but not benefit from inflation? Recall in Money Markets, I mentioned a few risks and how time generally increases each of them. “Risk exists in many forms; interest rate, credit, reinvestment, liquidity, fx, inflation, political, etc”. TIPS, like their nominal siblings are subject to each of those risks except inflation. The real yield must therefore contain expectations of the US’ future growth, credit quality and the Fed’s nominal Fed Funds rate.

You must understand, that these non-inflationary variables can result in higher/lower yields that cause TIPS to lose/gain value, despite adjusting for inflation. If US GDP grows at 5% constantly, you could expect the Fed to hike rates while inflation is running above target. **Why then should TIPS be unscathed?** Here, we model a rise in yields from -1.083% to -0.75% by the end of the year results in a projected loss of 1.71% on your holdings, even after factoring in the inflation adjustment.

Return Analysis			
Reinvestment Rate	0.056 %		
Inflation Rate	5.378 %		
Pre Tax		After Tax	
Total Return %	HPR %	MMKT %	Net P&L
-5.131	-1.708	-5.041	-19,500

Economic Factors	Settlement	Horizon
Base CPI	268.02090	268.02090
Reference CPI	271.61532	276.56287
CPI @ last coupon	268.02090	276.56287
Index Ratio	1.01341	1.03187
Flat Index Ratio	1.00000	1.03187
Accr Ratio Growth	.01341	.00000

The B/E of -0.93 shows what the horizon yield would need to be for you to come out flat on this trade by year end based on the inflation rate assumption. If you click on the View Cashflows you will see the breakdown. Note how the principal values drop by a small amount despite a larger change in clean price – inflation adjustment.



Fixed Income Horizon Analysis										
TII 0 1/8 07/15/31 Govt Settings										
112-19 3/4 /112-22 1/4 -1.083/-1.090 BGN @ 14:15 Buy Sell										
Load CIDX Save as CIDX Financing Dur/Cvx Tax Rates										
Swap Type Risk Settlement OAS										
Security	B/S	Amt (M)	Date	Price	Yield	W	Risk	Horizon Price	Yield	W
TII 0 1/8 07/15/31	B	1,000	08/31/21	112-19 3/4	-1.082505	M	5.63	110.56075	-0.930904	M
Add Security										
Add Security										
Return Analysis										
Reinvestment Rate 0.056% Inflation Rate 5.378%										
View Cashflows Pre Tax After Tax										
	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L		
TII 0 1/8 07/15/31	0.000	0.000	0.000	0	--	--	--	--	B/E -0.93	
Economic Factors			Settlement	Horizon						
Base CPI			268.02090	268.02090						
Reference CPI			271.61532	276.56287						
CPI @ last coupon			268.02090	276.56287						
Index Ratio			1.01341	1.03187						
Flat Index Ratio			1.00000	1.03187						
Accr Ratio Growth			.01341	.00000						

Fixed Income Horizon Analysis: Cashflows	
Pre Tax	
Settlement Date	TII 0 1/8 07/15/31 (B) 08/31/21
Price/Yield	112.617188 / -1.082505
Principal	-1,141,274
Accrued Interest	-162
NPV at Settlement	-1,141,436
Horizon Date	12/31/21
Price/Yield	110.560757 / -0.930904
Principal	1,140,843
Accrued Interest	592
Coupon Payments	
Reinvestment Income	
Net Future Value	1,141,436
Net Profit & Loss	
HPR %	0.000
Total Return %	0.000

This is all to highlight the inherent risks involved with trading TIPS like any other bond. The recursive nature of the real yield is highlighted at the start of this topic: **Real Yield = Nominal Yield – Inflation**. Each of these components affect the other.

11.5 Market-Based Measures of Inflation Expectations

Which brings me to the Breakeven Inflation rate (BEI). **BEIs are NOT AND I REPEAT, NOT INFLATION EXPECTATIONS**. Based on the simple equation and the name itself, the BEI is simply the rate of inflation at which, if held constant, results in a nominal bond returning the same yield as a TIPS.

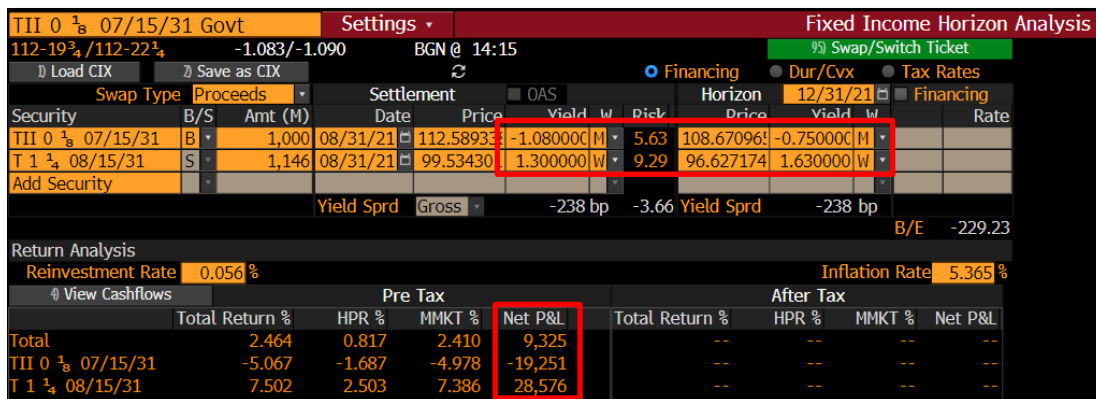
This presents a natural pair trade – Long (short) TIPS and short (long) Nominals. You'll often hear me say 'reals' instead of TIPS as I'm referring to real yields vs nominal yields but they effectively mean the same thing. If you are bullish on inflation and want to gain from it, then as mentioned buying TIPS alone won't do. You would need to somehow be long inflation. That's why you could go long reals and short nominals – if inflation turns out to keep increasing, then the value of the nominal will continue to decrease while your TIPS hold their value. This results in a gain on inflation.

But the BEI, being nominals minus reals means it has two levers:

1. Nominals up/down
2. Reals up/down

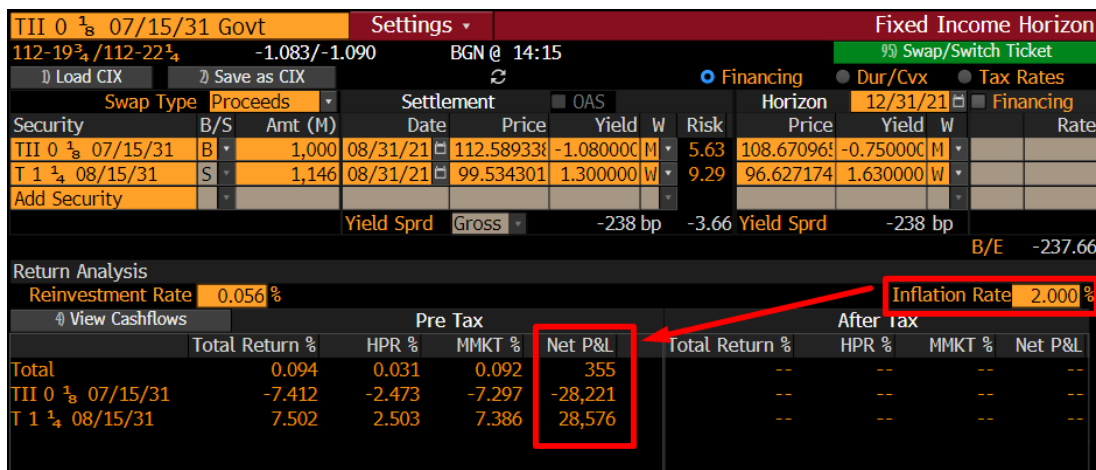
But it has no indication of the LEVEL of rates. If nominal 10y = 1.30 and real 10y = -1.08 then the BEI is 2.38. If nominals are 5.38 and reals are 3.00 the BEI is still 2.38.

Let's assume, current inflation runs at a constant rate and by the end of the year both noms and reals widened 33bps each. The 10s would be 1.63 and reals -0.75 but BEI is still 2.38%. What happens to the value of each?



Return Analysis		Pre Tax				After Tax			
	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L	
Total	2.464	0.817	2.410	9,325	--	--	--	--	
TII 0 1/8 07/15/31	-5.067	-1.687	-4.978	-19,251	--	--	--	--	
T 1 1/4 08/15/31	7.502	2.503	7.386	28,576	--	--	--	--	

Dollar for dollar, you would PROFIT on the trade. Why? Because TIPS have a lower duration than nominals. Recall the concept that FRNs have lower duration because their cashflows are reset to the market at each cashflow, the same applies here. BUT, remember inflation right now is assumed to be 5.365%. If you adjust the inflation assumption to the Fed's target of 2% you are now only barely breaking even by the end of the year:



Return Analysis		Pre Tax				After Tax			
	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L	
Total	0.094	0.031	0.092	355	--	--	--	--	
TII 0 1/8 07/15/31	-7.412	-2.473	-7.297	-28,221	--	--	--	--	
T 1 1/4 08/15/31	7.502	2.503	7.386	28,576	--	--	--	--	

Now a big issue with what I just showed you is that it's Dollar for Dollar >> on top left of FIHZ it's set to Swap Type [Proceeds]. Proceeds just means the equivalent principal amount. In practice, we know from prior topics that we do fixed income pair trades on a duration-matched approach. **This achieved by setting the Swap Type to [Risk].**

If initiating the pair trade on a duration-hedged basis, the rise in yields results in a loss for you, being long TIPS and short nominals. Again, we turn our eye to the B/E value and we can see that 241.95 is the breakeven over this horizon while we modelled a 238bps BEI. It requires the interest rate differential between reals and nominals to widen by a further 4bps for you to not lose money with the current inflation scenario.

Fixed Income Horizon Analysis

112-19 3/4 /112-22 1/4 -1.083/-1.090 BGN @ 14:15

Swap Type Risk

Security	B/S	Am't (M)	Settlement Date	Price	Yield	W	Risk	Horizon Price	Yield	W	Rate
TII 0 3/8 07/15/31	B	1,000	08/31/21	112.589338	-1.080000	M	5.63	108.670961	-0.750000	M	
T 1 1/4 08/15/31	S	607	08/31/21	99.534301	1.300000	W	9.29	96.627174	1.630000	W	

Yield Sprd Gross -238 bp -3.66 Yield Sprd -238 bp B/E -241.95

Return Analysis

Reinvestment Rate 0.056 % Inflation Rate 5.365 %

	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L
Total	-2.109	-0.699	-2.063	-4,225	--	--	--	--
TII 0 3/8 07/15/31	-5.067	-1.687	-4.978	-19,251	--	--	--	--
T 1 1/4 08/15/31	7.502	2.503	7.386	15,125	--	--	--	--

If nominals widen 10bps more than reals, i.e. the 10y goes to 1.73% this is the PnL:

Fixed Income Horizon Analysis

112-19 3/4 /112-22 1/4 -1.083/-1.090 BGN @ 14:15

Swap Type Risk

Security	B/S	Am't (M)	Settlement Date	Price	Yield	W	Risk	Horizon Price	Yield	W	Rate
TII 0 3/8 07/15/31	B	1,000	08/31/21	112.589338	-1.080000	M	5.63	108.670961	-0.750000	M	
T 1 1/4 08/15/31	S	607	08/31/21	99.534301	1.300000	W	9.29	95.760473	1.730000	W	

Yield Sprd Gross -238 bp -3.66 Yield Sprd -248 bp B/E -247.03

Return Analysis

Reinvestment Rate 0.056 % Inflation Rate 5.365 %

	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L
Total	0.516	0.171	0.505	1,034	--	--	--	--
TII 0 3/8 07/15/31	-5.067	-1.687	-4.978	-19,251	--	--	--	--
T 1 1/4 08/15/31	10.087	3.373	9.954	20,384	--	--	--	--

This is what makes trading breakevens so tricky. You need to account for:

1. Current duration risk
2. Expected inflation rate
3. Expected yield shift of each leg (i.e. the BEI move)
4. The horizon of your expected trade

Lastly, if you want to look at inflation expectations in the market you should really be looking at inflation swaps. First of all, let's look at an inflation swap (we will cover swap mechanics in more detail later):

USSWITS CMPN Curcy Security Description: Swap

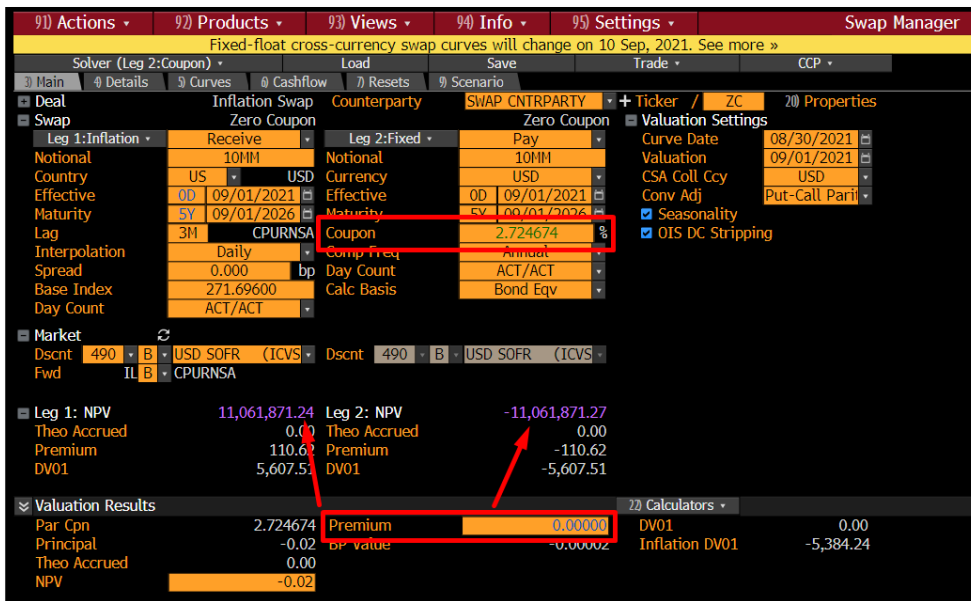
USD Inflation Swap Zero Coupon FIGI BBG009K9TVC5

A derivative used to transfer inflation risk from one party to another through an exchange of cash flows. In a zero coupon inflation swap, only one payment is done at maturity where one party pays a fixed rate on a notional principal amount, while the other party pays a floating rate linked to an inflation index.

Overview	Fixed Leg	Inflation Leg
Currency USD	Day Count 1/1	Day Count 1/1
Settlement T+2 Days 01-SEP-2021	Bus Adj ModifiedFollowing	Index CPURNSA Index
Term 5 Year 01-SEP-2026	Adjust Pay Dates	Bus Adj ModifiedFollowing
Discounting OIS	Roll Conv Backward (EOM)	Adjust Pay Dates
Lag 3 Month	Calc Cal FD, EN	Roll Conv Backward (EOM)
Interpolation Daily	Pay Delay 0 Business Days	Calc Cal FD, EN
Compound Freq Annual		Pay Delay 0 Business Days
Quote 2.7088 %		Reset Position In Advance

On Bloomberg you can run **SWPM -ILFX** to price a Zero-Coupon inflation swap. The name gives you a hint – one leg pays no coupon while the other leg is fixed to the CPI value with a 3-month lag. Here we have the 5-year zero coupon inflation swap. On the left hand side is one leg where its value is tied to the CPI number and in 5 years time

will have its principal adjusted according to the inflation index ratio. On the right hand side is the fixed leg that doesn't actually pay a coupon, but what it is doing is calculating the annual coupon required such that the present value of those cashflows equals the present value of the inflation leg.



The screenshot shows a Swap Manager interface for an Inflation Swap. The swap is structured as follows:


- Deal:** Inflation Swap, Counterparty: SWAP CNTRPARTY, Ticker: ZC, Properties: 20
- Leg 1 (Inflation):** Receive, Notional: 10MM, Country: US, Effective: 0D (09/01/2021), Maturity: 5Y (09/01/2026), Lag: 3M, Interpolation: Daily, Spread: 0.000 bp, Base Index: 271.69600, Day Count: ACT/ACT.
- Leg 2 (Fixed):** Pay, Notional: 10MM, Country: USD, Effective: 0D (09/01/2021), Maturity: 5Y (09/01/2026), Coupon: 2.724674%, Comp Freq: Annual, Day Count: ACT/ACT, Calc Basis: Bond Eqv.
- Market:** Dscnt: 490 (USD SOFR (ICVS)), Fwd: ILB (CPURNSA).
- Valuation Results:**
 - Par Cpn: 2.724674
 - Principal: -0.02
 - Theo Accrued: 0.00
 - NPV: -0.02
 - Premium: 0.00000
 - BP Value: -0.00002
 - Inflation DV01: -5,384.24

So based on this, the market is saying inflation should run at an annualized rate of 2.7247% over the next 5 years. As the value changes, it changes the ZC inflation curve and that in turn adjusts the coupon required. There is recursiveness.

That still isn't fully 'expectations' though. So we go one step further and look at **forward inflation swaps**. Recall from Bootstrapping that with zero rates you can then imply forward zero rates as well. Well, if I know the 5y ZC inflation swap rate, and I know the 10y inflation swap rate I can very easily find out the 5y ZC inflation swap rate, 5 years from now. That would be the 5y5y Inflation Swap.

If the 5y infl swap is 2.7248 and the 10y infl swap is 2.5343 then the 5y5y should roughly be

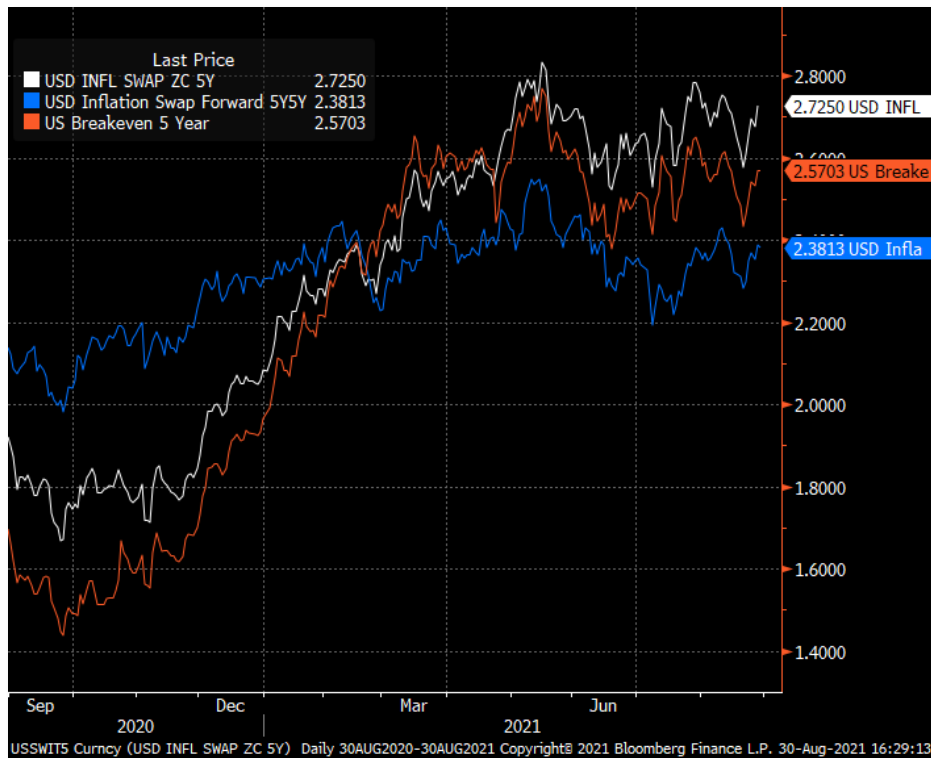
$$[(1.025343^{10}) / (1.0272487^5)]^{(1/5)} - 1 = 2.3440\%$$



The screenshot shows a Swap Manager interface for a 5y5y Inflation Swap. The swap is structured as follows:

- Deal:** Inflation Swap, Counterparty: SWAP CNTRPARTY, Ticker: ZC, Properties: 20
- Leg 1 (Inflation):** Receive, Notional: 10MM, Country: US, Effective: 5Y (09/01/2026), Maturity: 5Y (09/01/2031), Lag: 3M, Interpolation: Daily, Spread: 0.000 bp, Base Index: 310.78586, Day Count: ACT/ACT.
- Leg 2 (Fixed):** Pay, Notional: 10MM, Country: USD, Effective: 5Y (09/01/2026), Maturity: 5Y (09/01/2031), Coupon: 2.343869%, Comp Freq: Annual, Day Count: ACT/ACT, Calc Basis: Bond Eqv.
- Market:** Dscnt: 490 (USD SOFR (ICVS)), Fwd: ILB (CPURNSA).
- Valuation Results:**
 - Par Cpn: 2.343869
 - Principal: -0.04
 - Theo Accrued: 0.00
 - NPV: -0.04
 - Premium: 0.00000
 - BP Value: -0.00004
 - Inflation DV01: -4,914.05

The Fed uses an approximation, ticker **FWISUSS55 Index** which is (2 * 10 Inflation Swap) - 5y Inflation Swap which gives a close estimate. Here is a look at the various inflation metrics we have looked at today:



That's all there is for TIPS and Inflation. I hope this clears up some confusion or misunderstanding among you regarding TIPS, BEIs, and inflation in general and hopefully the end of BEIs being labelled inflation expectations.

11.6 Topic Question

If I want to be long inflation but short duration, what is the best way to construct this trade? Bear in mind my example where inflation adjustments for TIPS only compensates so much for inflation but a rise in yields still causes a loss.

There is no one simple way to do this but the most straightforward is the example that I used earlier; long TIPS and short nominals. Because you want to be short duration, you would have to over-sell nominals so that the net duration of the trade is negative (recall we looked at the trade from a duration hedged perspective in the example).

The pain point of this trade would be real rates rising and nominals falling, in which case you are losing on both sides. In this scenario, the market would likely be pricing in the risk of falling inflation from a rise in financing conditions and if you are long inflation, that is why you lose.



12. Mortgage Backed Securities (by Tom Graff @tdgraff)



Hello class. I'm Tom Graff and will be your guest lecturer in the BBB series today on Mortgage Backed Securities. For background, I'm a buy-side PM today but I actually came up as an MBS analyst, and one of the strategies I run is mortgage specific. We'll cover what MBS are, how they trade, how you analyze them, who the buyer base is, what a CMO is, when MBS tend to outperform, and whatever else the audience asked about.

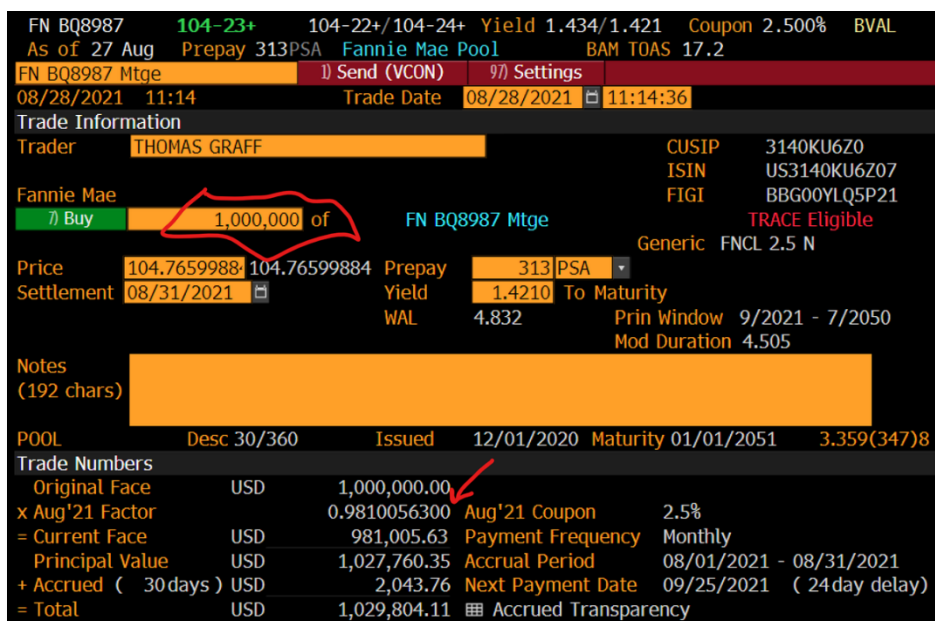
I'm going to focus on "agency" MBS, which are the ones backed by Fannie Mae, Freddie Mac or Ginnie Mae. Non-agency MBS (like what blew up in '08) are a far smaller portion of the market, and to be honest should be covered in a discussion of ABS/CMBS, which I'm not going to get into here. First, the MBS market is huge, at about \$11.5 trillion according to SIFMA. That's about \$1 trillion bigger than U.S. corporates, and only topped by Treasuries. It is also probably the second most liquid market in the world, after U.S. Treasuries. Again according to SIFMA, about \$300 billion of MBS trade per day, vs. just \$40 billion of corporates, \$9 billion of munis. Again, only topped by Treasuries (~\$620 billion).

12.1 Introduction

Mortgages that are sold to investors are bundled into "pools." The pool might hold as few as a dozen loans or it might hold 100,000+. The bank that originates the loan will sell the loan to one of the GSEs, and will pay a "guarantee fee" before selling it to the public. Once that happens some bank will become the "servicer." This could be the originating bank or someone else. The servicer is who actually deals with the borrower from here on. I.e., that's who you make your check out to, who would deal with you in delinquency, etc.

Basic MBS are often called "pass throughs." This is because the cash flow "passes through" from the actual borrower to investors. When you send in your monthly mortgage payment some of that is principal and some is interest, which we'll call "P&I" from here on. The servicer takes a fee out of the interest, then the rest of the interest plus the principal "passes through" to investors. Whatever principal is paid actually reduces the amount of bonds you own. The percentage that is remaining is called the "factor" on a mortgage.

Quick aside: the factor bit makes MBS trading easier. When we transact, the quantity quoted is in "original face" which is how much was originally outstanding. Then the factor is applied. Here is an example using the "BXT" function in BB.



FN BQ8987	104-23+	104-22+/104-24+	Yield 1.434/1.421	Coupon 2.500%	BVAL
As of 27 Aug	Prepay 313PSA	Fannie Mae Pool	BAM TOAS 17.2		
FN BQ8987 Mtge	Send (VCON)	Settings			
08/28/2021 11:14	Trade Date	08/28/2021	11:14:36		
Trade Information					
Trader	THOMAS GRAFF		CUSIP	3140KU6Z0	
			ISIN	US3140KU6Z07	
Fannie Mae			FIGI	BBG00YLQ5P21	
Buy	1,000,000	of	FN BQ8987 Mtge	TRACE Eligible	
			Generic	FNCL 2.5 N	
Price	104.7659988	104.76599884	Prepay	313	PSA
Settlement	08/31/2021		Yield	1.4210	To Maturity
			WAL	4.832	Prin Window 9/2021 - 7/2050
					Mod Duration 4.505
Notes (192 chars)					
POOL	Desc 30/360	Issued	12/01/2020	Maturity	01/01/2051 3.359(347)8
Trade Numbers					
Original Face	USD	1,000,000.00			
x Aug'21 Factor		0.9810056300	Aug'21 Coupon	2.5%	
= Current Face	USD	981,005.63	Payment Frequency	Monthly	
Principal Value	USD	1,027,760.35	Accrual Period	08/01/2021 - 08/31/2021	
+ Accrued (30 days)	USD	2,043.76	Next Payment Date	09/25/2021 (24 day delay)	
= Total	USD	1,029,804.11	Accrued Transparency		

In this example, I'd tell my counterparty that I'm buying 1mm of FN BQ8987 (which is the pool ID) at a price of \$104.766. Since this has 98.100563% outstanding, I actually wind up with \$981,005.63 "current face."

The GSE's role in all this is strictly as guarantor. If a loan goes delinquent, at first the GSE advances both P&I to investors. However if a loan goes more delinquent for 4 months, the GSE "buys" the loan from the pool at 100% of its original face. So in essence, any defaults act just like principal repayments from the investors' perspective. Worth noting that long-term delinquencies are rare. According to Fannie, about 1.7% of loans from 2009-2021 are seriously delinquent.

You can see the credit stats for a given pool using the CLP page in BB. This pool currently has zero delinquencies:

FN BQ8987 Mtge		Export Settings		Collateral Performance					
100% FNCL 2.5 N		3.359(347)8 CUSIP 3140KU6Z0		Pool Level ▾					
Months of History 6 ▾									
Classic	Delinq	Characteristics	Speeds	Custom	All				
			08/2021	07/2021	06/2021	05/2021	04/2021	03/2021	Issuance ^A
Balance (M)			4,463	4,472	4,480	4,488	4,502	4,511	4,550
Pool Factor			0.981	0.983	0.985	0.987	0.990	0.992	1.000
# of Loans			24	24	24	24	24	24	24
WAC			3.359	3.359	3.359	3.359	3.359	3.359	3.358
WAM			347	348	350	351	352	353	358
WALA			8	7	6	5	4	3	0
Orig LTV			77	77	77	77	77	77	77
WALTV (Amort) %									
WAOLS			190,118	190,117	190,117	190,116	190,114	190,113	190,108
Delinq 30 days %			0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delinq 60 days %			0.00	0.00	0.00	0.00	0.00	0.00	0.00
Delinq 90 days %			0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foreclosure %									

Now let's talk about the "TBA" market. It is one of the most important features of MBS and it explains why the market is so liquid. For those that have a mortgage on your house, you may remember that you "locked in" your rate at some point, but it was a few weeks before you actually settled on the house (or refi). Why was your bank willing to take all that interest risk between lock-in and settlement?

The answer is: they didn't. They pre-sold your loan before they actually had it in hand. The TBA (or "to be announced") is how this is possible.

12.2 The To-Be-Announced (TBA) Market

TBA is basically like a futures contract for mortgages. A bank can "sell" \$1mm of TBA MBS for delivery multiple months into the future and lock in the price that they'll get for your loan. This isn't very different from a farmer locking in the price of wheat by using futures.

TBA is so central to MBS that it dictates how the whole market works. E.g., TBA is organized by coupon and maturity. MBS coupons only exist in 0.5% increments. I.e., there is a Fannie Mae 2% and a 2.5% MBS, but not a 2.25%. Why? Because it makes it easier for TBA trading.

There are active TBA markets for 30-year and 15-year MBS, although volume in 30-year is substantially greater. MBS exist for 20 and 10-year mortgages as well as ARMs, but there is no TBA market for these and thus these MBS are far less liquid.

You can see the current TBA market on BB by just hitting **TBA<GO>**. The page I prefer is **TBPF** which allows you to see some other details like performance vs. hedges.

Save View		Settings ▾		Enable Swap		TBA Performance Monitor (Tra					
Agency FN ▾	Settle GO ▾	View		Duration							
30yr TBAs											
Bid	Ask	Chg	Swap	Treas	OAD	CT2	Perf	CT5	Perf		
FNCL 1.5	98-09+	13c	+ 09	+ 03 ¹ / ₄	+ 02 ³ / ₈	7.26	363.8	+ 05+	147.2	- 00 ¹ / ₄	
FNCL 2.0	101-12	13c	+ 08+	+ 02 ³ / ₈	+ 01 ⁵ / ₈	6.15	308.4	+ 04 ⁵ / ₈	124.8	- 00 ³ / ₈	
FNCL 2.5	103-26	27c	+ 07 ¹ / ₄	+ 02 ¹ / ₄	+ 01 ³ / ₄	4.99	250.1	+ 04 ¹ / ₈	101.2	+ 00 ¹ / ₈	
FNCL 3.0	104-17+	18c	+ 01 ³ / ₄	- 01 ¹ / ₄	- 01+	2.91	146.2	- 00 ¹ / ₈	59.2	- 02+	
FNCL 3.5	105-24	24+c	+ 00 ¹ / ₄	- 02 ³ / ₈	- 02 ⁵ / ₈	2.57	129.0	- 01 ³ / ₈	52.2	- 03 ³ / ₈	
FNCL 4.0	107-03+	04+c	+ 00+	- 01 ⁵ / ₈	- 01 ⁷ / ₈	2.31	116.1	- 00 ⁵ / ₈	47.0	- 02+	
FNCL 4.5	108-05+	07c	+ 00	- 02 ³ / ₈	- 02 ⁵ / ₈	2.69	135.0	- 01 ¹ / ₈	54.6	- 03 ³ / ₈	
FNCL 5.0	109-17	19c	- 00+	- 03	- 03 ¹ / ₄	2.95	147.7	- 01 ⁵ / ₈	59.8	- 04	
15yr TBAs											
FNCL 1.5	101-15+	17c	+ 06 ¹ / ₄	+ 02 ¹ / ₄	+ 01 ⁷ / ₈	4.09	204.9	+ 04	82.9	+ 00 ³ / ₄	
FNCL 2.0	103-14+	16c	+ 05 ³ / ₄	+ 02 ⁵ / ₈	+ 02 ¹ / ₄	3.32	166.4	+ 04 ¹ / ₈	67.3	+ 01+	
FNCL 2.5	104-17+	19+c	+ 00+	- 01	- 01 ¹ / ₄	2.19	109.8	- 00 ¹ / ₈	44.4	- 01 ⁷ / ₈	
FNCL 3.0	105-08	09c	+ 01	- 00+	- 00 ⁵ / ₈	1.81	91.1	+ 00 ¹ / ₄	36.9	- 01 ¹ / ₄	
FNCL 3.5	106-23+	24+c	- 01	- 02	- 02 ¹ / ₈	1.38	69.4	- 01+	28.1	- 02 ⁵ / ₈	
FNCL 4.0	106-04+	05+c	+ 00+	- 01	- 01 ¹ / ₈	1.80	90.0	- 00 ¹ / ₄	36.4	- 01 ³ / ₄	
FNCL 4.5	104-09	10c	+ 00	- 00 ³ / ₈	- 00+	1.20	60.3	- 00 ³ / ₈	24.4	- 01 ³ / ₈	
FNCL 5.0	104-14+	15+c	+ 00+	+ 00 ³ / ₈	+ 00 ³ / ₈	.88	44.1	+ 00 ³ / ₈	17.8	- 00 ³ / ₈	

TBA contracts settle on a certain day each month, called the "good day." Generally even if you are trading a real MBS bond, your counter-party will prefer to settle on good day, since it will correspond with their hedge.

TBA is also why trading MBS with long settlements is no big deal. There is very active TBA trading out 3 months, so it is easy to trade either TBA or cash bonds for settlement all the way to "good day" in October or November. Now like all bonds, you don't start accruing interest until the bond settles. Ergo waiting multiple months before settlement is disadvantageous to the buyer of the bond. They have locked in a price but aren't earning any carry.

This problem is solved via "drops". The drop is the difference between the price to settle in one month vs. the next month. Basically, if a buyer is going to wait an extra month to start earning carry, they get a discount on the price to compensate. Here's the current price for Sept, Oct and Nov 2% TBA.

The drops are indicated by "Sep/Oct" and "Oct/Nov", which is about 5 ticks or 5/32 of price (yes, MBS still trade in fractions!) The drop fluctuates a lot having to do with supply/demand as well as expected refi rates. It is something that MBS desks trade actively.

On TBA settlement day, if you are still short the contract you have to deliver MBS that meet the criteria. If the contract was 2% 30yr, you basically have to deliver a bond with more than 15yrs to maturity and a 2% coupon. There are some other details but they aren't important.

TBA		
11:48	Outright	Switch Bfly
TBA30 TBA15 MBS Swaps		
		2.0
UMBS	Sep	101-12 / 13
	Oct	101-05+ / 06+
	Nov	101-00 / 01
	Sep/Oct	05 ³ / ₄ / 06 ¹ / ₈
	Oct/Nov	05 ¹ / ₈ / 05+
FGLMC	Sep	/

Similar to other contracts, there is an implied "cheapest to deliver" concept here, which MBS guys often call "worst to deliver." Whoever is short a TBA will deliver the least attractive MBS they can get their hands on. More on what makes some bonds better than others later.

Regardless, most contracts are never delivered, they are just closed out and/or rolled to the next month. For example, I use TBA to get passive exposure to certain parts of the MBS market. I have no intention of taking delivery. Long before delivery day in Sept, I'm going to sell that contract and buy an October contract. This is call "rolling" and is very similar to what happens in other futures markets for people who want consistent long or short exposure.

OK let's get back to the originator. Remember that MBS only exist in 0.5% coupon increments, but real borrower rates are usually in 0.125% increments. So the originator has loans that are at 2.625%, 2.75%, 2.875%, etc. What kind of pool do these wind up in?

This is actually up to the originator. They can take a 2.875% loan and sell it into a 2% MBS, keeping 0.875% as a servicing fee. OR they could sell it into a 2.5% MBS and keep just 0.375%!

Since the price of the 2.5% MBS is higher (about 103.875 vs. 101.375 for 2%) it comes down to whether they want to collect more up front when selling the bond or if they want to collect a higher servicing fee over time.

For some history, it used to be that 0.5% was a good rule of thumb for servicing fees, but today that's much higher. Right now the average 30-year 2% MBS has a 0.85% average servicing fee. IOW, the average borrower actually faces a 2.85% rate. On Bloomberg, you can analyze a "generic" MBS by using the ticker "FNCL" or "FGLMC" and a coupon rate. So [FNCL 2 Mtge <GO>](#) will bring up a generic 2% Fannie Mae MBS for analysis. The stats on the DES page are the average for that coupon cohort. I'll hit what these stats are in a moment.



15) Prepay History												
	Aug21	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep20
1 Month CPR	4.4	3.9	3.0	2.5	1.9	3.1	2.2	8.3	6.0	6.2	5.1	3.4
3 Month CPR	3.9	3.2	2.5	1.8	0.5	2.7	2.0	7.0	5.9	5.1	3.6	2.4
6 Month CPR	2.9	1.9						5.4	4.2	3.3	2.2	1.3
12 Month CPR	4.2	4.0	3.8	3.6	3.4	3.5	3.5	3.6	3.0	2.6	2.4	

12.3 Analyzing MBS

OK enough technical stuff. Let's talk how you analyze MBS. The first thing to note is that US mortgages are prepayable anytime without penalty. They also aren't assumable, so if you move, you have to pay off your mortgage.

As a result, virtually all MBS analysis is about how quickly the underlying borrowers will repay their mortgages. The biggest factor is obviously refinancing due to falling rates. The second biggest is "turnover" or people selling their house. Then comes defaults. There is some effect to "curtailment" or people just paying a little extra over time. That's minor and rarely worth worrying about unless you have a deeply factored pool.

Earlier, we covered [callable bonds](#) – it's good to re-familiarize yourself with it because optionality is kind of a doozy with MBS. With a normal bond, you basically have one decision maker (the issuer) reacting to one incentive (can they reissue new bonds at a lower yield?). MBS are quite different on a number of fronts.



First, MBS are callable immediately upon issuance. Most bonds have some period of time before the bond is callable. Second, every borrower within the pool is making their own decision to refinance. So there are dozens to thousands of decision makers.

Third, each of those decision makers aren't facing the same circumstances as each other. Sure their current mtg rate is similar, but their lives are not. Here's where it gets really interesting. Let's say there are two borrowers. @EffMarketHype has a \$900,000 mortgage with a 3.375% rate. @tdgraff has a \$100,000 mortgage with a 3.625% rate. Let's say that both could get a new mortgage at 2.75%. The fee for doing the refi is \$3k.

Even though @EffMarketHype has a lower rate than @tdgraff, he saves way more money per mo. on the refi (~\$300 vs. only about \$50). So it only takes @EffMarketHype about 10 months to make back the refi fee, whereas it would take me about 63 months. Here we can see that while both could borrow at the same rate, they have very different actual refi incentive. This is just one of dozens of ways borrowers can face different incentives. From this is born the real fun of MBS: prepayment analysis.

First some quick definitions. How quickly principal is repaid is called "speeds" in MBS land, and there are two main measures. The OG is called Conditional Prepayment Rate or CPR.

CPR is basically the pct of the loan that would pay off in a year if payments kept coming in at the current pace. So if you saw a 3mo CPR of 12, it means 12% of the loan would pay off if the pace of the last 3mo continued for 12.

The other is PSA. The PSA assumes that a MBS starts at 0CPR in month 1, increases by 0.2CPR every month until it reaches 6CPR and remains there. The PSA is quoted as a percentage of this basic model. So 150PSA in month 31 = 9CPR (6CPR * 150%).

OK so let's look at how important these speeds can be to your bond's yield. Below is the YT function on BB for a generic 2.5% MBS. I'll walk through what's here.

FNCL 2.5 9/21 Mtge		Actions	Export	Settings						
100% FNCL 2.5		3.249(354)3	CUSIP 01F022691	Pool Level	As of 08/2021					
8/2021	847P 5.4C 0.0B			Coupon	2.5%					
3Mo	859 4.6 0.0	Orig Amt	99.4MMM	LTV/HLTV	75/75	Accrual	9/1-9/30	Age	3	0Yr 3Mo
6Mo	795 3.1 0.0	Curr Amt	97.8MMM	MAXLS	1,582,000	Next Pay	10/25/21	WAM	354	29Yr 6Mo
12Mo	-- -- --	Factor	0.98405775	WAOLS	358,003	WAC	3.249			
Life	725 2.4 --	# Pools	1,309							
Price-to-Yield										
Settle	09/14/21	0 MED	+300 MED	+200 MED	+100 MED	-100 MED	-200 MED	-300 MED		
Vary	0	392 PSA	98 PSA	105 PSA	148 PSA	971 PSA	1424 PSA	1597 PSA		
Price	103-27	1.5190	2.0585	2.0463	1.9698	0.5354	-0.1595	-0.4252		

Toward the middle of the page, you see a "Price-to-Yield" header and then a series of "0 MED" "+300 MED" etc. Each of these are BB's estimate of prepayment speeds given a certain change in mtg rates. The current (0 MED) is 392PSA. That gives the bond a yield of 1.519%



FNCL 2.5 9/21 Mtge										Actions	Export	Settings	Yield	
100% FNCL 2.5										3.249(354)3		CUSIP 01F022691	Pool Level	As of 08/2021
8/2021	847P	5.4C	0.0B							Coupon	2.5%			
3Mo	859	4.6	0.0	Orig Amt	99.4MMM	LTV/HLTV	75/75	Accrual	9/1-9/30	Age	3	0Yr	3Mo	
6Mo	795	3.1	0.0	Curr Amt	97.8MMM	MAXLS	1,582,000	Next Pay	10/25/21	WAM	354	29Yr	6Mo	
12Mo	--	--	--	Factor	0.98405775	WAOLS	358,003			WAC	3.249			
Life	725	2.4	--	# Pools	1,309									
Price-to-Yield														
Settle	09/14/21		0 MED	+300 MED	+200 MED	+100 MED	-100 MED	-200 MED	-300 MED					
Vary		0	392 PSA	98 PSA	105 PSA	148 PSA	971 PSA	1424 PSA	1597 PSA					
Price	103-27		1.5190	2.0585	2.0463	1.9698	0.5354	-0.1595	-0.4252					

However we see if the bond were to pay slower, say 148PSA (BB's estimate for speeds given 100bps rise in rates) the yield jumps all the way to 1.97%! Woot!

FNCL 2.5 9/21 Mtge										Actions	Export	Settings	Yield	
100% FNCL 2.5										3.249(354)3		CUSIP 01F022691	Pool Level	As of 08/2021
8/2021	847P	5.4C	0.0B							Coupon	2.5%			
3Mo	859	4.6	0.0	Orig Amt	99.4MMM	LTV/HLTV	75/75	Accrual	9/1-9/30	Age	3	0Yr	3Mo	
6Mo	795	3.1	0.0	Curr Amt	97.8MMM	MAXLS	1,582,000	Next Pay	10/25/21	WAM	354	29Yr	6Mo	
12Mo	--	--	--	Factor	0.98405775	WAOLS	358,003			WAC	3.249			
Life	725	2.4	--	# Pools	1,309									
Price-to-Yield														
Settle	09/14/21		0 MED	+300 MED	+200 MED	+100 MED	-100 MED	-200 MED	-300 MED					
Vary		0	392 PSA	98 PSA	105 PSA	148 PSA	971 PSA	1424 PSA	1597 PSA					
Price	103-27		1.5190	2.0585	2.0463	1.9698	0.5354	-0.1595	-0.4252					

Here we have two important things to note. First, let's say general yields did rise by 100bps. This is still a bond with duration, therefore it will lose money because of price decline. However, it won't lose as much as its duration implies, all else being equal. This is because the value of the embedded option declines. Remember with a callable bond, the investor has shorted a call to the borrower. When rates rise, the call gets further from its strike.

The second interesting thing here is what if you could get the slower prepayment speed *without rates changing*. In other words, just get extra yield without having to suffer through the whole annoying price decline bit. That's where doing prepayment analysis really benefits your performance. If I can buy a pool that pays slower than generics, I earn that extra yield. If I could buy that pool for the same price as the generics, I could even use the TBA market to hedge!

Alas, life isn't that easy. Take our example from earlier where one borrower had a very low balance on the mortgage and thus would be much slower to refinance. Everyone knows this, and so they demand a higher price for a mortgage full of such loans.

This is called a "payup" and it is quoted in 32's vs. TBA. Below is one dealer's estimate of generic payups for different types of pools. Here "LLB" means a pool where the largest loan is only \$85,000. The payup for as FN 2.5% is 71/32.

30yr Payups	1.5	2.0	2.5	3.0
Low WALA	0	0.5	1.5	20.5
LLB (85k)	5	40	71	156
MLB (110k)	3	33	65	140
HLB (150k)	1	27	50	104
SHLB (175k)	1	23	39	89
VHLB (\$200k)	1	16	31	75
225k max	1	9	21	60
NY Only	1	17	44	119
FL Only	1	11	23	65

So if TBA 2.5% is \$103 27/32 on the ask side for Sept (see below) and I payup 71/32, that comes to \$106 2/32 all in. This system is more convenient vs. classic yield spread because it avoids dealing with differing prepayment models and/or settlement preferences.

		2.0	2.5
UMBS	Sep	101-12 / 13	103-26 / 27
	Oct	101-05+ / 06+	103-19+ / 20
	Nov	101-00 / 01	103-14 / 14+
	Sep/Oct	05 ³ / ₄ / 06 ¹ / ₈	06 ¹ / ₄ / 06 ⁵ / ₈
	Oct/Nov	05 ¹ / ₈ / 05+	05+ / 05 ⁷ / ₈
FGLMC	Sep	/	/
	Oct	/	/

Pools where 100% of the items within it have some special characteristic are called "stip" pools (for stipulated). Note that it has to be 100%. If there were to be a pool where half of the loans were LLB but the other half were just average, no one would pay up for that.

Of course, those kinds of pools don't really exist. Going back to the originator, they aren't going to mix a bunch of generic loans with another set of loans that Wall Street will pay up for. They aren't in the business of throwing away money.

Quick aside for how I personally approach pass-throughs before moving on to CMOs. Big payup pools are risky. Take our LLB example, which currently is around +71. What happens if general interest rates rise? Suddenly that prepayment protection isn't worth as much.

On 3/31, here's that same dealer's estimate for payups. When rates were a bit higher, the LLB payup was 12/32 lower. So in effect, this bond has a higher duration that stated, because rising rates will cause both the base price AND the payup to decline.

30yr Payups	1.5	2.0	2.5	3.0
Low WALA	1	2.5	5.5	30.5
LLB (85k)	6	30	59	111
MLB (110k)	4	22	51	96
HLB (150k)	2	14	42	79
SHLB (175k)	1	10	34	70
VHLB (\$200k)	1	4	24	59
225k max	1	2	15	46
NY Only	1	4	25	73
FL Only	1	3	11	45

Now it is true that you can't find a pool with some LLB and some average loan balance, but you can find "mutt" pools that have various attractive characteristics at very low payups. That's especially true if you look during times when rates have recently risen.

I try to look for loans that are newer (people usually don't refi or move within the first few months), have some more favorable geographies (some places pay slower), more favorable servicers (some market more aggressively), and some other details that help out. If you can buy these kinds of pools with very little payup, your downside vs. TBA is capped. IOW, a pool can't trade less than the TBA price (assuming it is deliverable) since you could always just deliver it!

So if I only pay 4/32 for a pool, my relative downside is just those 4 ticks. I don't have to be all that right about my prepay work to outperform. Before we go any further, let's talk about convexity. Technically, the term is the second derivative of change in price to change in yield. I prefer to explain it in plainer English, especially with regard to MBS, because it not only makes more sense, but it is also more applicable.

A bond is negatively convex anytime its price underperforms what you'd expect by simply multiplying the delta of rates by its duration. **In the case of MBS, this is basically always the case when rates fall.** The bond doesn't appreciate because it is assumed everyone will refinance.

Ostensibly a bond with call protection, like our LLB bond, should have better convexity. In fact, your MBS salesperson will tell you this. It doesn't get refi'ed as quickly! But I already showed you how it can underperform when rates rise, because the stip payup falls. **But wait, it gets worse.** The LLB borrower doesn't refi as quickly at first, but eventually rates fall enough that it doesn't matter. He refis too. Now your payup was worthless. Ergo there's only this narrow range where the payup benefits you.

When I think about pools, I lump all of this into negative convexity in my head. Again, it doesn't fit neatly into the mathematical definition, but I think it is a cleaner way to think about the concept.

Last points on negative convexity. It is the main reason why MBS yield so much compared to other product. The stated yield on the MBS index is 1.70%, all govt guaranteed! Relatedly, this is a big reason why buy-and-hold investors love this space. Banks, insurance companies, etc. If you can just collect book yield, and especially if the light capital charges that Agency MBS have benefit you, MBS are a great space.

For total return investors like me, this is a source of inefficiency. Buy stuff that has a good total return profile but not great book yield. Speaking of banks and inefficiencies...let's talk CMOs.

12.4 Collateralized Mortgage Obligations (CMOs)

Again, I'm only going to focus on Agency-backed CMOs. If @EffMarketHype does a bit on ABS (or if he wants another guest lecture) the non-agency types should be covered there. (EMH here: Hell no I'm not doing that.)

OK so say you are Wall Street. You've got this huge MBS market with tons of flow. And buyers love AAA-rates bonds. Should be a gold mine! Here's the problem; so many bond buyers want certainty around when their principal will be returned. How can you get these investors to buy?

In the 80's they came up with a solution; you take set of pools and put them in a trust. Then you sell new bonds based on the cash flow coming out of that trust. Here's a simple example with what's called a "sequential" CMO. Say you sell three bonds off the original pool. The first bond gets every dollar of principal until it is paid off. Then the second, then the third. Assume each is exactly 1/3 of the original pool amount.

The speed of repayment for the first bond would be 3x as fast, because it is getting 100% of the principal but on only 1/3 of the base. So if the original pools were going to remain outstanding for 6 years, maybe this front sequential is only 2 years! And now take the last pay of this 3-part sequential. It probably has a very long average life, but certain buyers want that. Maybe you are an insurance company matching liabilities. This back sequential might be just what you want!

For Wall Street, CMOs are an arbitrage. Can you find someone who will pay up for the short-term certainty, someone else who will pay up to match a long liability, etc. such that the total paid for the pieces is more than it costs to acquire the pools in the first place?

Now as a wise MBS trader once told me early in my career, prepayment risk can neither be created nor destroyed. Whatever prepayment risk is lowered for someone within the structure, it has to be higher for someone else. Wall Street found there were always more buyers of the short bonds than the long bonds. So they needed to make more short bonds. But who could take the extra prepayment risk? Enter the PAC, or "planned amortization class."

A PAC tranche of a CMO will payoff in a narrow window. For example, you would get no principal until month 24, then the bond would pay off entirely by month 30. It kind of simulates a normal bond. If you are thinking "why not just buy a normal bond?" you get extra credit. (Of course, the answer is there's better sales credit in the PAC CMO so your friendly Citigroup sales person is going to badger you about it)

In order for the PAC to work, there needs to be some part of the structure to take any "extra" prepayments that would force principal too early, but also someone to cushion the PAC if prepayments come in too slowly. These are called "support tranches". I'm not going to go into the math of how supports work, but presume they are extremely volatile but at times are cheaper than they "should" be because Wall Street bribes people to take them to make the rest of their goldmine CMO structure work. But buyer beware.

Here's a quick example of what life in a support tranche looks like. Notice how wildly the average life fluctuates given changes in yield.

FNR 21-45 ZJ Mtge										
100% FNJMCK 2.5 N		3.223(356)3	CUSIP 3136BHV55	Pool Level	As of 08/2021					
8/2021	830P 5.0C 0.0B	Traits	Z,SUP	Coupon	2.5%	Maturity	7/25/51	CA	78%	2021 100%
3Mo	728 2.9 0.0	06/30/2021	10,000,000	LTV/HLTV	73/73	Accrual	9/1-9/30	WA	5%	
6Mo	-- -- --	08/25/2021	9,737,180	MAXLS	1,348,000	Next Pay	10/25/21	VA	3%	
12Mo	-- -- --	Factor	0.97371803	WACLS	675,301	Collar	No Band	CO	3%	
Life	821 4.1 --	# Loans	1,529							
Price-to-Yield										
Settle	09/01/21	0 MED	+300 MED	+200 MED	+100 MED	-100 MED	-200 MED	-300 MED		
Vary	0	479 PSA	91 PSA	95 PSA	130 PSA	1721 PSA	1963 PSA	2062 PSA		
Price	100-24 ³ / ₄	1.7854	2.4661	2.4654	2.4578	0.5219	0.3204	0.2453		
Avg Life		1.32	20.93	20.66	18.17	0.48	0.43	0.42		
Mod Duration		1.29	19.93	19.64	16.95	0.47	0.43	0.42		

OK this solves part of the problem of shuffling prepayment risk, but not all of it. The CMO is a closed loop. Every dollar that comes in has to go out, and there is no one who can contribute the pot. So if the supports get exhausted, the PAC can't hold up.

The speed at which this might happen is disclosed at the outset. This is called the "band" or the "collar." Here's an example where this bond was originally marketed to be a ~6.4yr avg life as long as the PSA was between 155-265. If it persists outside than band, it will "bust".

Current	Original
Bal USD	Bal USD
39,129,486	39,414,000
Fct (Aug 21)	WAL
0.992781400	6.4Yrs@ 200 PSA
Cpn (Aug 21)	1st Coupon
3.00000%	3.00000%
Class/Grp Pct	Class/Grp Pct
86.44%	85.97%
Beg Accrue	1st Pay
08/01/2021	07/25/2021
End Accrue	1st Settle
08/31/2021	06/30/2021
	Dated Date
	06/01/2021
	Priced
	06/25/2021
Collar (Aug 21...	Collar
170-246	155-265

Things get real hairy if speeds go really fast for a while and then slowdown. Say speeds run at 600PSA for a while then slow to 100. That can turn this bond into a "extend-o-matic", where it goes from having an extremely short life to a very long one due to lack of supports.

There's one special type of CMO worth mentioning, and those are interest-only strips, or just IOs. These are CMOs that only pay interest, no principal. Eventually they are worthless. It is a matter of how much interest you collect before that happens. Obviously the slower the prepayments in the underlying pools, the more interest gets collected in the trust and the better the IO will perform.



FNR 21-45 BI Mtge		Actions		Export		Settings		Yield	
100% FNCT 3.0 M	3.543(175)58	CUSIP	3136BHV71	Pool Level		As of	08/2021		
8/2021	551P	33.1C	0.0B	Traits	IO,NTL,PT	Coupon	3.0%	Maturity	7/25/41
3Mo	562	33.7	0.1	06/30/2021	54,828,428	LTV/HLTV	68/54	Accrual	9/1-9/30
6Mo	619	37.2	0.2	08/25/2021	50,890,798	MAXLS	781,000	Next Pay	10/25/21
12Mo	620	37.2	0.3	Factor	0.9281827	WACLS	173,527	Collar	No Band
Life	544	32.7	--	# Loans	3,397				
Price-to-Yield									
Settle	09/01/21	0 MED	+300 MED	+200 MED	+100 MED	-100 MED	-200 MED	-300 MED	
Vary	0	296 PSA	116 PSA	128 PSA	167 PSA	449 PSA	533 PSA	559 PSA	
Price	11-30 ³ / ₄	-2.7278	9.2694	8.4927	5.9468	-13.5836	-19.8454	-21.8320	

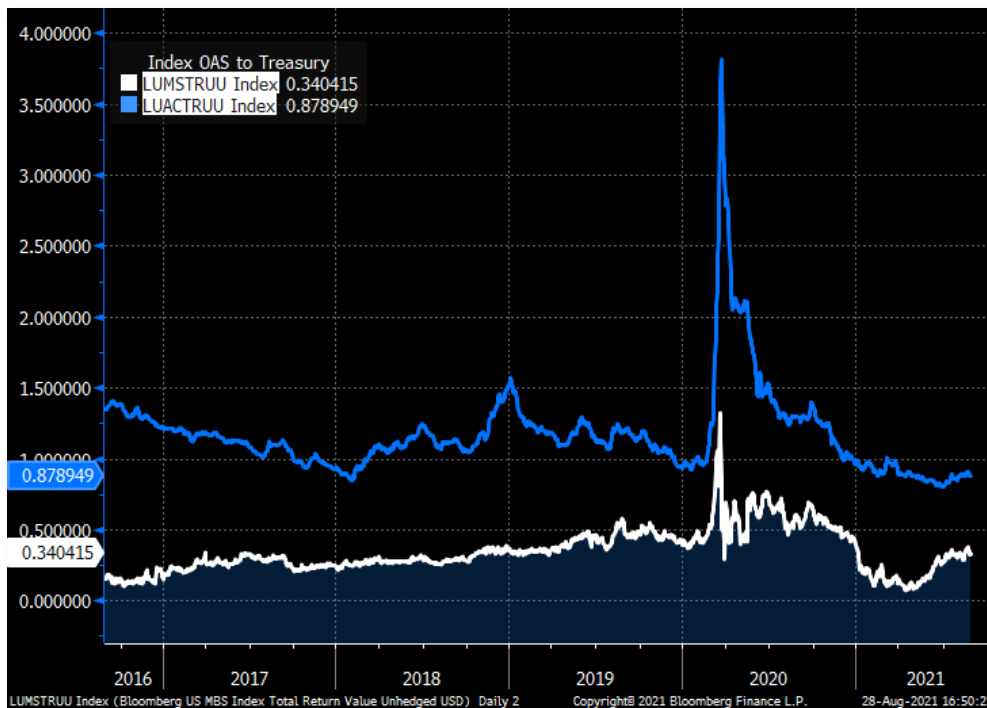
Here's an example of a stripped coupon off 3% MBS. Notice the dollar price is just shy of \$12. Notice also that the yield is *negative* at base speeds!

This results in these bonds having a funny property: **they have a**

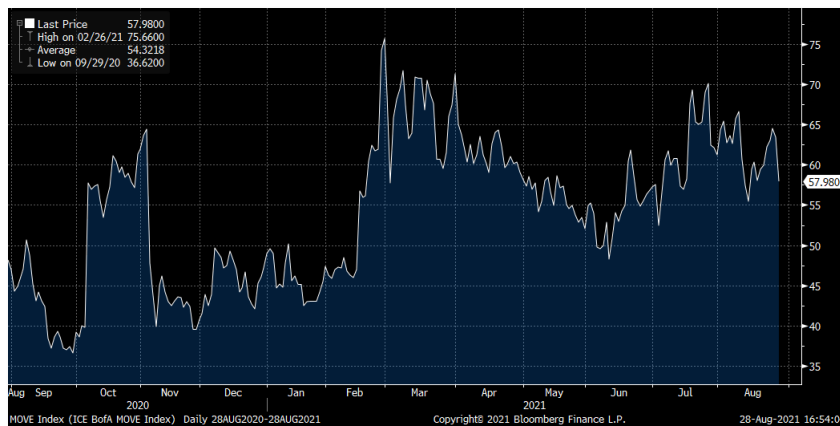
negative duration. Meaning, if interest rates rise, you get more coupon payments. Because there's no principal to discount, rising rates is all good for these bonds.

OK we're almost done. Congrats for making it this far.

A couple thoughts on the kinds of markets where MBS tend to outperform other types of high-quality bonds. IOW, why would someone like me who runs Barc Agg strategies overweight or underweight MBS? First, MBS have great carry as I mentioned before. So if you expect rates to be very range-bound, MBS can before very well. It is like writing covered calls on a stock that doesn't move. Second, MBS spreads (white) tend to be very stable compared to corporates (blue). They also aren't very correlated. If you think credit spreads are vulnerable, MBS can be a defensive position. OTOH, if credit spreads tighten, MBS definitely won't keep up.



MBS are also sensitive to interest rate volatility, for exactly the same reason that calls/puts on stocks are sensitive to the VIX. The MOVE index is something of a similar barometer. If volatility declines, MBS tend to outperform.



12.5 Appendix - Some Other Terms MBS Traders Use Not Mentioned Yet

"Orig" and **"Curr"**: We often look at the original of some loan stat vs. its current. Since the borrowers aren't homogenous, certain stats can change over time in meaningful ways. Sometimes abbreviated as just O and C, so **"OLTV"** is original loan-to-value.

Speaking of which: **LTV** is loan-to-value. Basically the inverse of how much equity the borrower has in the house. 80 is standard. High LTV pools are sometimes sold as call protection, but note that someone w/ 95 OLTV can get a better rate if price appreciation gets him to 80.

FICO is the borrower's credit score. Similar to LTV, this isn't a stip I like to buy. It only takes about a year for a low FICO borrower to "cure" if they stay on time and then they can refi into a lower rate even if general rates haven't fallen.

With both LTV and FICO, the point is that the GSE charges a higher guarantee fee, so the mortgage bank is going to charge a higher rate. If they "cure" these problems they will prepay quicker than average.

Geo's are the term for what states the loan is from. 100% in one state can be a stip, especially NY, where the fees for refinancing are especially high. Which states pay faster or slower sometimes has a lot to do with where home prices have recently been rising.

HPA = home price appreciation. The more prices rise the easier cash-outs are, the easier it is to move, LTVs get better, all no bueno for MBS investors.

WAC = weighted average coupon. This is the underlying mortgage rate faced by the borrowers.

WALA = weighted average loan age. How many months the loans have been outstanding (not the MBS, the loans).

WAL = weighted average life. This is how long each dollar of principal will be outstanding on average. Basically how long it will take for 1/2 of your bond to pay off.

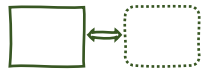
WARM = weighted average remaining mortgage. Also quoted in months.

Day delay: this is how long between the servicer getting the payment from the borrower and them passing it through to the bond. Its about 1 1/2 months. Keep this in mind when looking at speeds. This month's speeds reflect payments made two months ago.

"Collateral" and **"structure"**: terms CMO guys use for passthroughs (collateral) and CMOs (structure).

TPO: Third-party origination. Basically this is the pct of the loan that non-bank brokers originated. Might be a sign that the borrowers will pay faster since the brokers tend to market refis aggressively.

13. Introducing Interest Rate Swaps

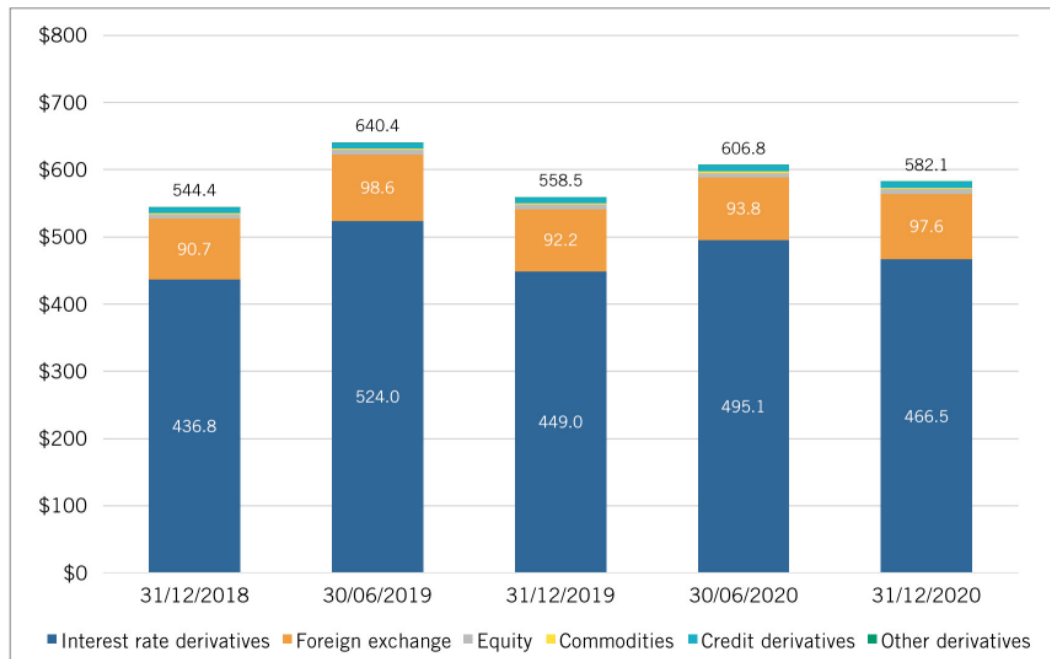


Here we focus on the mechanics of swaps, mainly interest rate swaps. The objective is an understanding of what's being quoted and why. It'll be intense but the key will be developing an intuition for the market.

I must first of all give a shout out to @shortendtrader and @aRishisays for their help in making sure I don't make too much of an ass of myself. If you don't follow these two on twitter already, please do (though SET's account is locked).

The global swaps market is huge with Interest Rate Derivatives Notional Outstanding of US\$466.5 trillion at the end of 2020 according to BIS. In comparison the entire US' debt outstanding (private and public) stands at US\$47T as of end-Dec 2020 according to the BIS.

Chart 1: Global OTC Derivatives Notional Outstanding (US\$ trillions)



Source: BIS OTC Derivatives Statistics

We're going to break down a plain vanilla interest rate swap first and foremost. Once familiar with that, in Part 2 we'll introduce and apply the concepts to other types of swaps such as ASW, TRS, Basis Swaps and Cross Currency Basis Swaps.

Full disclosure: I do not trade swaps, I only observe and try to understand the market. If you are reading this and an active participant, please point out where I'm wrong or missing nuances. And for the love of Fabozzi and all that is carry, please read the topic on bootstrapping

So first, let's lay out the concept of a swap – the name itself implies an **exchange of two things**. A swap always has two "legs" where one cashflow is being swapped for another.

I want you to keep 3 simple principles in mind:

1. A swap is simply 2 fixed income instruments combined, similar to a pair trade
2. We first analyse the swap from initiation i.e., $t=0$
3. The market aims for value equivalence (a.k.a. no free lunch)

Why do swaps exist? Well initially and from a high-level perspective, swaps are about comparative advantage which is about relative borrowing power and exploiting that.

Suppose the following:

Company A: can borrow Fixed at 5% or Floating at LIBOR+100bps

Company B: can borrow Fixed at 6% or Floating at LIBOR+175bps

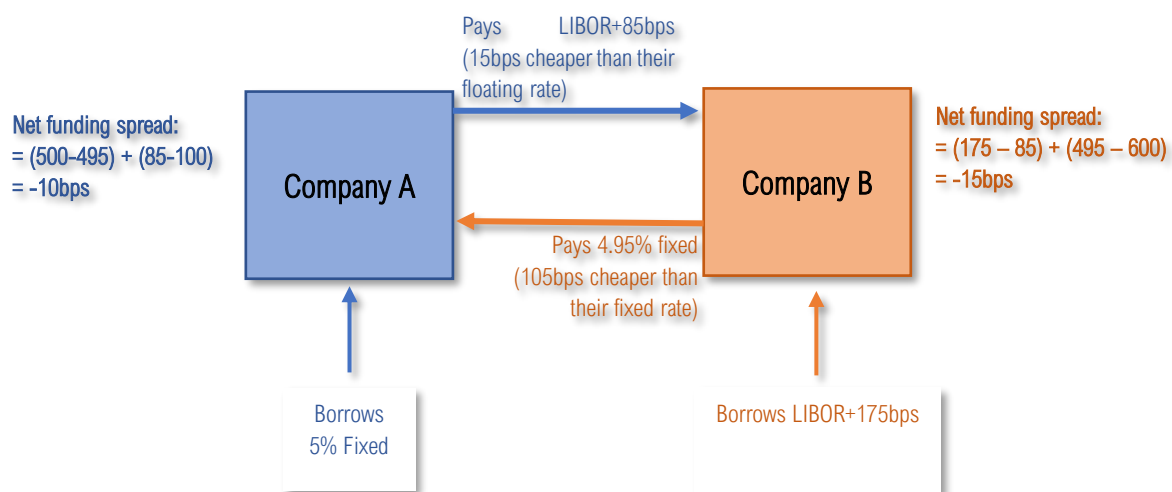
Company A is surely the better credit as its financing is lower overall. But say its asset cashflows are variable and their borrowing tends to be fixed, can they match cashflow types and borrow for cheaper?

If Company A borrows fixed @ 5% then agrees with Company B borrowing floating at 3ML+175 to swap cashflows whereby A pays B LIBOR+85 and B pays A 4.95% fixed – what is the net effect?

Company A now has floating rate debt 15bps cheaper, while receiving 5bps less in fixed. Net -10bps

Company B now has fixed rate debt 105bps cheaper, while receiving 90bps less in floating. Net -15bps

Win-win. Graphically it looks like this:



So, it's about transforming one type of cashflow or liability into another type – and banks are heavy users of swaps. Why? Because a bank typically funds itself through avenues that are short term and therefore change, i.e., rates that float – LIBOR being a prime example of this.

A bank that holds a fixed income bond might want to swap its asset cashflows into floating rate cashflows, so it matches their funding profile.

As the usage of swaps increased it became apparent that swaps markets were inherently capturing market expectations of interest rates (e.g., if you worried about rising rates you could turn fixed coupons into floating ones ahead of time using swaps). With this the swaps market grew.

13.1 Plain Vanilla Interest Rate Swap

The plain vanilla IRS is the most widely traded type of IRS and refers to a fixed-to-float IRS. Because there are two legs to any swap, the market must have a convention to focus on one side so everyone is referencing the same thing.

There must be a payer and a receiver. If the term 'payer' is mentioned, who is the payer? The party that is agreeing to pay the FIXED coupon of the swap. **What is the swap rate that gets quoted? The FIXED coupon rate of the swap.**

In the words of SET: “The second you hear someone say ‘I want to buy a swap’ then you know you can widen the bid/offer a touch” – paying vs receiving not buying vs selling

So, for a vanilla IRS the focus is on the FIXED coupon. As we work through it will make more sense why.

Here’s a typical example of a vanilla IRS:



THE 6 PARTS OF A PAR VANILLA SWAP TO PAY ATTENTION TO:

1. The fixed coupon
2. The floating index (notice you can add a spread to it)
3. DC Stripping
4. The fixed leg NPV
5. The floating leg NPV
6. The swap’s premium

At the top the Solver is set to Premium, meaning we will solve Fixed Coupon for a set premium.

Recall the **1st of 3 principles**: a swap is made up of two individual instruments. **Essentially a vanilla IRS is swapping a fixed coupon bond for a floating one.**

a) Leg 1 is a 5y fixed coupon bond paying 0.872421% coupon semi-annually

b) Leg 2 is a 5y floating rate note paying 3M LIBOR every quarter

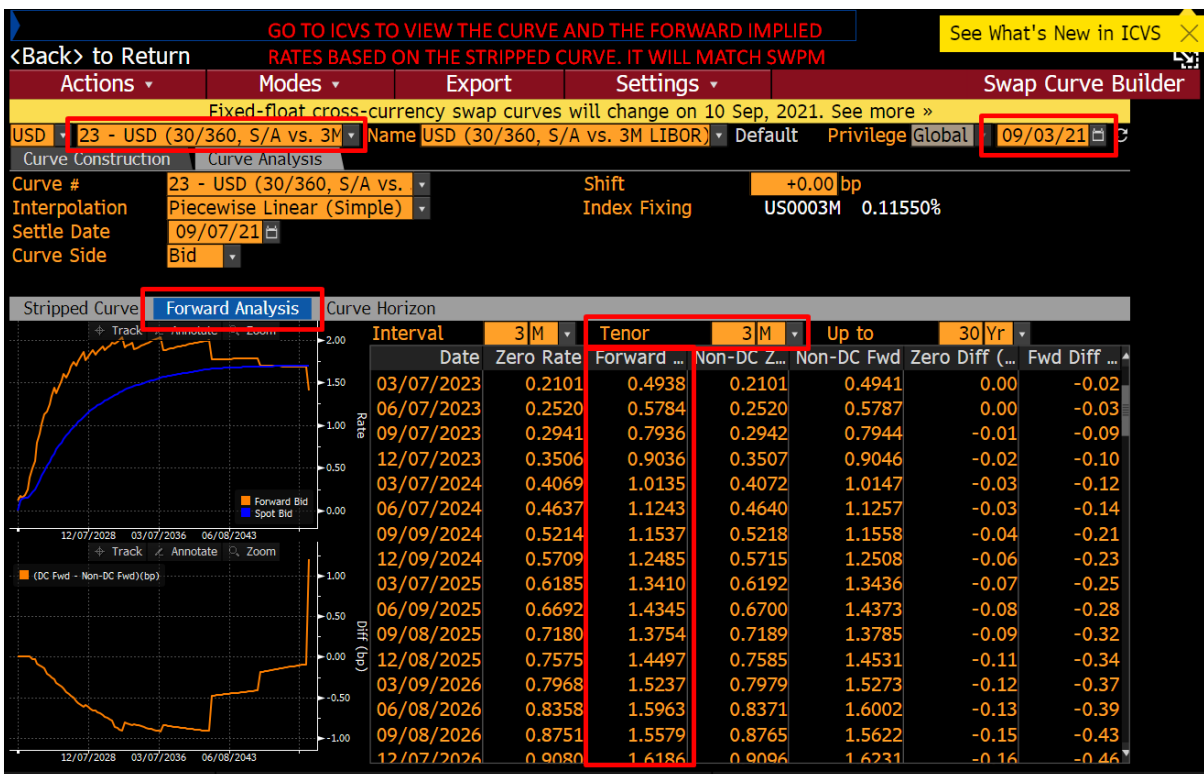
13.2 SWAP PARTS 1 & 2: The Fixed And Floating Coupon

A) The Fixed Coupon leg (like a fixed coupon bond) has a **known** series of cashflows paid semi-annually, which is \$43,621.05 every 6 months for 5 years.

B) The Floating Leg (like an FRN) has an **unknown** series of cashflows paid quarterly, tied to 3M LIBOR. In bootstrapping we learned that taking the par swaps curve we can strip it, then imply forward zero-coupon rates for any tenor. This is how we generate the future **implied** 3M LIBOR rates in a swap.



Reset Date	Reset Rate
09/03/2021	0.11550
12/03/2021	0.16878
03/03/2022	0.14917
06/01/2022	0.17789
09/05/2022	0.25182
12/05/2022	0.38321
03/03/2023	0.49384
06/05/2023	0.57840
09/05/2023	0.79358
12/05/2023	0.90358
03/05/2024	1.01346
06/05/2024	1.12433
09/05/2024	1.15369
12/05/2024	1.24692
03/05/2025	1.34103
06/05/2025	1.43553
09/04/2025	1.37537
12/04/2025	1.44971
03/05/2026	1.52323
06/04/2026	1.59633



GO TO ICVS TO VIEW THE CURVE AND THE FORWARD IMPLIED RATES BASED ON THE STRIPPED CURVE. IT WILL MATCH SWPM

See What's New in ICVS

Swap Curve Builder

Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »

23 - USD (30/360, S/A vs. 3M) Name USD (30/360, S/A vs. 3M LIBOR) Default Privilege Global 09/03/21

Curve Construction Curve Analysis

Curve # 23 - USD (30/360, S/A vs. Shift +0.00 bp

Interpolation Piecewise Linear (Simple) Index Fixing US0003M 0.11550%

Settle Date 09/07/21

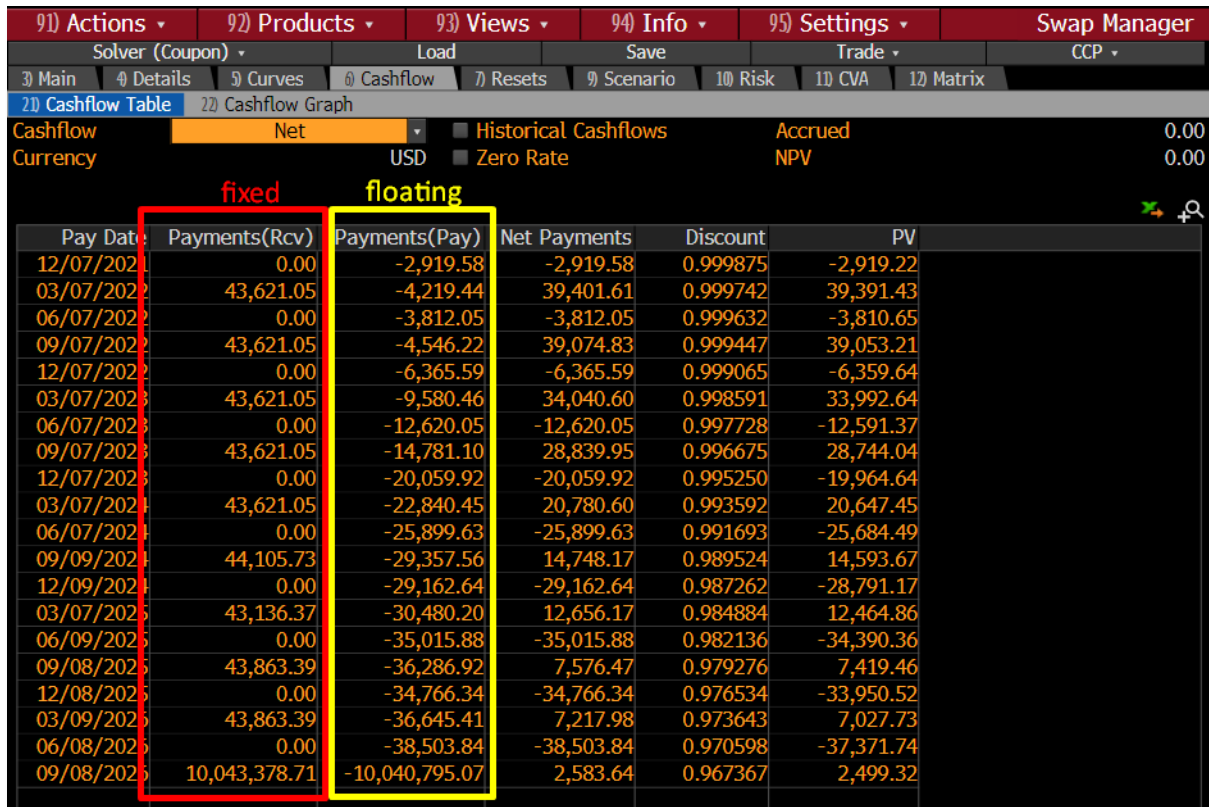
Curve Side Bid

Stripped Curve Forward Analysis Curve Horizon

Interval	3M	Tenor	3M	Up to	30 Yr	Fwd Diff ...
Date	Zero Rate	Forward ...	Non-DC Z...	Non-DC Fwd	Zero Diff (...)	Fwd Diff ...
03/07/2023	0.2101	0.4938	0.2101	0.4941	0.00	-0.02
06/07/2023	0.2520	0.5784	0.2520	0.5787	0.00	-0.03
09/07/2023	0.2941	0.7936	0.2942	0.7944	-0.01	-0.09
12/07/2023	0.3506	0.9036	0.3507	0.9046	-0.02	-0.10
03/07/2024	0.4069	1.0135	0.4072	1.0147	-0.03	-0.12
06/07/2024	0.4637	1.1243	0.4640	1.1257	-0.03	-0.14
09/09/2024	0.5214	1.1537	0.5218	1.1558	-0.04	-0.21
12/09/2024	0.5709	1.2485	0.5715	1.2508	-0.06	-0.23
03/07/2025	0.6185	1.3410	0.6192	1.3436	-0.07	-0.25
06/09/2025	0.6692	1.4345	0.6700	1.4373	-0.08	-0.28
09/08/2025	0.7180	1.3754	0.7189	1.3785	-0.09	-0.32
12/08/2025	0.7575	1.4497	0.7585	1.4531	-0.11	-0.34
03/09/2026	0.7968	1.5237	0.7979	1.5273	-0.12	-0.37
06/08/2026	0.8358	1.5963	0.8371	1.6002	-0.13	-0.39
09/08/2026	0.8751	1.5579	0.8765	1.5622	-0.15	-0.43
12/07/2026	0.9080	1.6186	0.9096	1.6231	-0.16	-0.46

Note: BLOOMBERG's swap functions are in a bit of a mess right now – FWCV does not incorporate dual-curve stripping, FWCM has just started to and ICVS displays both. Make sure everything is matched when trying to tie values from each screen (Bloomberg has a paper on this which can be found in their help pages).

On the 6) Cashflow tab you can see the swap cashflows – starting from today (**Principle #2**) what are the fixed coupons every 6 months and floating rates every 3 months?



The screenshot shows the Bloomberg Swap Manager interface with the 'Cashflow Table' tab selected. The table displays cashflows for a swap, with columns for Pay Date, Payments(Rcv), Payments(Pay), Net Payments, Discount, and PV. The 'fixed' leg is highlighted in red, and the 'floating' leg is highlighted in yellow.

Pay Date	Payments(Rcv)	Payments(Pay)	Net Payments	Discount	PV
12/07/2022	0.00	-2,919.58	-2,919.58	0.999875	-2,919.22
03/07/2023	43,621.05	-4,219.44	39,401.61	0.999742	39,391.43
06/07/2023	0.00	-3,812.05	-3,812.05	0.999632	-3,810.65
09/07/2023	43,621.05	-4,546.22	39,074.83	0.999447	39,053.21
12/07/2023	0.00	-6,365.59	-6,365.59	0.999065	-6,359.64
03/07/2024	43,621.05	-9,580.46	34,040.60	0.998591	33,992.64
06/07/2024	0.00	-12,620.05	-12,620.05	0.997728	-12,591.37
09/07/2024	43,621.05	-14,781.10	28,839.95	0.996675	28,744.04
12/07/2024	0.00	-20,059.92	-20,059.92	0.995250	-19,964.64
03/07/2025	43,621.05	-22,840.45	20,780.60	0.993592	20,647.45
06/07/2025	0.00	-25,899.63	-25,899.63	0.991693	-25,684.49
09/09/2025	44,105.73	-29,357.56	14,748.17	0.989524	14,593.67
12/09/2025	0.00	-29,162.64	-29,162.64	0.987262	-28,791.17
03/07/2026	43,136.37	-30,480.20	12,656.17	0.984884	12,464.86
06/09/2026	0.00	-35,015.88	-35,015.88	0.982136	-34,390.36
09/08/2026	43,863.39	-36,286.92	7,576.47	0.979276	7,419.46
12/08/2026	0.00	-34,766.34	-34,766.34	0.976534	-33,950.52
03/09/2027	43,863.39	-36,645.41	7,217.98	0.973643	7,027.73
06/08/2027	0.00	-38,503.84	-38,503.84	0.970598	-37,371.74
09/08/2027	10,043,378.71	-10,040,795.07	2,583.64	0.967367	2,499.32

13.3 SWAP PART 3: Dual Curve Stripping

By now we're familiar with discounting bond coupons (cashflows) to arrive at Price (NPV). But what do we use for discounting swaps? That's where the bootstrapping topic comes in.

Using spot rates (stripped curve to derive zero rates) we can discount the fixed leg's cashflows using the swaps curve. Prior to the GFC, IRS discounting used the LIBOR swaps curve which was...made up of LIBOR swaps across different tenors.

So, there was recursiveness built in where swaps were 'self-discounting'. They thought it was basically risk-free. Oops.

The convention now is to discount future cashflows using a true risk-free curve, it was OIS based on Fed Funds but since Oct 2020 has shifted to SOFR curve discounting. You imply fwd cashflows using the same swap curve and discount using a different curve. More details later on.

13.4 SWAP PART 4 & 5: The Fixed & Floating NPV

We have constant cashflows for the fixed leg, implied forward cashflows for the floating leg and we also have the SOFR spot curve (zero rates) to discount the cashflows.

Recall from the [bootstrapping topic](#) that we can take a spot rate and convert it into a discount factor for easy discounting. The screenshot shows the DFs and how we get a NPV for each leg. The sum of the PVs equals the NPV of the leg.

91) Actions ▾ 92) Products ▾ 93) Views ▾ 94) Info ▾ 95) Settings ▾ Swap Manager

Solver (Coupon) ▾ Load Save Trade ▾ CCP ▾

3) Main 4) Details 5) Curves 6) Cashflow 7) Resets 8) Scenario 10) Risk 11) CVA 12) Matrix

2) Cashflow Table 2) Cashflow Graph

Cashflow **Leg 1: Receive Fixed** ▾ Historical Cashflows Accrued 0.00
 Currency USD Zero Rate NPV 10,105,002.34
 Equiv. Coupon

Pay Date	Accrual Start	Accrual End	Da...	Notional	Principal	Payment	Discount	PV
03/07/2022	09/07/2021	03/07/2022	180	10,000,000.00	0.00	43,621.05	0.999742	43,609.78
09/07/2022	03/07/2022	09/07/2022	180	10,000,000.00	0.00	43,621.05	0.999447	43,596.91
03/07/2023	09/07/2022	03/07/2023	180	10,000,000.00	0.00	43,621.05	0.998591	43,559.60
09/07/2023	03/07/2023	09/07/2023	180	10,000,000.00	0.00	43,621.05	0.996675	43,475.99
03/07/2024	09/07/2023	03/07/2024	180	10,000,000.00	0.00	43,621.05	0.993592	43,341.55
09/09/2024	03/07/2024	09/09/2024	182	10,000,000.00	0.00	44,105.73	0.989524	43,643.66
03/07/2025	09/09/2024	03/07/2025	178	10,000,000.00	0.00	43,136.37	0.984884	42,484.30
09/08/2025	03/07/2025	09/08/2025	181	10,000,000.00	0.00	43,863.39	0.979276	42,954.38
03/09/2026	09/08/2025	03/09/2026	181	10,000,000.00	0.00	43,863.39	0.973643	42,707.27
09/08/2026	03/09/2026	09/08/2026	179	10,000,000.00	10,000,000.00	10,043,378.71	0.967367	9,715,628.90

91) Actions ▾ 92) Products ▾ 93) Views ▾ 94) Info ▾ 95) Settings ▾ Swap Manager

Solver (Coupon) ▾ Load Save Trade ▾ CCP ▾

3) Main 4) Details 5) Curves 6) Cashflow 7) Resets 8) Scenario 10) Risk 11) CVA 12) Matrix

2) Cashflow Table 2) Cashflow Graph

Cashflow **Leg 2: Pay Float** ▾ Historical Cashflows Accrued 0.00
 Currency USD Zero Rate NPV -10,105,002.34
 Equiv. Coupon

Pay Date	Accrual Start	Accrual End	Da...	Notional	Principal	Reset Date	Reset Rate	Payment	Discount	PV
12/07/2021	09/07/2021	12/07/2021	91	-10,000,000.00	0.00	09/03/2021	0.11550	-2,919.58	0.999875	-2,919.22
03/07/2022	12/07/2021	03/07/2022	90	-10,000,000.00	0.00	12/03/2021	0.16878	-4,219.44	0.999742	-4,218.35
06/07/2022	03/07/2022	06/07/2022	92	-10,000,000.00	0.00	03/03/2022	0.14917	-3,812.05	0.999632	-3,810.65
09/07/2022	06/07/2022	09/07/2022	92	-10,000,000.00	0.00	06/01/2022	0.17790	-4,546.22	0.999447	-4,543.70
12/07/2022	09/07/2022	12/07/2022	91	-10,000,000.00	0.00	09/05/2022	0.25183	-6,365.59	0.999065	-6,359.64
03/07/2023	12/07/2022	03/07/2023	90	-10,000,000.00	0.00	12/05/2022	0.38322	-9,580.46	0.998591	-9,566.96
06/07/2023	03/07/2023	06/07/2023	92	-10,000,000.00	0.00	03/03/2023	0.49383	-12,620.05	0.997728	-12,591.37
09/07/2023	06/07/2023	09/07/2023	92	-10,000,000.00	0.00	06/05/2023	0.57839	-14,781.10	0.996675	-14,731.95
12/07/2023	09/07/2023	12/07/2023	91	-10,000,000.00	0.00	09/05/2023	0.79358	-20,059.92	0.995250	-19,964.64
03/07/2024	12/07/2023	03/07/2024	91	-10,000,000.00	0.00	12/05/2023	0.90358	-22,840.45	0.993592	-22,694.10
06/07/2024	03/07/2024	06/07/2024	92	-10,000,000.00	0.00	03/05/2024	1.01346	-25,899.63	0.991693	-25,684.49
09/09/2024	06/07/2024	09/09/2024	94	-10,000,000.00	0.00	06/05/2024	1.12433	-29,357.56	0.989524	-29,050.00
12/09/2024	09/09/2024	12/09/2024	91	-10,000,000.00	0.00	09/05/2024	1.15369	-29,162.64	0.987262	-28,791.17
03/07/2025	12/09/2024	03/07/2025	88	-10,000,000.00	0.00	12/05/2024	1.24692	-30,480.20	0.984884	-30,019.45
06/09/2025	03/07/2025	06/09/2025	94	-10,000,000.00	0.00	03/05/2025	1.34103	-35,015.88	0.982136	-34,390.36
09/08/2025	06/09/2025	09/08/2025	91	-10,000,000.00	0.00	06/05/2025	1.43553	-36,286.92	0.979276	-35,534.92
12/08/2025	09/08/2025	12/08/2025	91	-10,000,000.00	0.00	09/04/2025	1.37537	-34,766.34	0.976534	-33,950.52
03/09/2026	12/08/2025	03/09/2026	91	-10,000,000.00	0.00	12/04/2025	1.44971	-36,645.41	0.973643	-35,679.54
06/08/2026	03/09/2026	06/08/2026	91	-10,000,000.00	0.00	03/05/2026	1.52323	-38,503.84	0.970598	-37,371.74
09/08/2026	06/08/2026	09/08/2026	92	-10,000,000.00	-10,000,000.00	06/04/2026	1.59633	-10,040,795.07	0.967367	-9,713,129.58

13.5 SWAP PART 6: The Premium

This is the crux of the swap valuation and **Principle #3: No Free Lunch**. The idea is that at initiation (t=0), both the payer and receiver enter a swap where both sides are currently equal.

If it wasn't equal, there is hardly any incentive to enter the agreement. Value equivalence is when both legs' NPVs are equal to one another. The **difference in the NPVs is the premium**, which logically means the premium should be 0 at inception.

The premium is expressed as a percent of par – so a premium of 1 is 1% of par notional. On \$10MM notional that is \$100,000.



Deal		Fixed Float Swap	Counterparty	SWAP CNTRPARTY	Ticker / SWAP	Properties
Leg 1:Fixed	Receive	Leg 2:Float	Pay			
Notional	10MM	Notional	10MM			
Currency	USD	Currency	USD			
Effective	0D 09/07/2021	Effective	0D 09/07/2021			
Maturity	5Y 09/07/2026	Maturity	5Y 09/07/2026			
Coupon	1.074681 %	Index	3M US0003M			
Pay Freq	SemiAnnual	Spread	0.000 bp			
Day Count	30I/360	Leverage	1.00000			
Calc Basis	Money Mkt	Latest Index	0.11550			
Reset Freq		Reset Freq	Quarterly			
Pay Freq		Pay Freq	Quarterly			
Day Count		Day Count	ACT/360			
Market						
Leg 1: NPV	10,205,002.34	Leg 2: NPV	-10,105,002.34			
Accrued	0.00	Accrued	0.00			
Premium	102.05	Premium	-101.05			
DV01	5,054.81	DV01	-82.93			
Valuation Results						
Par Cpn	0.872421	Premium	1.00000	PV01	4,944.13	
Principal	100,000.00	BP value	100.00000	DV01	4,971.88	
Accrued	0.00			Gamma (1bp)	2.75	
NPV	100,000.00					

IMPORTANT: The premium on SWPM is always expressed in the 1st Leg's perspective of NPV with respect to paying/receiving. By default, Leg 1 in an IRS on SWPM will be the fixed leg as per convention.

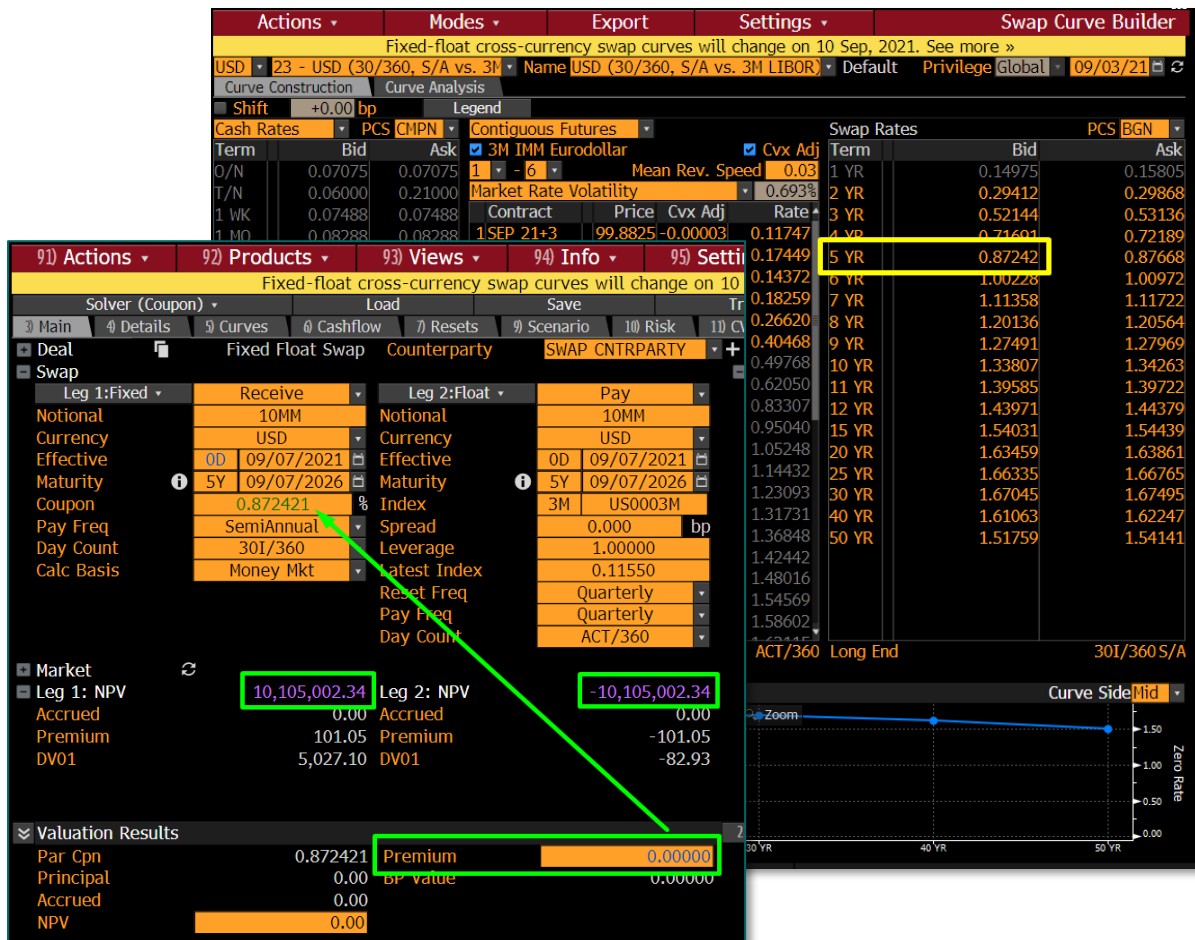
Hence if you are receiving fixed, the premium is the upfront to the PAYER. So, a +1.00 premium in this screenshot means the person receiving the fixed leg has an NPV \$100k higher than the NPV of the counterparty's floating leg. To be fair (i.e., not get a free lunch) – the fixed receiver (i.e., floating payer) should pay the fixed payer \$100k up front. This is to make both parties economically equal at inception.

Let's look at premium another way: There is an existing swap curve which determines the floating rate resets, and there is an SOFR curve to discount cashflows, but neither of them can be negotiated by the trader of a swap – so what can be negotiated? **The trader can only negotiate the fixed coupon or a spread over the floating rate.** For the par swaps curve we assume 0 spread on the floating leg, leaving only the fixed coupon that can change. At 2% fixed, the NPVs of the two legs net out to be 5.57% in favour of the fixed coupon – i.e., the fixed leg NPV is too high vs the floating leg NPV given where swaps are trading.

Deal		Fixed Float Swap	Counterparty	SWAP CNTRPARTY	Ticker / SWAP	Properties
Leg 1:Fixed	Receive	Leg 2:Float	Pay			
Notional	10MM	Notional	10MM			
Currency	USD	Currency	USD			
Effective	0D 09/07/2021	Effective	0D 09/07/2021			
Maturity	5Y 09/07/2026	Maturity	5Y 09/07/2026			
Coupon	2.000000 %	Index	3M US0003M			
Pay Freq	SemiAnnual	Spread	0.000 bp			
Day Count	30I/360	Leverage	1.00000			
Calc Basis	Money Mkt	Latest Index	0.11550			
Reset Freq		Reset Freq	Quarterly			
Pay Freq		Pay Freq	Quarterly			
Day Count		Day Count	ACT/360			
Market						
Leg 1: NPV	10,662,492.37	Leg 2: NPV	-10,105,002.34			
Accrued	0.00	Accrued	0.00			
Premium	106.62	Premium	-101.05			
DV01	5,181.62	DV01	-82.93			
Valuation Results						
Par Cpn	0.872421	Premium	5.57490	PV01	4,944.13	
Principal	557,490.03	BP value	557.49003	DV01	5,098.69	
Accrued	0.00			Gamma (1bp)	2.81	
NPV	557,490.03					



So...WHAT IS THE FIXED COUPON RATE NEEDED IN ORDER FOR THE SWAP PREMIUM TO BE 0?



KEY TAKEAWAY – the swap rate you see quoted on a daily basis is the FIXED coupon rate of the swap required to ensure the premium of a swap is 0 – i.e., the swap is trading at par. That is why the swap curve is called a par swaps curve.

13.6 PnL and Risk of a Swap

Once the swap has been initiated (at par), swap rates no longer stay the same; they move around just like any other market yield. This results in the floating leg NPV of the swap leg changing as the implied forward rates change while the fixed coupon leg cashflows do not change (note that the discount curve changes but because both legs share mutual discounting rates that effect is basically neutralized).

If rates were to rise then the floating leg cashflows would adjust accordingly while the fixed leg cashflows would not, resulting in a loss for the fixed receiver and a gain for the fixed payer. **In other words, the fixed receiver is net long duration and the payer is net short duration.**

91) Actions		92) Products		93) Views		94) Info		95) Settings		Swap Manager	
Solver (Coupon)		Load		Save		Trade		CCP			
Main		Details		Curves		Cashflow		Resets		Scenario	
Path Prog		Shift at Hzn Date		Fwd Evolution		No		Reinvestment Rate		Flat Rate	
Scenario 1		Scenario 2		Scenario 3		Scenario 4					
Market Shifts (SHOC)		IR +50bps		Negative Change		No Change		Positive Change			
Time Shift		3 Mo		12/03/2021		6 Mo		03/03/2022		6 Mo	
Swap Curve		USD,23									
Absolut		+50.00		Absolut		-50.00		Absolut		+0.00	
Term		Shift		Rate		Term		Shift		Rate	
3 MO		+50.00		0.61550		3 MO		-50.00		-0.38450	
EDU1*		+50.00		0.61747		EDU1*		-50.00		-0.38253	
EDZ1*		+50.00		0.67449		EDZ1*		-50.00		-0.32551	
EDH2*		+50.00		0.64372		EDH2*		-50.00		-0.35628	
EDH2*		+50.00		0.64372		EDH2*		+0.00		0.14372	
EDH2*		+50.00		0.64372		EDH2*		+50.00		0.61550	
EDH2*		+50.00		0.64372		EDH2*		+50.00		0.61747	
EDH2*		+50.00		0.64372		EDH2*		+50.00		0.67449	
EDH2*		+50.00		0.64372		EDH2*		+50.00		0.64372	
Calculate										Basic Results	
Basic Results											
DV01		4,589.18		4,593.04		4,477.88		4,366.32			
Gamma (1bp)		2.42		2.34		2.27		2.20			
Accrued		21,810.53		0.00		0.00		0.00			
Principal		-214,681.92		260,681.56		33,924.97		-187,164.09			
Leg 1 PV		9,901,455.45		10,355,440.74		10,124,838.81		9,900,544.75			
Leg 2 PV		-10,094,326.84		-10,094,759.18		-10,090,913.84		-10,087,708.83			
Net PV		-192,871.39		260,681.56		33,924.97		-187,164.09			
Reinvested PV		-2,919.58		37,813.60		37,813.60		37,813.60			
Total PV		-195,790.98		298,495.17		71,738.57		-149,350.48			
View Cashflow				View Cashflow				View Cashflow			

* The future tickers at horizon dates are for display purpose only.

Recall from our coverage of duration on fixed vs floating rate notes that a floater's duration is very low while a fixed bond's is objectively not – this carries over into a swap which is basically a two-asset portfolio of (long/short) floater+fixed.

91) Actions		92) Products		93) Views		94) Info		95) Settings		Swap Manager	
Solver (Premium)		Load		Save		Trade		CCP			
Main		Details		Curves		Cashflow		Resets		Scenario	
Deal		Fixed Float Swap		Counterparty		SWAP CNTRPARTY		+ Ticker / SWAP		20) Properties	
Swap		Leg 1:Fixed		Receive		Leg 2:Float		Pay		Valuation Settings	
Notional		10MM		Notional		10MM		Curve Date		09/03/2021	
Currency		USD		Currency		USD		Valuation		09/07/2021	
Effective		0D		Effective		0D		CSA Coll Ccy		USD	
Maturity		5Y		Maturity		5Y		OIS DC Stripping		<input checked="" type="checkbox"/>	
Coupon		0.872421		Index		3M					
Pay Freq		SemiAnnual		Spread		0.000		bp			
Day Count		30I/360		Leverage		1.00000					
Calc Basis		Money Mkt		Latest Index		0.11550					
Market				Reset Freq		Quarterly					
Leg 1: NPV		10,105,002.33		Leg 2: NPV		-10,105,002.34					
Accrued		0.00		Accrued		0.00					
Premium		101.05		Premium		-101.05					
DV01		5,027.10		DV01		-82.93					
Valuation Results										Remember: Like the Premium, this is in the perspective of the Fixed Receiver	
Par Cpn		0.872421		Premium		0.00000		PV01		4,944.13	
Principal		-0.01		BP Value		-0.00001		DV01		4,944.16	
Accrued		0.00						Gamma (1bp)		2.74	
NPV		-0.01									

13.7 Special Consideration of the risk profile surrounding Fixings.

@shortendtrader brought up a very interesting aspect here, particularly for short-end swaps; for something like a 1-year swap vs 3ML there are effectively 4 fixings where the floating leg is effectively a strip of FRAs. Now LIBOR fixing happens at 11:55am London at which point the swap's cashflows will adjust. This means that at 11am the swap has 100% risk but only 75% of the risk at 11:55am. Such simple intuition but blew my mind.

13.8 Final Points and Ancillary Notes

This wraps up the very basic nature of how a vanilla interest rate swap works but the principals will translate over in any other swap that you encounter and that we cover in the next part. Remember the three principals for structuring a swap and the 6 basic parts of a swap to take note of.

Before we end this part however, I want to cover some changes and developments that have taken place in the swaps market over the years that have resulted in some added intricacies to swap construction and valuation.

The ISDA Master Agreement

As swaps are OTC derivatives, they are essentially a private agreement between two parties. The agreement that covers this agreement is governed by what is known as an ISDA Master Agreement that includes some standardized elements of a swaps trade, including counterparty default scenarios. Not everyone can get an ISDA which means not everyone can trade swaps bilaterally (between two parties)

Central Clearing Houses and Swap Execution Facilities

The Dodd-Frank Act mandated that all eligible swaps (which was a lot) have to be centrally cleared by a clearing house, thus shifting the counterparty credit risk over from a bilateral OTC world (with optional initial margins) to a cleared world where margins are mandatory.

The largest swaps clearing house is London Clearing House (LCH) which handles the majority of the world's cleared vanilla IRS. How it works is you enter a bilateral swap with someone under your ISDA Master Agreement, then you send the swap trade to LCH and once they accept it...

...the original swap gets replaced by two swaps with LCH sitting in the middle and conducting the swap between both parties.

The other part of Dodd-Frank's impact on swaps was the requirement for eligible swaps to be executed on a Swaps Execution Facility (SEF). A SEF is an electronic platform where you can buy/sell swaps with other market participants much like a formal exchange but for swaps.

The curious case of Dual Curve Stripping:

Once it became clear that interbank risk was and could be significant in the aftermath of the GFC, discounting using LIBOR curves was no longer appropriate. Post-GFC the market demanded collateral for swap transactions, which is covered under a Credit Support Annexes within an ISDA Master Agreement. CSAs were valued using OIS, which as I mentioned in Topic 2, is closer to risk-free. Furthermore, after Dodd-Frank the amount of swaps that had to be cleared increased dramatically and thus, the amount of mandatory margins increased dramatically.

Once the market shifted to collateralized swap transactions, the need to move away from self-discounting was evident ([See: STIRs and Risk Topic](#)). This introduced the concept of dual-curve stripping. Using the swap curve (which is a 'risky' curve) we can imply its forward cashflows but then to value the swap we have to discount using a different and **risk-free** curve. This is a core aspect of swap valuations.

The key takeaway here is that self-discounting vs dual-curve discounting is a matter of uncollateralized vs collateralized swaps.

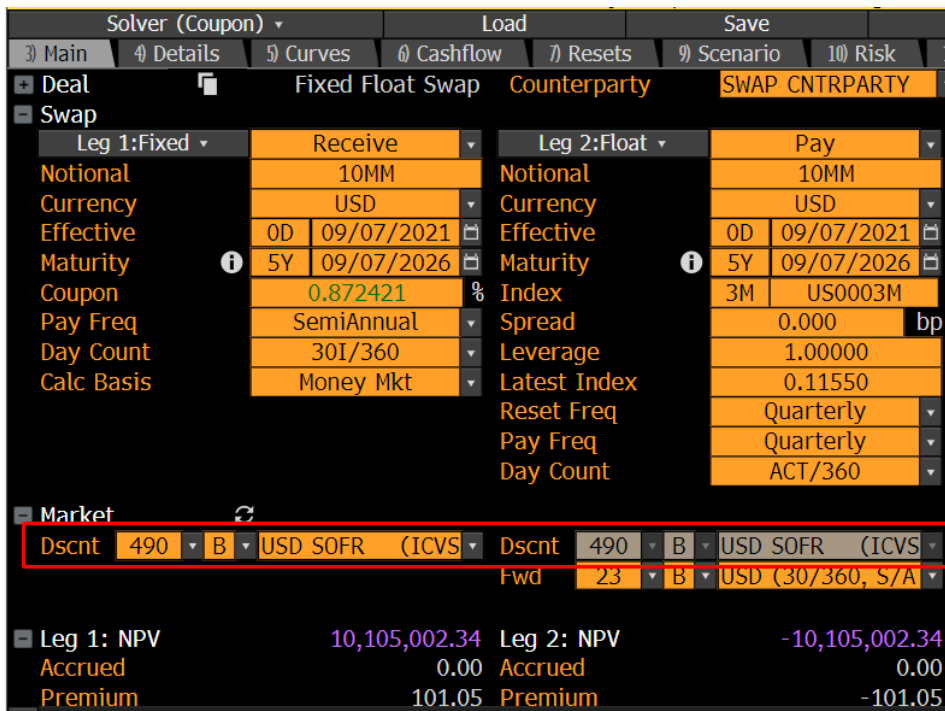
The King is Dead, Long Live the King

But wait, there's more! You see Fed Funds is an unsecured overnight rate whereas LIBOR's successor SOFR is a Secured Overnight Financing Rate.

You all know about LIBOR's demise and come December 2021 LIBOR will be no more with SOFR taking its place. This leaves quite a headache for the market and this poor idiot who decided to write a topic on swaps with decade-old information in his head! In October 2020, London Clearing House (LCH) shifted over from Fed Funds (OIS) to SOFR discounting, marking a transition for the swaps market from OIS (EFFR) to SOFR discounting.

<https://www.lch.com/resources/news/lch-successfully-completes-transition-sofr-discounting>

This is why now on **SWPM<GO>** you will notice the discount curve is the Curve 490 – SOFR, which previously defaulted to curve 42 – OIS curve as late as last year (2020).



Deal		Fixed Float Swap		Counterparty		SWAP CNTRPARTY	
Leg 1:Fixed	Receive	Leg 2:Float	Pay				
Notional	10MM	Notional	10MM				
Currency	USD	Currency	USD				
Effective	0D 09/07/2021	Effective	0D 09/07/2021				
Maturity	5Y 09/07/2026	Maturity	5Y 09/07/2026				
Coupon	0.872421 %	Index	3M US0003M				
Pay Freq	SemiAnnual	Spread	0.000 bp				
Day Count	30I/360	Leverage	1.00000				
Calc Basis	Money Mkt	Latest Index	0.11550				
		Reset Freq	Quarterly				
		Pay Freq	Quarterly				
		Day Count	ACT/360				
Market							
Dscnt	490	B	USD SOFR (ICVS)	Dscnt	490	B	USD SOFR (ICVS)
				Fwd	23	B	USD (30/360, S/A)
Leg 1: NPV	10,105,002.34	Leg 2: NPV	-10,105,002.34				
Accrued	0.00	Accrued	0.00				
Premium	101.05	Premium	-101.05				

Brief Introduction to XVAs – contribution by Rishi Mishra (@aRishisays)

I'm paraphrasing here so I hope I don't butcher Rishi's work. As mentioned before, the GFC brought to light the issues with assuming interbank credit risk was nil, which Rishi beautifully terms as the industry shifting from "money at any risk" to "money with manageable risk".

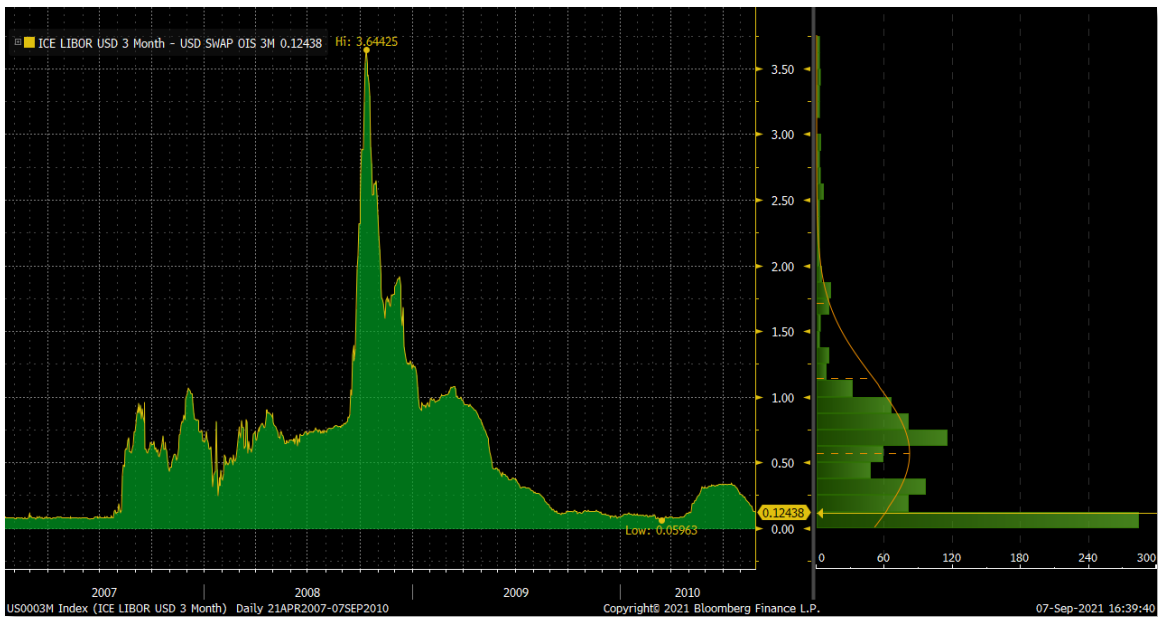
The market then moved to make adjustments to ascertain the true cost of doing business in swaps by accounting for counterparty default, funding of position, margin, etc. This adjustment became known as Cross-Valuation Adjustments of XVA.

1. Credit Valuation Adjustment, which the CSA that is in the ISDA Master Agreement tries to address by defining and recording the collateral offered by the swap counterparties. A counterparty can default, meaning the payoff will not be realized. This risk is incorporated into the valuation by augmenting the payoff to take account of default. For instance, one can hedge for default risk via Credit Default Swaps, locking in the cost. Thus, we get Credit Valuation Adjustment (or CVA).
2. Clear recognition of the vulnerability of banks during the crisis means their default risk is also to be taken into account. Hence, we get Debt Valuation Adjustment (or DVA).



- Since derivatives pricing is about estimating the cost of setting up a replica portfolio, the cost of funding should be an essential part of the price. As mentioned already, GFC proved interbank credit risk real and significant which led to short-term funding drying up completely.

As a result, funding spreads for banks (like Libor-OIS), which had always been an afterthought, widened ~350bps. This is when FVA became a widely accepted part of the business. FVA, or Funding Value Adjustment is basically about incorporating the cost at which the bank can fund collateral, when necessary, as a spread over the risk-free rate, since it would be compensated for the collateral at that rate.



- The GFC led to regulators requiring more derivatives to be cleared on exchanges or for the positions that are not exchange cleared, to post initial margin to an independent third party, both leading to Margin Valuation Adjustment (or MVA).
- Regulatory efforts since '08 to reduce interbank credit risk in times of stress come in the form of tweaks to risk-weighted assets (RWA) & higher cap requirements as a % of RWA.

KVA or Capital Value Adjustment is essentially the cost of raising money from shareholders whereas FVA is the cost of raising money from lenders.

All of this has had a drastic impact on the derivatives business, leading to either innovation like the advent of mark-to-market cross-currency swaps, or a decline in business for other derivatives. While you could theoretically hedge CVA via CDS, the reality is that CDS is not always readily tradable on the counterpart at hand. Unhedged, CVA risk is warehoused on the balance sheet, and a part of the profit is set aside to account for realized losses from counterparty default. The same for other XVA components as well, which is why most banks have an XVA desk set up to either manage/hedge or calc adjustments in derivative valuations for these risks.

Here is Rishi's full note without my bastardisation of it: <https://www.docdroid.net/5tR1LUv/how-the-great-financial-crisis-of-2008-changed-the-derivatives-business-forever-pdf>

That's it for the vanilla IRS, hopefully as understandable as possible. In the following part we will use the basic principles we covered here and delve into the basics of other commonly mentioned swaps such as ASW, TRS and XCCY.



Topic Question Today is September 10th, 2021. I want to value a par swap (\$1MM notional) that started on Sep 3rd when 3ML was 0.1155 and the fixed coupon was 0.887147%. Rates have not moved at all across the curve. Is the premium still 0? Is the NPV of the swap still 0? Assume ACT/360 daycounts for both legs. I don't need numbers, just intuition.

No, the premium is not zero but yes, the NPV of the swap is zero. If the curve has not changed at all then the valuation of each leg should still be the same (the forward term structure remains unchanged on the floating leg) so the NPV of each leg should still be the same. The reason why the premium isn't 0 though is because over the 7 days (Sep 3rd to Sep 10th) each leg has accrued a different amount of accrued interest for the first coupon (the fixed at 0.887% p.a. and the floating leg at 0.115% p.a.). This means that to exit the swap on the 10th you would have to pay/receive the net accrued interest.



14. Exploring Other Swap Types



Here we will take a brief look at a few other swap types that have been mentioned in this series so far, as well as some swap types you might read about in news/fintwit.

Again, we will not go too deep into each of them but more so focus on building the **right intuition** behind each of them – reasoning trumps rote.

14.1 OIS

Let's begin with the very first swap ever mentioned in this series – the Overnight Indexed Swap (OIS). As I mentioned in Part 1 – a USD OIS is typically referencing Fed Funds Effective Rate (EFFR). Here is what a 6-month USD OIS looks like:



The screenshot shows a Swap Manager interface for an OIS Swap. The main table displays the swap details for Leg 1 (Fixed) and Leg 2 (Float). The valuation results table is also visible at the bottom.

Deal	OIS Swap		Counterparty	SWAP CNTRPARTY	Ticker / SWAP	Properties
Swap	OIS Swap		OIS Swap	OIS Swap		Valuation Settings
Leg 1: Fixed	Receive	Leg 2: Float	Pay			Curve Date: 09/07/2021
Notional	10MM	Notional	10MM			Valuation: 09/09/2021
Currency	USD	Currency	USD			CSA Coll Ccy: USD
Effective	0D 09/09/2021	Effective	0D 09/09/2021			<input checked="" type="checkbox"/> OIS DC Stripping
Maturity	6M 03/09/2022	Maturity	6M 03/09/2022			
Coupon	0.073729 %	Index	1D FEDL01			
Pay Freq	Annual	Spread	0.000 bp			
Day Count	ACT/360	Leverage	1.00000			
Calc Basis	Money Mkt	Latest Index	0.08000			
		Reset Freq	Daily			
		Pay Freq	Annual			
		Day Count	ACT/360			
Market						
Leg 1: NPV	3,705.95	Leg 2: NPV	-3,705.95			
Accrued	0.00	Accrued	0.00			
Premium	0.04	Premium	-0.04			
DV01	0.19	DV01	502.46			
Valuation Results				Calculators		
Par Cpn	0.073729	Premium	0.00000	PV01	502.65	
Principal	0.00	BP Value	0.00000	DV01	502.65	
Accrued	0.00	Average Coupon	0.07373	Gamma (1bp)	0.05	
NPV	0.00					

Notice **the same 6 parts of a swap** we looked at in the [introduction to IRS](#):

- fixed/float legs
- DC stripping
- NPVs and premium.

No different than a vanilla 3ML IRS. The differences here are; first the index is based on EFFR which resets every day and secondly the payout frequency.

The “overnight” in OIS comes from the reference rate, not the term of the swap. In this example the swap maturity is 6M with an annual (i.e., 1 time) payout. Hence, any overnight rate can be used in OIS – EONIA (Europe), SONIA (UK) and going forward SOFR, ESTR and TONAR(Japan).

Notice that resets are daily (overnight) yet the cashflow payout is 1 single time with no exchange of principal.

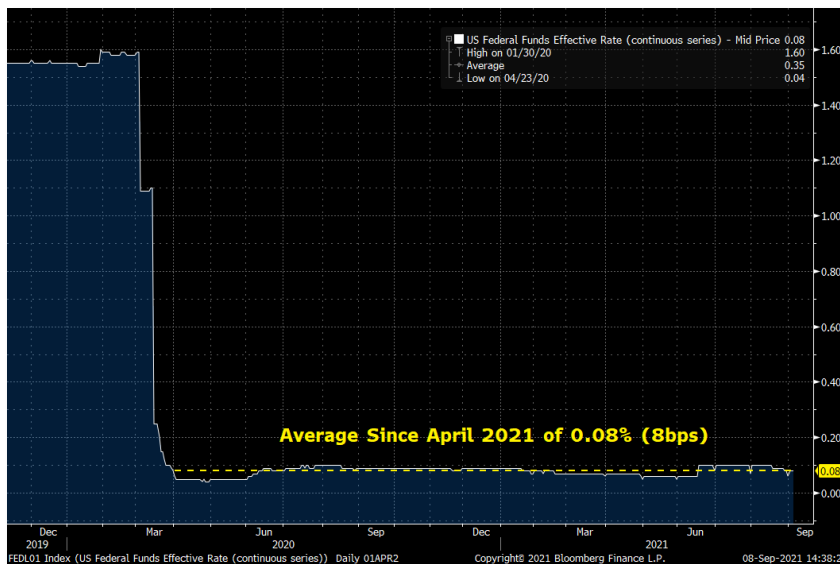


The screenshot shows two windows from a financial modeling application. The left window displays a 'Cashflow Table' with the following data:

Pay Date	Payments(Rcv)	Payments(Pay)	Net Payments	Discount	PV
03/11/2022	3,706.92	-3,706.92	0.00	0.999739	0.00

The right window shows a 'Resets' table for 'FEDL01' with the following data:

Reset Date	Reset Rate
09/09/2021	0.08000
09/10/2021	0.07467
09/13/2021	0.06934
09/14/2021	0.06667
09/15/2021	0.06401
09/16/2021	0.06134
09/17/2021	0.05601
09/20/2021	0.10059
09/21/2021	0.10624
09/22/2021	0.11189
09/23/2021	0.11755
09/24/2021	0.12885
09/27/2021	-0.00664
09/28/2021	-0.01644
09/29/2021	-0.02624



Assuming the Fed never hikes, there is little reason to imagine EFR rising much above its average since rates hit the floor. If for example, EFR stayed at 0.08% for 6 months, an investment rolled overnight for that term would return = $[1.0008^{(181/360)}] - 1 = 0.040214\%$

The fixed coupon just has to be the equivalent annualized coupon that returns the same at maturity (NPV will equal because discount curve is the

same and there's only 1 cashflow).

If we apply our concept of swap risk from earlier, we can imagine that PnL on the swap will change if the EFR does not stay at 0.08%. Thus, OIS is one way for a trader to bet on fed policy direction. Now, remember in TIPS we looked at market-based expectations through forward inflation swaps – the same can and is done here! You can trade forward starting OIS swaps such as a 1-month OIS swap starting in 1 year to bet on where OIS will be 1 year from now.

14.2 Asset Swaps

We introduced ASW back in the [Topic 8 on Credit Risk](#) but with our newfound appreciation for IRS hopefully this makes more sense. First of all, the name implies you are swapping an asset for another cashflow. Let's assume you're a bank and a client sells 1MM of a 7y AAPL 1.4 28 bond to you. You now have this bond on your books and let's assume you're magically able to hold it in inventory (lololol).

AAPL 1.4 08/05/28 \$ 199.497 +.114 99.295 / 99.697 1.508 / 1.446	
At 15:14 --x-- Source BGN	
AAPL 1.4 08/05/28 Corp Actions Settings Page 1/12 Security Description: Bond	
94 No Notes 95 Buy 96 Sell	
25 Bond Description	26 Issuer Description
Pages 11 Bond Info 12 Addtl Info 13 Reg/Tax 14 Covenants 15 Guarantors 16 Bond Ratings 17 Identifiers 18 Exchanges 19 Inv Parties 20 Fees, Restrict 21 Schedules 22 Coupons Quick Links 32 ALLQ Pricing 33 QRD Qt Recap 34 TDH Trade Hist 35 CACS Corp Action 36 CF Prospectus 37 CN Sec News 38 HDS Holders 60 Send Bond	Issuer Information Name APPLE INC Industry Technology (BCLASS) Security Information Mkt Iss GLOBAL Ctry/Reg US Currency USD Rank Sr Unsecured Series Coupon 1.400000 Type Fixed Cpn Freq S/A Day Cnt 30/360 Iss Price 99.77400 Maturity 08/05/2028 MAKE WHOLE @10.000000 until 06/05/28/ CALL ... Iss Sprd +40.00bp vs T 1 ¼ 06/30/28 Calc Type (1)STREET CONVENTION Pricing Date 07/29/2021 Interest Accrual Date 08/05/2021 1st Settle Date 08/05/2021 1st Coupon Date 02/05/2022
	Identifiers FIGI BBG011ZS1T38 CUSIP 037833EH9 ISIN US037833EH93 Bond Ratings Moody's Aa1 S&P AA+ Composite AA+ Issuance & Trading Amt Issued/Outstanding USD 2,300,000.00 (M) / USD 2,300,000.00 (M) Min Piece/Increment 2,000.00/ 1,000.00 Par Amount 1,000.00 Book Runner JOINT LEADS Reporting TRACE

As a bank, you want floating cashflows not fixed ones so you swap it – **what is the fair value to swap it?** Well, let's build a swap from scratch.

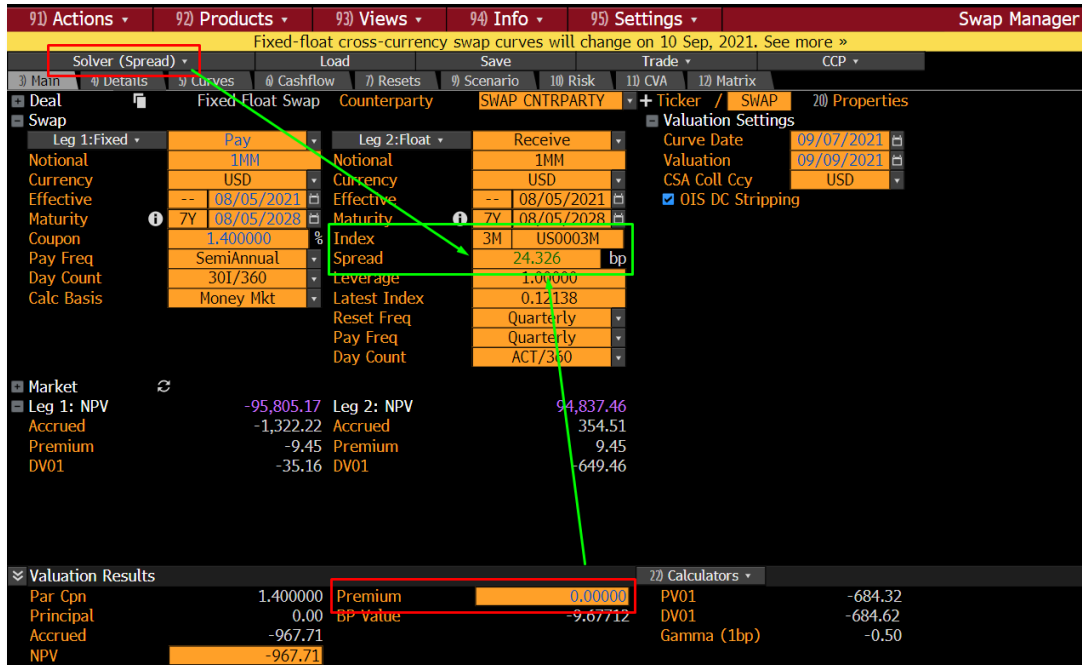
- Today is 9/7/21, settlement is T+2
- Bond pays a 1.4% coupon, S/A, 30/360
- Accrual date starting on 08/05/21
- Matures on 08/05/28

Plug that into a **plain vanilla IRS on SWPM**:

91 Actions		92 Products		93 Views		94 Info		95 Settings		Swap Manager	
Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »											
Solver (Premium) Load Save Trade CCP											
3 Main 4 Details 5 Curves 6 Cashflow 7 Resets 9 Scenario 10 Risk 11 CVA 12 Matrix											
Deal Fixed Float Swap Counterparty SWAP CNTRPARTY Ticker / SWAP 20 Properties											
Leg 1:Fixed Pay Leg 2:Float Receive Notional #3 1MM Notional 1MM Currency #3 USD Currency USD Effective #4 08/05/2021 Effective 08/05/2021 Maturity #2 7Y 08/05/2028 Maturity 7Y 08/05/2028 Coupon #2 1.400000 % Index 3M US0003M Pay Freq COUPON SemiAnnual Spread 0.000 bp Day Count 30I/360 Leverage 1.00000 Calc Basis Money Mkt Latest Index 0.12138 Reset Freq Quarterly Pay Freq Quarterly Day Count ACT/360											
Valuation Settings Curve Date 09/07/2021 #1 -TODAY Valuation 09/09/2021 #2 -SETTLEMENT CSA Coll Ccy USD <input checked="" type="checkbox"/> OIS DC Stripping											
Market Leg 1: NPV -95,805.17 Leg 2: NPV 77,926.39 Accrued -1,322.22 Accrued 118.01 Premium -9.45 Premium 7.78 DV01 -35.16 DV01 -655.45											
Valuation Results Par Cpn 1.152925 Premium -1.66746 PV01 -684.32 Principal -16,674.56 BP Value -178.78779 DV01 -690.61 Accrued -1,204.21 Gamma (1bp) -0.51 NPV -17,878.78											

Notice the premium is -1.66746 while you are paying fixed. **This means that you are overpaying at a 1.4% coupon** versus what the 3M LIBOR curve implies you will receive in floating cashflows, resulting in a negative NPV for you. Remember, swaps are about equivalence!

Now you're swapping a bond's coupon so you can't change the 1.4%. You also can't change what the 3M LIBOR curve is trading at either. So, what can you change to achieve value equivalence? The spread on the floating leg.



Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »

Solver (Spread)

Valuation Settings

Curve Date 09/07/2021

Valuation 09/09/2021

CSA Coll Ccy USD

☑ OIS DC Stripping

Leg 1: Fixed	Pay	Leg 2: Float	Receive
Notional	1MM	Notional	1MM
Currency	USD	Currency	USD
Effective	-- 08/05/2021	Effective	-- 08/05/2021
Maturity	7Y 08/05/2028	Maturity	7Y 08/05/2028
Coupon	1.400000	Index	3M US0003M
Pay Freq	SemiAnnual	Spread	24.326 bp
Day Count	301/360	Leverage	1.00000
Calc Basis	Money Mkt	Latest Index	0.12138
		Reset Freq	Quarterly
		Pay Freq	Quarterly
		Day Count	ACT/360

Market	Leg 1: NPV	Leg 2: NPV
Accrued	-95,805.17	94,837.46
Premium	-1,322.22	354.51
DV01	-9.45	9.45
	-35.16	649.46

Valuation Results		Calculators	
Par Cpn	1.400000	Premium	0.00000
Principal	0.00	BP Value	-9.67712
Accrued	-967.71	PV01	-684.32
NPV	-967.71	DV01	-684.62
		Gamma (1bp)	-0.50

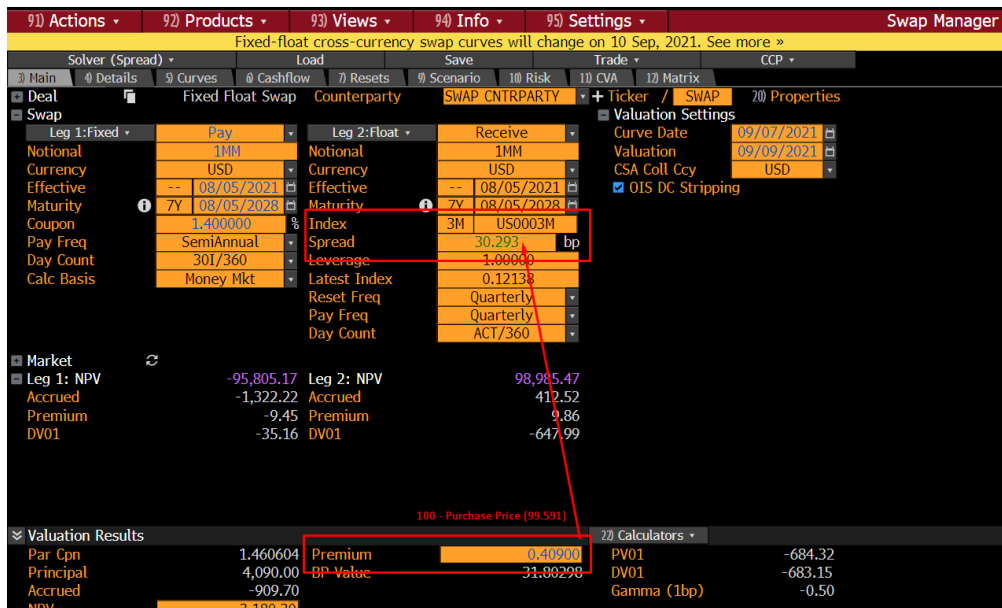
So, at a premium of 0, the spread over LIBOR should be 24.326bps. Are we good here? No.

Why? Because if you think about it, we're basically pricing a par swap (premium = 0). But in an asset swap I am swapping the cashflows from a bond I bought in the market. Did I buy this AAPL bond at 100? In this case...no. And very often you're going to buying a bond as a premium or discount to par.

Let's say on 09/07 we bought it at 99.591, meanwhile I swap out the cashflows into a par swap (value of 100) – which means I'm buying cheaper and selling for a PREMIUM. Remember how swaps are about value equivalence? So, the premium in this case is $100 - 99.591 = 0.409$ in my favour.

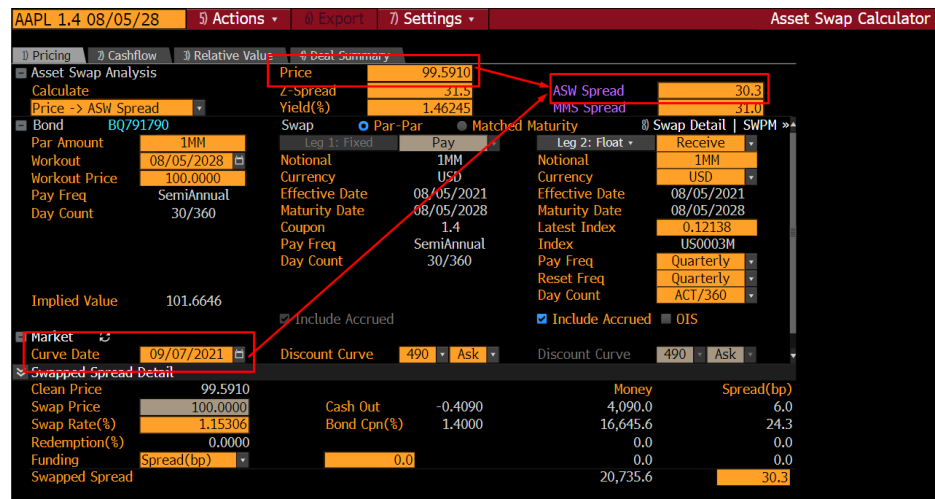
AAPL 1.4 08/05/28		\$ 99.511		+.128		99.309 / 99.713		1.506 / 1.444	
At 16:08						-- X --		Source BGN	
Range	08/02/2021 - 09/08/2021	Period	Daily	High	100.447 on	Page 1/1 Historical Price Table			
Market	Last Price	Ask Px	Currency	Low	99.220 on	08/12/21			
View	Price Table	Source	BGN	Average	99.670	99.860			
				Net Chg	-.884	-0.88%			
Date	Last Price	Ask Px	Date	Last Price	Ask Px	Date	Last Price	Ask Px	
Fr 09/10/21			Fr 08/20/21	99.562	99.761				
Th 09/09/21			Th 08/19/21	99.661	99.852				
We 09/08/21	99.495	99.695	We 08/18/21	99.687	99.868				
Tu 09/07/21	99.383	99.591	Tu 08/17/21	99.702	99.905				
Mo 09/06/21			Mo 08/16/21	99.772	99.969				
Fr 09/03/21	99.679	99.870	Fr 08/13/21	99.673	99.866				
Th 09/02/21	99.831	100.033	Th 08/12/21	99.220	99.410				
We 09/01/21	99.791	100.000	We 08/11/21	99.296	99.496				
Tu 08/31/21	99.762	99.989	Tu 08/10/21	99.227	99.433				
Mo 08/30/21	99.907	100.125	Mo 08/09/21	99.374	99.585				
Fr 08/27/21	99.605	99.813	Fr 08/06/21	99.594	99.777				
Th 08/26/21	99.280	99.477	Th 08/05/21	99.995	100.141				
We 08/25/21	99.310	99.497	We 08/04/21	100.266	100.406				
Tu 08/24/21	99.510	99.702	Tu 08/03/21	100.447	100.595				
Mo 08/23/21	99.691	99.899	Mo 08/02/21	100.379	100.473				

If I take the 0.409 premium and plug it into the SWPM calculator (remember I am paying fixed but owe the premium to my counterparty to make it fair) this is what it calculates the spread on floating leg to be: 30.293



The screenshot shows the Swap Manager interface. The main window displays swap details for a Fixed Float Swap. The floating leg (Leg 2) is set to Receive, with a notional of 1MM USD, an effective date of 08/05/2021, and a maturity of 7Y 08/05/2028. The spread is calculated as 30.293 bp. The valuation results at the bottom show a premium of 0.40900 and a BP Value of 31.80298.

With the bond loaded, you can run **ASW<GO>** to see the spread calculation. Given the same valuation date ASW returns 30.3bps which is **very close but not the same** as what we manually built in SWPM. Why?



The screenshot shows the Asset Swap Calculator interface. The ASW spread is calculated as 30.3 bps. The interface includes fields for Bond (BQ791790), Swap (Par-Par), and various parameters like Price (99.5910), Yield (1.46245%), and Implied Value (101.6646). The Swapped Spread Detail table at the bottom shows a swapped spread of 30.3 bps.

The reason is simple – cashflow dates.

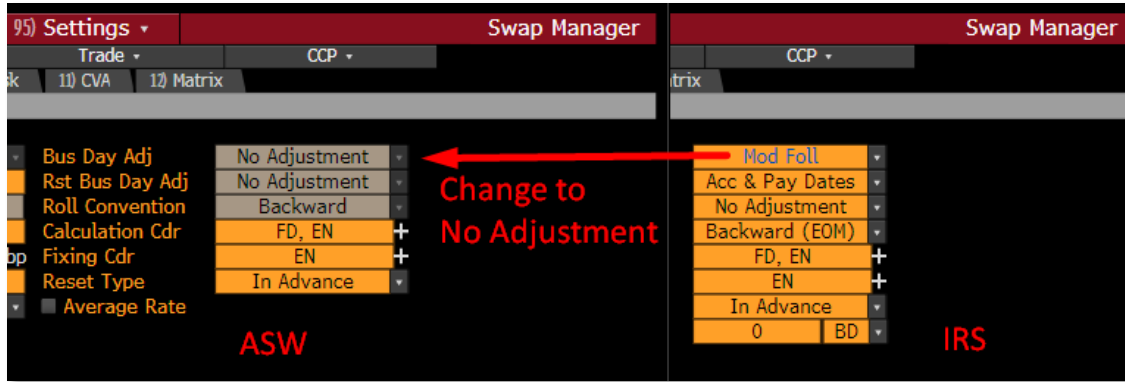
SWPM by default will assume swap convention dates and adjustments whereas ASW must follow the bond's cashflow schedule. The same on the float leg which on swap conventions modifies for biz dates. Once you adjust cashflows – ASW will match.

Swap Cashflow Dates

Accrual Start	Accrual End	Pay Dates
08/05/2021	02/05/2022	02/05/2022
02/05/2022	08/05/2022	08/05/2022
08/05/2022	02/05/2023	02/05/2023
02/05/2023	08/05/2023	08/05/2023
08/05/2023	02/05/2024	02/05/2024
02/05/2024	08/05/2024	08/05/2024
08/05/2024	02/05/2025	02/05/2025
02/05/2025	08/05/2025	08/05/2025
08/05/2025	02/05/2026	02/05/2026
02/05/2026	08/05/2026	08/05/2026
08/05/2026	02/05/2027	02/05/2027
02/05/2027	08/05/2027	08/05/2027
08/05/2027	02/05/2028	02/05/2028
02/05/2028	08/05/2028	08/05/2028

Bond Cashflow Dates

Accrual Start	Accrual End	Pay Dates
08/05/2021	02/07/2022	02/07/2022
02/07/2022	08/05/2022	08/05/2022
08/05/2022	02/06/2023	02/06/2023
02/06/2023	08/07/2023	08/07/2023
08/07/2023	02/05/2024	02/05/2024
02/05/2024	08/05/2024	08/05/2024
08/05/2024	02/05/2025	02/05/2025
02/05/2025	08/05/2025	08/05/2025
08/05/2025	02/05/2026	02/05/2026
02/05/2026	08/05/2026	08/05/2026
08/05/2026	02/05/2027	02/05/2027
02/05/2027	08/05/2027	08/05/2027
08/05/2027	02/07/2028	02/07/2028
02/07/2028	08/07/2028	08/07/2028



95) Settings ▾ Swap Manager

Trade ▾ CCP ▾

1) CVA 1) Matrix

Bus Day Adj: No Adjustment

Rst Bus Day Adj: No Adjustment

Roll Convention: Backward

Calculation Cdr: FD, EN +

Fixing Cdr: EN +

Reset Type: In Advance

Average Rate

ASW

Change to No Adjustment

Swap Manager

CCP ▾

Mod Foll

Acc & Pay Dates

No Adjustment

Backward (EOM)

FD, EN +

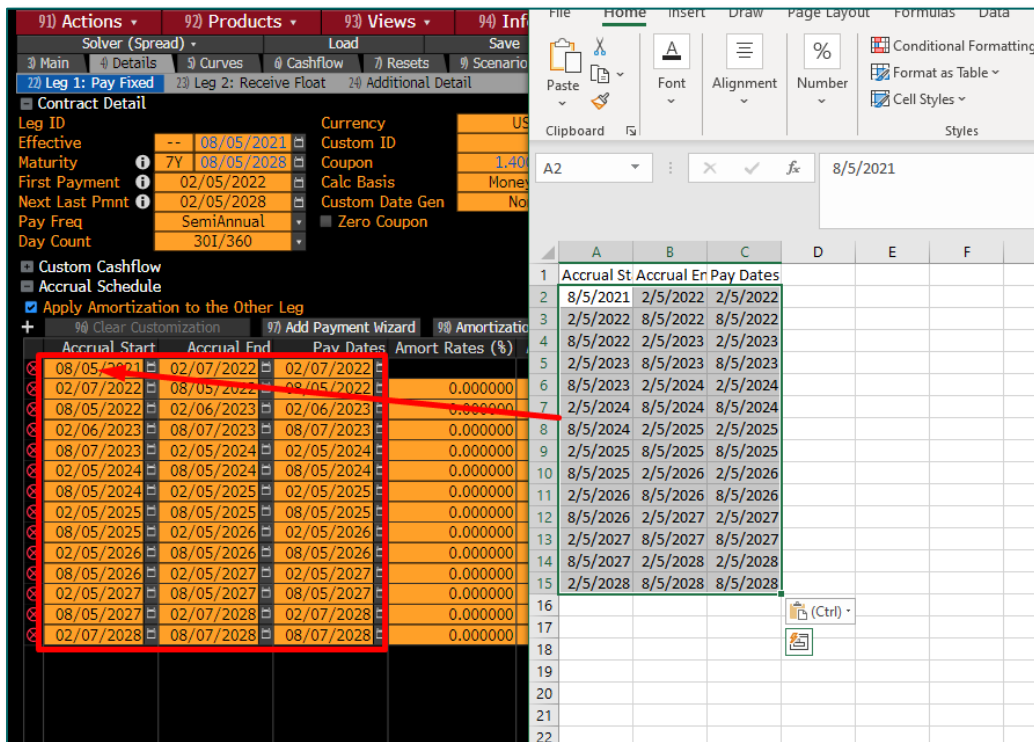
EN +

In Advance

0 BD

IRS

Tip: to quickly adjust – drag with your mouse until a dotted white box appears on Bloomberg, anything inside is copied to the clipboard. Use this to copy the Bond's cashflow dates then paste into Excel. Then drag the highlighted dataset from Excel into the first box of SWPM to paste the bond's cashflow dates. Now your dates should match.



91) Actions ▾ 92) Products ▾ 93) Views ▾ 94) Inf

Solver (Spread) ▾ Load Save

Main ▾ Details ▾ Curves ▾ Cashflow ▾ Resets ▾ Scenario

2) Leg 1: Pay Fixed 2) Leg 2: Receive Float 2) Additional Detail

Contract Detail

Leg ID: -- 08/05/2021 Currency: US

Effective: 7Y 08/05/2028 Custom ID

Maturity: 02/05/2022 Coupon: 1.40

First Payment: 02/05/2022 Calc Basis: Money

Next Last Pmnt: 02/05/2028 Custom Date Gen: No

Pay Freq: SemiAnnual Zero Coupon

Day Count: 301/360

Custom Cashflow

Accrual Schedule

Apply Amortization to the Other Leg

Clear Customization Add Payment Wizard Amortization

Accrual Start	Accrual End	Pay Dates	Amort Rates (%)
08/05/2021	02/07/2022	02/07/2022	
02/07/2022	08/05/2022	08/05/2022	0.000000
08/05/2022	02/06/2023	02/06/2023	0.000000
02/06/2023	08/07/2023	08/07/2023	0.000000
08/07/2023	02/05/2024	02/05/2024	0.000000
02/05/2024	08/05/2024	08/05/2024	0.000000
08/05/2024	02/05/2025	02/05/2025	0.000000
02/05/2025	08/05/2025	08/05/2025	0.000000
08/05/2025	02/05/2026	02/05/2026	0.000000
02/05/2026	08/05/2026	08/05/2026	0.000000
08/05/2026	02/05/2027	02/05/2027	0.000000
02/05/2027	08/05/2027	08/05/2027	0.000000
08/05/2027	02/07/2028	02/07/2028	0.000000
02/07/2028	08/07/2028	08/07/2028	0.000000

File Home Insert Draw Page Layout Formulas Data

Paste Font Alignment Number Conditional Formatting

Clipboard Styles

A2 8/5/2021

Accrual St	Accrual En	Pay Dates
8/5/2021	2/5/2022	2/5/2022
2/5/2022	8/5/2022	8/5/2022
8/5/2022	2/5/2023	2/5/2023
2/5/2023	8/5/2023	8/5/2023
8/5/2023	2/5/2024	2/5/2024
2/5/2024	8/5/2024	8/5/2024
8/5/2024	2/5/2025	2/5/2025
2/5/2025	8/5/2025	8/5/2025
8/5/2025	2/5/2026	2/5/2026
2/5/2026	8/5/2026	8/5/2026
8/5/2026	2/5/2027	2/5/2027
2/5/2027	8/5/2027	8/5/2027
8/5/2027	2/5/2028	2/5/2028
2/5/2028	8/5/2028	8/5/2028



Once you have done this you can go back to the main tab of the swap pricer and you will see that the Spread on the floating leg should match the spread that is automatically calculated by the ASW. Tadah!

The top screenshot shows a swap pricer interface with the following parameters:

- Deal: Customized Swap
- Counterparty: IRS CTRTPARTY
- Leg 1: Fixed (Pay) - Notional: 1MM, Currency: USD, Effective: 08/05/2021, Maturity: 7Y 08/05/2028, Coupon: 1.400000%, Pay Freq: SemiAnnual, Day Count: 30/360, Calc Basis: Money Mkt
- Leg 2: Float (Receive) - Notional: 1MM, Currency: USD, Effective: 08/05/2021, Maturity: 7Y 08/05/2028, Index: 3M US0003M
- Spread: 30.330 bp
- Market: Dscnt 490 A USD SOFR (ICVS), Fwd 23 A USD (30/360, S/A)

The bottom screenshot shows the same swap pricer interface with the following parameters:

- Deal: Customized Swap
- Counterparty: SWAP CTRTPARTY
- Leg 1: Fixed (Pay) - Notional: 1MM, Currency: USD, Effective: 08/05/2021, Maturity: 7Y 08/05/2028, Coupon: 1.400000%, Pay Freq: SemiAnnual, Day Count: 30/360, Calc Basis: Money Mkt
- Leg 2: Float (Receive) - Notional: 1MM, Currency: USD, Effective: 08/05/2021, Maturity: 7Y 08/05/2028, Index: 3M US0003M
- Spread: 30.330 bp
- Market: Dscnt 490 A USD SOFR (ICVS), Fwd 23 A USD (30/360, S/A)

Valuation Results (from the bottom screenshot):

Category	Value	Category	Value
Leg 1: NPV	-95,732.75	Leg 2: NPV	98,913.42
Accrued	-1,322.22	Accrued	412.89
Premium	-9.44	Premium	9.85
DV01	-35.10	DV01	-647.52
Par Cpn	1.460650	Premium	0.409000
Principal	4,090.00	BP Value	31.80663
Accrued	-909.34	PV01	-683.81
NPV	3,180.66	DV01	-682.62
		Gamma (1bp)	-0.50

Note that this is what is termed a Par-Par Asset Swap, where the bond's premium is factored in as a result of pricing the fixed leg at par. This is the most common form however you can also swap at market value rather than par, in which case the spread will change.

What does ASW mean?

Think of ASW as a Bond + IRS. You buy a bond for 99.591 and then proceed to swap its cashflows. The credit risk of the bond is captured in its cashflows, which you are swapping at par.

After compensating for the bond premium/discount, that credit risk must now be captured in the floating leg to achieve equivalence in the swap. This is why ASW is looked at as a measure of a bond's credit risk over the swaps curve.

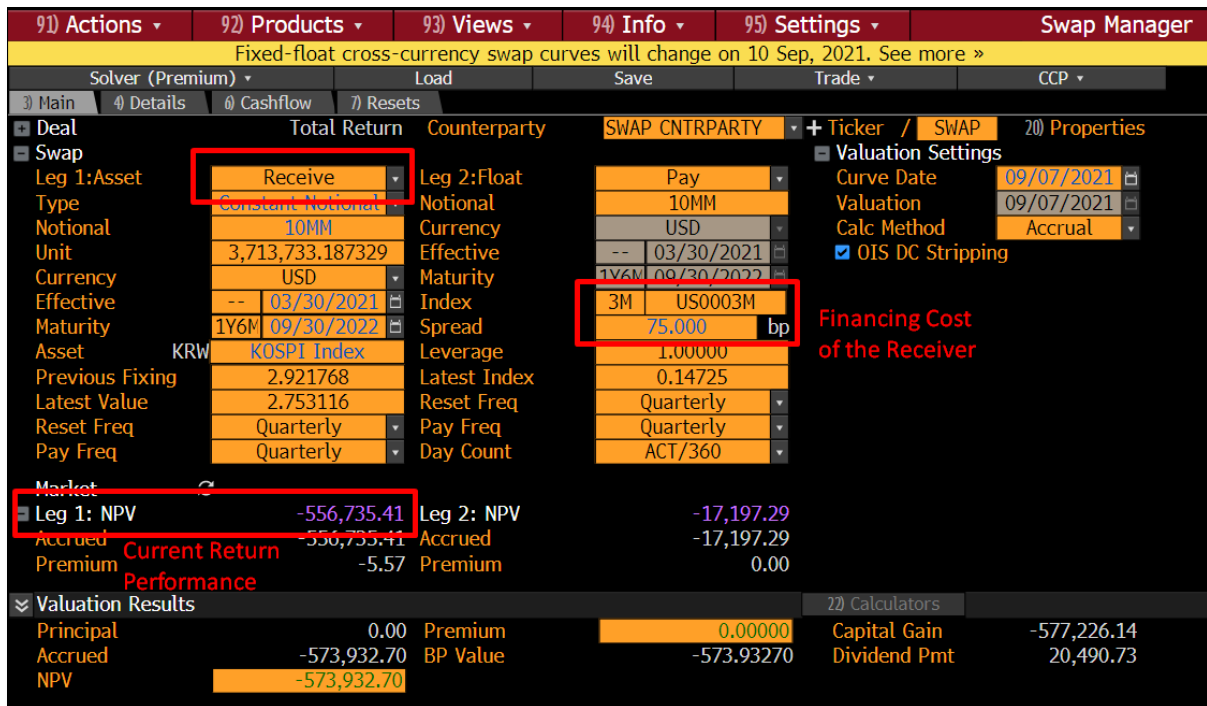
14.3 Total Return Swaps

Total return swaps are simply a way to gain exposure to the total return performance of an asset in exchange (swapping) for typically a floating rate cashflow.

For example, if my financing cost is typically LIBOR+75bps then to borrow 1MM from my broker to purchase equities while 3M LIBOR is 0.11575%, I would have to pay $(0.86575\% / 4) * 1MM = \$2,164$ in margin financing a quarter.

The benefit of TRS is that like most swaps, you do not have to exchange notionals nor actually own the underlying asset. Years ago, when I was on a prime brokerage desk as an intern one fairly large client was doing TRS on KOSPI.

Why? Because to invest directly in Korea you need to open a local account and register with local regulators/authorities. TRS instead allows for synthetic exposure to an asset. With TRS you are able to utilize your counterparty's balance sheet by effectively leasing the asset and paying a borrowing fee for it. This allows for significant leveraged exposure to an asset's performance – the latest famous example was Archegos who was doing exactly this.



91) Actions ▾ 92) Products ▾ 93) Views ▾ 94) Info ▾ 95) Settings ▾ Swap Manager

Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more >>

Solver (Premium) ▾ Load Save Trade ▾ CCP ▾

3) Main 4) Details 6) Cashflow 7) Resets

Deal Total Return Counterparty SWAP CNTRPARTY Ticker / SWAP 20) Properties

Swap

Leg 1:Asset Receive Leg 2:Float Pay

Type Constant Notional Notional 10MM

Notional 10MM Currency USD

Unit 3,713,733.187329 Effective -- 03/30/2021

Currency USD Maturity 1Y6M 09/30/2022

Effective -- 03/30/2021 Index 3M US0003M

Maturity 1Y6M 09/30/2022 Spread 75,000 bp

Asset KRW KOSPI Index Leverage 1.00000

Previous Fixing 2.921768 Latest Index 0.14725

Latest Value 2.753116 Reset Freq Quarterly

Reset Freq Quarterly Pay Freq Quarterly

Pay Freq Quarterly Day Count ACT/360

Market

Leg 1: NPV -556,735.41 Leg 2: NPV -17,197.29

Accrued -556,735.41 Accrued -17,197.29

Premium -5.57 Premium 0.00

Valuation Results

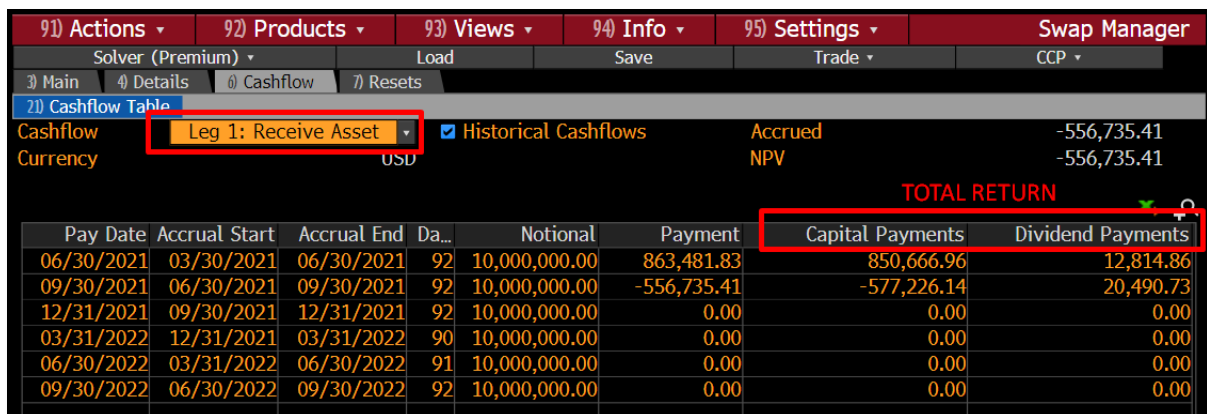
Principal 0.00 Premium 0.00000 Capital Gain -577,226.14

Accrued -573,932.70 BP Value -573.93270 Dividend Pmt 20,490.73

NPV -573,932.70

22) Calculators

Financing Cost of the Receiver



91) Actions ▾ 92) Products ▾ 93) Views ▾ 94) Info ▾ 95) Settings ▾ Swap Manager

Solver (Premium) ▾ Load Save Trade ▾ CCP ▾

3) Main 4) Details 6) Cashflow 7) Resets

21) Cashflow Table

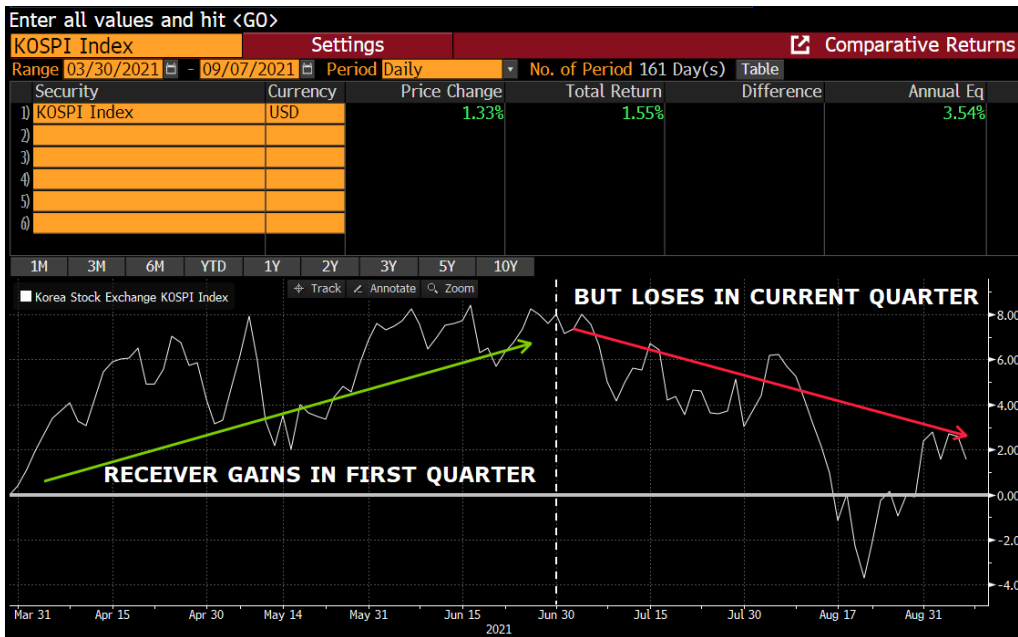
Cashflow Leg 1: Receive Asset Historical Cashflows Accrued -556,735.41

Currency USD NPV -556,735.41

TOTAL RETURN

Pay Date	Accrual Start	Accrual End	Da...	Notional	Payment	Capital Payments	Dividend Payments
06/30/2021	03/30/2021	06/30/2021	92	10,000,000.00	863,481.83	850,666.96	12,814.86
09/30/2021	06/30/2021	09/30/2021	92	10,000,000.00	-556,735.41	-577,226.14	20,490.73
12/31/2021	09/30/2021	12/31/2021	92	10,000,000.00	0.00	0.00	0.00
03/31/2022	12/31/2021	03/31/2022	90	10,000,000.00	0.00	0.00	0.00
06/30/2022	03/31/2022	06/30/2022	91	10,000,000.00	0.00	0.00	0.00
09/30/2022	06/30/2022	09/30/2022	92	10,000,000.00	0.00	0.00	0.00

In this example you are receiving the performance of KOSPI on a quarterly basis (capital gains plus dividends, in USD) while paying LIBOR+75. If it started in March, you would have made money in the first quarter net of LIBOR+75 and in the current quarter you would be losing money on the KOSPI and paying LIBOR+75 on top of that.

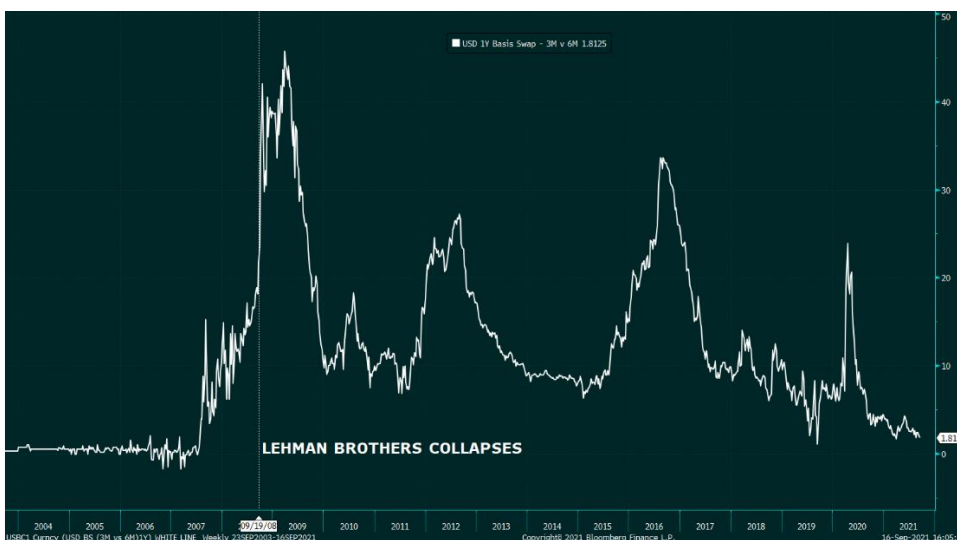


Unlike a fixed/float swap, an equity TRS doesn't require you to imply forward the floating leg rates. It is simply marking each current quarter's performance against a financing rate (that floats). You can do TRS on any instrument, not just equities and many do for bonds as well.

14.4 Basis Swaps

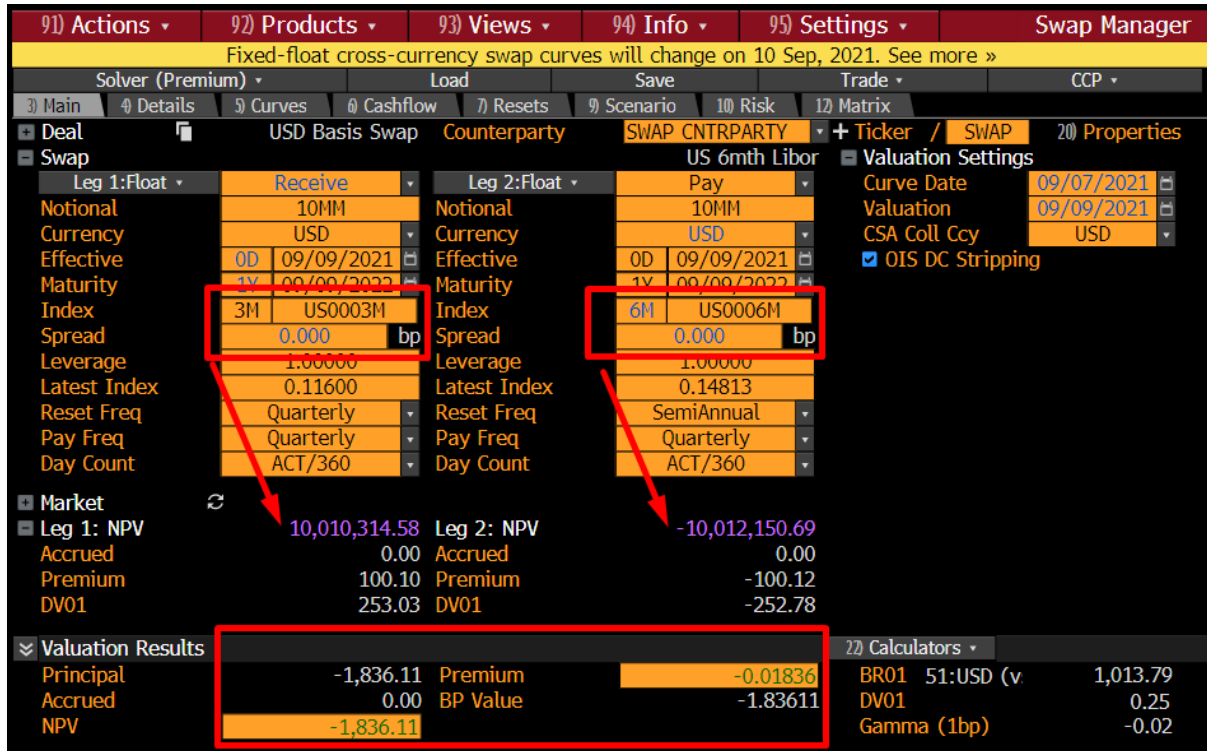
With basis swaps we move away from the vanilla IRS where it was fixed cashflows swapping to floating ones and now look at floating-to-floating swaps. What is "basis"? For example, when hedging you are hoping to offset one asset for another and the difference between the two is known as the basis, or the source of an imperfect hedge. Basis is the gap between two instruments.

So, in swaps, say I have a loan tied to a floating rate that I pay interest on every 3 months, but I have revenues that come in every 6 months – this means my loan payment can fluctuate twice as often as my receipts. How do I hedge out this risk? By converting the 6M to 3M cashflows or vice versa. Remember how we talked about how time increases risk in many forms? Credit risk, reinvestment risk, etc. And 3 months difference might not seem long but in times of stress it makes all the difference (imagine lending money to Merrill for an additional 3 months just after Lehman fell).



By that logic, the shorter the time frame, the “safer” the investment, but that is only HALF the **story of certainty**. Let's look at swapping 3M LIBOR and 6M LIBOR without any spread added. The math here is exactly the same as in the vanilla IRS' floating leg.

We are implying the cashflows forward at 3M and 6M intervals respectively using risky swap curves then discounting them to present value using the SOFR swaps curve.



Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »					
Deal		Counterparty		SWAP CNTRPARTY	
Deal	USD Basis Swap	Counterparty	US 6mth Libor	Ticker / SWAP	20 Properties
Leg 1: Float	Receive	Leg 2: Float	Pay	Valuation Settings	Curve Date 09/07/2021
Notional	10MM	Notional	10MM	Valuation	09/09/2021
Currency	USD	Currency	USD	CSA Coll Ccy	USD
Effective	0D 09/09/2021	Effective	0D 09/09/2021	<input checked="" type="checkbox"/> OIS DC Stripping	
Maturity	1Y 09/09/2022	Maturity	1Y 09/09/2022		
Index	3M US0003M	Index	6M US0006M		
Spread	0.000 bp	Spread	0.000 bp		
Leverage	1.00000	Leverage	1.00000		
Latest Index	0.11600	Latest Index	0.14813		
Reset Freq	Quarterly	Reset Freq	SemiAnnual		
Pay Freq	Quarterly	Pay Freq	Quarterly		
Day Count	ACT/360	Day Count	ACT/360		
Market		Market			
Leg 1: NPV	10,010,314.58	Leg 2: NPV	-10,012,150.69		
Accrued	0.00	Accrued	0.00		
Premium	100.10	Premium	-100.12		
DV01	253.03	DV01	-252.78		
Valuation Results				Calculators	
Principal	-1,836.11	Premium	-0.01836	BR01 51:USD (v	1,013.79
Accrued	0.00	BP Value	-1.83611	DV01	0.25
NPV	-1,836.11			Gamma (1bp)	-0.02

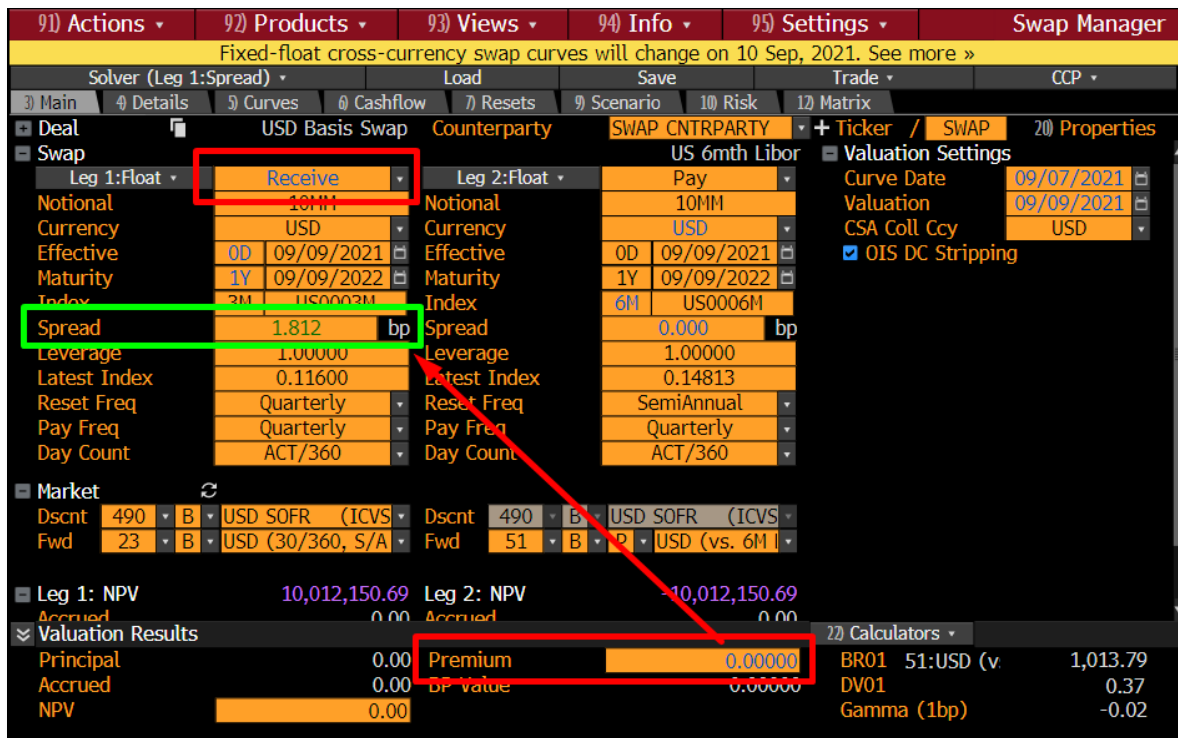
First, here 3M has a lower rate than 6M. Second, just based on discounting of their implied cashflows the NPV for the 3M leg is lower, resulting in a negative premium for the 3M receiver.

Let's stop to ask why. Why aren't they the same? You have two options, fund for 3 months then roll into another 3 months of funding OR just fund once for 6 months. Which has more **certainty**? The 6-month funding.

KEY TAKEAWAY: The guarantee of 6M funding today is more valuable than funding for 3M today and another 3mths in 3mths time. This is the other HALF of the story of certainty.

This logic applies across the curve. 3M funding is more valuable than 3x1M and 1M funding is more valuable than 30-day O/N funding.

In order to achieve value equivalence, we must find the spread on top of 3M to make the NPVs equal. This spread, is a funding premium. If you want to swap shorter funding for longer guaranteed funding, you have to cough up a premium. **That is exactly what basis swaps are about.**



Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »

Solver (Leg 1: Spread) Load Save Trade CCP

3) Main 4) Details 5) Curves 6) Cashflow 7) Resets 9) Scenario 10) Risk 12) Matrix

Deal USD Basis Swap Counterparty SWAP CNTRPARTY Ticker / SWAP 20) Properties

Swap

Leg 1: Float Receive Leg 2: Float Pay US 6mth Libor

Notional 10MM Notional 10MM

Currency USD Currency USD

Effective 0D 09/09/2021 Effective 0D 09/09/2021

Maturity 1Y 09/09/2022 Maturity 1Y 09/09/2022

Index 3M US0003M Index 6M US0006M

Spread 1.812 bp Spread 0.000 bp

Leverage 1.00000 Leverage 1.00000

Latest Index 0.11600 Latest Index 0.14813

Reset Freq Quarterly Reset Freq SemiAnnual

Pay Freq Quarterly Pay Freq Quarterly

Day Count ACT/360 Day Count ACT/360

Market

Dscnt 490 B USD SOFR (ICVS) Dscnt 490 B USD SOFR (ICVS)

Fwd 23 B USD (30/360, S/A) Fwd 51 B USD (vs. 6M)

Leg 1: NPV 10,012,150.69 Leg 2: NPV -10,012,150.69

Accrued 0.00 Accrued 0.00

Valuation Results

Principal 0.00 Premium 0.00000

Accrued 0.00 DP value 0.00000

NPV 0.00

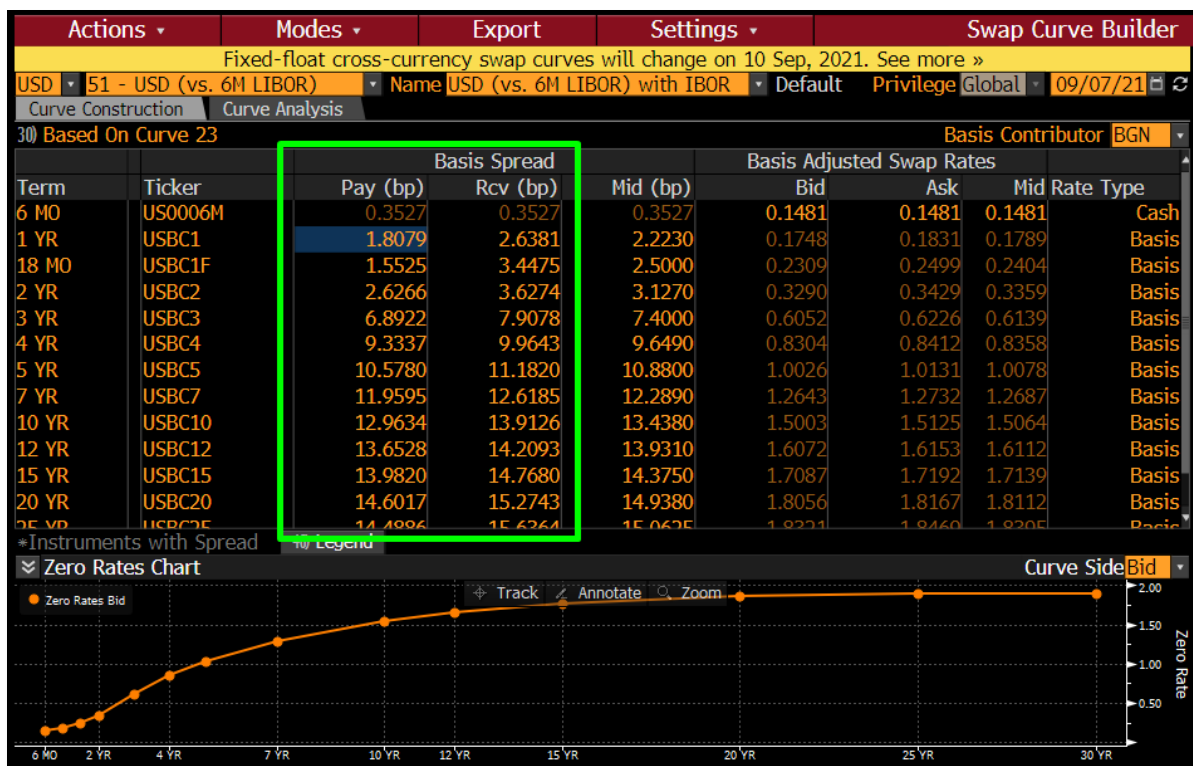
Calculators

BR01 51:USD (v. 1,013.79

DV01 0.37

Gamma (1bp) -0.02

For 1 year, if you were to swap 3M and 6M cashflows the 3M receiver should get 1.8bps extra each quarter to compensate for the higher value of paying the 6M leg. If you look at contributed quotes on [ICVS<GO>](#) you'll find the rate is pretty close.



Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »

USD 51 - USD (vs. 6M LIBOR) Name USD (vs. 6M LIBOR) with IBOR Default Privilege Global 09/07/21

Curve Construction Curve Analysis

30) Based On Curve 23 Basis Contributor BGN

Term	Ticker	Basis Spread		Mid (bp)	Basis Adjusted Swap Rates			Rate Type
		Pay (bp)	Rcv (bp)		Bid	Ask	Mid	
6 MO	US0006M	0.3527	0.3527	0.3527	0.1481	0.1481	0.1481	Cash
1 YR	USBC1	1.8079	2.6381	2.2230	0.1748	0.1831	0.1789	Basis
18 MO	USBC1F	1.5525	3.4475	2.5000	0.2309	0.2499	0.2404	Basis
2 YR	USBC2	2.6266	3.6274	3.1270	0.3290	0.3429	0.3359	Basis
3 YR	USBC3	6.8922	7.9078	7.4000	0.6052	0.6226	0.6139	Basis
4 YR	USBC4	9.3337	9.9643	9.6490	0.8304	0.8412	0.8358	Basis
5 YR	USBC5	10.5780	11.1820	10.8800	1.0026	1.0131	1.0078	Basis
7 YR	USBC7	11.9595	12.6185	12.2890	1.2643	1.2732	1.2687	Basis
10 YR	USBC10	12.9634	13.9126	13.4380	1.5003	1.5125	1.5064	Basis
12 YR	USBC12	13.6528	14.2093	13.9310	1.6072	1.6153	1.6112	Basis
15 YR	USBC15	13.9820	14.7680	14.3750	1.7087	1.7192	1.7139	Basis
20 YR	USBC20	14.6017	15.2743	14.9380	1.8056	1.8167	1.8112	Basis
25 YR	USBC25	14.4896	15.6264	15.0625	1.8223	1.8460	1.8205	Basis

*Instruments with Spread Legend

Zero Rates Chart

Curve Side Bid

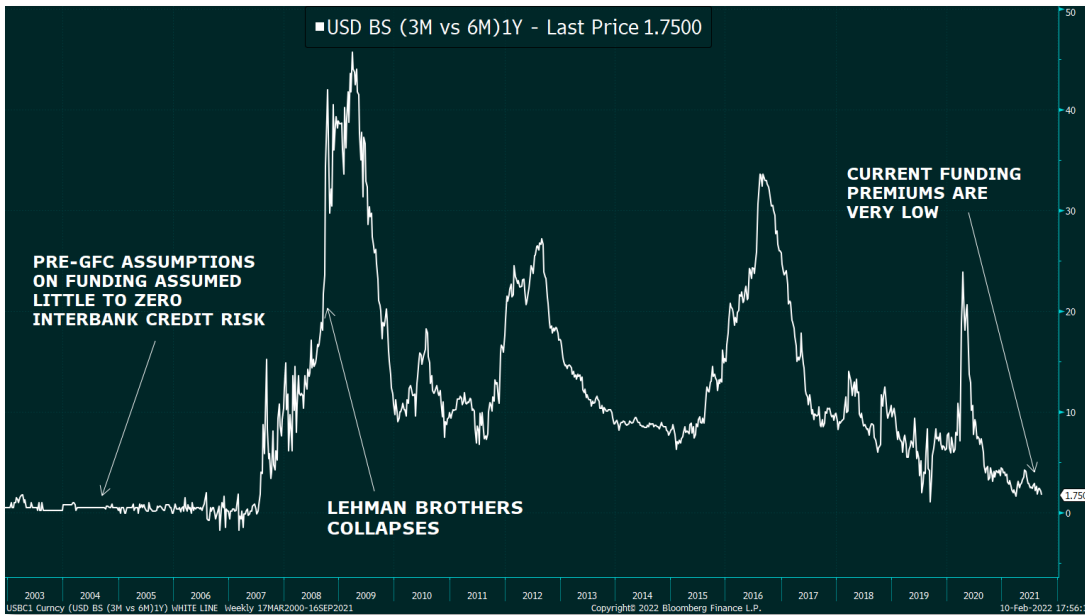
Zero Rates Bid

Track Annotate Zoom

Zero Rate

6 MO 2 YR 4 YR 7 YR 10 YR 12 YR 15 YR 20 YR 25 YR 30 YR

Float/Float basis swaps are really about how the money market values the certainty of longer funding. Note in the chart how that premium to receive 3v6 funding after Lehman collapsed skyrocketed while the excess supply of cash in current times is why the basis is so low.



This idea of swapping one floating rate for another is key piece of the next and very popularly discussed type of swap: the Cross Currency Basis Swap (XCCY).

14.5 Cross Currency Basis Swap XCCY

The first thing I will say is that please get terminology correct – cross currency basis swaps and FX swaps are not the same thing. An FX swap is basically a FX Forward where you’ve also exchanged currencies at spot, locking in the exchange rate gain/loss. XCCY is different.

Let’s first imagine I’m a French investor – 5pm in office is overtime, I see more strikes at work than the bowling alley and I also happen to want to buy some US bonds, but I only own Euros. If I were to ask someone with USD to swap their USD with me for EUR, I would have to pay him the USD rate while I would earn the EUR rate. Right now, EUR rates are all negative so instead of earning on EUR I’m actually losing.

Country	1 Year	2 Year	3 Year	5 Year	7 Year	10 Year	15 Year	30 Year
US S/A	0.1585	0.3150	0.5512	0.8943	1.1292	1.3479	1.5437	1.6680
US Ann	0.1575	0.3105	0.5441	0.8826	1.1162	1.3325	1.5265	1.6470
Canada		0.7915	1.0073	1.2746	1.4724	1.6665	1.9280	2.1597
Mexico	5.4250	5.8700	6.1900	6.5599	6.7900	7.0200	7.3500	7.6000
United Kingdom	0.2260	0.5141	0.6289	0.7560	0.8347	0.9222	1.0033	0.9754
Euro	-0.4940	-0.4653	-0.4135	-0.3013	-0.1775	0.0132	0.2546	0.3493
Switzerland	-0.5900	-0.6495	-0.5782	-0.4205	-0.2625	-0.0580	0.1363	0.1750
Sweden		0.0677	0.1506	0.3298	0.4850	0.6670	0.8915	0.9880
Denmark	-0.1396	-0.1213	-0.0820	0.0115	0.1227	0.3016	0.5247	0.5897
South Africa	4.0314	4.6060	5.0850	5.8370	6.4750	7.2050	7.8050	8.1700
Japan	-0.0213	-0.0056	0.0025	0.0075	0.0300	0.0888	0.2100	0.4850
Hong Kong	0.1950	0.3250	0.5220	0.8300	1.0633	1.2950	1.5300	
Australia	0.0504	0.2179	0.4370	0.8220	1.1054	1.3940	1.6745	1.7810
New Zealand	1.0406	1.3696	1.5608	1.7531	1.8745	2.0350	2.2650	
South Korea	1.3050	1.4700	1.5450	1.6350	1.6650	1.7100	1.6875	
Singapore	0.2650	0.4450	0.7525	1.1250	1.3200	1.5612	1.7050	1.7200

So already in a 1-year lending scenario I’m paying $0.1585 - (-0.490) = 0.6525\%$ as a EUR holder looking for access to USD.

Under Interest Rate Parity theory, for me to borrow the USD and invest it then at the same time lock in a forward rate to exchange the net proceeds back to EUR, it would be the same return as if I had just invested my EUR domestically. Most of the time it's close to true. Most.

Let's look at the XCCY: First we start with USD 3M LIBOR vs EUR 3M EURIBOR as a base example. We assume neither have a spread on top, just like with the basis swap example. Valuations are set to USD (dropdown on the right).



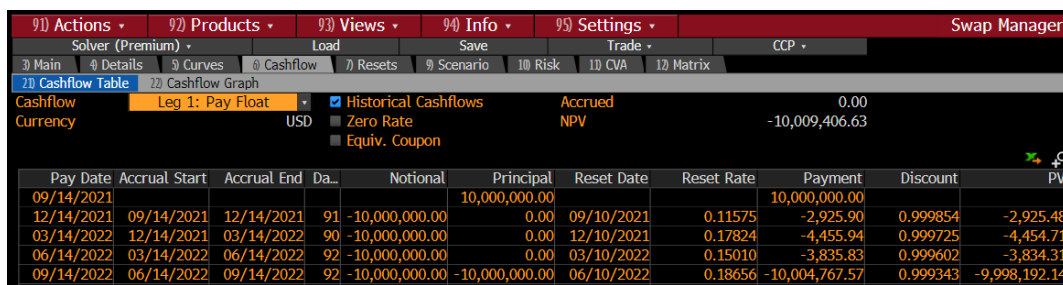
Deal	XCCY	Leg 1: Float	Leg 2: Float
Swap	Flt Flt Swap	Pay	Receive
Notional	10MM	10MM	8,438,995.55
Currency	USD	USD	EUR
Effective	0D 09/14/2021	0D 09/14/2021	0D 09/14/2021
Maturity	1Y 09/14/2022	1Y 09/14/2022	1Y 09/14/2022
Index	3M US0003M	3M EUR003M	
Spread	0.000 bp	0.000 bp	
Leverage	1.00000	1.00000	
Latest Index	0.11575	-0.54100	
Reset Freq	Quarterly	Quarterly	
Pay Freq	Quarterly	Quarterly	
Day Count	ACT/360	ACT/360	

Market	Leg 1: NPV	Leg 2: NPV
NPV	-10,009,406.63	10,018,100.51
Accrued	0.00	0.00
Premium	-100.09	100.18
DV01	-252.86	253.51

Valuation Results	Principal	Accrued	NPV	Premium	BP Value
Principal	8,693.87			0.08694	
Accrued	0.00			8.69387	
NPV	8,693.87				

In this scenario the NPV of the EUR leg is worth more than the NPV of the USD leg resulting in a premium to the USD payer. Let's dig into the cashflows to see what's going on:

First the USD payer receives US\$10MM then proceeds to pay quarterly LIBOR where using the swaps curve, the forward rates are implied. Then using a risk-free curve, the cashflows are discounted. Familiar so far.



Pay Date	Accrual Start	Accrual End	Da...	Notional	Principal	Reset Date	Reset Rate	Payment	Discount	PV
09/14/2021					10,000,000.00			10,000,000.00		
12/14/2021	09/14/2021	12/14/2021	91	-10,000,000.00	0.00	09/10/2021	0.11575	-2,925.90	0.999854	-2,925.48
03/14/2022	12/14/2021	03/14/2022	90	-10,000,000.00	0.00	12/10/2021	0.17824	-4,455.94	0.999725	-4,454.71
06/14/2022	03/14/2022	06/14/2022	92	-10,000,000.00	0.00	03/10/2022	0.15010	-3,835.83	0.999602	-3,834.31
09/14/2022	06/14/2022	09/14/2022	92	-10,000,000.00	-10,000,000.00	06/10/2022	0.18656	-10,004,767.57	0.999343	-9,998,192.14

At the same time, they are receiving EUR interest on the other leg. So, they lend EUR8.45MM (FX = 1.18255) and receive implied forward 3M EURIBOR each quarter. Note the cashflows are negative until maturity: they are actually paying on the receiving leg.



Pay Date	Accrual Start	Accrual End	Da...	Notional	Principal	Reset Date	Reset Rate	Payment	Discount	PV
09/13/2021					-8,456,302.06			-8,456,302.06		
12/13/2021	09/13/2021	12/13/2021	91	8,456,302.06	0.00	09/09/2021	-0.54100	-11,564.23	1.001634	-11,583.13
03/14/2022	12/13/2021	03/14/2022	91	8,456,302.06	0.00	12/09/2021	-0.49368	-10,552.63	1.003588	-10,590.49
06/13/2022	03/14/2022	06/13/2022	91	8,456,302.06	0.00	03/10/2022	-0.48395	-10,344.82	1.005217	-10,398.79
09/13/2022	06/13/2022	09/13/2022	92	8,456,302.06	8,456,302.06	06/09/2022	-0.46146	8,446,329.71	1.006842	8,504,118.53

The Net effect is that the USD borrower pays USD interest, and then **also** pays EUR interest (because it's negative). For the first payment it goes like this:

USD Interest paid: -\$2,925.90

EUR Interest earned (in USD): -11,564.23 * 1.18465 = -\$13,699.56

Total Interest earned/paid: -\$16,625.45

Discount this by the USD DF and you get the PV.

Pay Date	Payments(Rcv)	Payments(Pay)	Fwd FX	Net Payments	Discount	PV
09/13/2021	-10,000,000.00	10,000,000.00	1.18255	0.00		
12/13/2021	-13,699.55	-2,925.90	1.18465	-16,625.45	0.999859	-16,623.12
03/14/2022	-12,527.21	-4,489.00	1.18712	-17,016.30	0.999727	-17,011.65
06/13/2022	-12,302.12	-3,793.90	1.18921	-16,096.03	0.999591	-16,089.44
09/13/2022	10,062,507.17	-10,004,753.45	1.19135	57,753.72	0.999408	57,719.50

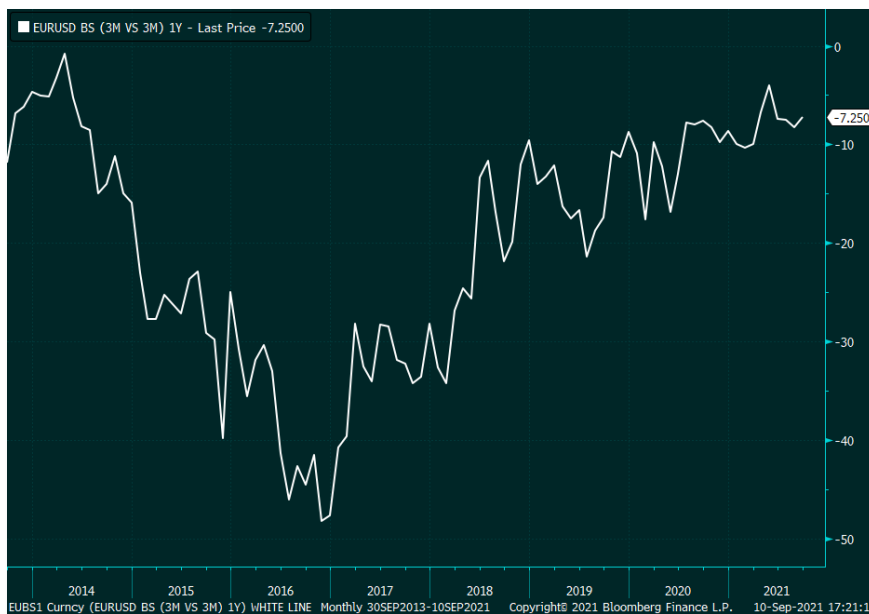
By now it's clear that **the value of a XCCY swap is affected by USD swap rates, EUR swap rates AND FX forward rates**. The FX portion is particularly important here because it is affected by the demand for foreign investors to hedge their USD investments.

We also know that if set to a spread of 0 for both legs, the USD borrower is set to gain. If the swap were to be equal given the current conditions, he would have to earn LESS from his EUR loan. If we set the swap premium to 0 and solve for the EUR spread, it looks like this:



Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »									
Solver (Leg 2:Spread)		Load		Save		Trade		CCP	
Main		Details		Curves		Cashflow		Resets	
Scenario		Risk		CVA		Matrix			
Deal		XCCY Flt Flt Swap		Counterparty		SWAP CNTRPARTY		+ Ticker / SWAP	
Swap		3 Month Euribor		Valuation Settings		Properties			
Leg 1:Float	Pay	Leg 2:Float	Receive	Curve Date	09/09/2021				
Notional	10MM	Notional	8,456,302.06	Valuation	09/13/2021				
Currency	USD	Currency	EUR	CSA Coll Ccy	USD				
Effective	0D 09/13/2021	Effective	0D 09/13/2021	Coll Crv	490 USD SOFR				
Maturity	1Y 09/13/2022	Maturity	1Y 09/13/2022	Valuation Ccy	USD				
Index	3M US0003M	Index	3M EUR003M	FX Rate	1.182550				
Spread	0.000 bp	Spread	-7.852 bp	<input checked="" type="checkbox"/> OIS DC Stripping					
Leverage	1.00000	Leverage	1.00000						
Latest Index	0.11575	Latest Index	-0.54200						
Reset Freq	Quarterly	Reset Freq	Quarterly						
Pay Freq	Quarterly	Pay Freq	Quarterly						
Day Count	ACT/360	Day Count	ACT/360						
Market		Leg 1: NPV		Leg 2: NPV					
Accrued		0.00		0.00					
Premium		-100.10		100.10					
DV01		-252.98		252.99					
Valuation Results		Premium		0.00000		2) Calculators			
Accrued		BP Value		0.00000		BR01 EUR vs. US		1,018.69	
NPV		0.00				DV01		0.02	
						Gamma (1bp)		0.00	

We also know that in order to get USD you have to give up more EUR – the flipside is that the USD lender (your counterparty) gets to EARN more from borrowing EUR from you. The more you want to get your hands on USD the more he can ask from you. (If the EUR lending rate was positive, it would mean the more he can negotiate a lower EUR borrowing rate, but in a negative rate scenario lower means more for him)



This is why for a while (especially 2016), many negative yielding currencies saw their XCCY turn deeply negative when their domestic investors increased demand for USD. This is also why with so much liquidity currently, there is little cost to access USD globally.

In 2016, 1Y EURUSD XCCY went as deep as -48bps implying that EUR holders were willing to pay higher and higher net interest in

order to get USD. At -48bps today a 1y swap valuation would imply a 2% discount on the swap for the USD borrower from the get-go.



Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »

Solver (Premium) Load Save Trade CCP

Main Details Curves Cashflow Resets Scenario Risk CVA Matrix

Deal XCCY Flt Flt Swap Counterparty SWAP_CNTRPARTY Ticker / SWAP Properties

Swap 3 Month Euribor Valuation Settings

Leg 1: Float	Pay	Leg 2: Float	Receive	Curve Date	09/10/2021
Notional	10MM	Notional	8,440,527.37	Valuation	09/14/2021
Currency	USD	Currency	EUR	CSA Coll Ccy	USD
Effective	0D 09/14/2021	Effective	0D 09/14/2021	Coll Crv	490 USD SOFR
Maturity	5Y 09/14/2026	Maturity	5Y 09/14/2026	Valuation Ccy	USD
Index	3M US0003M	Index	3M EUR003M	FX Rate	1.184760
Spread	0.000 bp	Spread	-48.000 bp	<input checked="" type="checkbox"/> OIS DC Stripping	
Leverage	1.00000	Leverage	1.00000		
Latest Index	0.11575	Latest Index	-0.4300		
Reset Freq	Quarterly	Reset Freq	Quarterly		
Pay Freq	Quarterly	Pay Freq	Quarterly		
Day Count	ACT/360	Day Count	ACT/360		

Market Dscnt 490 A USD SOFR (ICVS) Dscnt 403 MBB USD Coll for EUR Fwd 23 A USD (30/360, S/A) Fwd 201 A EUR (vs. 3M EURIBOR)

Leg 1: NPV	-10,102,551.34	Leg 2: NPV	9,897,739.60
Accrued	0.00	Accrued	0.00
Premium	-101.03	Premium	98.93
DV01	-81.46	DV01	23.90

Valuation Results

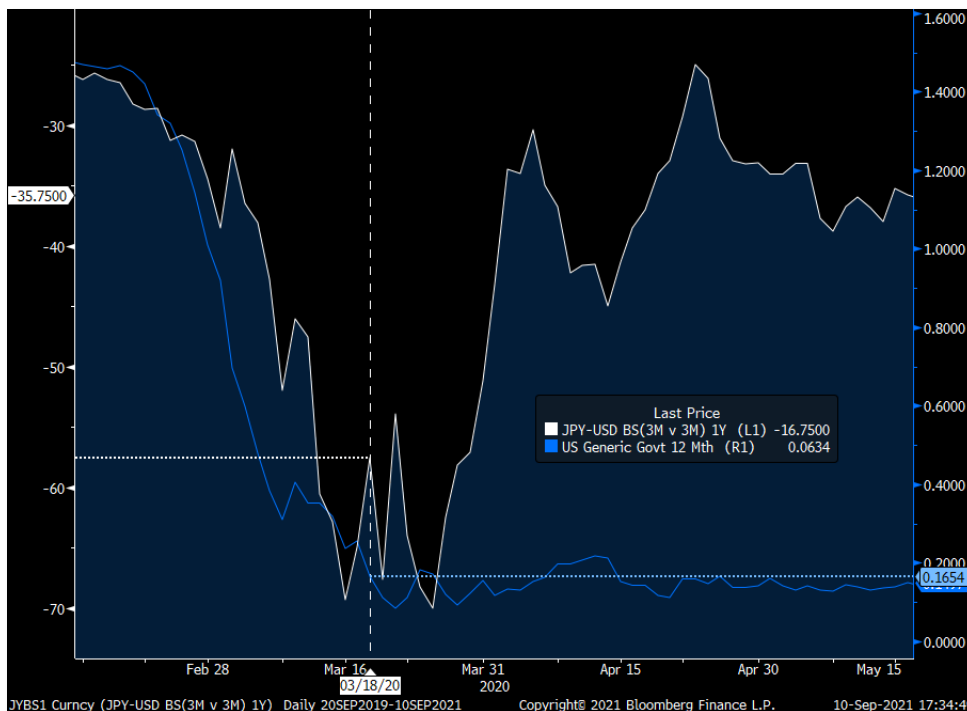
Principal	-209,811.74	Premium	-2.09812
Accrued	0.00	BP Value	-209,811.74
NPV	-209,811.74		

Calculators BR01 EUR vs. US 5,134.09 DV01 -57.56 Gamma (1bp) -0.02

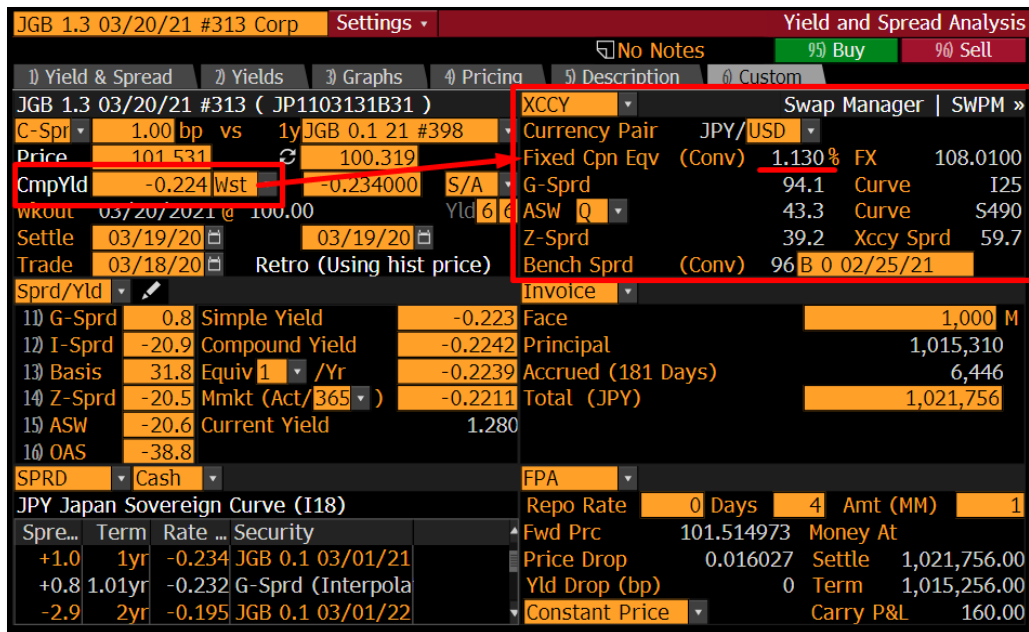
This is a key instance in which value equivalence does not hold in financial markets and things like Interest Rate Parity cease to hold. This is why XCCY is commonly used as an indicator for foreign demand for USD (or any other currency).

So, if you're a USD holder and basis is deeply negative, can you profit from this and how?

In March last year during the pandemic, JPY-USD basis dropped to -57bps while the US 1y rate also fell to 0.1654 as investors reached for safety and the dollar. At the same time, a JGB with 1 y of maturity left (maturing March 2021) was trading at a yield of -0.22%



Because people wanted USD so badly, a USD based investor could theoretically have bought a JGB at -0.22% then swapped it back to USD over the next year.



The screenshot shows a bond trading interface for JGB 1.3 03/20/21 #313 Corp. The main data table includes:

C-Spr	1.00 bp	vs	1y JGB 0.1 21 #398	Currency Pair	JPY/USD	Swap Manager SWPM »
Price	101.531		100.319	Fixed Cpn Eqv (Conv)	1.130 %	FX 108.0100
CmpYld	-0.224		-0.234000	G-Sprd	94.1	Curve I25
ASW	-20.6		1.280	Z-Sprd	39.2	Curve S490
OAS	-38.8			Bench Sprd (Conv)	96	B 0 02/25/21

Below the main data, there is a section for 'JPY Japan Sovereign Curve (I18)' and a table of spread/yield data:

SPRD	Cash				
1) G-Sprd	0.8	Simple Yield	-0.223	Face	1,000 M
2) I-Sprd	-20.9	Compound Yield	-0.2242	Principal	1,015,310
3) Basis	31.8	Equiv 1 /Yr	-0.2239	Accrued (181 Days)	6,446
4) Z-Sprd	-20.5	Mmkt (Act/365)	-0.2211	Total (JPY)	1,021,756
5) ASW	-20.6	Current Yield	1.280		
6) OAS	-38.8				

If you click on the SWPM value at the top right, you can see it structured as a swap – what we are doing now is combining the concept of an asset swap with the concept of cross currency basis swaps. Giddyup!



The screenshot shows a 'Swap Manager' window for a 'Fixed-float cross-currency swap curves will change on 10 Sep, 2021. See more »'. The swap details are as follows:

Deal	XCCY Fix Fix Swap	Counterparty	SWAP CNTRPARTY	Ticker / SWAP	20 Properties
Leg 1: Fixed	Pay	Leg 2: Fixed	Receive	Valuation Settings	Curve Date 03/18/2020
Notional	1MM	Notional	9,252.58	Valuation	03/19/2020
Currency	JPY	Currency	USD	CSA Coll Ccy	USD
Effective	-- 09/20/2019	Effective	-- 09/20/2019	Coll Crv	490 USD SOFR
Maturity	1Y6M 03/20/2021	Maturity	1Y6M 03/20/2021	Valuation Ccy	USD
Coupon	1.300000 %	Coupon	1.129730 %	FX Rate	0.009253
Pay Freq	SemiAnnual	Pay Freq	SemiAnnual	<input checked="" type="checkbox"/> OIS DC Stripping	
Day Count	ACT/365.FIXED	Day Count	301/360		
Calc Basis	Bond Eqv	Calc Basis	Bond Eqv		

Market and Valuation Results:

Leg 1: NPV	-9,543.46	Leg 2: NPV	9,394.13
Accrued	-59.65	Accrued	51.97
Premium	-102.50	Premium	100.97
DV01	-0.97	DV01	0.95

Valuation Results:

Principal	-141.66	Premium	-1.53100	BR01 97:JPY vs.	-0.97
Accrued	-7.67	BP Value	-161.39307	DV01	-0.02
NPV	-149.33			Gamma (1bp)	0.00

First, you buy the JGB then swap it so you are the Payer on leg 1 – the details of the bond are input, including its 1.3% coupon. In return, you swap it for a USD fixed coupon leg. How do you arrive at this?

Well, you first match the cashflows timings of the JGB so there is no timing mismatch, then you solve for the USD fixed coupon given a set premium.

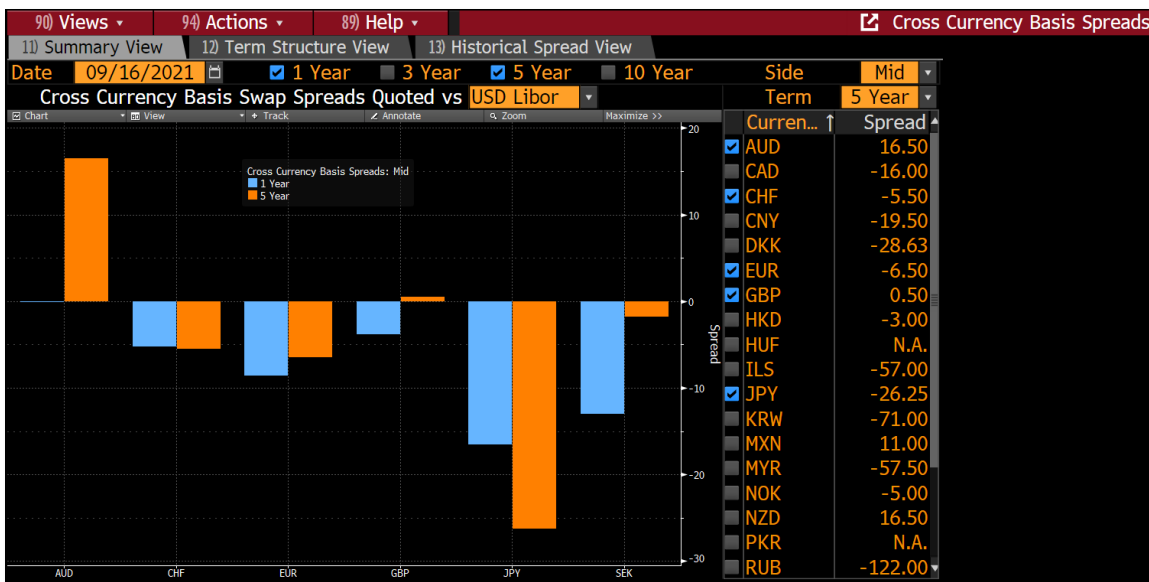


Pay Date	Payments(Rcv)	Payments(Pay)	Fwd FX	Net Payments	Discount	PV
03/23/2020	52.26	-60.16	0.00925	-7.89	0.999989	-7.89
09/23/2020	52.26	-60.60	0.00932	-8.34	0.999255	-8.33
03/22/2021	9,304.84	-9,438.17	0.00938	-133.32	0.998367	-133.10

Premium is the premium over par that you pay for the JGB: $100 - 101.531 = -1.531$ just like in ASW! This means upfront you buy the JGB for 101.531 and get paid 1.53 back from the swap and proceed to earn 1.1299% fixed on the USD leg when domestic 1y bills were yielding 0.1654%!

Note that in a market swap (i.e., premium is 0) then the fixed coupon will be even higher to compensate for the overpayment of the bond in return for a par swap.

Run `XCCY<GO>` to see the cross-currency basis swaps around the world against a benchmark currency.



Some resources and articles on XCCY:

BIS on FX hedging impact on basis:

https://www.bis.org/publ/qtrpdf/r_qt1609e.pdf

Hedged-JGBs for foreigners:

<https://www.reuters.com/article/japan-rates-idUSL3N1YN13G>

BOJ review on XCCY trends (2016):

https://www.bis.org/events/bissymposium0517/symposium0517_1_nagano_wr.pdf

That is all that I will cover in swaps. There's a much deeper world out there that goes far beyond what I know or dare to look at. Hopefully this helps you start understanding how swaps are used and why they're instrumental in transforming and capturing changes in interest rates.

More than anything, I hope it gives you a bit more of an idea what all these smart people I follow are talking about!

14.6 Topic Question (courtesy of @shortendtrader):

At 11 am London time I buy \$500MM 1y USD 3s6s basis at 2.

1. What is my total delta at time of trade?
2. What is my total delta at 11:55:01?
3. Assuming I do no further trades in the day and economic data comes out strong at 1.30 causing yields to rise aggressively in the 1y sector, is my trade in the money, out of the money or unchanged and why.

Assume that 3m and 6m LIBOR come in where you expect them to come in at fixing.

1) 0 delta

2) You are now long 500 eurodollars futures roughly (500 6m fixed and 500 3m fixed leaving me 500m 3s6s exposure)

3) I am out of the money because my 3s6s FRA that I implicitly sold by not hedging the basis post-fixing has cost me lots of money and I am sad.



15. Appendix 1: The Cheapest to Deliver Bond of a Futures Contract

\$ \$ \$

This is the first educational twitter post that started it all, so it's only fitting that I include it here. I would have put it in the Futures section but that might have made your brain explode and made the chapter as long as my...list of losing trades. So anyway, here it is and congrats on making it to the end of the book.

First, let's establish the futures contract. We'll use the 10-year future TYA Comdty on Bloomberg, /ZN for non-Bloomberg users.

When you buy/sell a future you are agreeing to buy/sell the cash bond in the FUTURE. This is key. So what bonds specifically can you deliver/receive? A whole bunch!

TYU1 Comdty	US 10YR NOTE (CBT)Sep21	Security Description: Notes CBT-Chicago Board of Trade
<p>** Product specifications link below ** 10-Year US Treasury Note Futures ***Effective 2/29/2016, The Board of Trade of the City of Chicago, Inc. ("CBOT") will amend the daily and final settlement procedures for all options on CBOT Treasury futures and options on 30-Day Federal Funds futures to permit the minimum settlement value to be Cabinet (\$1.00), in line with the procedures for CME interest rate options. The "Trade" Tick Size in the Contract Specifications will remain the same, so there will be no tick size changes on the Bloomberg***</p> <p>Effective October 7, 2015: The Board of Trade of the City of Chicago plans to eliminate the fourth and fifth delivery months in its listings of U.S. Treasury Note futures and companion options. This action will align the listing schedule for Treasury Note futures and companion options with the listing schedule that has applied to Treasury Bond futures ("ZB") and Long-Term Treasury Bond ("UB") futures and their respective companion options since 2010.</p> <p>**Effective July 6, 2015 and pending all relevant CFTC regulatory review periods, CME will close Open-Outcry (PIT) for all Futures except for S&P 500 Futures (SPA Index DES<GO>}. On the Bloomberg, PIT ticker tail will remain for historical Open-Outcry reference and will thereafter represent CME Clearport Pricing Data.**</p> <p>Grade and Quality: U.S. Treasury notes maturing at least 6 1/2 years, but not more than 10 years, from the first day of the delivery month. The invoice price equals the futures settlement price times a conversion factor plus accrued interest. The conversion factor is the price of the delivered note (\$1 par value) to yield 6 percent.</p> <p>**ETYA is no longer supported, you will be able to see the same data in TYA ELEC <COMDTY>.**</p> <p>Exchange ticker: TY</p> <p>Contract Months : The first three consecutive contracts in the March, June, September, and December quarterly cycle.</p> <p>Last Trading Day: Seventh business day preceding the last business day of the delivery month.</p> <p>Trading in expiring contracts closes at 12:01 p.m. on the last trading day.</p> <p>First Delivery Date: First business day of the contract delivery month.</p> <p>Last Delivery Day: Last business day of the delivery month.</p>		

The red box is the key part. Any UST with 6.5-10 years of maturity can be used! But because futures are standardised, they use some conventions the most important being a 6% coupon (hello 1995). This requires a conversion factor to align theoretical bond with the real bond.

Bloomberg, PIT ticker tail will remain for historical open-outcry reference and will thereafter represent CME Clearport Pricing Data.**

Grade and Quality: U.S. Treasury notes maturing at least 6 1/2 years, but not more than 10 years, from the first day of the delivery month. The invoice price equals the futures settlement price times a conversion factor plus accrued interest. The conversion factor is the price of the delivered note (\$1 par value) to yield 6 percent.

ETYA is no longer supported, you will be able to see the same data in TYA ELEC <COMDTY>.

Exchange ticker: TY

So now you know, if I buy a bond-future I will be able to receive a cash bond at expiry from the seller of the future - the seller has the RIGHT to choose any bond in the eligible criteria to deliver to me. Which will he pick? **The cheapest one for him.** But what is cheapest?

This brings us to the Cheapest to Deliver concept and the page on Bloomberg (DLV<GO>). When you short a future, you will deliver a bond. You must factor in the bond's accrued interest from now to the delivery - the carry.



The Invoice Price = (Future Price * Conversion Factor + Accrued Interest) * Contracts

TYU1 Comdty		Export		Settings			Cheapest-to-Deliver			
US 10YR NOTE (CBT)Sep21		Price	131-29	Trade	06/18/21	Delivery	09/30/21			
Sort By				Settle	06/21/21	Cheapest IRP	0.047			
Implied Repo		Decreasing		Prices in Decimals		Days	101	Act /	360	
Cash Security	Price	Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)		
Adjust Value										
1) T 2 7/8	05/15/28	110-24 1/4	BGN	1.2430	0.8338	24.780	0.047	0.068	0.208	
2) T 2 7/8	08/15/28	110-27 1/4	BGN	1.2821	0.8286	49.729	-2.429	0.068	24.930	
3) T 1 1/4	05/31/28	99-28 1/4	BGN	1.2677	0.7474	41.475	-3.392	0.068	31.047	
4) T 1 1/4	04/30/28	99-31+	BGN	1.2523	0.7474	44.725	-3.753	0.068	34.358	
5) T 1 1/4	03/31/28	100-01+	BGN	1.2427	0.7474	46.725	-3.962	0.068	36.299	
6) T 3 1/8	11/15/28	112-23 1/4	BGN	1.3143	0.8376	71.740	-4.365	0.068	44.985	
7) T 2 5/8	02/15/29	109-08 1/4	BGN	1.3475	0.8039	102.988	-8.104	0.068	80.395	
8) T 2 3/8	05/15/29	107-15 1/4	BGN	1.3730	0.7836	131.674	-11.459	0.068	111.473	
9) T 1 5/8	08/15/29	101-27	BGN	1.3850	0.7320	169.228	-16.901	0.068	155.450	
10) T 1 3/4	11/15/29	102-24+	BGN	1.3998	0.7331	194.085	-19.338	0.068	179.344	
11) T 1 1/2	02/15/30	100-15 1/4	BGN	1.4411	0.7105	216.229	-22.457	0.068	203.551	
12) T 0 5/8	05/15/30	92-30 1/4	BGN	1.4737	0.6462	246.640	-28.880	0.068	241.718	
13) T 0 5/8	08/15/30	92-20	BGN	1.4900	0.6382	270.158	-31.796	0.068	265.185	
14) T 0 7/8	11/15/30	94-17+	BGN	1.4991	0.6476	291.980	-33.462	0.068	284.873	
15) T 1 1/8	02/15/31	96-16 3/4	BGN	1.5135	0.6577	312.598	-34.874	0.068	303.219	

Which means you are short the cash bond in return for the invoice. I.e., Your basis is the Bond Price - Invoice Price >> This is known as the Gross Basis.

If you bought the cash bond and sold the future, you lock in a return - this is the **CASH AND CARRY TRADE**

TYU1 Comdty		Export		Settings			Cheapest-to-Deliver			
US 10YR NOTE (CBT)Sep21		Price	131-29	Trade	06/18/21	Delivery	09/30/21			
Sort By				Settle	06/21/21	Cheapest IRP	0.047			
Implied Repo		Decreasing		Prices in Decimals		Days	101	Act /	360	
Cash Security	Price	Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)		
Adjust Value										
1) T 2 7/8	05/15/28	110-24 1/4	BGN	1.2430	0.8338	24.780	0.047	0.068	0.208	
2) T 2 7/8	08/15/28	110-27 1/4	BGN	1.2821	0.8286	49.729	-2.429	0.068	24.930	
3) T 1 1/4	05/31/28	99-28 1/4	BGN	1.2677	0.7474	41.475	-3.392	0.068	31.047	
4) T 1 1/4	04/30/28	99-31+	BGN	1.2523	0.7474	44.725	-3.753	0.068	34.358	
5) T 1 1/4	03/31/28	100-01+	BGN	1.2427	0.7474	46.725	-3.962	0.068	36.299	
6) T 3 1/8	11/15/28	112-23 1/4	BGN	1.3143	0.8376	71.740	-4.365	0.068	44.985	
7) T 2 5/8	02/15/29	109-08 1/4	BGN	1.3475	0.8039	102.988	-8.104	0.068	80.395	
8) T 2 3/8	05/15/29	107-15 1/4	BGN	1.3730	0.7836	131.674	-11.459	0.068	111.473	
9) T 1 5/8	08/15/29	101-27	BGN	1.3850	0.7320	169.228	-16.901	0.068	155.450	
10) T 1 3/4	11/15/29	102-24+	BGN	1.3998	0.7331	194.085	-19.338	0.068	179.344	
11) T 1 1/2	02/15/30	100-15 1/4	BGN	1.4411	0.7105	216.229	-22.457	0.068	203.551	
12) T 0 5/8	05/15/30	92-30 1/4	BGN	1.4737	0.6462	246.640	-28.880	0.068	241.718	
13) T 0 5/8	08/15/30	92-20	BGN	1.4900	0.6382	270.158	-31.796	0.068	265.185	
14) T 0 7/8	11/15/30	94-17+	BGN	1.4991	0.6476	291.980	-33.462	0.068	284.873	
15) T 1 1/8	02/15/31	96-16 3/4	BGN	1.5135	0.6577	312.598	-34.874	0.068	303.219	

Here's the math:

A) Cash bond = 110 - 24.25 = 110.7578125

B) Invoice = 131-29 * 0.8338 = 109.9834313

C) Gross Basis = (A - B) * 32 = 24.7802

TYU1 Comdty		Export		Settings		Cheapest-to-Deliver			
US 10YR NOTE (CBT)Sep21		Price	131-29	Trade	06/18/21	Delivery	09/30/21		
Sort By				Settle	06/21/21	Cheapest IRP	0.047		
Implied Repo		Decreasing		Prices in Decimals		Days	101 Act /	360	
Cash Security	Price	Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)	
Adjust Value									
1) T 2 ⁷ / ₈ 05/15/28	110-24 ¹ / ₄	BGN	1.2430	0.8338	24.780	0.047	0.068	0.208	
2) T 2 ⁷ / ₈ 08/15/28	110-27 ¹ / ₄	BGN	1.2821	0.8286	49.729	-2.429	0.068	24.930	
3) T 1 ¹ / ₄ 05/31/28	99-28 ¹ / ₄	BGN	1.2677	0.7474	41.475	-3.392	0.068	31.047	
4) T 1 ¹ / ₄ 04/30/28	99-31+	BGN	1.2523	0.7474	44.725	-3.753	0.068	34.358	
5) T 1 ¹ / ₄ 03/31/28	100-01+	BGN	1.2427	0.7474	46.725	-3.962	0.068	36.299	
6) T 3 ¹ / ₈ 11/15/28	112-23 ¹ / ₄	BGN	1.3143	0.8376	71.740	-4.365	0.068	44.985	
7) T 2 ⁵ / ₈ 02/15/29	109-08 ¹ / ₄	BGN	1.3475	0.8039	102.988	-8.104	0.068	80.395	
8) T 2 ³ / ₈ 05/15/29	107-15 ¹ / ₄	BGN	1.3730	0.7836	131.674	-11.459	0.068	111.473	
9) T 1 ⁵ / ₈ 08/15/29	101-27	BGN	1.3850	0.7320	169.228	-16.901	0.068	155.450	
10) T 1 ³ / ₄ 11/15/29	102-24+	BGN	1.3998	0.7331	194.085	-19.338	0.068	179.344	
11) T 1 ¹ / ₂ 02/15/30	100-15 ¹ / ₄	BGN	1.4411	0.7105	216.229	-22.457	0.068	203.551	
12) T 0 ⁵ / ₈ 05/15/30	92-30 ¹ / ₄	BGN	1.4737	0.6462	246.640	-28.880	0.068	241.718	
13) T 0 ⁵ / ₈ 08/15/30	92-20	BGN	1.4900	0.6382	270.158	-31.796	0.068	265.185	
14) T 0 ⁷ / ₈ 11/15/30	94-17+	BGN	1.4991	0.6476	291.980	-33.462	0.068	284.873	
15) T 1 ¹ / ₈ 02/15/31	96-16 ³ / ₄	BGN	1.5135	0.6577	312.598	-34.874	0.068	303.219	

So that's the basic idea of the gross basis, but I still haven't gotten around to the idea of the cheapest to deliver! If you haven't noticed yet, the DLV screen sorts the deliverables by Implied Repo.

Why?

TYU1 Comdty		Export		Settings		Cheapest-to-Deliver			
US 10YR NOTE (CBT)Sep21		Price	131-29	Trade	06/18/21	Delivery	09/30/21		
Sort By				Settle	06/21/21	Cheapest IRP	0.047		
Implied Repo		Decreasing		Prices in Decimals		Days	101 Act /	360	
Cash Security	Price	Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)	
Adjust Value									
1) T 2 ⁷ / ₈ 05/15/28	110-24 ¹ / ₄	BGN	1.2430	0.8338	24.780	0.047	0.068	0.208	
2) T 2 ⁷ / ₈ 08/15/28	110-27 ¹ / ₄	BGN	1.2821	0.8286	49.729	-2.429	0.068	24.930	
3) T 1 ¹ / ₄ 05/31/28	99-28 ¹ / ₄	BGN	1.2677	0.7474	41.475	-3.392	0.068	31.047	
4) T 1 ¹ / ₄ 04/30/28	99-31+	BGN	1.2523	0.7474	44.725	-3.753	0.068	34.358	
5) T 1 ¹ / ₄ 03/31/28	100-01+	BGN	1.2427	0.7474	46.725	-3.962	0.068	36.299	
6) T 3 ¹ / ₈ 11/15/28	112-23 ¹ / ₄	BGN	1.3143	0.8376	71.740	-4.365	0.068	44.985	
7) T 2 ⁵ / ₈ 02/15/29	109-08 ¹ / ₄	BGN	1.3475	0.8039	102.988	-8.104	0.068	80.395	
8) T 2 ³ / ₈ 05/15/29	107-15 ¹ / ₄	BGN	1.3730	0.7836	131.674	-11.459	0.068	111.473	
9) T 1 ⁵ / ₈ 08/15/29	101-27	BGN	1.3850	0.7320	169.228	-16.901	0.068	155.450	
10) T 1 ³ / ₄ 11/15/29	102-24+	BGN	1.3998	0.7331	194.085	-19.338	0.068	179.344	
11) T 1 ¹ / ₂ 02/15/30	100-15 ¹ / ₄	BGN	1.4411	0.7105	216.229	-22.457	0.068	203.551	
12) T 0 ⁵ / ₈ 05/15/30	92-30 ¹ / ₄	BGN	1.4737	0.6462	246.640	-28.880	0.068	241.718	
13) T 0 ⁵ / ₈ 08/15/30	92-20	BGN	1.4900	0.6382	270.158	-31.796	0.068	265.185	
14) T 0 ⁷ / ₈ 11/15/30	94-17+	BGN	1.4991	0.6476	291.980	-33.462	0.068	284.873	
15) T 1 ¹ / ₈ 02/15/31	96-16 ³ / ₄	BGN	1.5135	0.6577	312.598	-34.874	0.068	303.219	

If I short the future and have to deliver a bond, I can use the proceeds to buy the cash bond at initiation to lock in the gross basis. This IMPLIES a breakeven of sorts.

We can model this through the fixed income horizon page on Bloomberg - **FIHZ<GO>**

You buy the cash bond at 110-24.25 today (6/18/21, settles 6/21/21). You agree to sell at (131-29 * 0.8338) on 09/30/21 (future delivery date) resulting in a holding period return of 0.013%, but in an annualized Money Market Convention Return it is.....0.047%!

T 2 7/8 05/15/28 Govt										Settings		Fixed Income Horizon Analysis			
107-16 3/4 /107-18		1.618/1.612		BGN @ 16:44		95 Buy		90 Sell							
Swap Type Risk		Settlement		OAS		Horizon 09/30/21		Financing							
Security	B/S	Amt (M)	Date	Price	Yield	W	Risk	Price	Yield	W	Rate				
T 2 7/8 05/15/28	B	1,000	06/21/21	110-24 1/4	1.243012	W	6.98	109.98343	1.297361	W					
Return Analysis										B/E		1.30			
Reinvestment Rate 0.000 %		Income Tax 0.000 %		Capital Gains Tax 0.000 %											
View Cashflows				Pre Tax				After Tax							
	Total Return %	HPR %	MMKT %	Net P&L	Total Return %	HPR %	MMKT %	Net P&L							
T 2 7/8 05/15/28	0.048	0.013	0.047	147	0.048	0.013	0.047	147							

And that, is the IMPLIED REPO RATE.

TYU1 131-30 - 02+ 131-30 /131-30+i 1334x702 Prev 132-00+											
At 12:02		Vol 80546		Op 132-01+		Hi 132-02		Lo 131-28		OpenInt 4360802	
TYU1 Comdty			Export			Settings			Cheapest-to-Deliver		
US 10YR NOTE (CBT)Sep21			Price 131-29			Trade 06/18/21			Delivery 09/30/21		
Sort By			Settle 06/21/21			Cheapest IRP 0.047					
Implied Repo Decreasing			Prices in Decimals			Days 101 Act / 360					
Cash Security	Price	Source	Conven Yield	Conver Factor	Gro/Bas (32nds)	Implied Repo%	Actual Repo%	Net/Bas (32nds)			
Adjust Value											
1) T 2 7/8 05/15/28	110-24 1/4	BGN	1.2430	0.8338	24.780	0.047	0.068	0.208			
2) T 2 7/8 08/15/28	110-27 1/4	BGN	1.2821	0.8286	49.729	-2.429	0.068	24.930			
3) T 1 1/4 05/31/28	99-28 1/4	BGN	1.2677	0.7474	41.475	-3.392	0.068	31.047			

In simple terms, the implied repo rate is the implied money market return from a cash and carry trade. And for a treasury futures seller, that determines which bond is the cheapest for him to deliver to the futures buyer.



16. Disclaimer

Nothing in this book is financial advice, a lot of the content could be wrong, much of it are just my opinions. Bloomberg didn't have any involvement in this or pay me, though they should with how awesome this book is. Be good, be honest, work hard. Love people fiercely but hold them gently. Always learn. Have a good day.