



FE5101: Lecture 5 – Fixed Income Derivatives

Debt Risk Management Products

Lecture 5 Topics:

1. Interest Rate Swaps
2. Pricing of IRSs
3. Credit Default Swaps



L5: Topic 1

Interest Rate Swaps

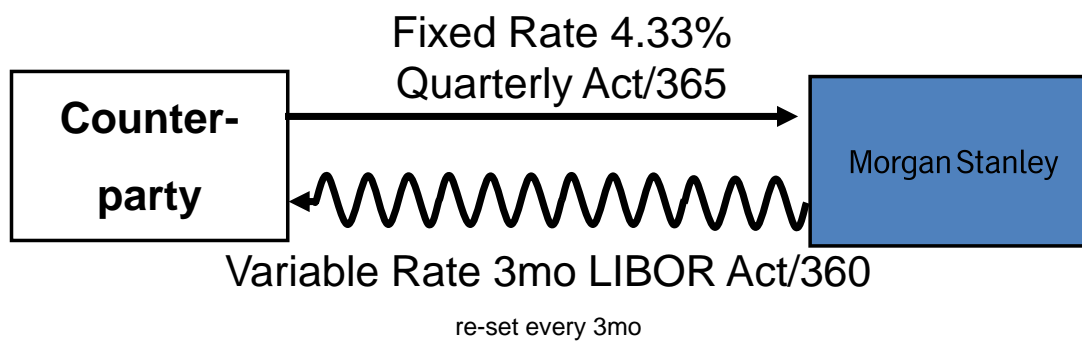
*Managing Rate Risk with
Derivatives*

Interest Rate Swap (IRS)

- An *Interest Rate Swap* is a bilateral financial contract between two parties exchanging streams of cash flows linked to interest rates for a specified term
 - *Counter-parties* exchange payments
 - Payments are based on interest rates applied to notional amount to calculate the payments' cash amounts
 - Both counter-parties pay a fair but differently-indexed/calculated rate
- Unfunded *Notional* Amount is used to size the IRS's cash flows (interest payments)
 - The same way bond par sizes the coupon payments
 - For example, at the end of this current quarterly accrual period of 92 actual days, you...
 - pay 3mo LIBOR Act/360, which was set at 3.54%, and
 - you receive 4.33% quarterly Act/365
 - Calculated on a notional amount of \$10m
 - What are the cash amounts you pay _____ and receive _____?

Fixed-Floating IRS

- Morgan Stanley *receives* Fixed at 4.33% and *pays* Floating (variable) 3Mo USD LIBOR

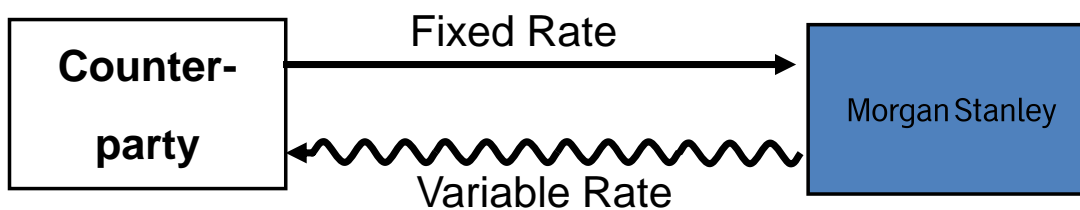


Fixed-Floating IRS

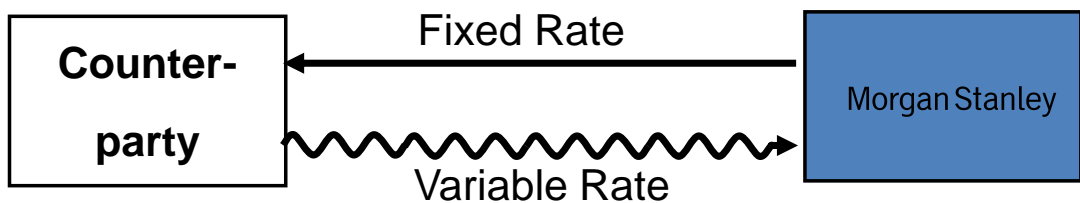
- Fixed-floating IRS is most common version of IRS
 - Unfunded *Notional* Amount agreed to size the transaction
 - The same way bond par sizes the coupon payments
 - E.g. \$10m of Notional (aka “notional principal”)
 - Exchange of cashflows based on fixed rate vs. a defined variable benchmark rate
 - E.g. Fixed at 4.33% quarterly Act/365 vs. 3-month LIBOR Act/360, tenor = 5yrs
 - Fixed Term of 5yrs → 20 re-sets of 3mo LIBOR
- Assuming in the first of the IRS quarterly accrual periods (e.g. 15Mar-15Jun, 92 days), 3mo LIBOR sets at 3.54%
 - Morgan Stanley
 - Pay $\$10\text{m} \times 92/360 \times .0354 = \text{USD } 90,466.67$
 - Rec $\$10\text{m} \times 92/365 \times .0433 = \text{USD } 109,139.73$
 - So, net for that period, MS receive USD 18,673.06
 - But then of course, there are 19 more re-set periods to pay and settle after the first one

Terminology: Who does what with the Fixed Rate

- Morgan Stanley Receives Fixed and Pays Floating



- Morgan Stanley Pays Fixed and Receives Floating



US Dollars IRS Quote Screen

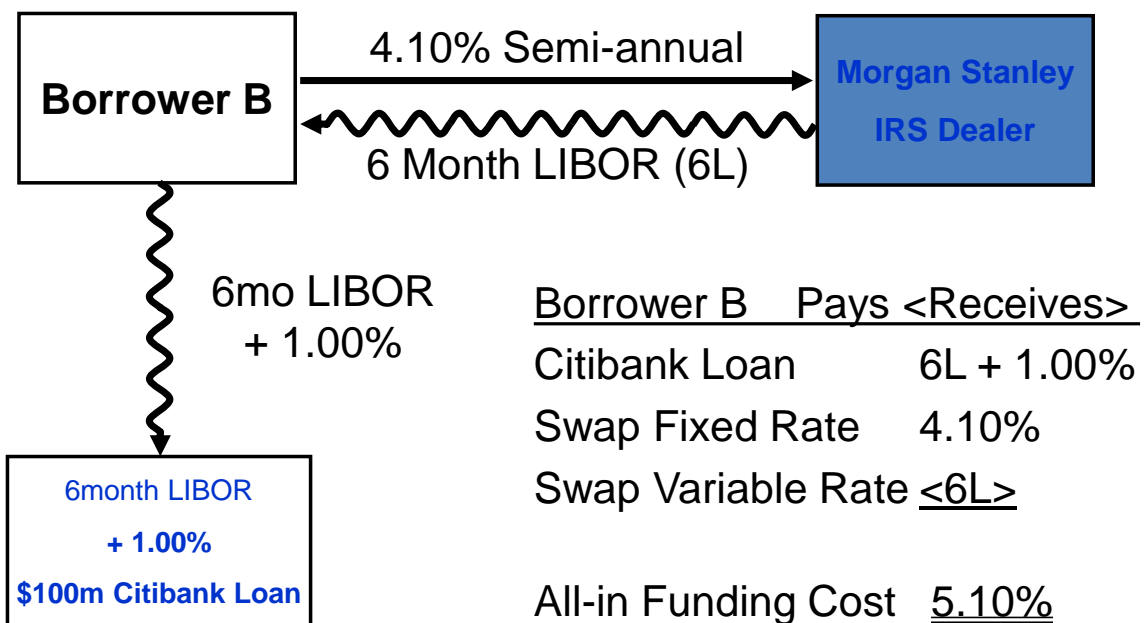
Assume these are quarterly act/365 vs. 3mo LIBOR Act/360

↺	maturity	bid	ask	contributor	updated	
📄	1Y	4.269	4.289	REUTERS	22:21 GMT	23 NOV 2007
📄	2Y	3.980	4.010	REUTERS	22:22 GMT	23 NOV 2007
📄	3Y	4.045	4.085	REUTERS	22:21 GMT	23 NOV 2007
📄	4Y	4.171	4.211	REUTERS	22:22 GMT	23 NOV 2007
📄	5Y	4.310	4.350	REUTERS	22:22 GMT	23 NOV 2007
📄	6Y	4.416	4.456	REUTERS	22:22 GMT	23 NOV 2007
📄	7Y	4.517	4.557	REUTERS	22:22 GMT	23 NOV 2007
📄	8Y	4.605	4.645	REUTERS	22:22 GMT	23 NOV 2007
📄	9Y	4.673	4.714	REUTERS	22:22 GMT	23 NOV 2007
📄	10Y	4.737	4.777	REUTERS	22:22 GMT	23 NOV 2007
📄	15Y	4.929	4.969	REUTERS	22:22 GMT	23 NOV 2007
📄	20Y	5.022	5.063	REUTERS	22:22 GMT	23 NOV 2007
📄	30Y	5.053	5.094	REUTERS	22:16 GMT	23 NOV 2007
ric code		USDIRS=RR			data source	Real-time

Example of Basic IRS Application

- Borrower B has a US\$100m term loan with Citibank on which
 - they pay 6-month LIBOR +1% (“6L + 100bp”) p.a. Act/360
 - and 2 banking days before the end of each accrual period, the interest rate is re-set to the newly-benchmarked 6L
- Borrower B’s treasury management wish to fix the rate on this loan for 3yrs
- Morgan Stanley IRS Desk quote to receive fixed at 4.10% Act/365 vs. 6L on \$100m notional for 3yrs
 - Borrower B, accept (deal on) their offer

Basic IRS Use Case: Fixing a Floating Rate Loan



IRS Use Cases

- Borrower (e.g. corp tsy) fixes rate on variable rate debt
- Borrower issues bond and swaps to attain synthetic variable rate debt
- Investor (e.g. unit trust) uses IRS to manage duration of a bond or bond portfolio
- Speculator (e.g. hedge fund) uses IRS to position for changes in yield-curve
- Institution (e.g. bank) uses IRS to align asset yield to funding cost profile

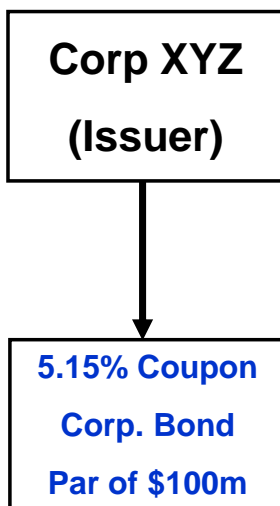
IRS Use Case: Swapping a Bond to Floating

- Assume Corp XYZ is AA- rated bond issuer
- Corp XYZ want 5yr financing on a variable rate basis, and face the following choices:
 - They can issue a 5yr floating rate note (FRN) at 3mo LIBOR + 1.10% (underwriter's estimate)
 - They can also borrow variable rate from banks at 3mo LIBOR + 1% (bank loan)
 - They can issue a 5yr 5.15% quarterly coupon bond, (Act/Act) at par in \$100m, and then swap it into variable rate based on 3mo LIBOR

Exercise 1: Bond Issue Swapped into Variable

- Based on the 5yr swap rates shown in earlier pricing slide:
 - If Corp XYZ want to issue the bond and swap to replicate issuing a 5yr FRN, do they have to pay or receive fixed in an IRS?
 - At what fixed rate?
- Label the boxes and arrows depicting this and show their all-in cost of funds on the next slide

Exercise 1: Synthetic Floating Rate Note Issue



IRS Deal
Not'l = _____

Issuer Pays <Receives>

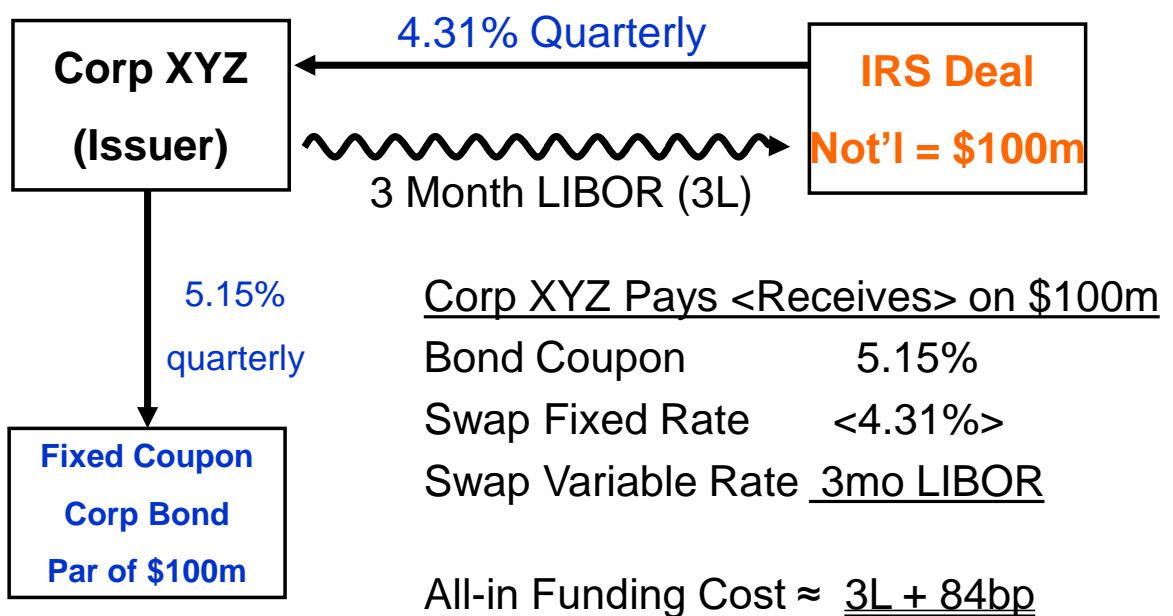
Bond Coupon

Swap Fixed Rate < >

Swap Variable Rate _____

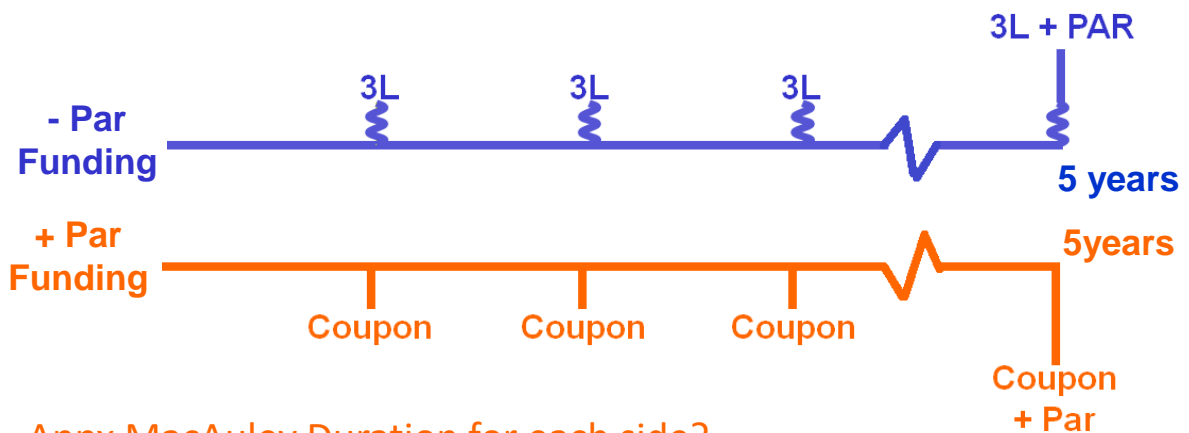
All-in Funding Cost

Exercise 1: Synthetic FRN Answers



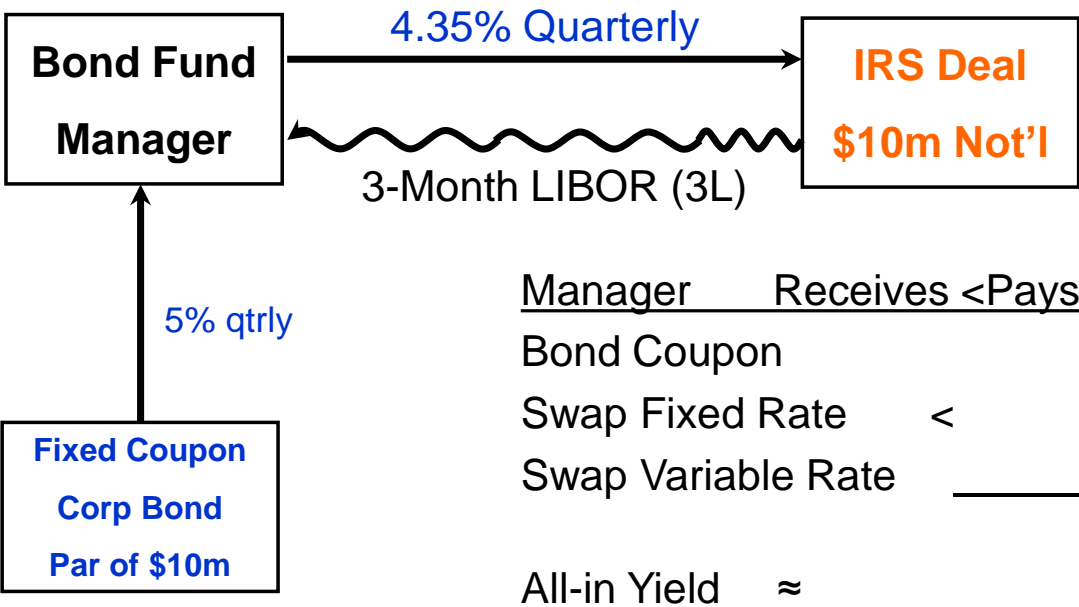
Investment Use Case: Managing Duration with IRS

- Paying fixed and receiving 3mo LIBOR in an IRS has same CFs as issuing a bond and buying an FRN:

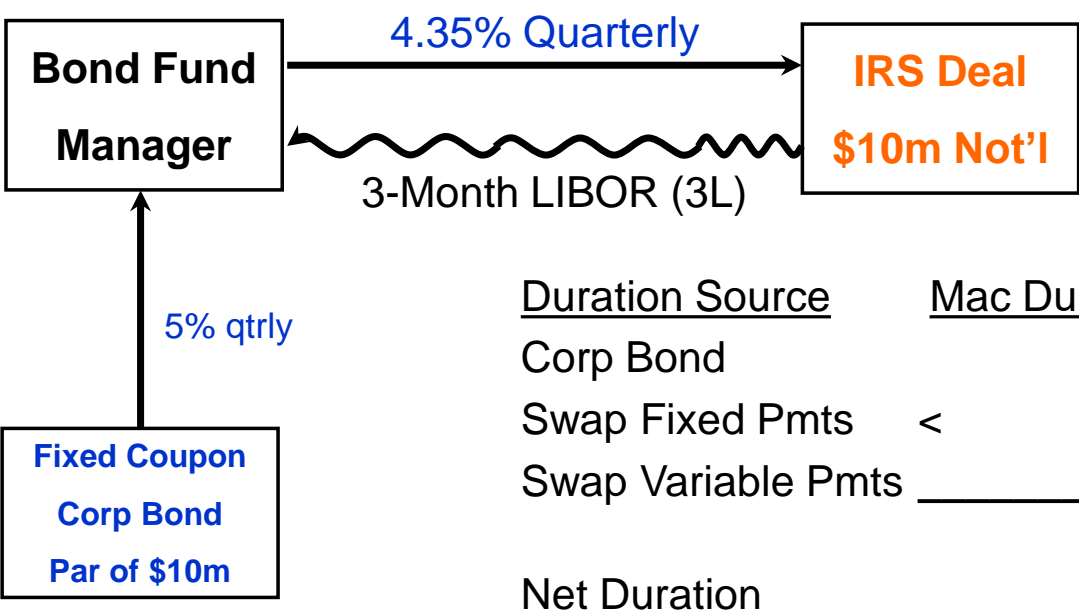


- Appx MacAuley Duration for each side?
 - 5yr FRN
 - 5yr Fixed coupon bond

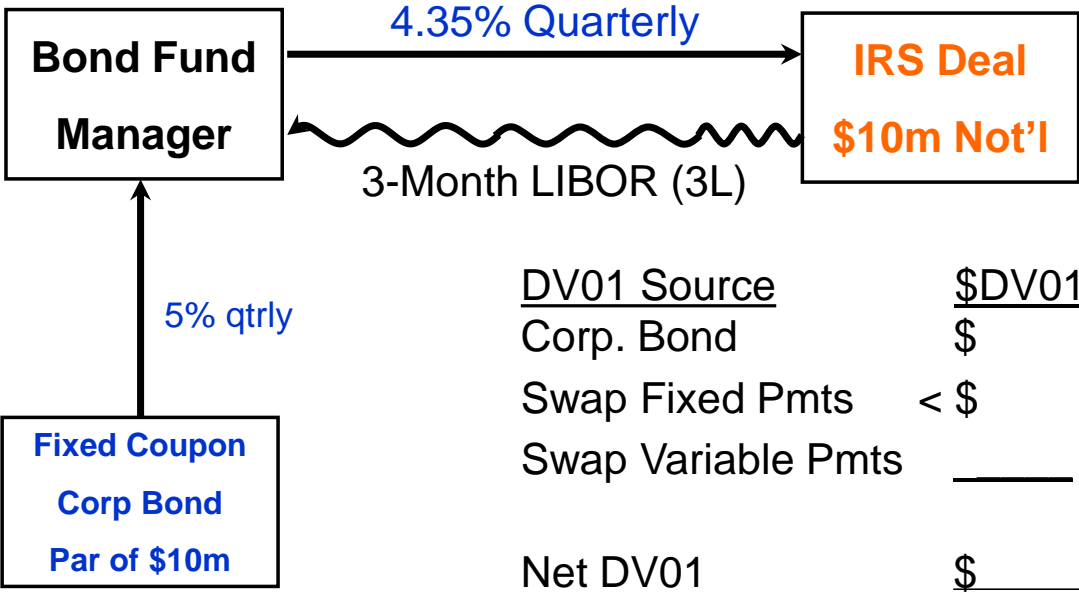
Exercise 2a: Asset-swap into VARIABLE RATE



Exercise 2b: Asset-swap into SHORTER DURATION

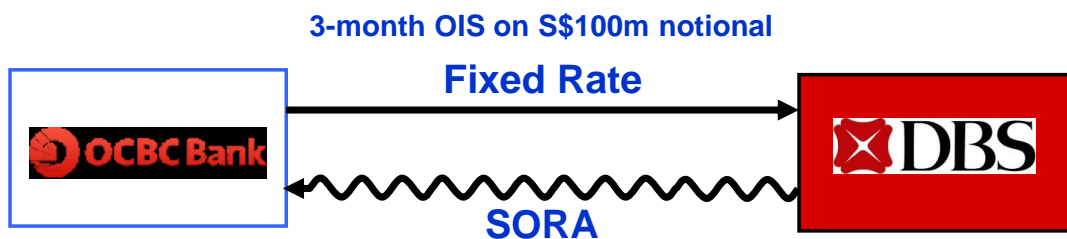


Exercise 2c: Asset-swap into SMALLER DV01



Overnight Index Swaps

- Because banks frequently use overnight funding markets (i.e. money borrowed today and repaid tomorrow), they are exposed to overnight rates
 - E.g. SORA, SOFR, SONIA, EONIA
- OIS is a frequently used fixed-floating rate swap used in the inter-bank market, allowing the transfer of overnight rate risk between counter-parties
- OIS pricing underlies IRS pricing and valuation in the post-Global Financial Crisis environment



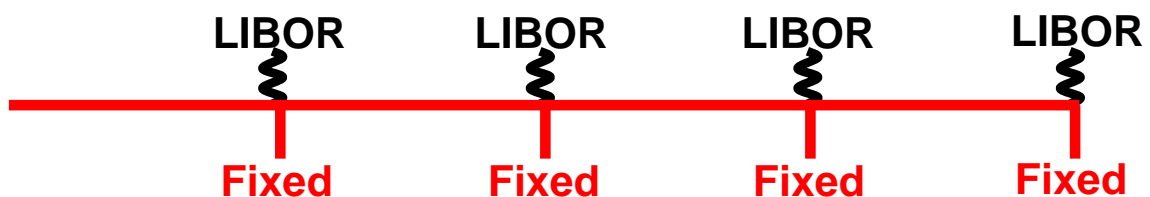


L5: Topic 2 IRS Pricing

Using LIBOR futures to price IRS

Cash flows of the IRS

- LIBOR-variable payments can be hedged using CME LIBOR futures, which means we can quantify and value the variable series, by projecting them and taking their total PV
- Fixed rate can be found to render a series of CFs that have the same total present value
- At inception, swap counter-parties will require to receive payments of equal value to the payments that they're making
- This means we can use DCF methodology to price IRSs (we know the forward rates and we know the zero rates, so we can calculate the fixed rate)



Swap Pricing using Discounted Cash Flow

- Fair Value Fixed Rate = the IRS Fixed Rate that generates a series of fixed payments such that

$$\sum PV(\text{Fixed}) = \sum PV(\text{Variable})$$

- A = Notional Amount
- $R\%$ = Fixed Rate
- Days_n = Actual Days in Calculation Period n
- ${}_{n-1}f_n\%$ = implied forward rate for accrual period n
- Day-ct = day convention being applied to fixed or variable side
- Z_n = Zero coupon discount rate corresponding to period n

$$\sum \frac{A_n \times R\% \times \frac{\text{Days}_n}{\text{Day-ct}_R}}{(1 + Z_n)^n} = \sum \frac{A_n \times {}_{n-1}f_n\% \times \frac{\text{Days}_n}{\text{Day-ct}_f}}{(1 + Z_n)^n}$$

What Rates go into the Numerators?

- Fixed payments simply calculated using dealt rate, and day-count, applied to the notional amount
- Variable payments are visible in the market
 - FRAs and Futures
 - Or can be *bootstrapped* from the prices of inter-bank IRSs (i.e. follow same methodology as with bonds)

What Zero-curve for the DFs in IRS Pricing?

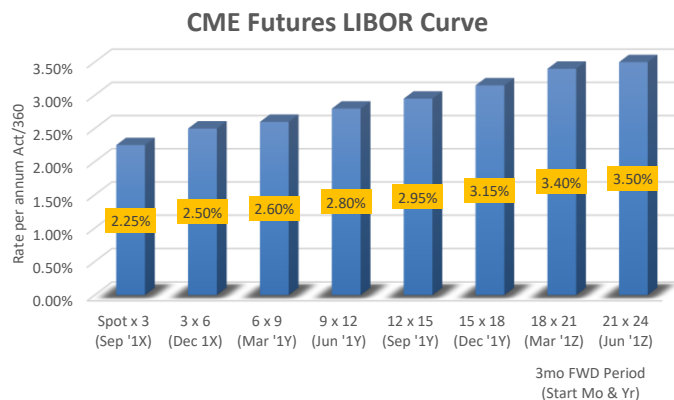
- From *Traditional* Zero-curve = the LIBOR-based zero rates calculated from forwards (or bootstrapped from the Swap Curve) that correspond to the LIBOR-indexed variable payments in the IRS in question.
- From *OIS-based* zero-curve – same calculation, but using OIS-derived zero-rates in the DCF formula
 - This recognising that the OIS curve better represents the cost of funding of Swap-book in the post 2008 Crisis financial environment
 - See Donald Smith Supplement Note on OIS pricing
 - <http://www.bu.edu/questrom/files/2011/10/A-Teaching-Note-on-Pricing-and-Valuing-Interest-Rate-Swaps-with-LIBOR-and-OIS-Discounting-2.pdf>

Traditional Pricing to CME LIBOR Futures

- The spot 3-month LIBOR followed by the quarterly futures make the forward curve easily discoverable at any moment
- The futures can be used to hedge the variable rate side of the swap to a known cost
 - This means we can transact futures as a hedge of the variable rates
 - Receive fixed in IRS = pay LIBOR → Sell E\$ futures to hedge
 - Pay fixed in IRS = receive LIBOR → Buy E\$ futures to hedge
 - Once we've done that we now know the amount of cashflows of the variable rate series of the swap
 - So we know their PV, and....
 - We can find a fixed rate that gives us the same PV

Forward Rates from Futures to Price the IRS

- The Fixed Rate on the IRS will be appx the average of the relevant forward short-term rates corresponding to the variable series of payments



Exercise 3 (Homework): Price IRS to CME Futures

- Assume you wish to price a 2-year spot-starting IRS on \$100m Not'l for Quarterly fixed rate vs. 3-month LIBOR (both Act/360)
- You face this series of prices:

3mo Accrual	Accrual Period	Market	Implied	
Calc Period	Start Date	Price	Rate	Act Days
Spot-3mo	20-Sep-1X	2.25%	2.25%	91
3 X 6	20-Dec-1X	97.50	2.50%	90
6 X 9	20-Mar-1Y	97.40	2.60%	92
9 x 12	20-Jun-1Y	97.20	2.80%	91
12 x 15	19-Sep-1Y	97.05	2.95%	91
15 x 18	19-Dec-1Y	96.85	3.15%	91
18 x 21	20-Mar-1Z	96.60	3.40%	91
21 x 24	19-Jun-1Z	96.50	3.50%	91

- Open the spreadsheet provided to price the IRS
 - Begin by inputting these prices where indicated
 - Audit the cells to see how the futures are used to populate variable cashflows as well as zero-rates
 - Then iterate to the fixed rate that gives $NPV = 0$



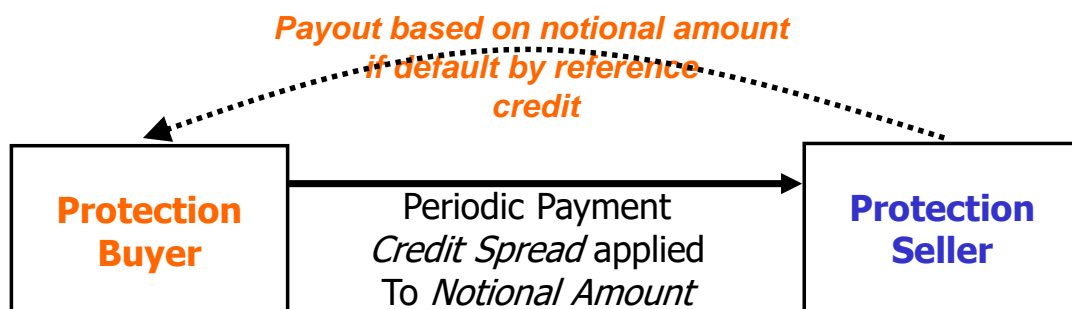
L5: Topic 3 Credit Default Swaps

*Managing a Bond's Credit Risk
with Derivatives*

Credit Default Swaps (CDS)

- CDSs are bilateral financial contracts transferring default risk from a bond or loan from one counter-party to the other.
 - Allow a lender to own a financial asset but to ‘outsource’ the default risk by attaining form of third party guaranty
 - CDS = insurance against credit-default losses.
 - But can be used without having any exposure to insured (i.e. speculatively)
- CDSs have similar legal structure to IRSs, but one side makes fixed payments, while the other counter-party makes only a contingent payment
 - And may not make this payment at all if the contingency does not arise

Credit Default Swap Structure



In the event of default by the reference credit, protection seller must compensate protection buyer by compensating protection buyer for losses vs. par value covered by the notional amount.

CDSs and Default Exposure

- CDS pay-outs are referenced to credit events that may occur with respect to a
 - Named Borrower (“*name*”)
 - Specific Bond or loan (“*asset*”)
- CDSs
 - create *unfunded* credit exposure for the protection seller, for which the seller collects payments
 - Create avoidance of credit exposure for the protection buyer, which is why they make the series of payments
- No lending occurs in the CDS, but the seller bears default risk as if they’ve guaranteed a loan or bond

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The Referenced Name or Asset

- The *Reference Asset*, is typically, a publicly traded obligation of a named obligor (corp or govt)
 - Bond
 - Syndicated Loan
- Alternatively, the CDS may specify any senior debt of the referenced name
 - Remember, all loans and bonds are cross-defaulted, so the CDS can be specified to simply reference any debt of the borrower

CDS Contingent Pay-out

- Contingent Payment occurs only after a *credit event*, as defined:
 - Bankruptcy, insolvency, receivership, material adverse restructuring of debt, or failure to meet payment obligations when due.
 - Defined so a Credit Event is not triggered by a technical (non-credit-related) default, (e.g. a disputed or late payment)
 - Operationally communicated by providing 2 references to public information indicating a financial default
- This usually occurs as
 - Purchase of asset at original par value (by protection seller from protection buyer)
 - This requires the buyer to deliver a loan or bond
 - Compensation for change in value due to credit event (*ISDA* and *Markit* protocol)
 - This is a net payment, requiring no asset delivery

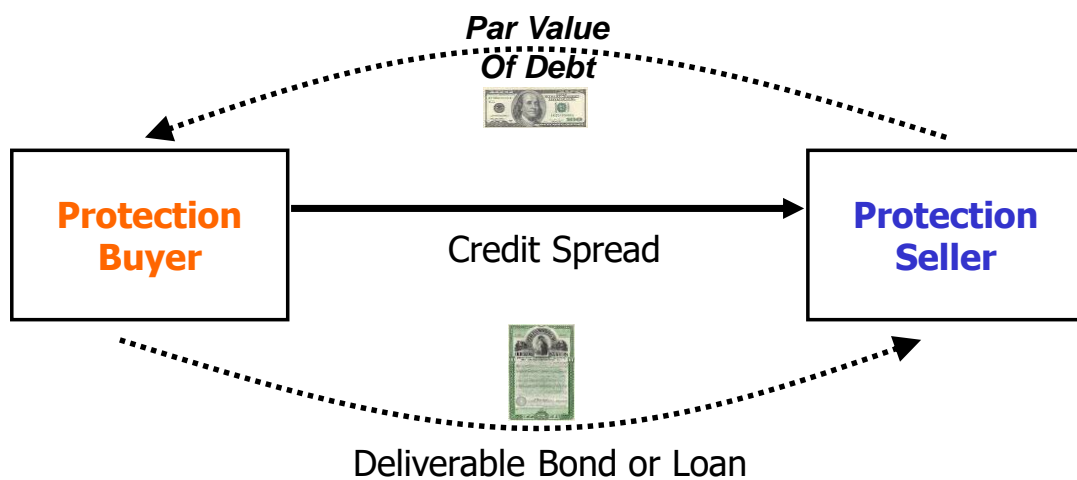
CDS Physical Settlement

- Protection Buyer makes physical delivery of a specified Deliverable Obligation in return for payment of its face amount.
 - Deliverable Obligations may be
 - The Reference Obligation
 - Or one of a broad class of obligations meeting certain specifications, such as any senior unsecured claim against the Reference Entity.
- Following physical delivery, the Protection Seller now is the creditor
 - has recourse to the Reference Entity and participates in the restructuring/liquidation as creditor to of the defaulted obligor

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Physical Settlement on Default by Reference Credit

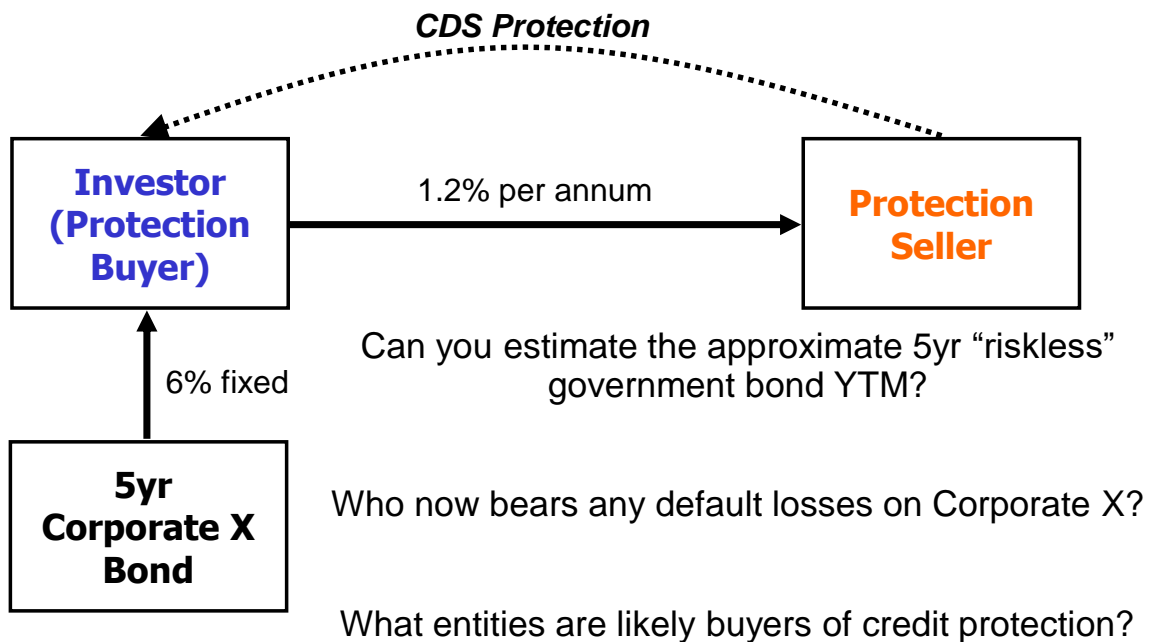
Public Notice of Reference Credit Default



CDS Net Value Settlement

- Most CDSs now specify net value settlement of default-related losses. This involves cash compensation by
 - Quantifying the default loss percentage
 - e.g. distressed debt trading at 37% of par
 - So CDS pay-out = 63% of notional
 - Protection seller pays that percentage of CDS notional to buyer
 - No need to deliver a defaulted bond or loan
 - *ISDA-Markit Protocol*
- *Avoids the need for a deliverable debt instrument*

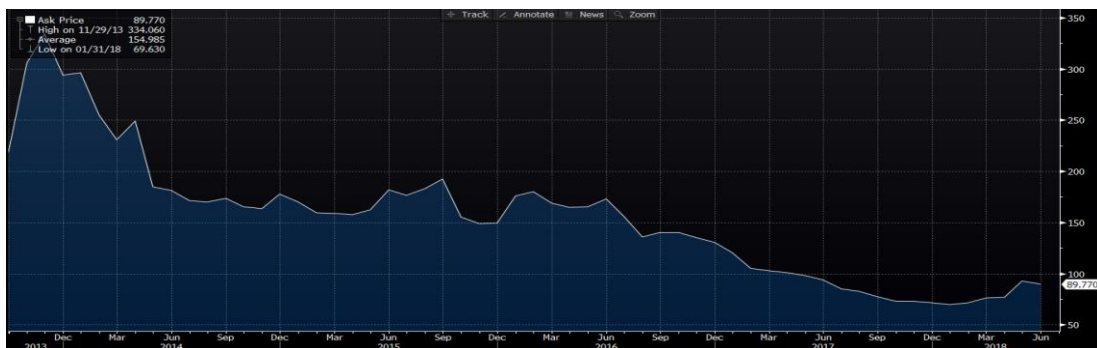
CDS Use Case : Applied to Eliminate Credit Exposure



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Sample CDS Historical Pricing

- India Sovereign CDS
 - CDS on 5yr USD General Obligation issued by India
 - Bloomberg screen-shot covering 2013-18 mid-price



Simplistic CDS Pricing Logic

- Assume we are pricing a BBB+ rated Corp XYZ 1yr CDS in EUR
- EUR 1-yr IRS = 3% p.a. (consider this the EUR “riskless” rate)
- Corp XYZ has a 2.5% probability of defaulting on EUR-based obligation in the next year
- If Corp XYZ does default, it is estimated that the recovery rate will be 40% of what they owe
 - This means their Loss Given Default (LGD) is 60%
- What is the minimum you can charge Corp XYZ on a 1yr bond issued at par in terms of YTM?

Use Case: Synthetic Bonds using CDSs

- Assume bond fund manager seeks the following investment:
 - To buy \$100m of SingTel USD 5yr bonds
 - But there are no SingTel USD 5yr bonds issued, so on behalf of the fund, a bank combines the following two instruments/positions:
 - Buy a US Treasury 5yr Note, YTM = 3% (\$100m of par)
 - Sell credit default swap protection on SingTel for 5yrs earning the annual credit spread of 50 basis points p.a. on notional amount of \$100m
 - Bank takes pledge of Treasury note as collateral against performance on the CDS (if the CDS pay-out is triggered, note is liquidated to cover pay-out obligation)
 - The combination of buying a low-risk bond and selling credit protection on a risky credit, is called a Credit-linked Note, CLN
-

CLN: Two Potential Outcomes for Investor

No default by SingTel:

- Fund collects all UST coupons and the CDS credit spread, total yield = ____% p.a.
- T-note repays par at 5yr maturity
- CDS expires with ____ obligation

SingTel Defaults:

- Fund ____ collecting coupons and spread payments
- CDS pay-out by Fund = $(1 - \text{recovery \%}) \times \text{____}$
- US T-note sold at market value, from which CDS pay-out is _____. Remainder returned to Fund in lieu of par



End of Lecture 5

Final Q&A



End of Daniel's Lectures

*Good luck in second half of the course
Prepare for midterm 20 Sep
Contact me any time at
danielstone@frablackstone.com*