Swap Pricing Convention
Before and After the GFC

What happened outside of the classroom?

Jul 11th 2022

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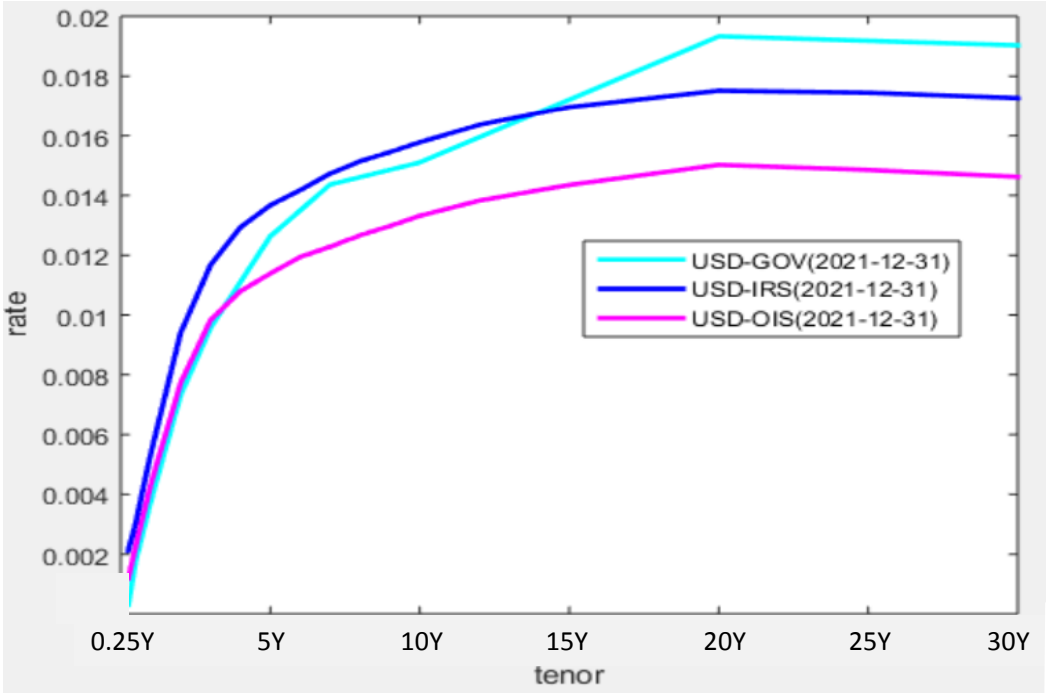
Objectives

- Walk through how swap discounting convention has changed from before the GFC to after the GFC, i.e. single curve discounting → dual curve discounting.
- Understand the rationale of collateral driven discounting and OIS rates(indexed to RFR) coming into risk free rates.
- Identify the inherent risks of non-collateralized swap transactions that is able to justify the valuation adjustment.
- Find out challenges to achieve the fair value pricing in the domestic swap market.

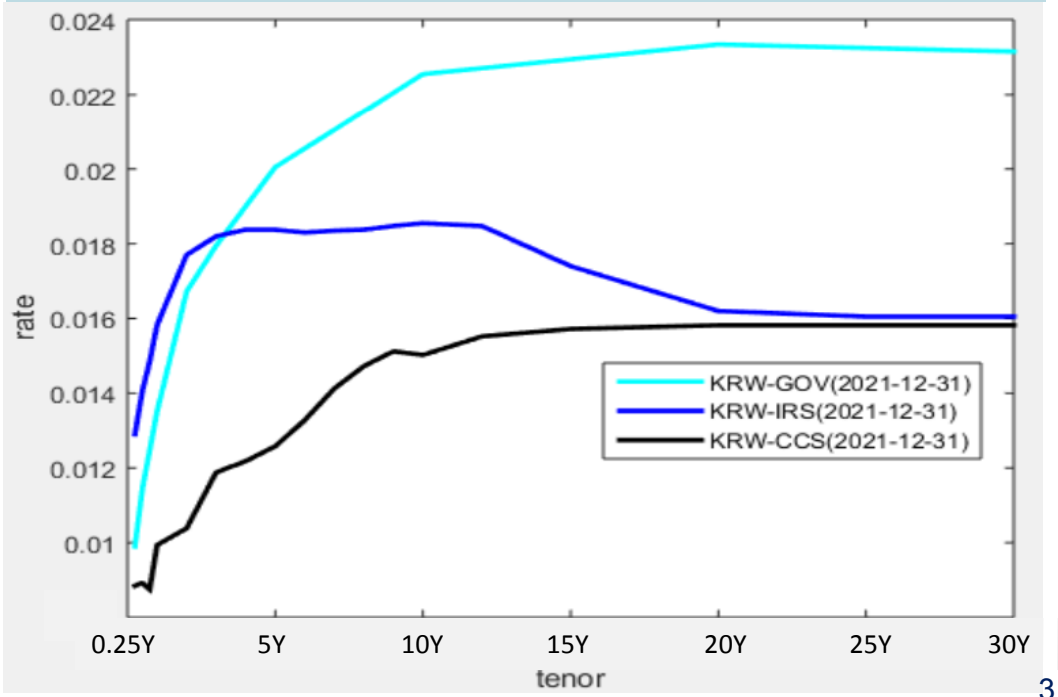
Quiz 1 – Risk Free Curve

- Before the GFC, **which USD curve was used as risk free curve** out of IRS, Gov't bond and OIS curve?
- Now, **which USD curve is used as risk free curve** among IRS, Gov't bond and OIS curve?
- Before the GFC, **which KRW curve was used as risk free curve** out of IRS, Gov't bond and CCS curve?
- Now, **which KRW curve is used as risk free curve** among IRS, Gov't bond and CCS curve?

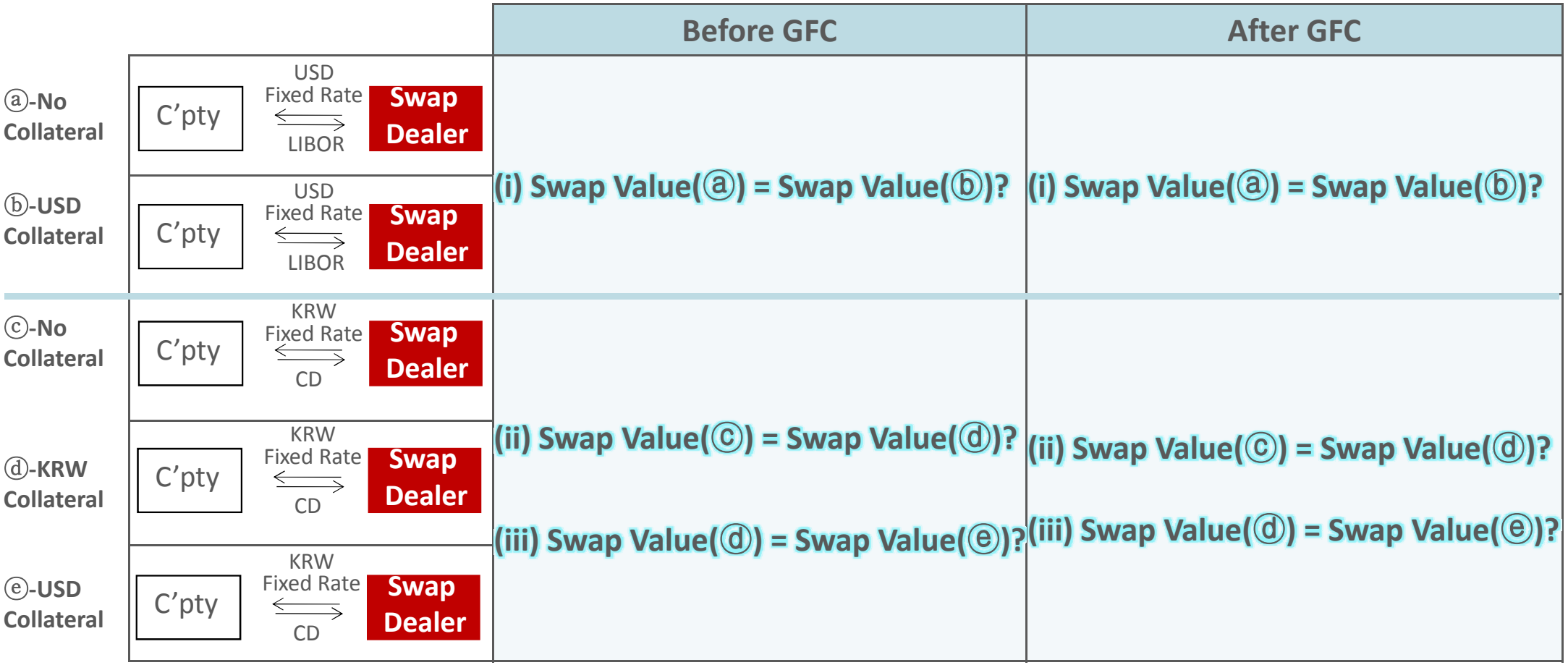
USD Curves(Dec 31st 2021)



KRW Curves(Dec 31st 2021)



Quiz 2 – Swap Value (True or False)

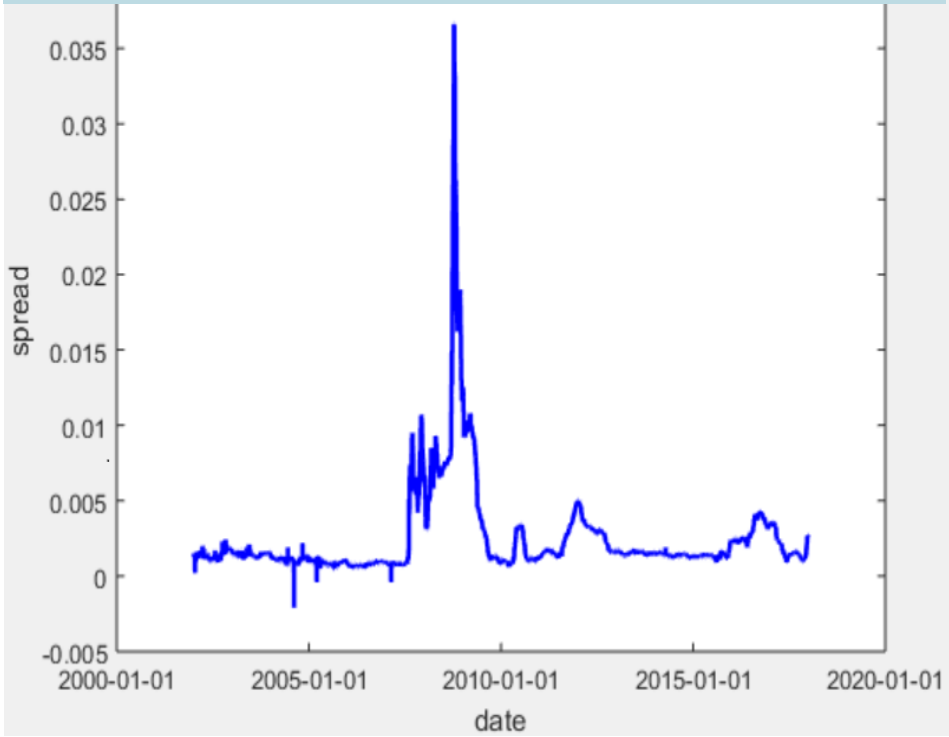


Over-rated LIBOR before the GFC

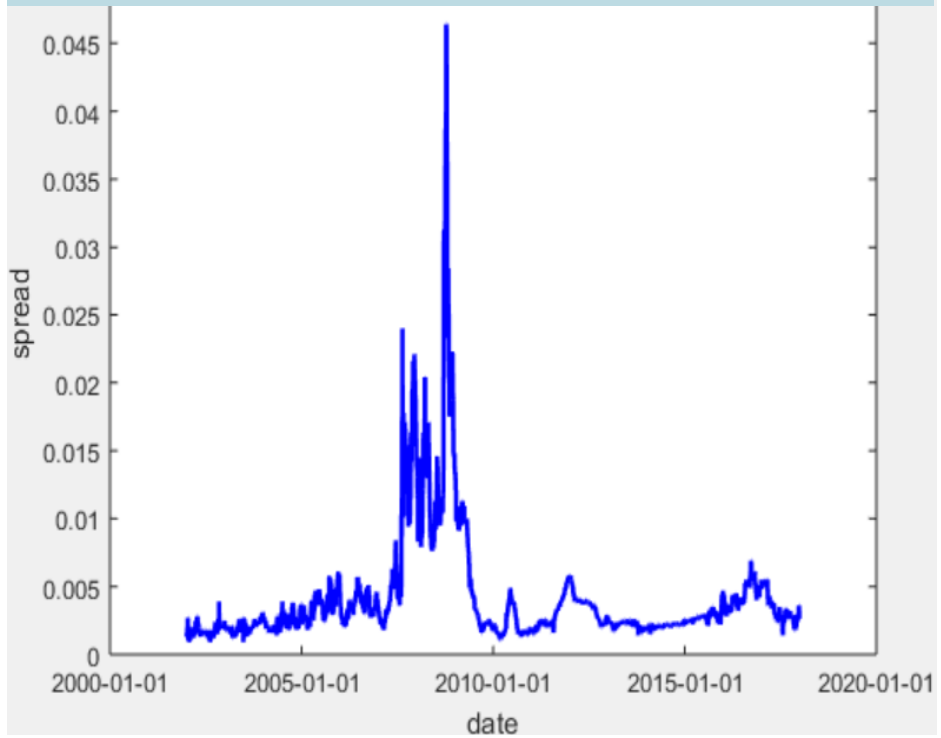
- LIBOR used as Landmark Index in derivatives products, loan and funding since 1990.
- Market participants not bothered with discounting default risk of swap dealers.
- LIBOR as unsecured funding rate not that higher than overnight funding rate.
- Swap rates indexed to LIBOR used as the proxy of risk free rates.

LIBOR as Credit Risky Index

USD Spread ($LIBOR_{3M}$-OIS_{3M})

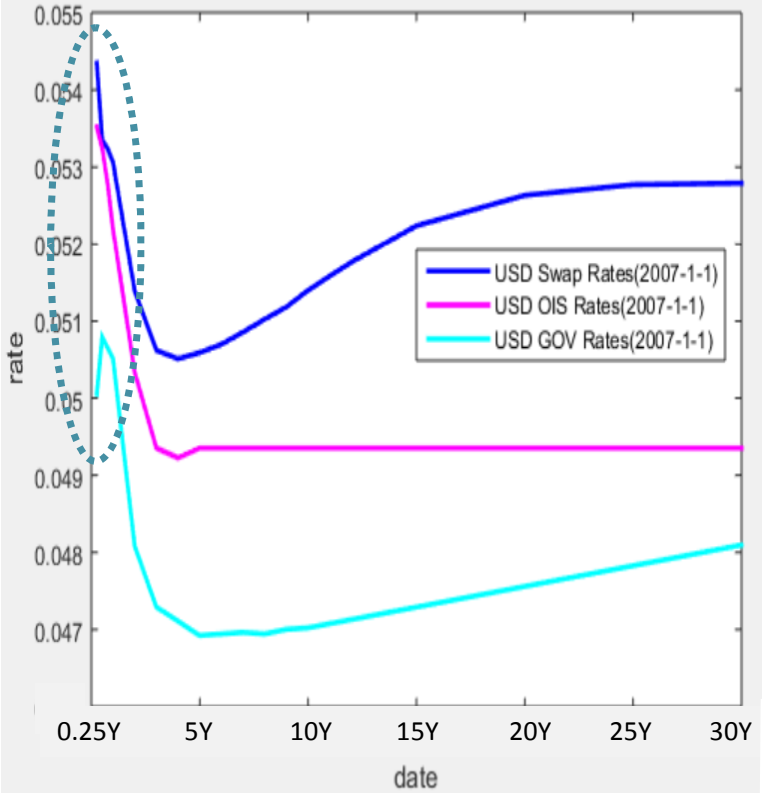


USD Spread ($LIBOR_{3M}$-T $Bill_{3M}$)

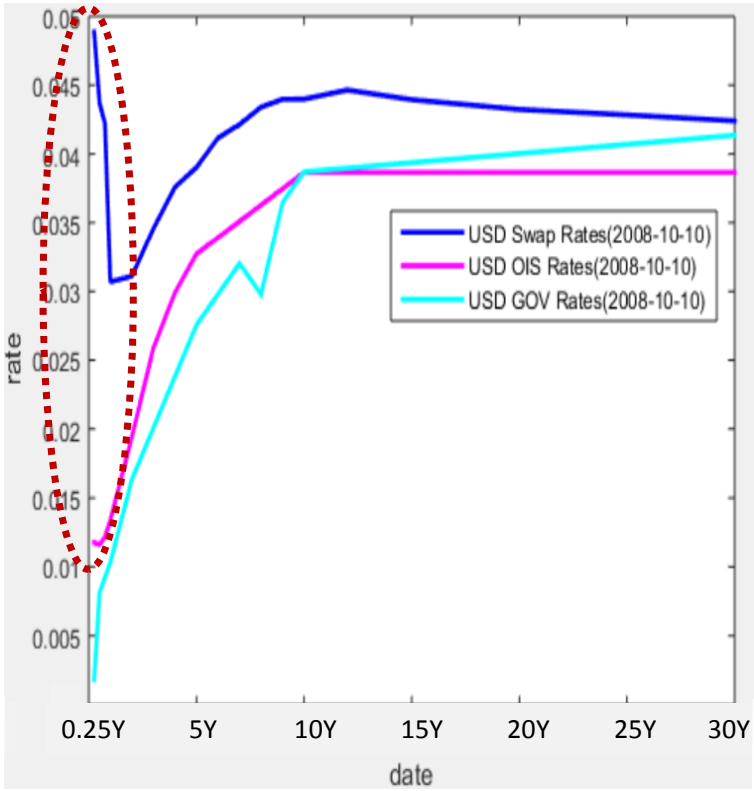


USD 3M Rates during the GFC

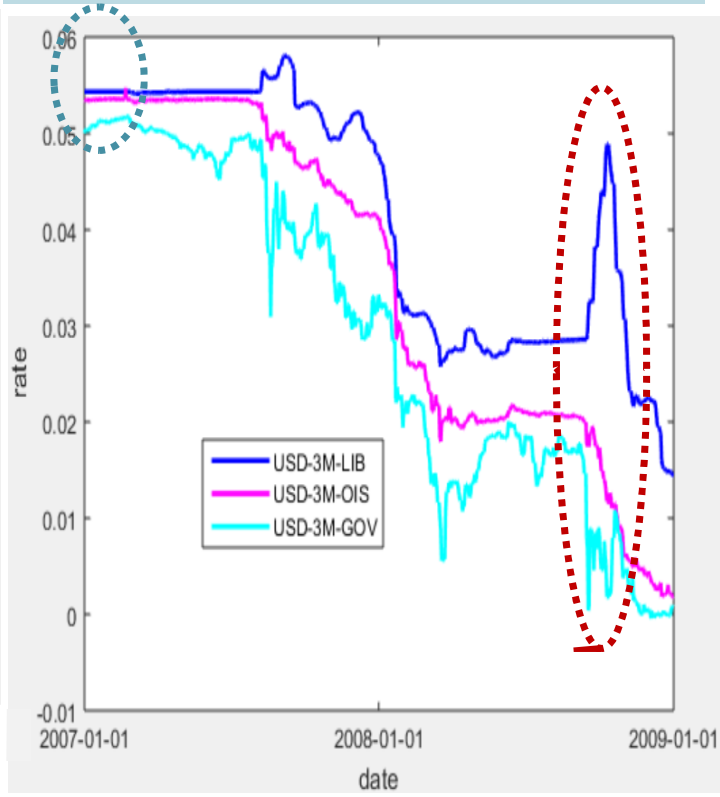
Jan 1st 2007



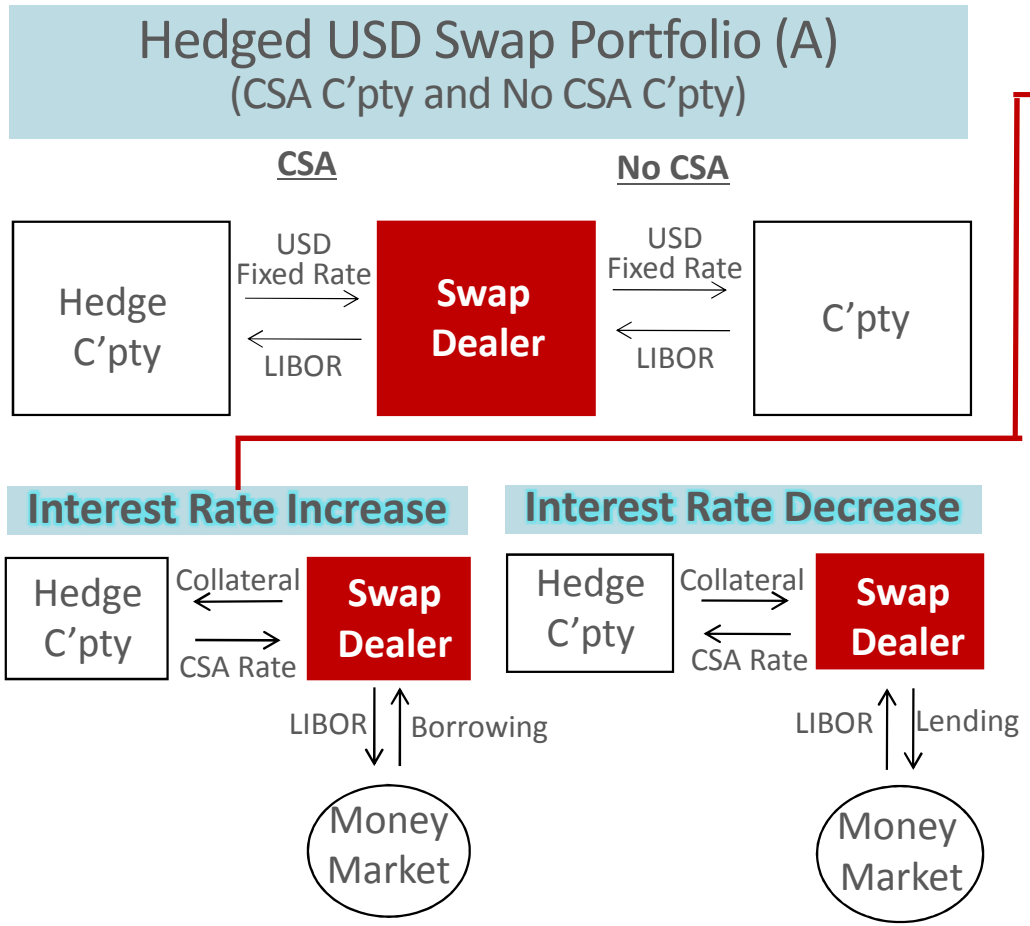
Oct 10th 2008



Jan 2007 to Dec 2008
(USD 3M Rates)



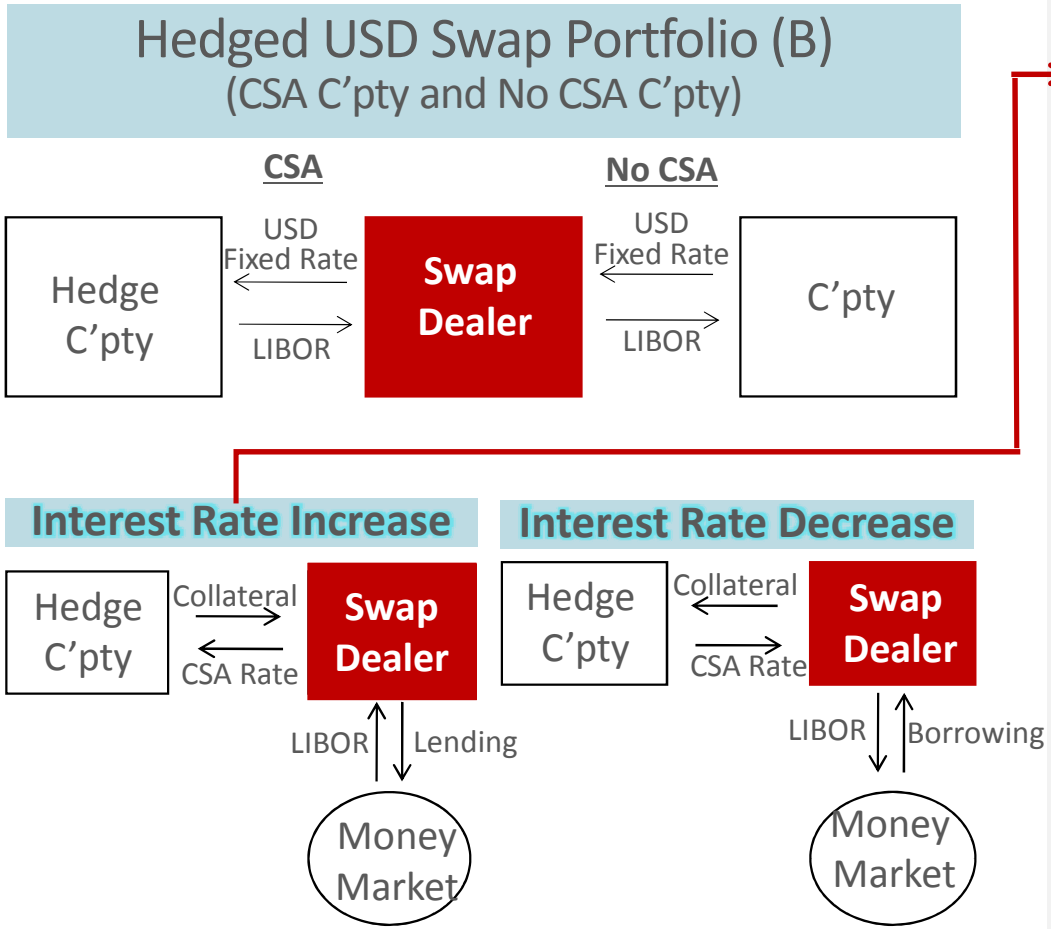
Consequence of LIBOR Spike



- USD swap rates going up, swap dealer to post collateral with short term funding and receive CSA rate.
- LIBOR spiking up, (i) funding cost to swap dealer surged and (ii) credit risk of unsecured c'pty to swap dealer much heightened

→Collateral asymmetry pumped funding cost and credit risk to swap dealer

Consequence of LIBOR Spike



- USD swap rates going up, swap dealer to receive collateral and pay CSA rate.
- LIBOR spiking up, (i) funding benefit to swap dealer surged, (ii) credit risk of swap dealer to unsecured c'pty much heightened

→Collateral asymmetry caused funding benefit to swap dealer and credit risk of swap dealer to unsecured c'pty

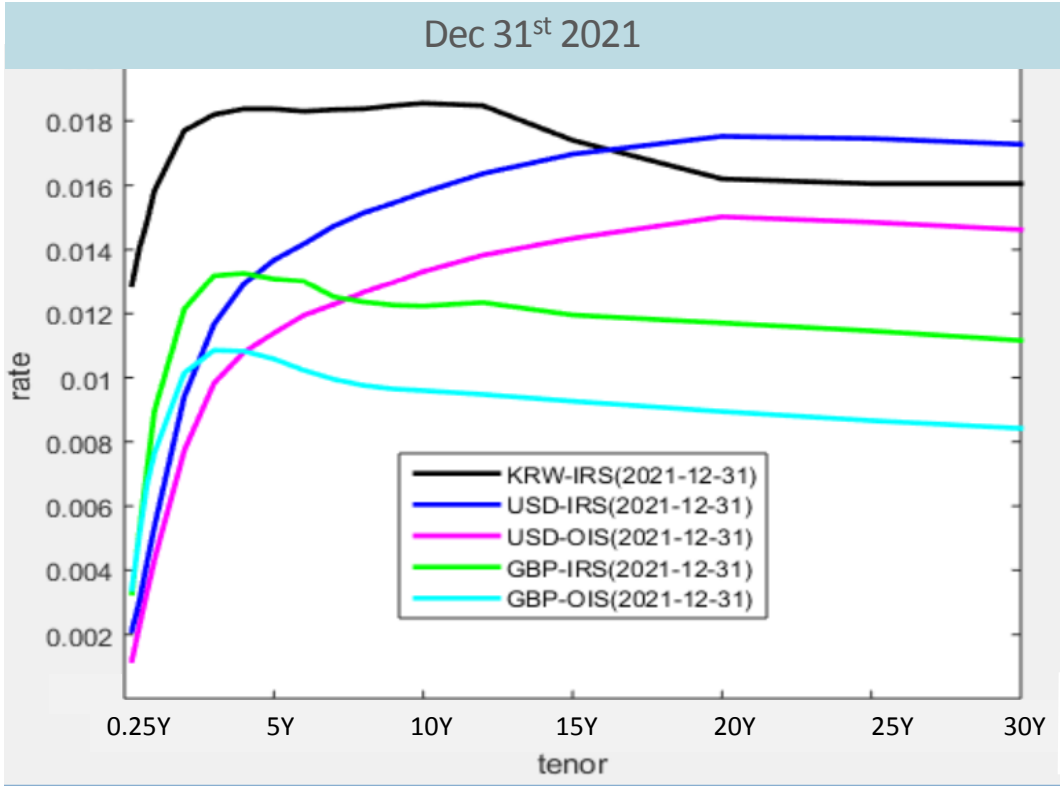
Transition of LIBOR to RFR

- After the GFC, CCP Clearing and Global Margin pushed collateralized swap transactions to grow substantially.
- Benchmark rapidly moved to RFR from LIBOR.
- OIS rates indexed to RFR newly accepted as risk free rates.
- Swap pricing re-organized from single curve discounting to dual curve discounting.

Single and Dual Curve Discounting

- Before the GFC - **single curve discounting**, collateral not considered
- After the GFC – **dual curve discounting**, collateral considered

		USD Swap			KRW Swap		
CSA		No	Yes	Yes	No	Yes	Yes
Collateral Currency		-	USD	GBP	-	KRW	USD
Before GFC	Cash Flow	USD/ LIBOR	USD/ LIBOR	USD/ LIBOR	KRW/ CD	KRW/ CD	KRW/ CD
	Discounting	**USD/ LIBOR**	**USD/ LIBOR**	**USD/ LIBOR**	**KRW/ CD**	**KRW/ CD**	**KRW/ CD**
After GFC	Cash Flow	USD/ LIBOR	USD/ LIBOR	USD/ LIBOR	KRW/ CD	KRW/ CD	KRW/ CD
	Discounting	***USD/ OIS**	***USD/ OIS**	**GBP/ OIS**	****KRW/ CD (To be KRW/OIS)**	****KRW/ CD (To be KRW/OIS)**	***USD/ OIS**



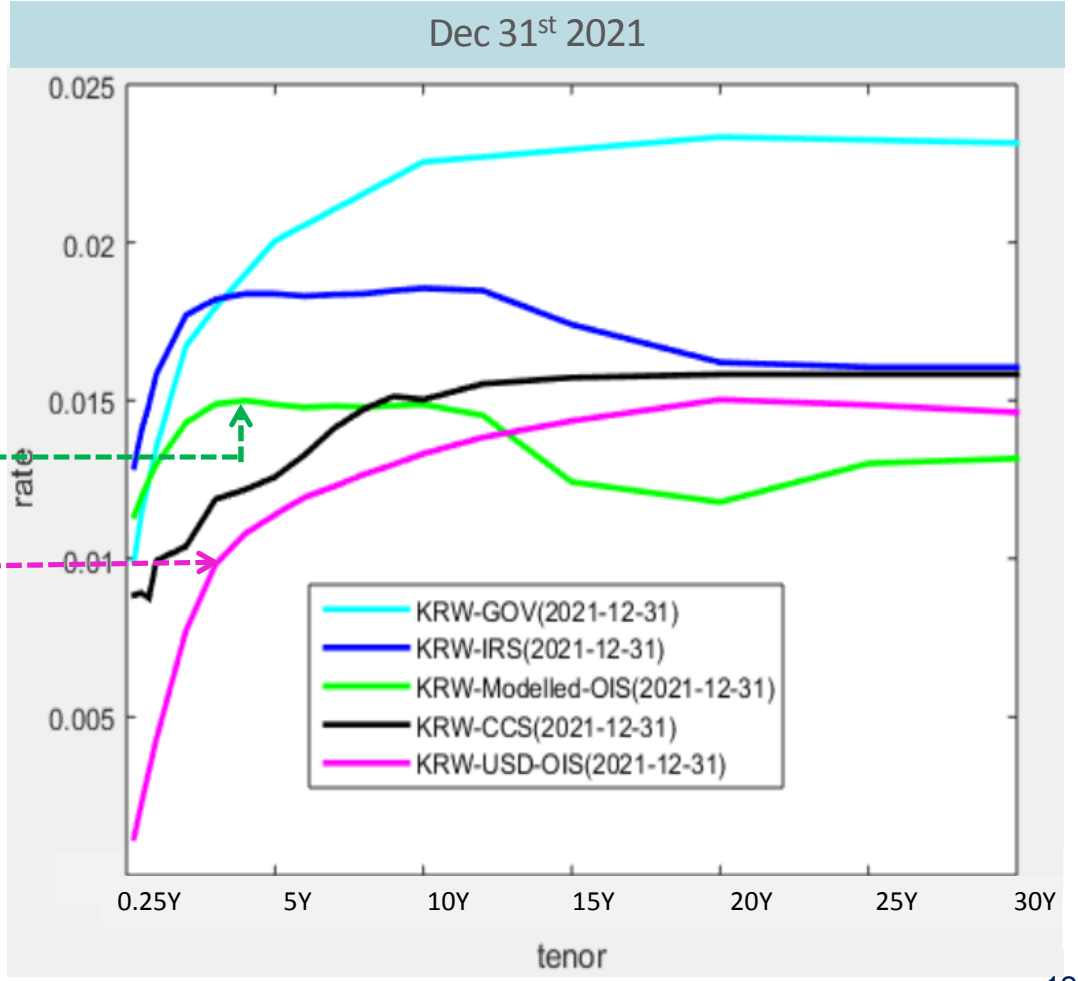
***After the GFC, USD swap without CSA is priced by USD/OIS, however, PV(USD/OIS) should be adjusted upon funding and credit risk.**
****KRW/CD is used for pricing in the absence of KRW/OIS, but KRW/CD should be replaced with KRW/OIS, once KRW OIS has been traded.**

KRW Curve from KRW and USD Collateral

		KRW Swap		
CSA		No	Yes	Yes
Collateral Currency		-	KRW	USD
After GFC	Cash Flow	KRW/CD	KRW/CD	KRW/CD
	Discounting	***KRW/ Modeled OIS**	***KRW/ Modeled OIS**	**USD/OIS**

***KRW/Modeled OIS is an estimated one(by HW1F).**

- For KRW swap with KRW collateral cleared through KRX CCP, its pricing should be done by KRW curve like KRW/Modeled OIS.
- For KRW swap with USD collateral, USD/OIS to be converted to KRW curve, which is used for discounting KRW cash flow, i.e. KRW swap cleared through CME is priced by KRW curve derived from USD/OIS.



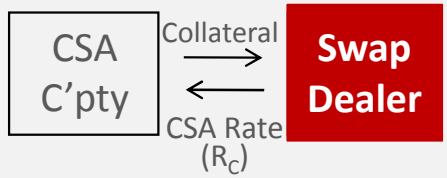
Rationale of Collateral Driven Discounting

	t		T		Rate
Internal borrowing	*(a)*	V_t	*(a)'*	$-V_t(1+R_L)^T$	R_L
Loan to outside	***(b)***	$\mathbf{-V_t}$	***(b)'***	**100**	**?**
Collateral from outside	*(c)*	V_t	*(c)'*	$-V_t(1+R_C)^T$	R_C
Repayment of borrowing	*(d)*	$-V_t$	*(d)'*	$V_t(1+R_L)^T$	R_L

- Value at t: *Zero = (a)+(b)+(c)+(d)*
- Value at T: *Zero = (a)'+(b)'+(c)'+(d)',* where no arbitrage condition holds

$$100 = V_t(1+R_L)^T+V_t(1+R_C)^T-V_t(1+R_L)^T$$
$$100 = V_t(1+R_C)^T$$
$$\mathbf{V_t = 100/(1+R_C)^T}$$

- Under CSA, collateral cost is RFR as CSA rate, i.e. R_C.

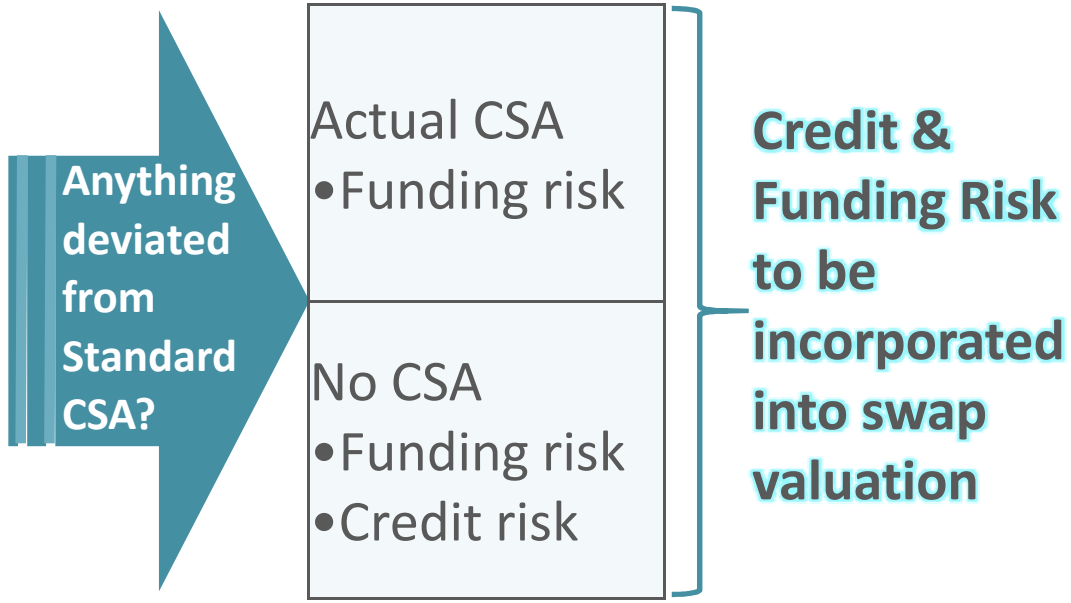


- For collateralized swap, OIS curve indexed to RFR has been used for discounting since the GFC.
- **Collateralized swap is nothing but funding instrument**

Standard CSA World & Standard Discounting

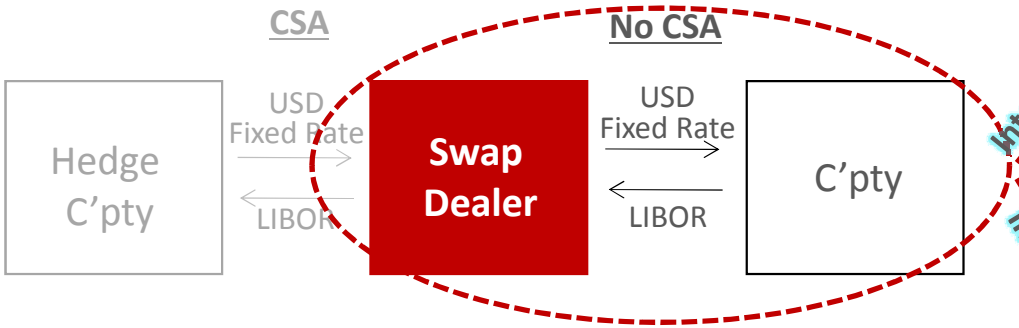
	Standard CSA	Standard Discounting	Remark
USD Swap	USD Cash, US Treasury(TT*)	USD/SOFR	From OIS market
GBP Swap	GBP Cash, UK Treasury(TT*)	GBP/SONIA	From OIS market
EUR Swap	EUR Cash, EURO Treasury(TT*)	EUR/ESTR	From OIS market
JPY Swap	JPY Cash, JPN Treasury(TT*)	JPY/TONAR	From OIS market
KRW Swap	KRW Cash, KOR Treasury(TT*)	KOR/KOFR	To be from OIS market

*TT stands for Title Transferred.



Credit and Funding Risk without Collateral

Hedged USD Swap Portfolio (A)
(CSA C'pty and No CSA C'pty)

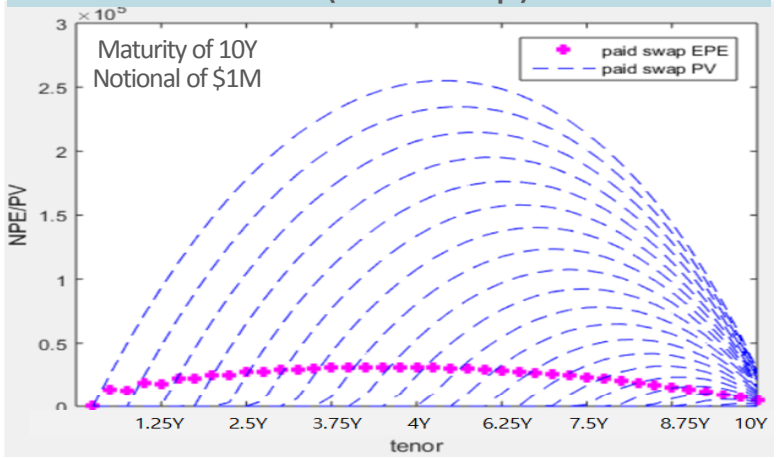


Interest Rate Increase

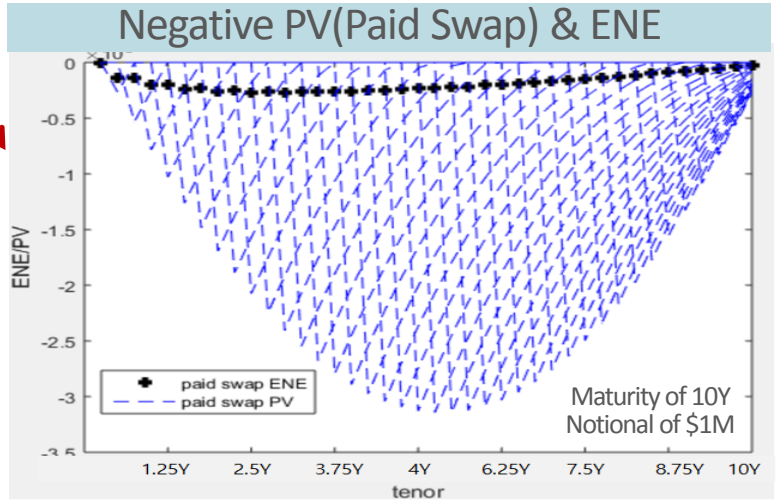
Interest Rate Decrease

Positive PV (Paid Swap)	What if unsecured c'pty goes on default?	Loss from credit event
	What if funding spread(LIBOR-OIS) surges?	Funding cost higher
Negative PV (Paid Swap)	What if swap dealer goes on default?	Gain from credit event
	What if funding spread(LIBOR-OIS) surges?	Funding benefit higher

Positive PV(Paid Swap) & EPE



Negative PV(Paid Swap) & ENE



Types of Valuation Adjustment

- Firstly, **swap is priced by OIS rates**, regardless of collateral.
- Secondly, **any deviation from Standard CSA is reflected into swap value**, which is so called the valuation adjustment

Positive PV (Paid Swap)	Loss from credit event	**CVA** (Credit Valuation Adjustment)
	Funding cost higher	**FCA** (Funding Cost Adjustment)
Negative PV (Paid Swap)	Gain from credit event	**DVA** (Debt Valuation Adjustment)
	Funding benefit higher	**FBA** (Funding Benefit Adjustment)

$$PV_{Unsecured} = PV_{Secured} - CVA + DVA - FCA + FBA$$

$PV_{Secured}$ is obtained by using USD/OIS rates indexed to RFR

- What if no credit risk but funding risk only?

$$PV_{Unsecured} = PV_{Secured} - FCA + FBA$$
$$PV(LIBOR) = PV(OIS) - FCA + FBA$$

- What if no funding risk but credit risk only?

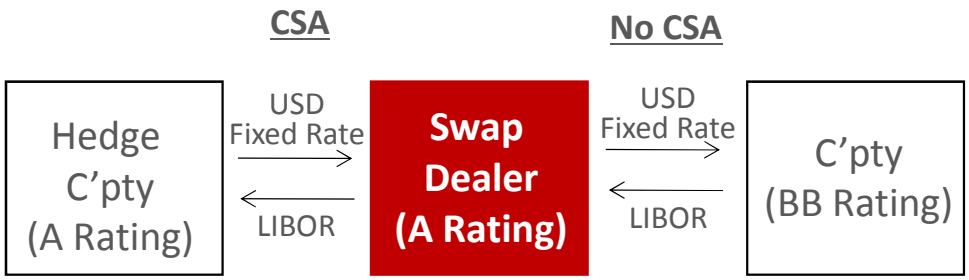
$$PV_{Unsecured} = PV_{Secured} - CVA + DVA$$

Example of Valuation Adjustment

- Hedged Swap Portfolio (A) is always valued at zero, in case the valuation adjustment is ignored.
- However, **the valuation adjustment highlights how much cost swap dealer should bear**, thanks to non-collateralized swap.

Hedged USD Swap Portfolio (A)
(CSA C'pty and No CSA C'pty)

- Trade Date: 2021-12-31
- Tenor: 10Y
- Notional: $1M
- Recovery Rate: 40%



(Unit: USD)

			IRS^{Paid}	IRS^{Received}
C'pty	CVA		6,611	
	DVA		806	
Hedge C'pty	FVA			970
		FCA		2,209
		FBA		1,239
Adjusted Value	***-CVA+DVA-FVA***		***-6,775***	

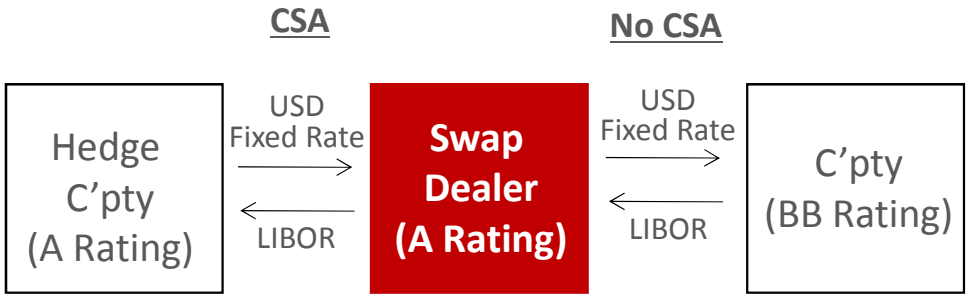
Note) The adjusted value is estimated, using interest rate binomial tree by Ho-Lee model.

Example of Risk Metrics by the Valuation Adjustment

- Hedged Swap Portfolio (A) will be shown no risks, in case the valuation adjustment is ignored.
- However, **the risks that swap dealer runs will be popped up through the valuation adjustment**.

Hedged USD Swap Portfolio (A)
(CSA C'pty and No CSA C'pty)

- Trade Date: 2021-12-31
- Notional: $1M
- Tenor: 10Y
- Recovery Rate: 40%



(Unit: USD)	Risk Sensitivity
$DV01_{IRS}$	-192
$DV01_{OIS}$	54
$Vega_{IRS}$	-517
$Vega_{OIS}$	349
$CS01_{A\text{-}Rating}$	-6
$CS01_{BB\text{-}Rating}$	-46

Note) The risk sensitivity is calculated by using interest rate binomial tree with Ho-Lee model.
Vega is by 1bp up in normal volatility.

Challenges Post KOFR

- Promote the growth of KOFR Futures and KRW OIS indexed to KOFR.
- Generate KRW OIS curve as KRW risk free curve across the short and long end to keep up with the global standard.
- Infer the KOFR forward term rates from KOFR Futures price.
- Introduce the valuation adjustment to any swap transactions away from the standard CSA.

No one knows the fair price. However, the market is constantly pursue a fair price.

Thank You!!