

Cross Currency Swap Trading & Pricing Formulae - A PowerPoint Overview with Excel Pricing Examples

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Executive Summary

Swap Preliminaries

- Interest Rate Swaps
- Yield Curves
- Rates Trading, Pricing & Risk

Xccy Swaps

- Xccy Swap Theory - Formulae
- Xccy Swap Practice - Pricing Demo

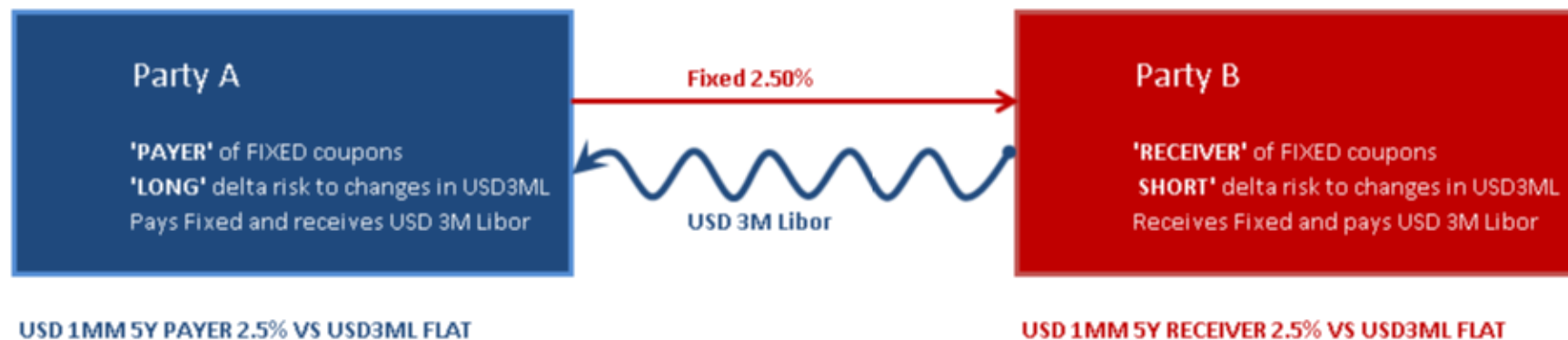
Detailed Notes

<https://ssrn.com/abstract=3278907>



Interest Rate Swaps Market

- **Notional Outstanding \$200tn**: Traded in large volume
- **Very Liquid** : Bid-Offer 1/10th Basis Point i.e. 0.001%
- **Swap Cashflows**: Each set of cashflows called the trade 'leg'
- **Typically Fixed-Float**: or Float-Float for Basis Swaps
- **Payer/Receiver**: of Fixed cashflows, but long/short the risk
- **Quoted at Par**: Zero upfront cost



Swap Pricing Terminology

Pricing Terminology

- **PV**: Present Value or Price
- **Basis Points (bps)**: 1/100th of a percent i.e. $1\text{bps} = 0.01\%$
- **Par Rate**: The fixed rate in % to make the trade PV zero
- **Par Spread**: The float spread in bps to make trade PV zero
- **PV01**: PV sensitivity to forward rates, also called Annuity
- **DV01**: PV sensitivity to forward rates and discount factors

Quotation

- **New Deals**: Quoted as a par rate or a spread over Treasuries
- **Bespoke Deals**: Quoted as a PV, since not trading at par
- **Basis Trades**: Float-Float deals are quoted as a par spread

Bloomberg Trading Venue

Bloomberg Trading Portal, BBTI - Interest Rate Swaps

Interest Rate Swaps				2) Tools	3) Settings
Venue	BGL	Currency		USD	
5) Outright	6) Curves	7) Butterflies	8) Rolls	9) Basis	
10) S/A v 3M	11) S/A v 1M	12) S/A v 6M	13) Ann v 3M	14) MAC S	
Semi-annual v 3 Month Libor					
Tenor	Bid / Ask		Change		
30) 6 Months	2.668 / 2.673		-0.006		
31) 12 Months	2.643 / 2.647		-0.010		
32) 18 Months	2.605 / 2.610		-0.015		
33) 2 Year	2.552 / 2.555		-0.019		
34) 3 Year	2.481 / 2.484		-0.026		
35) 4 Year	2.453 / 2.456		-0.027		
36) 5 Year	2.453 / 2.456		-0.027		
37) 6 Year	2.472 / 2.475		-0.028		
38) 7 Year	2.497 / 2.500		-0.028		
39) 8 Year	2.527 / 2.530		-0.028		
40) 9 Year	2.559 / 2.562		-0.028		
41) 10 Year	2.591 / 2.594		-0.028		
42) 12 Year	2.648 / 2.651		-0.027		
43) 15 Year	2.705 / 2.708		-0.026		
44) 20 Year	2.750 / 2.754		-0.025		
45) 25 Year	2.762 / 2.766		-0.024		
46) 30 Year	2.765 / 2.769		-0.023		
47) 40 Year	2.743 / 2.748		-0.023		
48) 50 Year	2.707 / 2.714		-0.026		

Swaps as a Spread over US Treasuries

Par Rate = US Treasury Yield + Spread (Bps)

IRS Trading Portal					
S/A	15) IMM S/A	16) IMM Ann	17) OIS	18) SOFR	19) FOMC
Spreads v Treasuries					
Tenor	Bid		Ask	Change	
1 Year	14.627		15.614	-0.794	
70) 2 Year	9.991		10.374	+0.068	
71) 3 Year	8.082		8.432	-0.262	
4 Year	5.250		5.535	-0.385	
72) 5 Year	5.053		5.446	-0.360	
6 Year	2.500		2.875	-0.253	
73) 7 Year	0.356		0.671	-0.308	
8 Year	0.503		0.809	-0.877	
9 Year	-0.125		0.500	-0.377	
74) 10 Year	0.072		0.441	-0.471	
12 Year	6.113		6.424	-1.038	
15 Year	1.125		1.375	-0.563	
20 Year	-4.875		-4.500	-0.565	
25 Year	-13.500		-13.000	-1.125	
75) 30 Year	-24.171		-23.786	-0.715	

Interest Rate Swap Pricing

Swap Specification & Pricing

To specify a swap many parameters are required to generate the swap cashflow schedules accurately. To price a swap we require Libor forecast rates, OIS discount rates and a Swap pricing formula.

$$PV^{Swap} = N \sum_{\forall i} r^{Fixed} \tau_i P(t_0, t_i) - N \sum_{\forall j} (L_j + s) \tau_j P(t_0, t_j)$$



Bloomberg Swap Manager, SWPM

Par Swap - 5Y Receiver vs USD3ML

GBP-EUR X-RATE Curncy | SWPM | Related Functions Menu

Message ★ [Icons] ?

91) Actions ▾ 92) Products ▾ 93) Views ▾ 94) Info ▾ 95) Settings ▾ Swap Manager

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

Swap

Leg 1:Fixed ▾	Receive ▾	Leg 2:Float ▾	Pay ▾
Notional	1MM	Notional	1MM
Currency	USD	Currency	USD
Effective	0D 03/26/2019	Effective	0D 03/26/2019
Maturity	5Y 03/26/2024	Maturity	5Y 03/26/2024
Coupon	2.288000 %	Index	3M US0003M
Pay Freq	SemiAnnual ▾	Spread	0.000 bp
Day Count	30I/360 ▾	Leverage	1.00000
Calc Basis	Money Mkt ▾	Latest Index	2.60988
		Reset Freq	Quarterly ▾
		Pay Freq	Quarterly ▾
		Day Count	ACT/360 ▾

Valuation Settings

Curve Date 03/22/2019

Valuation 03/26/2019

CSA Coll Ccy USD

☒ OIS DC Stripping

Market

Leg 1: NPV	108,088.45	Leg 2: NPV	-108,088.45
Accrued	0.00	Accrued	0.00
Premium	10.81	Premium	-10.81
DV01	29.03	DV01	443.39

Valuation Results

Par Cpn	2.288000	Premium	0.00000
Principal	0.00	BP Value	0.00000
Accrued	0.00		
NPV	0.00		

22) Calculators ▾

PV01	472.41
DV01	472.42
Gamma (1bp)	0.25

300) Edit Panel 301) Expand Panel

549 APW 23:08 A Look At Russians Who Became Mixed Up in Trump Probe

548 NYP 23:08 New York Post: Judge cites Second Amendment in striking down NY ta

547 NYP 23:08 New York Post: Inside Ja Morant's and Murray State's lives as over

1-BLOOMBERG 3-BLOOMBERG 4-BLOOMBERG 2-BLOOMBERG

IRS Pricing Formula

Fixed Leg

$$PV(Fixed) = N \times r^{Fixed} \underbrace{\sum_{\forall i} \tau_i P(t_0, t_i)}_{Annuity}$$

Float Leg

$$PV(Float) = N \sum_{\forall j} (L_j + s) \tau_j P(t_0, t_j)$$

Swap Price

$$PV(Swap) = \phi(PV(Fixed) - PV(Float))$$

Swap Rate

$$ParRate = \frac{PV(Float)}{N \times Annuity}$$

Other Swap Types

- ① **Interest Rate Swaps** - Rate Hedging
- ② **Tenor Basis Swaps** - Frequency Matching
- ③ **Xccy Swaps** - Funding in another Currency
- ④ **Asset Swaps** - Bond & Corporate Financing
- ⑤ **Credit Default Swaps** - Hedging Counterparty Risk
- ⑥ **Inflation Swaps** - Inflation Hedging

Libor Benchmark Rate Reform [New Swaps]

- Risk-Free Curves (RFRs)
- Alternative Reference Rates (ARRs)
- SOFR Swaps - Secured Overnight Funding Rate

Xccy Swap Overview

Xccy Basis Swaps

- Exchange a set of cashflows for an equivalent set in another currency
- Used to secure cheaper funding in a different currency, manage FX exposures and liquidity risk

Features

- Marked-to-Market (MTM)
- Notional Resets to Reduce Credit Exposures
- Choice of Valuation Currency
- Spot FX Required
- Multi-Currency Yield Curves Required
- OIS Discounting with Foreign CSA Collateral
- Xccy Par-Spread usually on Non-USD leg

Bloomberg MtM Xccy Swap USD/EUR

USD/EUR MtM Xccy Swap 1Y

91) Actions ▾	92) Products ▾	93) Views ▾	94) Info ▾	95) Settings ▾	Swap Manager
Solver (Premium) ▾	Load	Save	Trade ▾	CCP ▾	
3) Main	4) Details	5) Curves	6) Cashflow	7) Resets	9) Scenario
10) Risk	12) Matrix				
Deal	MTM XCCY Swap	Counterparty	SWAP CNTRPARTY	+ Ticker / SWAP	20) Properties
Swap	*Notional Reset b...		3 Month Euribor	Valuation Settings	
Leg 1:Float	Receive ▾	Leg 2:Float	Pay ▾	Curve Date	03/22/2019
Notional	1MM	Notional	884,799.15	Valuation	03/26/2019
Currency	USD ▾	Currency	EUR ▾	CSA Coll Ccy	USD ▾
Effective	0D 03/26/2019	Effective	0D 03/26/2019	Valuation Ccy	USD ▾
Maturity	1Y 03/26/2020	Maturity	1Y 03/26/2020	FX Rate	1.130200
Index	3M US0003M	Index	3M EUR003M	<input checked="" type="checkbox"/> OIS DC Stripping	
Spread	0.000 bp	Spread	-12.625 bp		
Leverage	1.00000	Leverage	1.00000		
Latest Index	2.60988	Latest Index	-0.30900		
Reset Freq	Quarterly ▾	Reset Freq	Quarterly ▾		
Pay Freq	Quarterly ▾	Pay Freq	Quarterly ▾		
Day Count	ACT/360 ▾	Day Count	ACT/360 ▾		
Market					
Leg 1: NPV	1,002,566.12	Leg 2: NPV	-1,002,566.12		
Accrued	0.00	Accrued	0.00		
Premium	100.26	Premium	-100.26		
DV01	22.74	DV01	-22.74		
Valuation Results				22) Calculators ▾	
Principal	0.00	Premium	0.00000	BR01 92:EUR vs.	-102.10
Accrued	0.00	BP Value	0.00000	DV01	0.00
NPV	0.00			Gamma (1bp)	0.00

Bloomberg Xccy Swap - USD Leg

USD/EUR MtM Xccy Swap 1Y - USD Leg

91) Actions ▾		92) Products ▾		93) Views ▾		94) Info ▾		95) Settings ▾		Swap Manager	
Solver (Premium) ▾				Load		Save		Trade ▾		CCP ▾	
3) Main		4) Details		5) Curves		6) Cashflow		7) Resets		9) Scenario	
10) Risk		11) Matrix		21) Cashflow Table		22) Cashflow Graph					
Cashflow		Leg 1: Receive Float ▾		<input type="checkbox"/> Historical Cashflows		Accrued		0.00			
Currency		USD		<input type="checkbox"/> Zero Rate		NPV		1,002,566.12			
				<input type="checkbox"/> Equiv. Coupon							
Pay Date	Accrual Start	Accrual End	Da...	FX Fixing Date	FX Rate	Notional	Principal	Reset Date			
06/26/2019	03/26/2019	06/26/2019	92			1,000,000.00	-7,613.37	03/22/2019			
09/26/2019	06/26/2019	09/26/2019	92	06/24/2019	0.87811	1,007,613.37	-7,662.23	06/24/2019			
12/27/2019	09/26/2019	12/27/2019	92	09/24/2019	0.87149	1,015,275.60	-7,305.65	09/24/2019			
03/26/2020	12/27/2019	03/26/2020	90	12/23/2019	0.86526	1,022,581.25	1,022,581.25	12/23/2019			

Bloomberg Xccy Swap - EUR Leg

USD/EUR MtM Xccy Swap 1Y - EUR Leg

91) Actions ▾		92) Products ▾		93) Views ▾		94) Info ▾		95) Settings ▾		Swap Manager	
Solver (Premium) ▾				Load		Save		Trade ▾		CCP ▾	
3) Main		4) Details		5) Curves		6) Cashflow		7) Resets		9) Scenario	
10) Risk		11) Matrix		21) Cashflow Table		22) Cashflow Graph					
Cashflow		Leg 2: Pay Float ▾		<input type="checkbox"/> Historical Cashflows		Accrued		0.00			
Currency		EUR		<input type="checkbox"/> Zero Rate		NPV		-887,069.65			
				<input type="checkbox"/> Equiv. Coupon							

Yield Curves, Fwd Rates & Disc Factors

Curve Construction & Dependencies

- 1 First Calibrate Standard/Native CSA Curves
- 2 Then build USD CSA Curves using Xccy Swaps
- 3 Then build Non-USD CSA Curves using FX Fwd Invariance

CSA Discount Factors

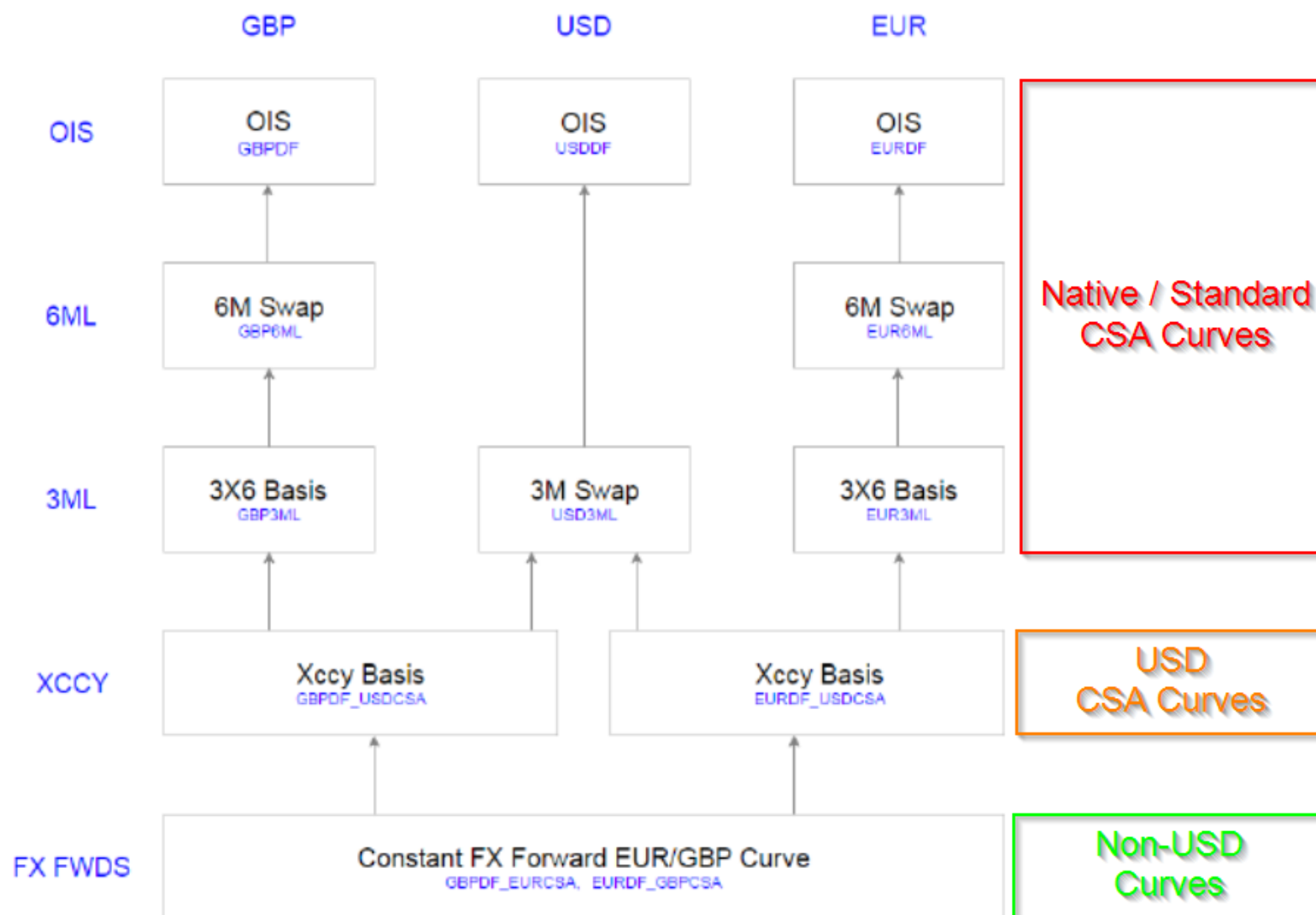
- Forward rates are independent of CSA
- Discount factors depend on CSA

Standard/Native CSA Disc Factors

- Native CSA discount factors same as No CSA
- Example: $\text{USDOIS_USDCSA} = \text{USDOIS}$

Curve Dependency Tree

Example: EURDF with GBP Collateral
EUROIS-GBPCSA



Xccy Curves - Discounting with Collateral

USD CSA Discount Factors

- Implied directly from market Xccy Swap Spreads
- Typically Xccy trades have a USD leg and post USD collateral

Example: USD/EUR Xccy

- We **know**: Par Spread, USDOIS, USD3ML and EURIBOR3M
- from which we **imply** EUROIS-USDCSA

Xccy Trade - Curves & DF Requirements

SWPM -FLFL -XCCY -MTM -USD 1MM 5Y

91) Actions ▾		92) Products ▾		93) Views ▾		94) Info ▾		95) Settings ▾		Swap Manager	
Solver (Premium) ▾				Load		Save		Trade ▾		CCP ▾	
3) Main		4) Details		5) Curves		6) Cashflow		7) Resets		8) Scenario	
9) Risk		10) Matrix									
Deal		MTM XCCY Swap		Counterparty		SWAP CNTRPARTY		Ticker / SWAP		20) Properties	
Swap		#Notional Reset b...		3 Month Euribor				Valuation Settings			
Leg 1:Float	Receive	Leg 2:Float	Pay	Curve Date	03/25/2019			Valuation	03/27/2019		
Notional	1MM	Notional	883,704.49	CSA Coll Ccy	USD			Valuation Ccy	USD		
Currency	USD	Currency	EUR	FX Rate	1.131600						
Effective	0D 03/27/2019	Effective	0D 03/27/2019								
Maturity	5Y 03/27/2024	Maturity	5Y 03/27/2024								
Index	3M US0003M	Index	3M EUR003M								
Spread	0.000 bp	Spread	-12.750 bp								
Leverage	1.00000	Leverage	1.00000								
Latest Index	2.60988	Latest Index	-0.31000								
Reset Freq	Quarterly	Reset Freq	Quarterly								
Pay Freq	Quarterly	Pay Freq	Quarterly								
Day Count	ACT/360	Day Count	ACT/360								
Market											
Dscnt	42 M USD OIS (ICVS L	Dscnt	403 M MBB USD Coll for EUR								
Fwd	23 M USD (30/360, S/A	Fwd	201 M EUR (vs. 3M EURIE								
Leg 1: NPV		1,011,849.88		Leg 2: NPV		-1,011,849.88					
Valuation Results								22) Calculators ▾			
Principal	0.00	Premium	0.00000	BR01 92:EUR vs.		-514.42					
Accrued	0.00	BP Value	0.00000	DV01		0.00					
NPV	0.00			Gamma (1bp)		0.00					

Non-USD CSA Curves

FX Forward Invariance

For Non-USD CSA calculations we assume FX forward invariance

FX Forward Invariance Example for EUR_JPYCSA

$$FwdFX(t, T)^{EUR/JPY} = S \underbrace{\frac{P(t, T)^{EUR_JPYCSA}}{P(t, T)^{JPY_JPYCSA}}}_{JPY_JPYCSA \text{ from OIS Curve}} = S \underbrace{\frac{P(t, T)^{EUR_USDCSA}}{P(t, T)^{JPY_USDCSA}}}_{\text{From Xccy Curve}}$$

where t denotes the valuation date, S the FX spot rate, $P(t, T)$ the discount factor at time t for tenor T with $0 \leq t \leq T$

Non-USD CSA Discount Factors

- Use LHS to imply from using FX Forwards
- Use RHS to imply from Xccy Basis quotes

Replication Logic

- We can create a synthetic EUR/JPY forward FX rate
- Borrow JPY, buy spot EUR/JPY and deposit the EUR
- The forward FX rate is constant for any given CSA

Xccy Swap Pricing Formula

FOR/DOM Xccy Price

$$PV(\Omega_{Xccy}) = \phi \left[PV(\Omega_{FOR}) - PV(\Omega_{DOM}) \right]$$

$$PV(\Omega_{Xccy}) = \phi \left[PV(\text{Cpn}, \Omega_{FOR}) + PV(\text{Exch}, \Omega_{FOR}) + PV(\text{Resets}, \Omega_{FOR}) \right. \\ \left. - PV(\text{Cpn}, \Omega_{DOM}) - PV(\text{Exch}, \Omega_{DOM}) - PV(\text{Resets}, \Omega_{DOM}) \right]$$

Example: USD/EUR MtM Xccy Swap

- Valuation Currency: USD
- Collateral Currency: USD
- Reset Currency: USD
- Quotation: EUR Par-Spread
- EUR Leg: 3M EURIBOR with EUROIS-USDCSA discounting
- USD Leg: 3M USD Libor with USDOIS discounting

Xccy Swap Pricing Formula [Expanded]

$$\begin{aligned}
 PV(\Omega_{Xccy}) = & \underbrace{\phi \left[\sum_{j=1}^m N_{t_0}^{FOR} \Psi(t_j)^{FOR} (l_j + s_{FOR}) \tau_j P(0, t_j)^{FOR-CSA} \right]}_{\text{Foreign Float Coupons}} \\
 & + \left(\underbrace{N_{t_0}^{FOR} \Psi(t_m)^{FOR} P(0, t_m)^{FOR-CSA}}_{\text{Foreign Final Exchange}} - \underbrace{N_{t_0}^{FOR} \Psi(t_0)^{FOR} P(0, t_0)^{FOR-CSA}}_{\text{Foreign Upfront Exchange}} \right) \\
 & + \underbrace{\mathbb{1}_{\{\Omega=MtM\}} \mathbb{1}_{\{FOR=C^{Reset}\}} \sum_{j=1}^{m-1} N_{t_0}^{FOR} \left(\Psi(t_j)^{FOR} - \Psi(t_{j+1})^{FOR} \right) P(0, t_j)^{FOR-CSA}}_{\text{Foreign Notional Resets}} \\
 & - \underbrace{\sum_{j=1}^m N_{t_0}^{DOM} \Psi(t_j)^{DOM} (l_j + s_{DOM}) \tau_j P(0, t_j)^{DOM-CSA}}_{\text{Domestic Float Coupons}} \\
 & - \left(\underbrace{N_{t_0}^{DOM} \Psi(t_m)^{DOM} P(0, t_m)^{DOM-CSA}}_{\text{Domestic Final Exchange}} - \underbrace{N_{t_0}^{DOM} \Psi(t_0)^{DOM} P(0, t_0)^{DOM-CSA}}_{\text{Domestic Upfront Exchange}} \right) \\
 & - \underbrace{\mathbb{1}_{\{\Omega=MtM\}} \mathbb{1}_{\{DOM=C^{Reset}\}} \sum_{j=1}^{m-1} N_{t_0}^{DOM} \left(\Psi(t_j)^{DOM} - \Psi(t_{j+1})^{DOM} \right) P(0, t_j)^{DOM-CSA}}_{\text{Domestic Notional Resets}} \Big]
 \end{aligned}$$

Xccy Features: MtM

Marked-to-Market

- Xccy swaps present users with FX risk
- The MtM feature mitigates this
- MtM Xccy Swaps track and reset the FX rate each period
- FX losses on the Notional reimbursed on each FX fixing date

Understanding the Notional

Xccy Coupon Notional

We always scale the **initial** notional by ψ_i

$$N_i = N_0 \psi_i$$

Notional Reset Factor

$$\psi_i = \underbrace{\alpha(t_0, C^{Leg})}_{\text{Valuation Adj}} \underbrace{\beta(t_i, C^{Leg})}_{\text{FX Reset Adj}}$$

Spot FX Valuation Adjustment, α

$$\alpha(t, C^{Leg}) = \begin{cases} 1 & , \text{ if } C^{Leg} = C^{Val} \\ s^{FOR/DOM} & , \text{ if } C^{Leg} \neq C^{Val} \text{ and } C^{Leg} = C^{FOR} \\ s^{DOM/FOR} & , \text{ if } C^{Leg} \neq C^{Val} \text{ and } C^{Leg} = C^{DOM} \end{cases}$$

Forward FX MtM Reset Adjustment, β

$$\beta(t, C^{Leg}) = \begin{cases} 1 & , \text{ if } C^{Leg} \neq C^{Reset} \\ \left(\frac{f(t)^{FOR/DOM}}{s^{FOR/DOM}} \right) & , \text{ if } C^{Leg} = C^{Reset} \text{ and } C^{Leg} = C^{FOR} \\ \left(\frac{f(t)^{DOM/FOR}}{s^{DOM/FOR}} \right) & , \text{ if } C^{Leg} = C^{Reset} \text{ and } C^{Leg} = C^{DOM} \end{cases}$$

Notional Resets & Exchanges

Initial & Final Exchanges

Borrow funds at start and return at end

$$\text{Initial Exchange} = N_0 \Psi_0 P(0, t_0)$$

$$\text{Final Exchange} = -N_0 \Psi_n P(0, t_n)$$

Notional FX Resets

FX immunized: FX losses reimbursed each FX fixing date

$$\begin{aligned} \text{FX Reset} &= N_i P(0, t_i) - N_{i+1} P(0, t_i) \\ &= N_0 \Psi_i P(0, t_i) - N_0 \Psi_{i+1} P(0, t_i) \end{aligned}$$

Coupon Pricing

Floating Cashflows

$$\begin{aligned} PV(Coupon) &= \sum_{i=1}^n N_0 \Psi_i (l_i + s) \tau_i P(0, t_i) \\ &= \sum_{i=1}^n N_0 \Psi_i l_i \tau_i P(0, t_i) + s \sum_{i=1}^n N_0 \Psi_i \tau_i P(0, t_i) \\ &= \sum_{i=1}^n N_0 \Psi_i l_i \tau_i P(0, t_i) + s \text{ Annuity} \end{aligned}$$

where

$$\text{Annuity} = \sum_{i=1}^n N_0 \Psi_i \tau_i P(0, t_i)$$

Xccy Par Spread

Par Spread, s

Applied to the Non-USD Leg

$$s = - \left(\frac{\text{PV(Trade with No Spread)}}{\text{Annuity(Non-USD Leg)}} \right)$$

where

$$\text{Annuity} = \sum_{i=1}^n N_0 \Psi_i \tau_i P(0, t_i)$$

Bloomberg: Xccy Quotes

Bloomberg Par Rates



Xccy Pricing Demo Workbook

Demo Workbook:

5Y USD/EUR MTM XCCY SWAP USD 1MM

Cross Currency Swap, Ω_{Xccy}

TradeDate	Fri, 26-Oct-18	Wed, 25-Oct-23
Maturity (Years)	5Y	
Trade Notional	1,000,000	
Trade Currency	USD	
MtM	YES	
NotionalExchanges	YES	
Reset Currency	USD	USD
CSA Currency	USD	
Valuation Currency	USD	
SpotFX	1.14030	USD/EUR
LegCurrency	EUR	USD
LegNotional	876,962	1,000,000
PayOrReceive	PAY	RECEIVE
LegType	FLOATING	FLOATING
RateOrSpread (%)	0.00000%	0.00000%
FloatIndex	EUR EURIBOR 3M	USD LIBOR 3M
Frequency	QUARTERLY	QUARTERLY
LegResetsRequired	NO	YES
LegSpotFX	0.87696	1.14030
ValuationFXAdj	1.14030	1.00000
DaycountBasis	ACT/360	ACT/360
UseMarketSchedule	NO	NO

Prices / ParSpreads	LEG1: EUR	LEG2: USD
LegPV	-24,992	15,686
SwapPV	-9,306	USD

Leg1 - EUR Cashflows

	Notional	FXFixingDate	ForwardFX	NotionalExchange	Spread	FloatRate	Coupon	DiscountFactor	CouponPV	SpotFX	ValuationPV
0				876,962			876,962	1.000000	876,962	1.1403	1,000,000
1	-876,962	Fri, 26-Oct-18	1.00000	0	0.00000%	-0.31695%	703	1.002365	704	1.1403	803
2	-876,962	Fri, 25-Jan-19	1.00000	0	0.00000%	-0.31644%	701	1.004182	704	1.1403	803
3	-876,962	Fri, 26-Apr-19	1.00000	0	0.00000%	-0.28931%	641	1.005926	645	1.1403	736
4	-876,962	Fri, 26-Jul-19	1.00000	0	0.00000%	-0.22709%	503	1.007807	507	1.1403	579
5	-876,962	Sat, 26-Oct-19	1.00000	0	0.00000%	-0.13634%	302	1.009467	305	1.1403	348
6	-876,962	Sat, 25-Jan-20	1.00000	0	0.00000%	-0.05021%	111	1.010835	113	1.1403	128
7	-876,962	Sat, 25-Apr-20	1.00000	0	0.00000%	0.02216%	-49	1.011997	-50	1.1403	-57
8	-876,962	Sat, 25-Jul-20	1.00000	0	0.00000%	0.08249%	-183	1.013047	-185	1.1403	-211
9	-876,962	Sun, 25-Oct-20	1.00000	0	0.00000%	0.13501%	-299	1.013962	-303	1.1403	-346
10	-876,962	Sun, 24-Jan-21	1.00000	0	0.00000%	0.19845%	-440	1.014734	-446	1.1403	-509
11	-876,962	Sun, 25-Apr-21	1.00000	0	0.00000%	0.27912%	-619	1.015295	-628	1.1403	-716
12	-876,962	Sun, 25-Jul-21	1.00000	0	0.00000%	0.37754%	-837	1.015577	-850	1.1403	-969
13	-876,962	Mon, 25-Oct-21	1.00000	0	0.00000%	0.48748%	-1,081	1.015536	-1,097	1.1403	-1,251
14	-876,962	Mon, 24-Jan-22	1.00000	0	0.00000%	0.58832%	-1,304	1.015210	-1,324	1.1403	-1,510
15	-876,962	Mon, 25-Apr-22	1.00000	0	0.00000%	0.67584%	-1,498	1.014663	-1,520	1.1403	-1,733
16	-876,962	Mon, 25-Jul-22	1.00000	0	0.00000%	0.74980%	-1,662	1.013957	-1,685	1.1403	-1,922
17	-876,962	Tue, 25-Oct-22	1.00000	0	0.00000%	0.81171%	-1,799	1.013132	-1,823	1.1403	-2,079
18	-876,962	Tue, 24-Jan-23	1.00000	0	0.00000%	0.87156%	-1,932	1.012214	-1,956	1.1403	-2,230
19	-876,962	Tue, 25-Apr-23	1.00000	0	0.00000%	0.93160%	-2,065	1.011157	-2,088	1.1403	-2,381
20	-876,962	Tue, 25-Jul-23	1.00000	-876,962	0.00000%	0.99282%	-879,163	1.009939	-887,901	1.1403	-1,012,474

Leg2 - USD Cashflows

	Notional	FXFixingDate	ForwardFX	NotionalExchange	Spread	FloatRate	Coupon	DiscountFactor	CouponPV	SpotFX	ValuationPV
0				-1,000,000			-1,000,000	1.000000	-1,000,000	1.0000	-1,000,000

Appendix - Useful Resources

References

1. Collateralization & CSA Fundamentals

<https://ssrn.com/abstract=3035648>

2. Discounting with Collateral

<https://ssrn.com/abstract=3009281>

3. An Interest Rate Swap Primer

<https://ssrn.com/abstract=2815495>

4. Cross Currency Swaps

<https://ssrn.com/abstract=3278907>

5. Interest Rate Modeling: Volume I-III

Atlantic Financial Press - Vladimir Piterbarg

6. Interest Rate Models - Theory & Practice

Springer - Damiano Brigo, Fabio Mercurio