

# 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

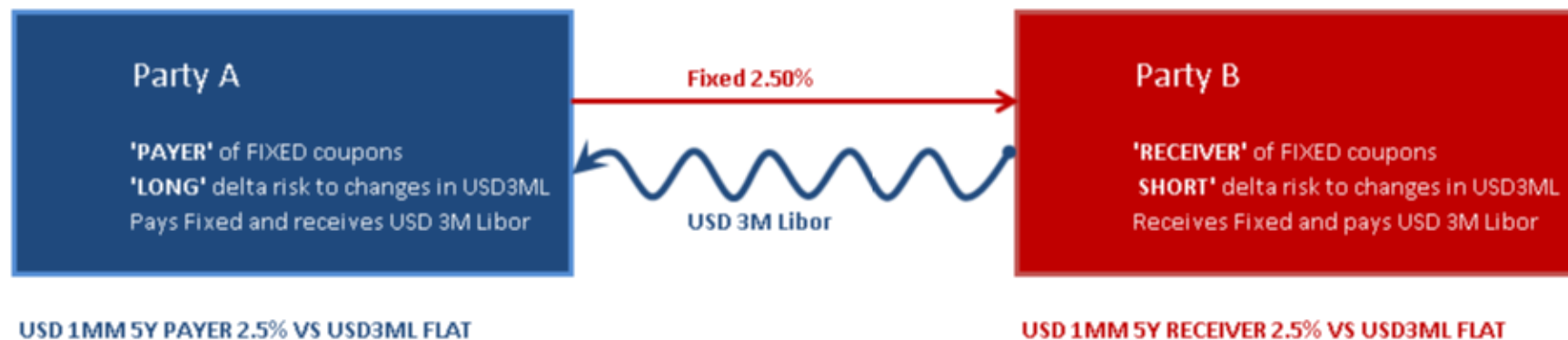
## Detailed Notes

<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

The screenshot displays the Bloomberg Swap Manager (SWPM) interface. The top menu bar includes 'GBP-EUR X-RATE Curncy', 'SWPM', and 'Related Functions Menu'. The main navigation bar shows tabs for '91) Actions', '92) Products', '93) Views', '94) Info', '95) Settings', and 'Swap Manager'. The 'Swap Manager' tab is active, showing a 'Fixed Float Swap' configuration.

**Swap Configuration:**

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

**Market Data:**

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

**Valuation Results:**

Field	Value
Par Cpn	2.288000
Principal	0.00
Accrued	0.00
NPV	0.00

**Calculators:**

Field	Value
PV01	472.41
DV01	472.42
Gamma (1bp)	0.25

**Bottom 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

**Footer:** 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

12) Matrix

21) Cashflow Table

22) Cashflow Graph

Cashflow

Leg 1: Receive Float ▾

Historical Cashflows

Zero Rate

Equiv. Coupon

Accrued

NPV

0.00

1,002,566.12

Currency

USD

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		12) 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							
		 									
Pay Date	Accrual Start	Accrual End	Da...	Notional	Principal	Reset Date	Reset Rate	Payment			
06/26/2019	03/26/2019	06/26/2019	92	-884,799.15	0.00	03/22/2019	-0.30900	984.17			
09/26/2019	06/26/2019	09/26/2019	92	-884,799.15	0.00	06/24/2019	-0.29881	961.11			
12/27/2019	09/26/2019	12/27/2019	92	-884,799.15	0.00	09/24/2019	-0.29511	952.77			
03/26/2020	12/27/2019	03/26/2020	90	-884,799.15	-884,799.15	12/23/2019	-0.28394	-883,891.82			

# 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

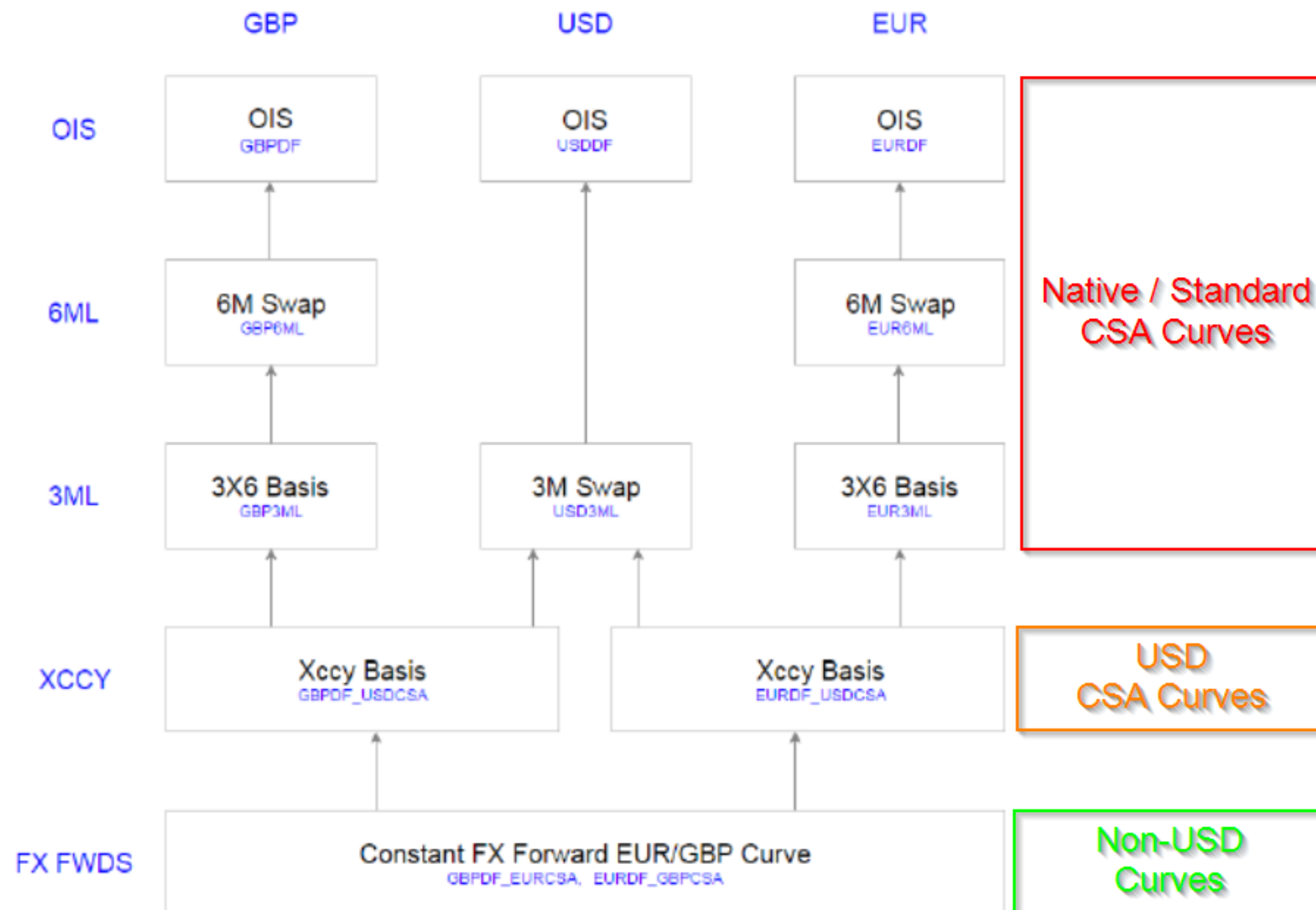
## Standard/Native CSA Disc Factors

- 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	
+ 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 ▾	
Notional		1MM		Notional		883,704.49		Valuation		03/27/2019 ▾	
Currency		USD ▾		Currency		EUR ▾		CSA Coll Ccy		USD ▾	
Effective		0D 03/27/2019 ▾		Effective		0D 03/27/2019 ▾		Valuation Ccy		USD ▾	
Maturity		5Y 03/27/2024 ▾		Maturity		5Y 03/27/2024 ▾		FX Rate		1.131600	
Index		3M US0003M		Index		3M EUR003M		<input checked="" type="checkbox"/> OIS DC Stripping			
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 I ▾		Dscnt 403 ▾		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]

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

# 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  $\psi_i$

$$N_i = N_0 \psi_i$$

## 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, $\alpha$

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

## Forward FX MtM Reset Adjustment, $\beta$

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

# 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,  $\Omega_{Xccy}$

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