Avoiding Collateral Surprises: Managing the Embedded Optionality of Multi-Currency CSAs

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Our Presenters:

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@jjockle

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http://linkd.in/JimJockle
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• Ask Questions
  • Use the Q&A Panel to Submit A Question At ANY TIME During the Presentation

• Join The Conversation
  • Add your comments and thoughts to our live @nxanalytics. Twitter Stream with hash tag #Collateral

• Contact Us If You’re Having Difficulties
  • Trouble Hearing? Bad Connection? Message us using the Chat panel.

We will provide the slides following the webinar to all attendees.
Agenda

- Collateral management and optimization
- CSA existing and future
- Cheapest-To-Deliver and Optionality
- XCCY Curve Construction
- CSA and CTD construction
- Pricing portfolio
  - Cash, T-bonds, Corporate Bonds
  - USD, EUR, JPY, GBP, CHF, CAD
- Collateral management and optimization
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Why collateral management is important?

Why now?

- Increased usage of collateral as a way to mitigate risk of counterparty default

- Divergence of rates after the crisis and complex CSAs

- Collateral shortage

- Equally important for sell-side and buy-side

- Choice of collateral significantly affects derivative pricing

- Push from traders and front-office – profit is the drive
What is the purpose of central collateral management process & why identifying CTD is necessary:

- Profit!
- Effectiveness!
- Liquidity
- Beneficial to post CTD (cheapest-to-deliver)
- Minimize funding costs
- Maximize return
- Bigger choice of collateral
- Optimization – best use of existing assets within the firm
Central collateral management process challenges:

- New system:
  - Each business in the firm – separate systems different architecture
  - Different systems and process for each desk in OTC

- Validate ALL CSAs – lost in translation
- Dedicate group to manage
- Keep track of huge flow of collaterals
- Big data input requirement
- High degree of operation management
Is Cheapest = Optimal?

Is cheapest collateral always the most effective one?

- Massive amount of rules and requirements depending on
  - Funding rates
  - Available assets

- Get rid of excess of existing asset

- Is cheaper to source new collateral or use existing one?

- Keep track of all funding rates
- Collateral management and optimization
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Complexity of CSA Agreements

Current CSA agreements:

- Almost each agreement is unique
  - Choice of collateral currency
  - Big list of eligible collaterals
  - Various termination dates and events
  - Different thresholds

- Lack of transparency

- Valuation discrepancies between counterparties for simple trades

- Impossible to compare prices between dealers
New standard ISDA CSA agreements:

- 17 silos
  - Like clearing houses
  - Easier to add
  - Easier to take out

- Cash ONLY
- Discount with OIS or proxy of OIS
- All others to USD or EUR buckets
- No rehypothecation
- Initial margin to be delivered
- Netting
Difficulties with Standardized CSA:

- Dollar dominance
- Two systems in parallel – for old and new
- Cross-currency settlement risk (PVP vs Netting)
- Slow initial development
Standardized CSAs

Should resolve:

- Discrepancies in counterparty valuations
- Cheapest-to-deliver modeling and optionality
- Addition of new currencies
- Boost liquidity in OIS market
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Steps:

1. Construct appropriate curves – OIS, Swap, Basis Curves, XCCY curves
2. Translate curves in different currencies to the trade currency
3. Pick cheapest throughout the life of the trade
4. Construct blended CTD curve
5. Discount cash flows with CTD curve

EASY?

!!! 3 Currencies = 15 curves!!!

TEDIOUS!
How to construct CTD?

Collateral: Cash
Currencies: USD, EUR, GBP, JPY, CHF, CAD

!!! 6 cash collateral currencies = 29 Curves to build !!!
Cheapest-To-Deliver and Optionality

What to be aware of:

- Choice of currency and collateral type
- Calibration
- Initial margin, up and down thresholds, minimum transfer amounts
- Consistency with counterparty
- Cross currency debate

• See Numerix webinar: “Impact of OIS Discounting – Valuation Approaches re-examined”
• Alan Brace
  “Primer: The FST Theorem for Pricing with Domestic or Foreign Collateral”*
  “Primer: Curve Stripping with Full Collateralization”*

* Available through NSP for existing clients or through support@numerix.com under NDA
- Collateral management and optimization
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### Cross Currency Basis Swap – single curve world:

<table>
<thead>
<tr>
<th>Domestic Float Leg</th>
<th>Foreign Float Leg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ym</strong> Index DomCCY</td>
<td><strong>Zm</strong> Index ForCCY + Spread</td>
</tr>
<tr>
<td><strong>Projection Curve</strong></td>
<td><strong>Zm Swap For Yield Curve</strong></td>
</tr>
<tr>
<td><strong>Discount Curve</strong></td>
<td><strong>Implied Zm/Ym For/Dom Basis Curve</strong></td>
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</tbody>
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### Cross Currency Basis Swap – multi curve world:

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</tr>
</tbody>
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---

**Domestic Float Leg**

- *Ym* Index DomCCY
- Projection Curve: *Ym Swap Dom Yield Curve*
- Discount Curve: OIS Dom Curve

**Foreign Float Leg**

- *Zm* Index ForCCY + Spread
- Projection Curve: *Zm Swap For Yield Curve*
- Discount Curve: **Implied Zm/Ym For/Dom Basis Curve**
How to obtain CC Implied Foreign Basis Curve?

- Bootstrap from FX Forward
  - Assumption: both markets moved to OIS

- Bootstrap from CC OIS Basis Swaps
  - Assumption: instruments exist and liquid (not yet true)

- Bootstrap from CC Basis Swaps and FX Forwards (or CC ND Swaps)
  - Assumption: instruments exist (exist in various markets)
Cross Currency Curve Construction – Multi-Curve

Instruments to bootstrap the curve:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX Forwards</td>
<td>USD/JPY (up to 5y)</td>
</tr>
<tr>
<td>CC basis swap quoted as spread</td>
<td>3m USD Libor vs 3m JPY Libor + Spread (up to 30y)</td>
</tr>
</tbody>
</table>

Steps:

<table>
<thead>
<tr>
<th>Step</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Get domestic OIS curve</td>
<td>1. OIS FedFunds Curve</td>
</tr>
<tr>
<td>2. Get domestic projection curve</td>
<td>2. 3m USD Libor Curve (OIS FedFunds Curve)</td>
</tr>
<tr>
<td>3. Get domestic projection curve for the underlying tenor</td>
<td>3. n/a</td>
</tr>
<tr>
<td>4. Get foreign OIS curve</td>
<td>4. OIS Mutan Curve</td>
</tr>
<tr>
<td>5. Get foreign projection curve</td>
<td>5. 6m JPY Libor Curve (OIS Mutan Curve)</td>
</tr>
<tr>
<td>6. Get foreign projection curve for the underlying tenor</td>
<td>6. 3m JPY Libor Curve (JPY Basis swaps &amp; OIS Mutan Curve)</td>
</tr>
<tr>
<td>7. Solve for implied foreign basis discount curve given FX Forwards, CC Basis Swaps, 1,3 (if n/a then 2), 6 (if n/a then 5)</td>
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</tr>
</tbody>
</table>
Steps to strip implied foreign discount curve from CC Basis Swaps & FX Forwards:

- Domestic OIS Curve
  - Domestic Projection Curve
  - Domestic Basis Curve
- Foreign OIS Curve
  - Foreign Projection Curve
  - Foreign Basis Curve

FX Forwards

CC Basis swaps

Implied Foreign Discount Curve
Cross Currency Curve Construction – Multi-Curve

Date: 21-Aug-2012

3m Forward Rates
Implied CC USD/JPY Basis Curve

TONAR.CURVE
JPY_CURVE_6M_MID
JPY_LIBOR_3M6M.BASIS
USDJPY_BASISCURVE
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  - USD, EUR, JPY, GBP, CHF, CAD
Types of collateral and how to approximate

Collateral types and corresponding curves:

<table>
<thead>
<tr>
<th>Collateral</th>
<th>Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>OIS Curve</td>
</tr>
<tr>
<td>Treasury Bonds</td>
<td>OIS Curve</td>
</tr>
<tr>
<td>Corporate Bonds</td>
<td>Libor + Spread</td>
</tr>
</tbody>
</table>

Steps:

1. Construct appropriate curves – OIS, Swap, Basis Curves, XCCY curves
2. Translate curves in different currencies to the trade currency
3. Pick cheapest through out the life of the trade
4. Construct blended CTD curve
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2. Translate curves in different currencies to the trade currency
3. Pick cheapest through out the life of the trade
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What does your CTD tell you?

- Deterministic
- Unique for each trade
- Snapshot as of today
- Frequency window – how often do you switch collateral
- Analysis tool to identify cheapest collateral
- Value the trade with collateral switch assumption
- Match counterparty
- Doesn’t take into account minimum threshold, margin, min transfer amount
Summary:

- Extremely tedious
- 6 currencies – 29 curves
- Different curves to approximate Cash, Treasury Bonds, Corporate Bonds
- Sensitive to interpolation and smoothing
- Proxies for not that liquid currencies
• Collateral management and optimization
• CSA existing and future
• Cheapest-To-Deliver and Optionality
• XCCY Curve Construction
• CSA and CTD construction
• Pricing portfolio
  o Cash, T-bonds, Corporate Bonds
  o USD, EUR, JPY, GBP, CHF, CAD
Pricing cases

- Pricing portfolio

Case1. Par swaps with different currency cash collateral

Case2. IR Swaps with cash vs corp bonds collateral

Case3. IR swaps in EUR and JPY
Pricing Case 1: IR Par Swaps USD

Setup:

<table>
<thead>
<tr>
<th>Value Date</th>
<th>21-Aug-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Currency</td>
<td>USD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Collateral Type/Currency</th>
<th>USD</th>
<th>EUR</th>
<th>JPY</th>
<th>GBP</th>
<th>CHF</th>
<th>CAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash/Treasury</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Corporate Bonds</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Implied Curves

<table>
<thead>
<tr>
<th>OIS</th>
<th>USD</th>
<th>EUR</th>
<th>JPY</th>
<th>GBP</th>
<th>CHF</th>
<th>CAD</th>
<th>Cheapest-to-Deliver</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD_OIS</td>
<td>EUR_EONIA</td>
<td>JPY_TONAR</td>
<td>BP_SONIA</td>
<td>CHF_TOIS</td>
<td>CAD_OIS</td>
<td>CTD_CURVE</td>
<td></td>
</tr>
</tbody>
</table>

Portfolio of par swaps:

<table>
<thead>
<tr>
<th>ID</th>
<th>Instrument</th>
<th>Currency</th>
<th>Pay/Receive</th>
<th>Effective Date</th>
<th>Maturity</th>
<th>Rate %</th>
<th>Notional $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FixFloat Par Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>23-Aug-12</td>
<td>5y</td>
<td>0.7158%</td>
<td>100,000,000.00</td>
</tr>
<tr>
<td>2</td>
<td>FixFloat Par Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>23-Aug-12</td>
<td>10y</td>
<td>1.6509%</td>
<td>100,000,000.00</td>
</tr>
<tr>
<td>3</td>
<td>FixFloat Par Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>23-Aug-12</td>
<td>15y</td>
<td>2.1182%</td>
<td>100,000,000.00</td>
</tr>
<tr>
<td>4</td>
<td>FixFloat Par Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>23-Aug-12</td>
<td>20y</td>
<td>2.3075%</td>
<td>100,000,000.00</td>
</tr>
<tr>
<td>5</td>
<td>FixFloat Par Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>23-Aug-12</td>
<td>30y</td>
<td>2.4702%</td>
<td>100,000,000.00</td>
</tr>
</tbody>
</table>
Pricing Case 1: IR Par Swaps USD

Price par swaps with different cash collateral assumptions + CTD:

- Pricing to par under USD cash collateral (FedFunds curve)
- Significant difference for longer maturity swaps
- Range from 0-3bps running and 0-72bps upfront
- Largest difference for CTD (highest forward rates, lowest discount factors)
### Pricing Case 2: Portfolio of IR Swaps

**Setup:**

<table>
<thead>
<tr>
<th>Value Date</th>
<th>8/21/2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spot Date</td>
<td>8/23/2012</td>
</tr>
<tr>
<td>Trade Currency</td>
<td>USD</td>
</tr>
<tr>
<td>Collateral</td>
<td>Cash - USD, EUR, GBP, JPY</td>
</tr>
</tbody>
</table>

**Portfolio of USD IR Swaps various maturities:**

<table>
<thead>
<tr>
<th>ID</th>
<th>Instrument</th>
<th>Currency</th>
<th>Pay/Receive</th>
<th>Effective Date</th>
<th>Maturity</th>
<th>Rate %</th>
<th>Notional $</th>
<th>In years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>12-Jan-07</td>
<td>12-Jan-32</td>
<td>5.3000%</td>
<td>100,000,000.00</td>
<td>20y</td>
</tr>
<tr>
<td>2</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>1-May-09</td>
<td>1-May-42</td>
<td>2.7300%</td>
<td>100,000,000.00</td>
<td>30y</td>
</tr>
<tr>
<td>3</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>16-Nov-12</td>
<td>16-Nov-22</td>
<td>3.9000%</td>
<td>100,000,000.00</td>
<td>10y</td>
</tr>
<tr>
<td>4</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>7-May-10</td>
<td>7-May-27</td>
<td>4.0000%</td>
<td>100,000,000.00</td>
<td>15y</td>
</tr>
<tr>
<td>5</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>16-Nov-06</td>
<td>18-Nov-15</td>
<td>5.3470%</td>
<td>100,000,000.00</td>
<td>3y</td>
</tr>
<tr>
<td>6</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>19-Dec-07</td>
<td>9-Dec-17</td>
<td>5.0230%</td>
<td>100,000,000.00</td>
<td>5y</td>
</tr>
<tr>
<td>7</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>18-Oct-11</td>
<td>19-Oct-15</td>
<td>1.1576%</td>
<td>100,000,000.00</td>
<td>3y</td>
</tr>
<tr>
<td>8</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>16-Jan-12</td>
<td>16-Jan-17</td>
<td>1.1140%</td>
<td>100,000,000.00</td>
<td>5y</td>
</tr>
<tr>
<td>9</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>17-Aug-17</td>
<td>17-Aug-27</td>
<td>3.5000%</td>
<td>100,000,000.00</td>
<td>15y</td>
</tr>
<tr>
<td>10</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>26-Sep-17</td>
<td>28-Sep-37</td>
<td>3.5370%</td>
<td>100,000,000.00</td>
<td>25y</td>
</tr>
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</table>
## Pricing Case 2: Portfolio of IR Swaps

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<td>USD</td>
</tr>
<tr>
<td>Collateral Currency</td>
<td>Cash vs Libor, USD, EUR, GBP, JPY</td>
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</tbody>
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### Pricing under Libor:

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<tr>
<td>1</td>
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<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>12-Jan-07</td>
<td>12-Jan-32</td>
<td>5.3000%</td>
<td>100,000,000.00</td>
<td>20y</td>
<td>44,580,562.03</td>
<td>43,352,911.61</td>
</tr>
<tr>
<td>2</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>1-May-09</td>
<td>1-May-42</td>
<td>2.7300%</td>
<td>100,000,000.00</td>
<td>30y</td>
<td>2,303,894.44</td>
<td>2,716,395.53</td>
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<td>16-Nov-22</td>
<td>3.9000%</td>
<td>100,000,000.00</td>
<td>10y</td>
<td>17,317,523.81</td>
<td>17,562,950.72</td>
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<td>7-May-10</td>
<td>7-May-27</td>
<td>4.0000%</td>
<td>100,000,000.00</td>
<td>15y</td>
<td>22,711,135.66</td>
<td>21,208,161.39</td>
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<td>16,496,086.76</td>
<td>16,364,514.71</td>
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<td>21,196,398.94</td>
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<td>9</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>17-Aug-17</td>
<td>17-Aug-27</td>
<td>3.5000%</td>
<td>100,000,000.00</td>
<td>15y</td>
<td>2,886,948.32</td>
<td>2,716,459.43</td>
</tr>
<tr>
<td>10</td>
<td>FixFloat IR Swap</td>
<td>USD</td>
<td>Pay 3m LIBOR</td>
<td>26-Sep-17</td>
<td>28-Sep-37</td>
<td>3.5370%</td>
<td>100,000,000.00</td>
<td>25y</td>
<td>2,674,409.05</td>
<td>2,747,921.70</td>
</tr>
</tbody>
</table>

### Pricing under Cash:

<table>
<thead>
<tr>
<th>Currency</th>
<th>USD</th>
<th>GBP</th>
<th>EUR</th>
<th>JPY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>45,819,527.40</td>
<td>45,273,488.24</td>
<td>44,560,054.88</td>
<td>43,457,901.12</td>
</tr>
<tr>
<td>Cash</td>
<td>2,104,365.90</td>
<td>2,308,044.68</td>
<td>2,353,995.69</td>
<td>2,453,440.33</td>
</tr>
<tr>
<td>Cash</td>
<td>18,116,022.10</td>
<td>18,040,764.99</td>
<td>17,790,886.97</td>
<td>17,461,516.71</td>
</tr>
<tr>
<td>Cash</td>
<td>22,986,859.26</td>
<td>21,855,510.40</td>
<td>22,549,056.77</td>
<td>21,217,193.74</td>
</tr>
<tr>
<td>Cash</td>
<td>16,578,382.02</td>
<td>16,355,771.99</td>
<td>16,445,147.98</td>
<td>16,308,393.62</td>
</tr>
<tr>
<td>Cash</td>
<td>21,640,379.55</td>
<td>21,594,508.45</td>
<td>21,371,822.43</td>
<td>21,107,395.86</td>
</tr>
<tr>
<td>Cash</td>
<td>2,027,204.79</td>
<td>2,024,304.56</td>
<td>2,019,040.44</td>
<td>2,000,339.29</td>
</tr>
<tr>
<td>Cash</td>
<td>2,352,048.82</td>
<td>2,365,468.18</td>
<td>2,340,221.74</td>
<td>2,293,766.22</td>
</tr>
<tr>
<td>Cash</td>
<td>3,202,044.82</td>
<td>3,200,501.11</td>
<td>3,187,174.02</td>
<td>3,137,261.60</td>
</tr>
</tbody>
</table>

| SUM       | $136,826,232.47 | $133,887,066.78 | $132,371,965.44 | $130,463,687.70 |
| % of CTD  | 4.94%           | 2.69%           | 1.52%           | 0.06%          |
| USD Cash  | 45,819,527.40   | 45,273,488.24   | 44,560,054.88   | 43,457,901.12  |
| GBP Cash  | 2,104,365.90    | 2,308,044.68    | 2,353,995.69    | 2,453,440.33   |
| EUR Cash  | 18,116,022.10   | 18,040,764.99   | 17,790,886.97   | 17,461,516.71  |
| JPY Cash  | 22,986,859.26   | 21,855,510.40   | 22,549,056.77   | 21,217,193.74  |
| CTD Cash  | 16,578,382.02   | 16,355,771.99   | 16,445,147.98   | 16,308,393.62  |
| SUM       | $138,419,503.96 | $137,636,243.37 | $135,906,585.86 | $133,502,406.34 |
| % of CTD  | 3.77%           | 3.18%           | 1.89%           | 0.09%          |
Pricing Case 2: Portfolio of IR Swaps

- Corporate bonds collateral is cheaper
- Haircuts
- Assumption – all swaps have the same CSA terms
- Snapshot as of today
- How much collateral to post?
- Risk numbers
Pricing Case 3: IR Swaps in EUR and JPY

Portfolio of IR Swaps in EUR:

Portfolio of IR Swaps in JPY:
Pricing: Summary

- Choice of collateral significantly affects price of the trade
- Helps to analyze counterparty numbers & assumptions
- Pricing with CTD = assumption that counterparty posts always cheapest collateral
- Pricing with deterministic CTD = assumption no costs, thresholds, min transfer amounts, etc.
- Affects amount of collateral to be posted
- Affects risk sensitivities
What did we look at:

• How to construct XCCY curves in multi-curve framework

• How to translate different type of collaterals into curves

• How to construct deterministic CTD curve for multi-CSAs

• How CTD curve helps to pick appropriate collateral

• How trade price varies under different collateral choices
Central collateral management system is important

- Cheapest-to-deliver tool to analyze
- Cheapest is not always optimal
- Should include rules and requirements on top

New Standard CSA should eliminate optionality, but

- Implementation is only starting
- Still need to handle existing CSAs
- Still need to have all the curves for netting
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