OIS and Its Impact on Modeling, Calibration and Funding of OTC Derivatives

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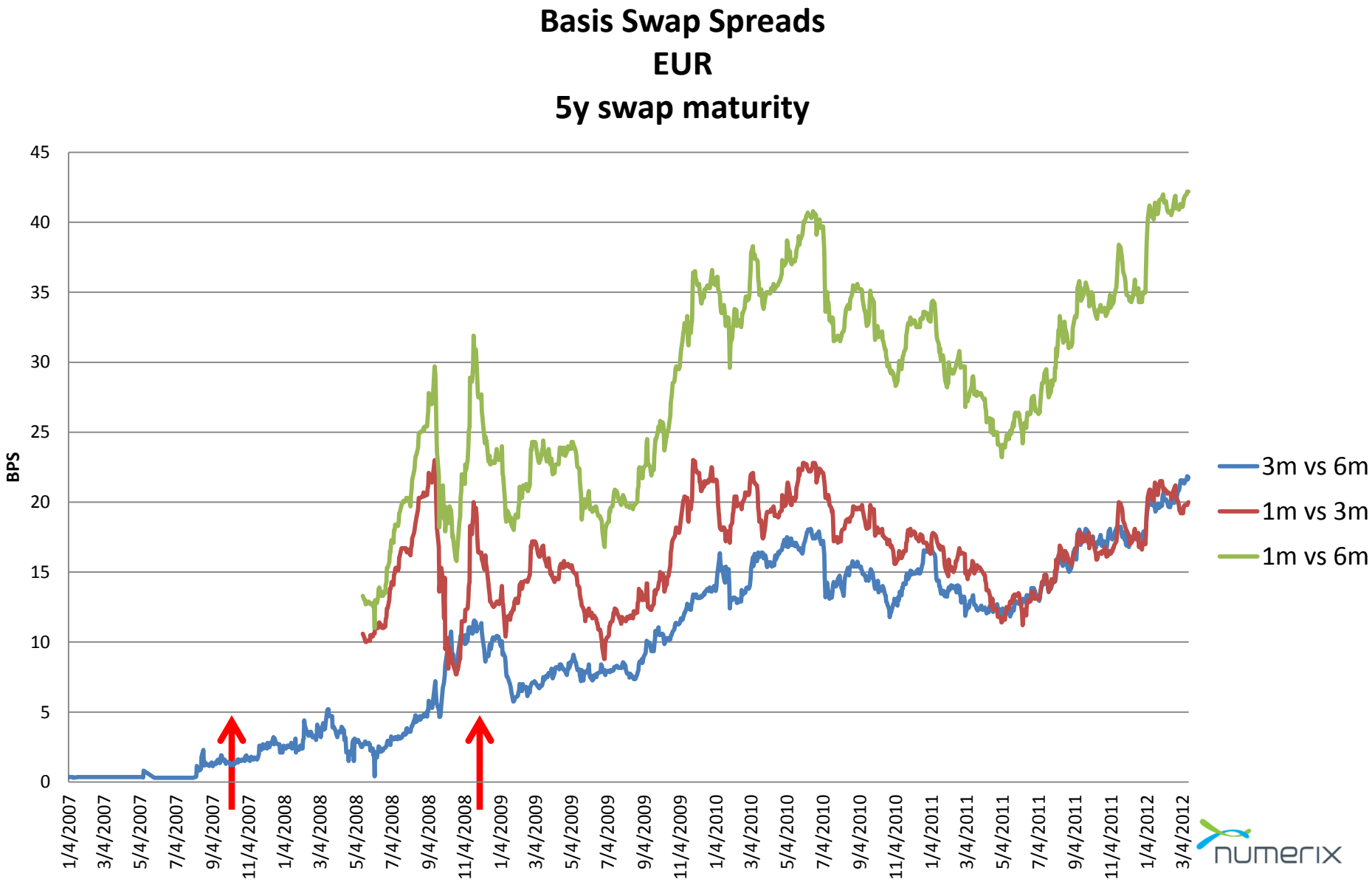
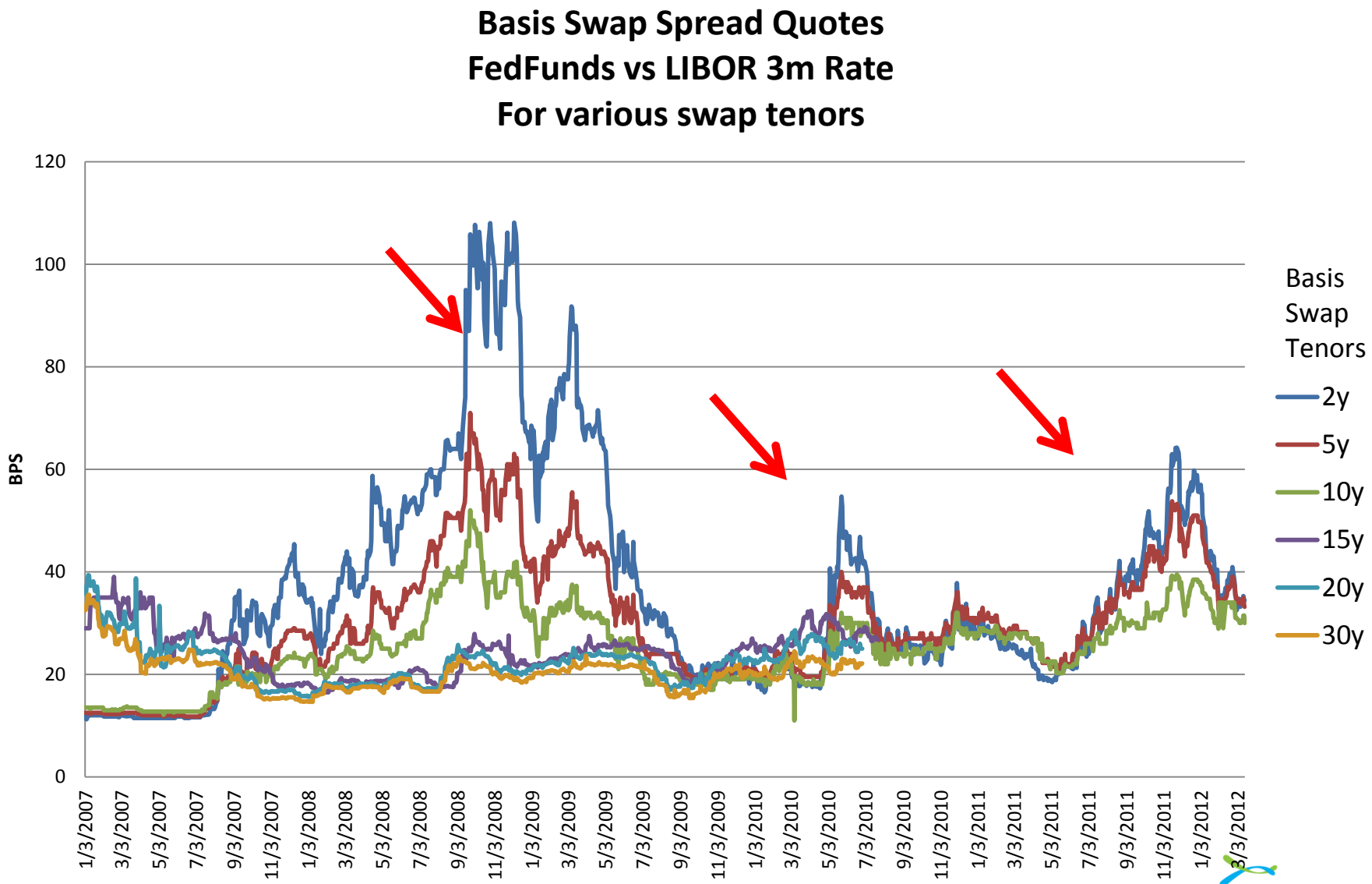
Agenda

- Changes in Interest Rate market dynamics after the market crisis
- Impact on OTC Derivatives Valuation
- Curve Construction
- Single vs Cross Currency Situation
- Deterministic Spread Framework
- Stochastic Spread Frameworks
- Risk & Hedging
- Conclusions

Huge Increase in Basis Swaps Spreads



Much Wider Libor-OIS Spread



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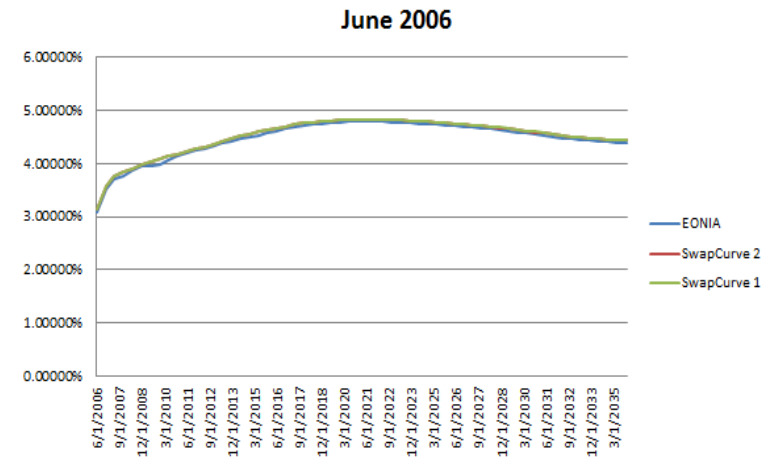
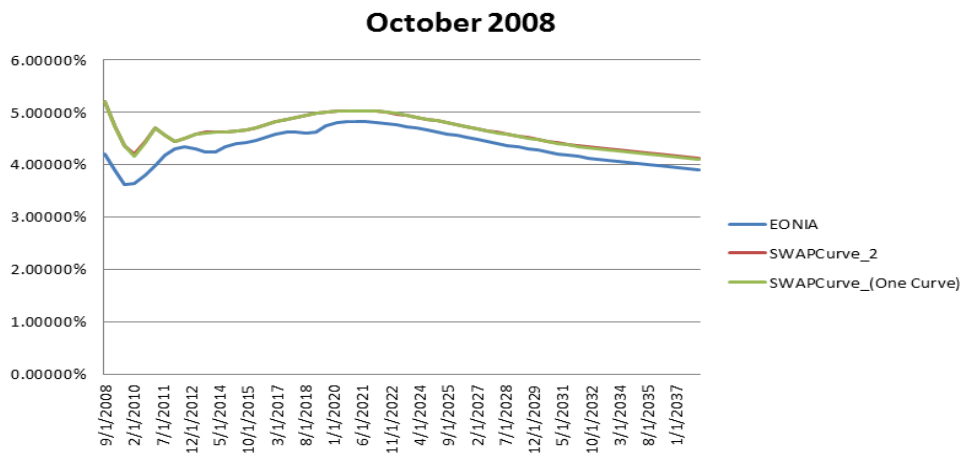
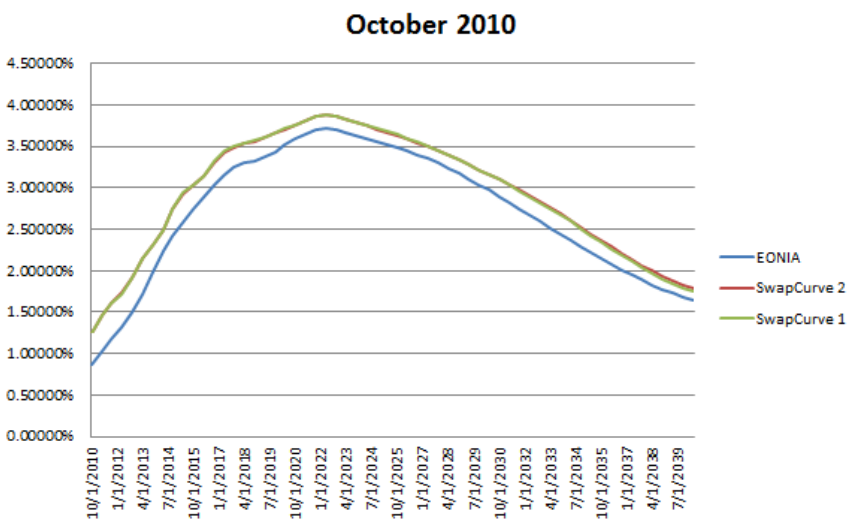
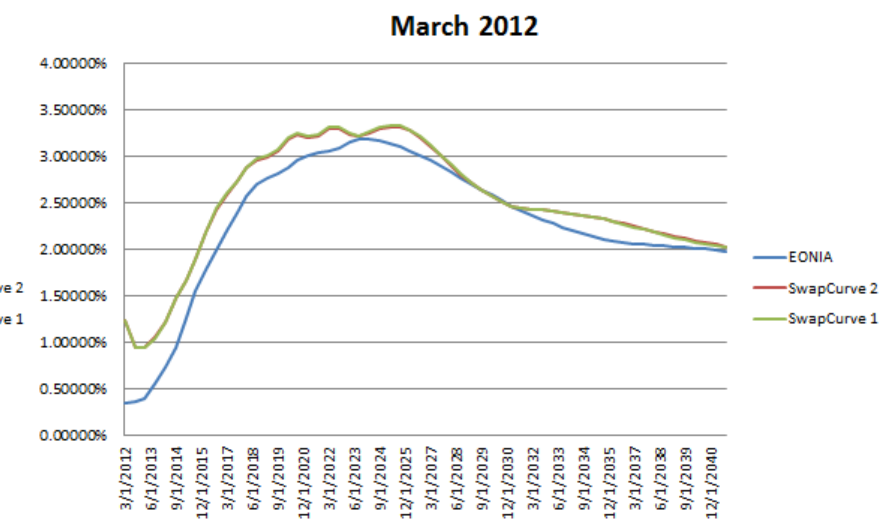
Spread Curve Changes Over Time









Source: Anna Barbashova, Numerix Internal Working Paper

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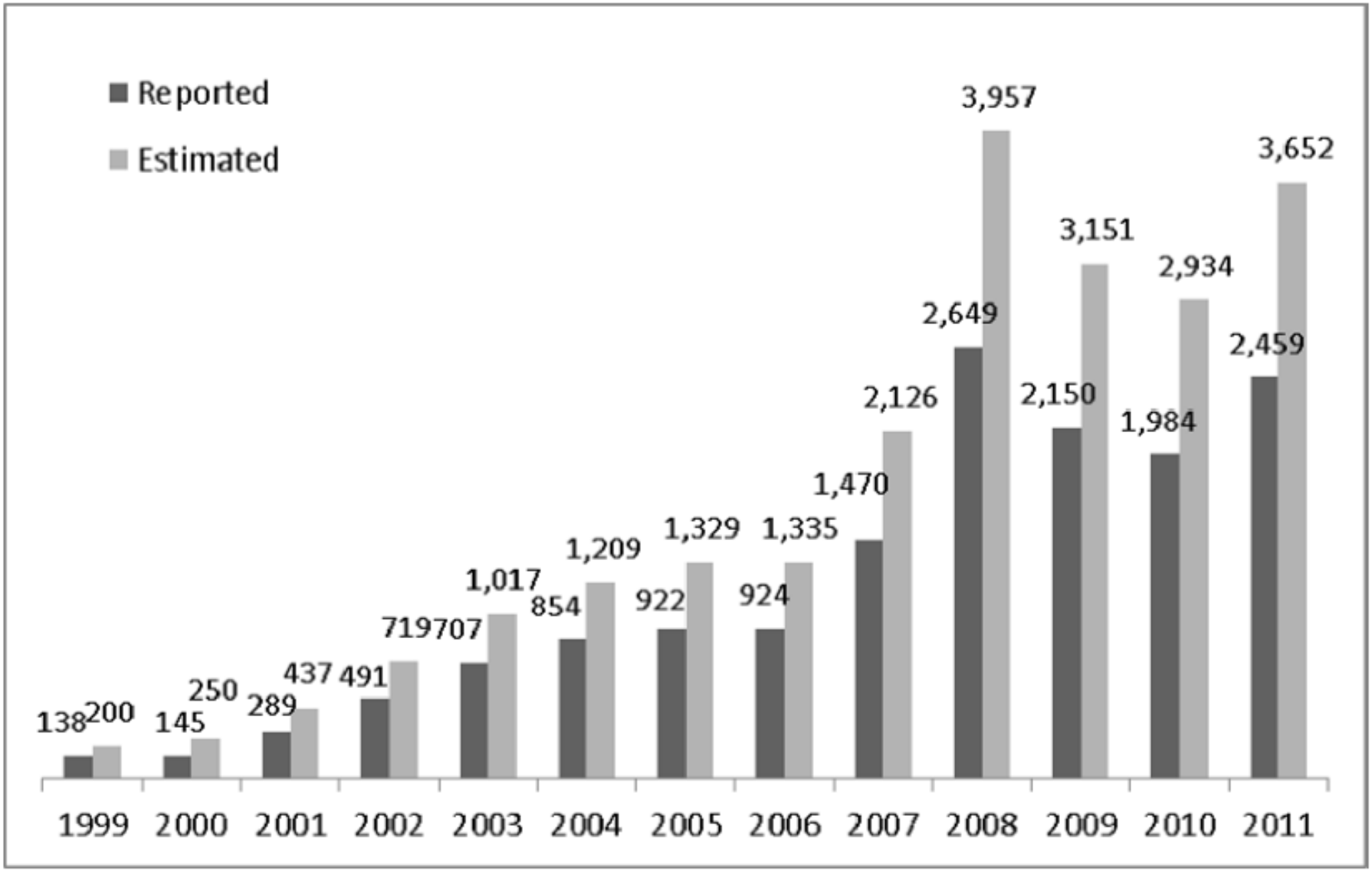
Big Increase in Collateral Posted (USD Billions)



Source: ISDA Margin Survey, 2012

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Impact on OTC Derivative Valuation

- The “right” discounting curve, depends on Credit quality of self, counterparty, netting and collateral clauses in CSA (valuation & even curve construction is a “portfolio” problem)
- Since collateralization is standard practice in a large portion of the market:
  - Each OTC derivative is really bound to an underlying CSA
  - Standardization around cash collateral, funded at OIS/Compounded Overnight Cash rates
  - Since cost of funding for most large participants is OIS, funding curve is converging to OIS in market quotations
- Even in the absence of collateralization, modeling funding costs explicitly is a must due to divergence among different funding rates (various Libor tenors, OIS, Repo, etc)
- Even in the presence of collateralization, “imperfect” CSAs result in CVA, DVA and FVA exposures that need to be factored in to the valuation
- Explicit modeling of Credit, Liquidity premia, and funding costs

Impact on OTC Derivative Valuation (contd.)

- Interest rate Curves evolve to an Interest Rate “Surface” based on tenor and credit quality
- Curve Construction and Volatility Surface construction need to incorporate OIS discounting
- Model Calibration should incorporate multiple interest rate curves
- The spreads between different types of rates need to be modeled effectively
- Calculating CVA/DVA requires joint calibration and simulation of interest rate and credit factors
- Hedging and Risk Management need to be rethought: Basis risk across maturities and credit qualities is now significantly higher and needs to be measured and managed
- Valuation challenges can turn an ordinary swap into a Level 2 FAS 157 asset

Multi-curve modeling is really one component of the new, post-crisis modeling framework that includes credit costs/benefits (CVA/DVA), funding costs (FVA) and collateral agreements

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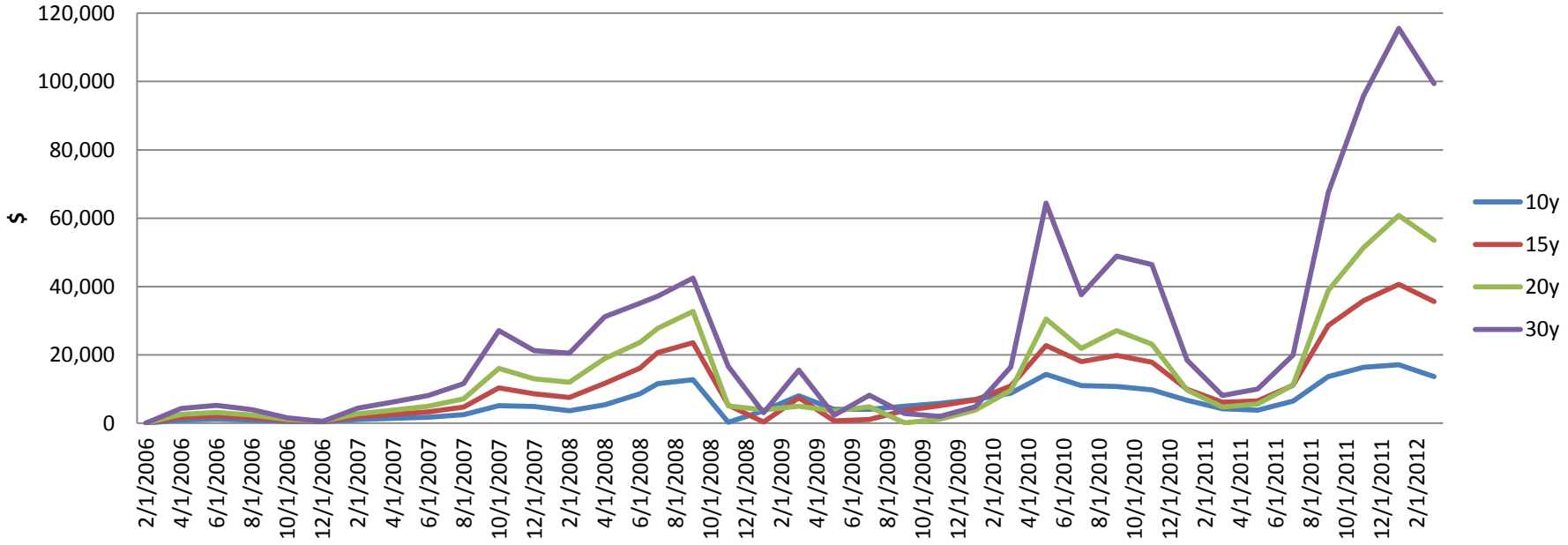
Swap Pricing under Single vs Dual Curves

- Take swaps with 10y, 15y, 20y, 30y maturity
- Price in single curve and dual curve framework from 2006 to 2012

Start	2/7/2006	
Matuirty	Notional	Swap Rate
10y	10,000,000	3.67510%
15y	10,000,000	3.85410%
20y	10,000,000	3.94150%
30y	10,000,000	3.98450%

Difference in swap prices under single vs dual curves approach valuation



Source: Anna Barbashova, Numerix Internal Working Paper

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Steps in Curve Construction

Currency	OIS Curve	Benchmark Curve	Forward Curve	Basis Curve (Single Currency)
EUR	Eonia-->	Euribor6m-->	Euribor1m Euribor3m Euribor12m	Euribor3mvs6m Euribor12mvs6m
GBP	Sonia-->	GBP Libor6m-->	Libor1m Libor3m Libor12m	
JPY	Tonar-->	JPY Libor6m-->	Libor1m Libor3m	Libor3mvs6m
USD	FedFund * -->	USD Libor3m-->	MuniSwap	Libor1mvs3m Libor6mvs3m Libor12mvs3m Munivs3m CPvsLibor3m FedFundvsLibor3m** PrimevsLibor3m T-BillvsLibor3m

Note:

- The list in the table is not a complete list and new instruments are keep evolving

* OIS curve in USD is a bit more complex. We will discuss more in the following session

** Traditionally (one curve), FedFundvsLibor3m basis swap is used to strip FedFund curve given Libor3m curve; Now (under two curve), FedFund curve could be OIS curve itself

Source: Dan Li, Internal Numerix Working Paper

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Steps in Curve Construction (USD)

Fed Fund Basis Swap	
Pay	Receive
LiborLeg	FedFundLeg
-3mLibor	+WeightedAvgFedFund + BasisSprd

IRS	
Receive	Pay
LiborLeg	FixedLeg
+3mLibor	-FixedSwapRate

Synthetic Fed Fund Swap	
Receive	Pay
FedFundLeg	FixedLeg
+WeightedAvgFF + BasisSprd	-FixedSwapRate

Source: Dan Li, Internal Numerix Working Paper

Cross Currency Case: Foreign OIS CC-Basis Curve

Using USD 3m Libor vs JPY 3m Libor as an example:

1. Construct Domestic OIS discounting curve (e.g. FF OIS Curve as described earlier)
2. Construct Domestic projection curve (e.g. USD 3m Libor curve)
3. Construct Foreign OIS discounting curve (e.g. JPY OIS Curve from Tonar)
4. Construct Foreign Benchmark projection curve (e.g JPY 6m Libor)
5. Construct Foreign projection curve (e.g JPY 3m Libor from Libor Basis swap 3m vs 6m
6. Solve Implied Foreign Basis Curve (Foreign OIS CC-Basis Curve) from Cross Currency basis swaps given 1, 2 and 5 above

Source: Dan Li, Internal Numerix Working Paper

Modeling: Deterministic Spread Approach

$$L(t,T_1,T_2) = \frac{1}{\delta T}\left(\frac{P(t,T_1)}{P(t,T_2)} - 1\right) + s(T_1,T_2)$$

The model calibration reduces to a swaption payment modification w.r.t. the single-modeling. Namely, the swap price can be rewritten as

$$S(t) = \sum_{i=1}^{M-1} \delta T_i \, P(t,T_{i+1}) \, \left(L_{th}(t;T_i,T_{i+1}) + s(T_i,T_{i+1}) - K\right)$$

leading to

$$S(t) = P(t,T_1) - P(t,T_M) - \sum_{i=1}^{M-1} \delta T_i \, P(t,T_{i+1}) \, \left(K - s(T_i,T_{i+1})\right)$$

Thus, the multiple-curve model calibration with deterministic spread is equivalent to calibration of the single-curve model to *bespoke* swaptions

$$\mathbb{E}\left[\frac{\left(P(t,T_1) - P(t,T_M) - \sum_{i=1}^{M-1} \delta T_i \, P(t,T_{i+1}) \, \left(K - s(T_i,T_{i+1})\right)\right)^+}{N(t)}\right]$$

Source: Alexander Antonov, Numerix Internal Working Paper

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Dynamics of basis spreads

USD 3m OIS rates vs 3m LIBORs

USD 6m OIS rates vs 6m LIBORs

Vol(3m OIS) = 68%
Vol(3m LIBOR) = 17%
Vol(3m Basis) = 59%
Corr(3m OIS, 3m LIBOR) = 1%
Corr(3m OIS, 3m Basis) = −62%
Corr(3m LIBOR, 3m Basis) = 60%

Vol(6m OIS)= 75%
Vol(6m LIBOR)= 15%
Vol(6m Basis)= 39%
Corr(6m OIS, 6m LIBOR)= -1%
Corr(6m OIS, 6m Basis)= -65%
Corr(6m LIBOR, 6m Basis)= 64%

Corr(3m Basis, 6m Basis)= 66%

Source: Fabio Mercurio, Calibration of multi-curve models, Global Derivatives 2012, Bloomberg

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The Case for Stochastic Spread Modeling

- CSA agreements have embedded options, particularly “Cheapest to Deliver”
- Longer dated, complex structures like CMS Spread Bermudan Callables, etc can be sensitive to the spread correlation and vol dynamics
- Some markets trade single currency interest rate spread options
- OIS-Libor basis is a key, independent risk factor in bank stress scenarios and options on these instruments might trade in the future

The Case for Stochastic Spread Modeling

"Theoretically, it is not difficult to put together a model – it would be an extension of a stochastic basis model where you have more than one basis," says Vladimir Piterbarg, global head of quantitative research at Barclays Capital in London. "The huge question is whether you are able to execute the hedging strategy required."
(Quoted in "Multi-currency CSA chaos behind push to standarized CSA, RISK, 2011, Nick Sawyer")

Hedging and accurate calibration require a liquid market in:

- OIS Cross Currency Basis Swaps
- Options on OIS and OIS CC Basis Swaps

Resulting complexity might create confusion and be a further challenge to valuation & liquidity, therefore push to standardized CSAs with no optionality

Model Construction: Cross Currency Analogy

	Cross Currency World		Dual Curve World	
	Domestic	Foreign	Discounting	Forward
	USD	JPY	OIS	XIBOR
2 Currency Curves	USD Yield Curve	JPY Basis-adjusted Curve	OIS Curve	XIBOR (adjusted for OIS)
1 Currency Curve		JPY Yield Curve		XIBOR Forward Curve

Source: Dan Li, Internal Numerix Working Paper

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Model Construction: Credit Risky Model Analogy

	Credit Risky Model World		Dual Curve World	
	Discounting	Foreign	Discounting	Forward
	Risky	Risk Free	OIS	XIBOR
Credit Risky model	Obligor Credit curve	XIBOR	OIS Curve	XIBOR (adjusted for OIS)
1 Currency Curve		JPY Yield Curve		XIBOR Forward Curve

- Since funding spreads are usually non-negative, this approach may be better to constrain the dynamics so that the OIS curve is below XIBOR
- Also, spreads modeled directly as a distinct risk factor allows more direct measurement of sensitivities and hedge ratios
- Default risk is not the only source for stochastic spreads, so default modeling may be confusing

Source: Christian Fries, Funded Replication: Valuing with Stochastic Funding

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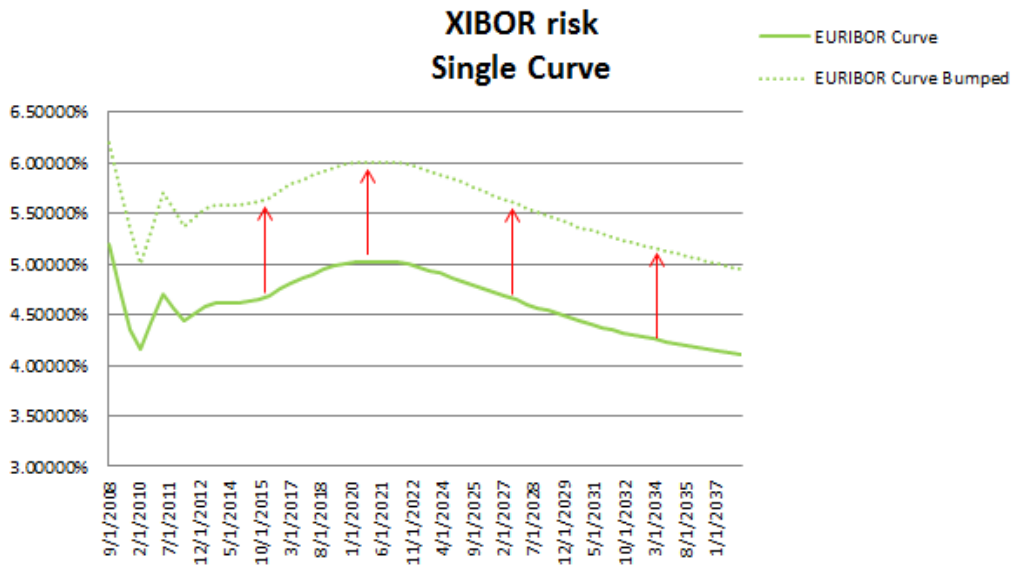
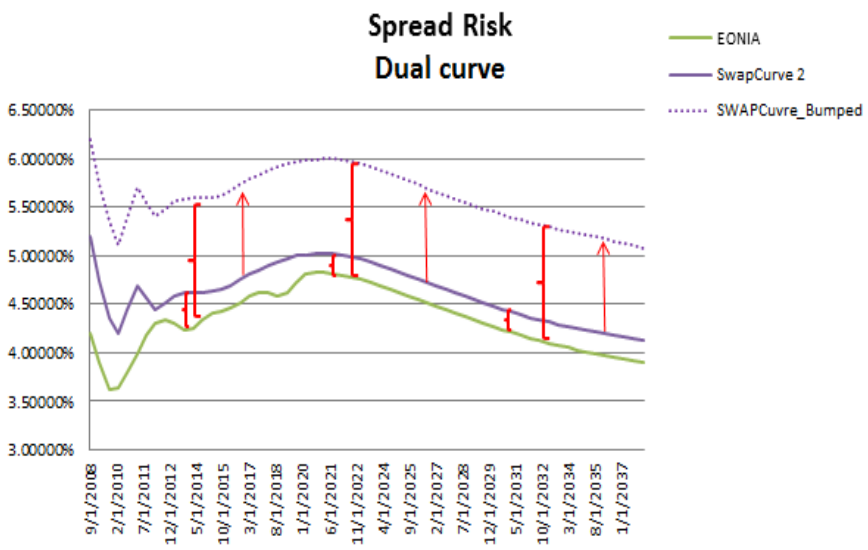
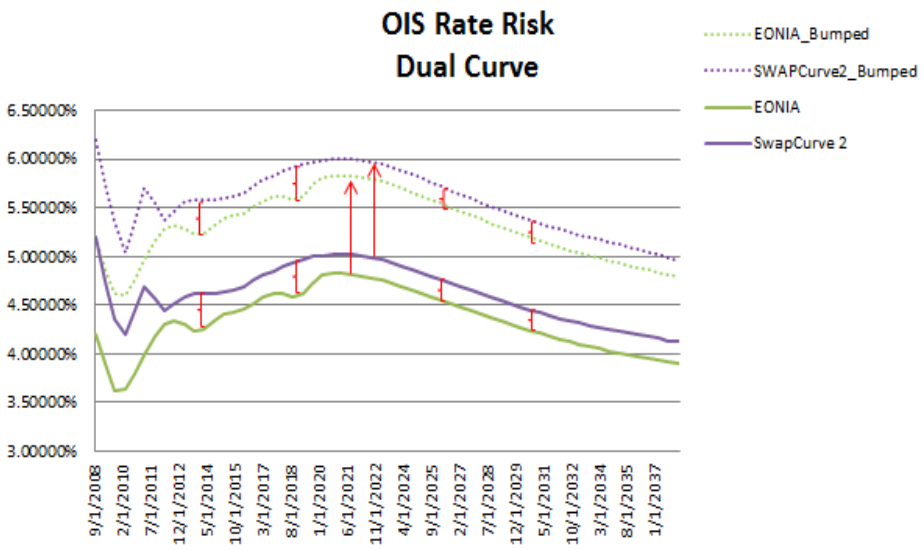
Risk Sensitivities







Conclusions

- Valuation and Risk methodologies fundamentally changed after 2008
  - Convergence around “OIS” discounting as a market standard
  - CVA, DVA & FVA measures included as part of trade valuation
  - Curve Construction, Model Calibration, Valuation & Risk methodologies updated
  - Stochastic spread modeling being discussed but not widely used yet
- Consistency of valuation techniques throughout a firm and broadly in the market still a challenge
- Aside from major markets, “OIS-like” curves not available
- Increasing push towards Standardized CSAs* will help to create consensus around methodology

* Source: Nick Sawyer, Isda working group close to finalising standard CSA, RISK

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