Consistent treatment of XVA

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About Numerix

- Numerix is the leading independent analytics provider for cross-asset solutions.
- Over 700 clients and 75 partners across more than 25 countries.

- **Structured Products Magazine's Technology Rankings**
  - **2013: #1 in All Pricing Categories: Rates, Credit, Equities, FX, Commodities**
  - **2013, 2012: #1 in Risk Management – Credit & Market**
  - **2013: Overall #1 Technology Vendor ; 2012: Overall Winner**

- **Waters Rankings :** Compliance / Risk Management
  - **2013, 2012: Best Risk Analytics Provider, Best Credit Risk Solution Provider**

- **Risk Magazine Technology Rankings**
  - **2013, 2012, 2011: #1 for CVA, DVA & FVA**
  - "Enterprise Risk Management" - Credit Valuation Adjustment (CVA), Debt Valuation Adjustment (DVA) and Funding Valuation Adjustment (FVA) calculations
  - "Pricing Analytics" - Structured Products and Cross-Asset

Agenda

- Why risky discounting isn’t enough
- Framework for consistent XVA calculation
- Taking CSA into account
- Calculating Total Valuation Adjustment
- XVA Case Studies

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Why risky discounting isn't enough

- In the derivatives business, credit risk used to be taken into account by discounting with the risky curve
- Consider simple example of a ZCB with maturity of 5y and notional EUR 10k (i.e. receipt of 10k at maturity, assuming recovery of zero)

Name	Value (EUR)
PV risky discounting	81.72%
PV risk-free	90.07%
CVA	-8.35%
PV risk-free+CVA	81.72%

- risky PV = risk-free PV + CVA in this particular example
- Is that always true?

Why risky discounting isn't enough

- Consider a 10y ATM receiver swap starting in 5y forward with a fixed rate=4.04% and EUR 10k notional

Name	Value (EUR)
PV risky discounting	-0.3%
PV risk-free	0%
CVA	-0.86%
PV risk-free + CVA	-0.86%

- Accounting for credit risk by discounting does not work for products where future cash flows can be positive or negative

Framework for consistent XVA

Financial instrument

Collateral asset

HY Model

Exposure engine

Exposure profiles of financial instruments

DATE	VALUE 1	VALUE 2	...
6/30/2014	0.02	0.02	...
9/30/2014	-115.68	459.63	...
12/30/2014	-311.55	375.62	...
...	...	...	...

Exposure profiles of collateral assets

DATE	VALUE 1	VALUE 2	...
6/30/2014	1.000	1.000	...
9/30/2014	1.007	1.010	...
12/30/2014	1.013	1.021	...
...	...	...	...

Survival probabilities and curves

DATE	VALUE 1	VALUE 2	...
6/30/2014	100.0%	100.0%	...
9/30/2014	99.8%	99.8%	...
12/30/2014	99.6%	99.6%	...
...	...	...	...

CSA

NAME	VALUE
HighT	100
LowT	100
CP_MTA	0
SELF_MTA	20
...	...

XVA engine

PV, CVA, DVA, FVA, FCA, CollVA...

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Taking CSA into account

- CSA has great impact on XVA
- Standard parameters include thresholds, minimum transfer amounts, frequency of rebalancing, eligible collateral
- May contain optionality (different assets as collateral)

```
IF ISACTIVE(MarginCallDates) THEN
    C = CollateralUnits * CollateralAssetValue
    Delta = MAX(V - HighT, 0) - MAX(- V - LowT, 0) - C
    Delta = WHEN((Delta > 0) AND(Delta < CP_MTA), 0, Delta)
    Delta = WHEN((Delta < 0) AND(Delta > - SELF_MTA), 0, Delta)
    C += Delta
    CollateralUnits = C / CollateralAssetValue
END IF
```

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Calculating Total Valuation Adjustment

- What is the relationship between CVA/DVA/FVA?

$$\underbrace{-(1-R_{CP})\mathbb{E}_t\left[\int_t^T du\,\lambda_{CP}(u)\,(v_t(u)-C(u))^+\,D_E(t,u)\right]}_{\text{CVA}}$$

$$\underbrace{-(1-R_B)\mathbb{E}_t\left[\int_t^T du\,\lambda_B(u)\,(v_t(u)-C(u))^-\,D_E(t,u)\right]}_{\text{DVA}}$$

$$\underbrace{-\mathbb{E}_t\left[\int_t^T du\,\lambda_F(u)\,(v_t(u)-C(u))\,D_E(t,u)\right]}_{\text{FVA}}$$

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How to calculate Total Valuation Adjustment

- Knowledge of the replication/hedging strategy is fundamental for consistent aggregation of VA's
- If we do not hedge the self default: TVA=CVA+FVA
- If we hedge the self default: TVA=CVA+DVA

```
// Credit Valuation Adjustment
CVA -= hzr_cp *(1 - rec_cp) * MAX(V - C, 0) * int_factor

// Debt Valuation Adjustment
DVA -= hzr_self *(1 - rec_self) * MIN(V - C, 0) * int_factor

// Funding Cost Adjustment
FCA -= hzr_self *(1 - rec_self) * MAX(V - C, 0) * int_factor

// Funding Valuation Adjustment
FVA -= hzr_self *(1 - rec_self) *(V - C) * int_factor
```

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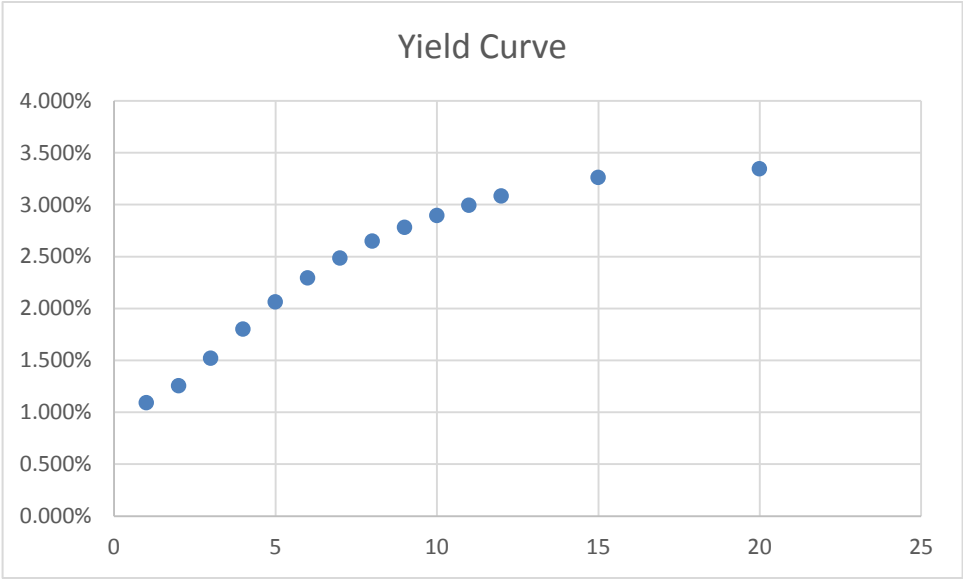
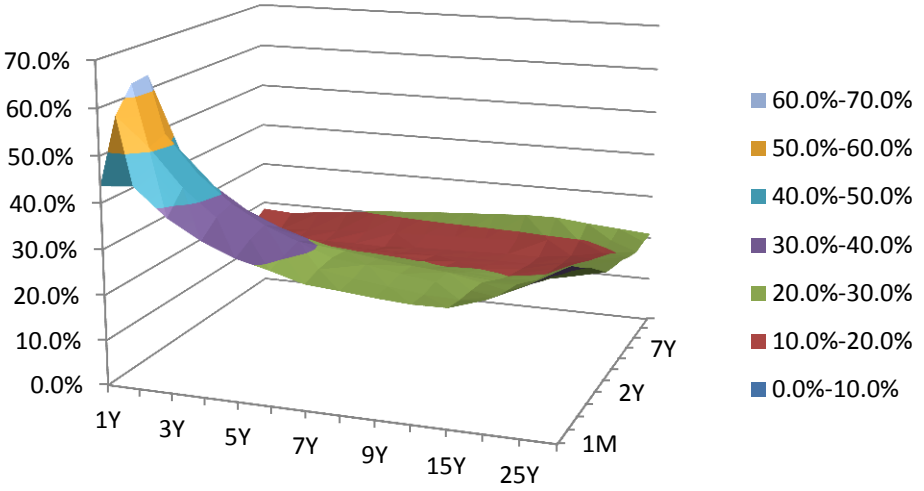
XVA Case Study

- I’d like to thank my colleagues Rahul Karkun (London), Mohit Agarwal (NYC) and Alexandre Antonov (Paris) for their contributions
- All errors are mine

Market data

- IR Market Data





- CR Market Data and CSA
  - CP_REC = 24%
  - SELF_REC = 40%
  - CP_HZRD = 2.5%
  - SELF_HZRD = 1%
  - Frequency of rebalancing = 1M

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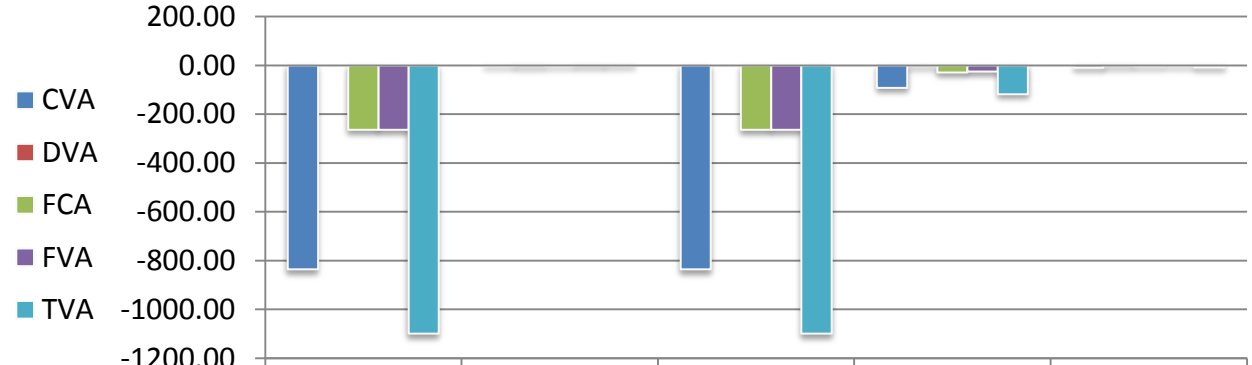
XVA Case Study – Impact of CSAs

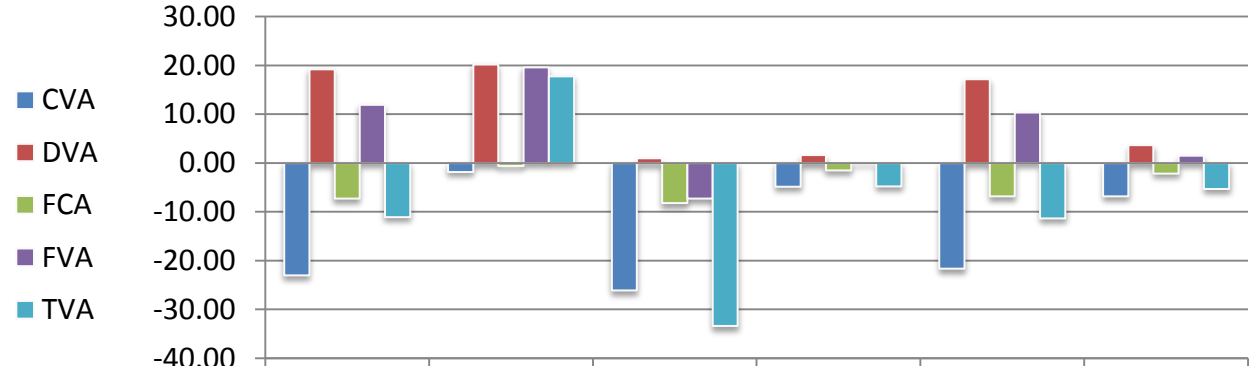
- 5 year Zero Coupon Bond with notional EUR 10k



	No Collateral	One Way Collateral - Counterparty	One Way Collateral - Self	Two Way Collateral, Threshold = 1000	Two Way Collateral, Threshold = 100
CVA	-835.64	-1.33	-835.64	-92.92	-9.43
DVA	0.00	4.74	0.00	3.83	4.29
FCA	-263.89	-0.42	-263.89	-29.34	-2.98
FVA	-263.89	4.32	-263.89	-25.51	1.32
TVA	-1099.52	2.99	-1099.52	-118.43	-8.11

XVA Case Study – Impact of CSAs

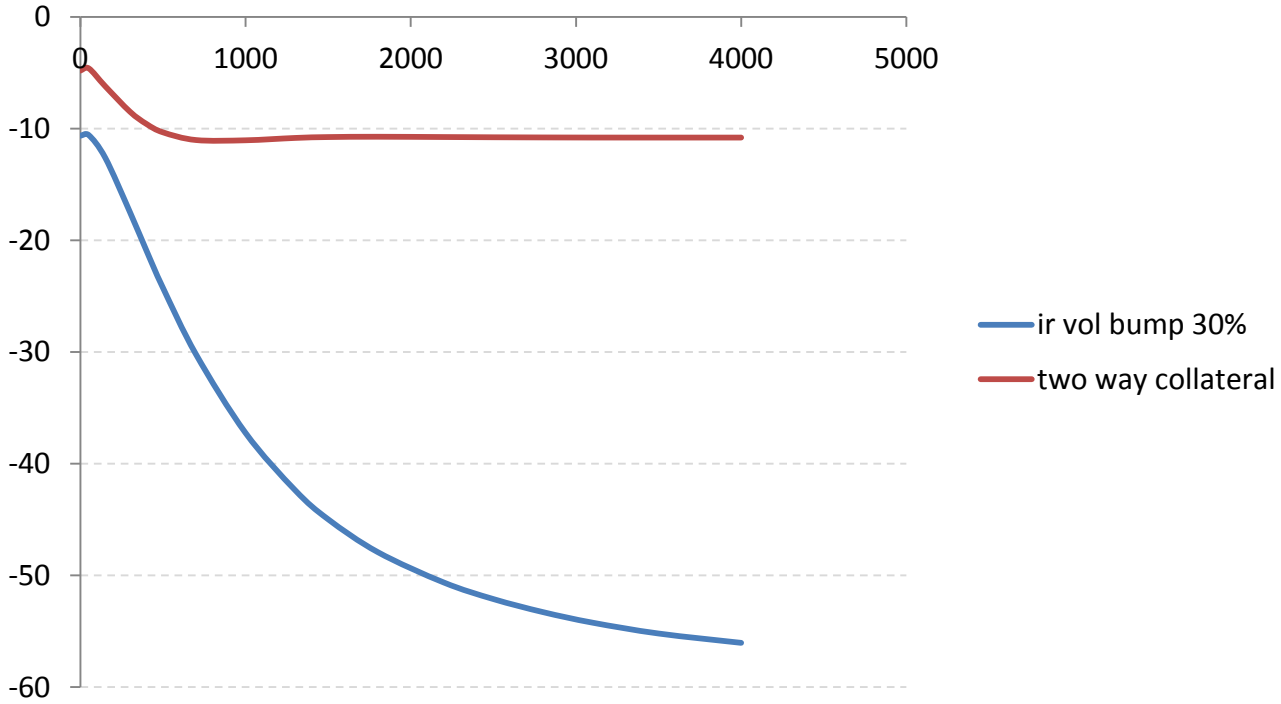
- 10 year ATM Swap with notional EUR 10k



	No Collateral	One Way Collateral - Counterparty	One Way Collateral - Self	Two Way Collateral, Threshold = 0	Two Way Collateral, Threshold = 1000	Two Way Collateral, Threshold = 100
CVA	-23.01	-1.83	-26.11	-4.89	-21.68	-6.86
DVA	19.20	20.18	0.94	1.60	17.15	3.66
FCA	-7.27	-0.58	-8.25	-1.54	-6.85	-2.17
FVA	11.93	19.60	-7.30	0.06	10.31	1.50
TVA	-11.08	17.77	-33.41	-4.83	-11.37	-5.36

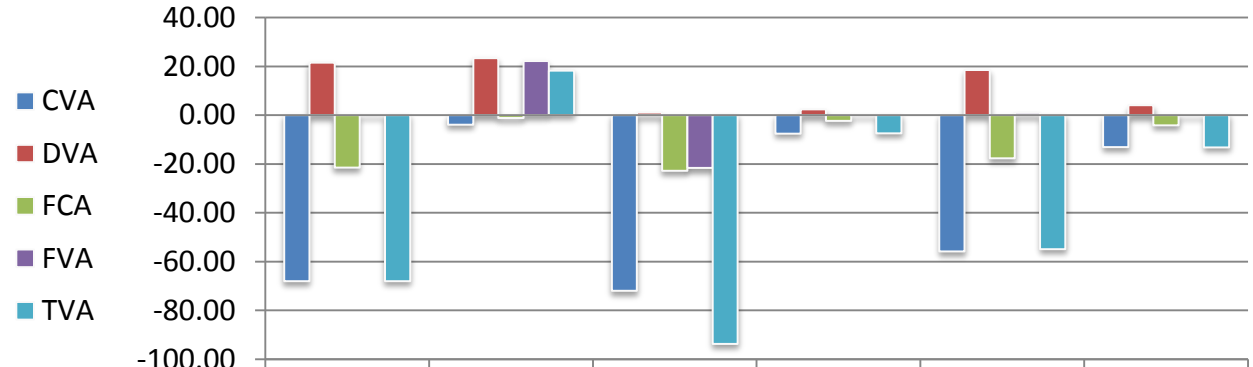
XVA Case Study – Impact of CSAs

- 10 year ATM Swap with notional EUR 10k
- Dependency of TVA on collateral threshold



XVA Case Study – Impact of CSAs

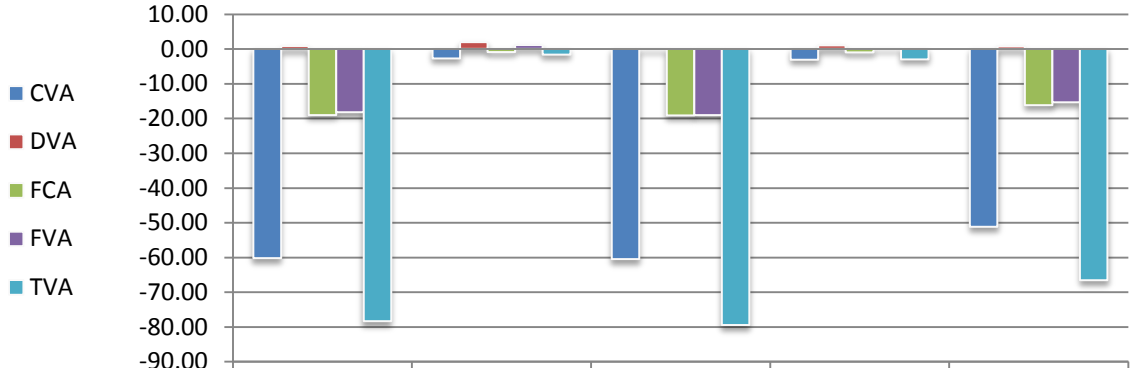
- 10 year ATM Swap starting 5 year forward



	No Collateral	One Way Collateral - Counterparty	One Way Collateral - Self	Two Way Collateral, Threshold = 0	Two Way Collateral, Threshold = 1000	Two Way Collateral, Threshold = 100
CVA	-68.02	-3.88	-71.99	-7.53	-55.81	-13.14
DVA	21.50	23.41	1.06	2.39	18.56	4.07
FCA	-21.48	-1.23	-22.73	-2.38	-17.62	-4.15
FVA	0.02	22.18	-21.68	0.01	0.94	-0.08
TVA	-68.00	18.30	-93.66	-7.52	-54.88	-13.22

XVA Case Study – Impact of CSAs

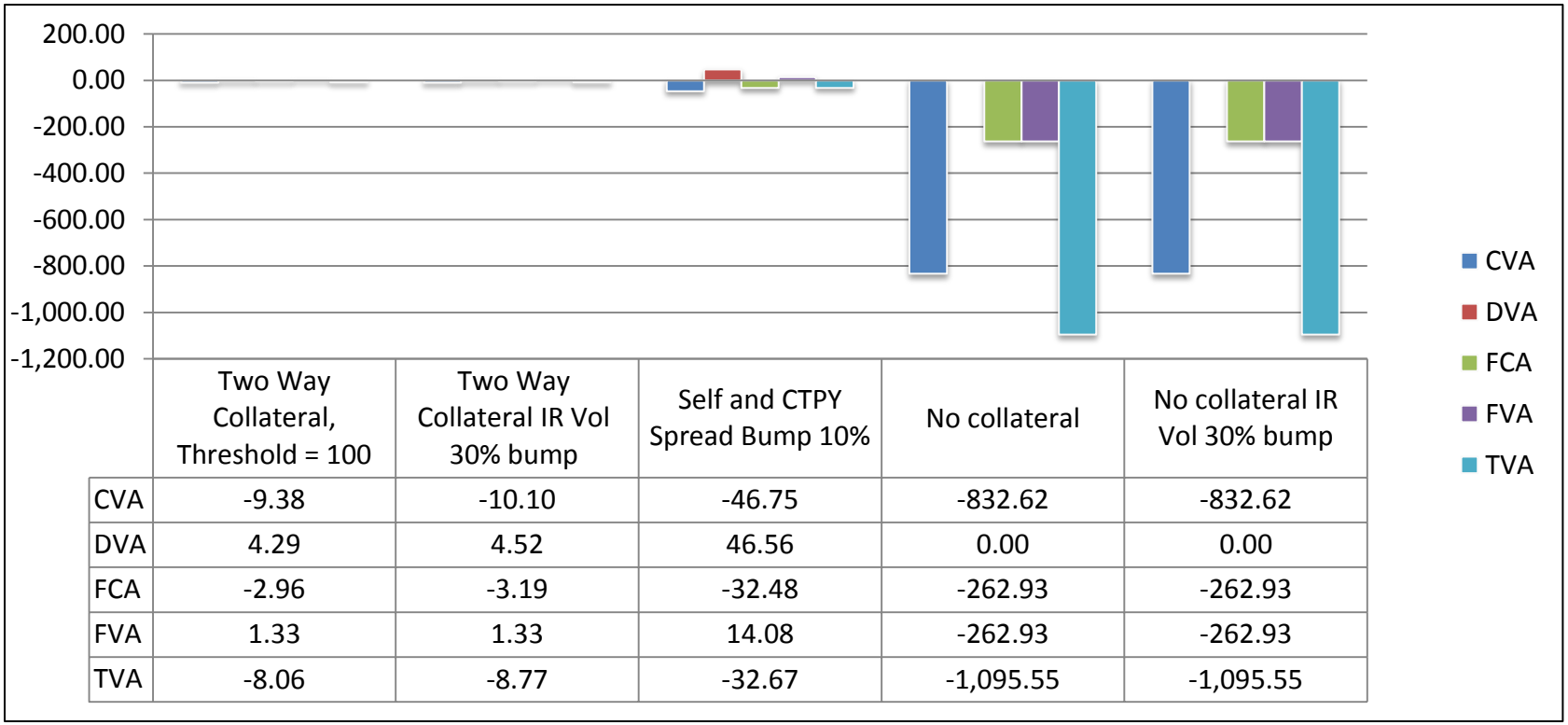
- 5 yr X 10 yr ATM Swaption, PV = EUR 300



	No Collateral	One Way Collateral - Counterparty	One Way Collateral - Self	Two Way Collateral, Threshold = 0	Two Way Collateral, Threshold = 1000
CVA	-60.21	-2.75	-60.49	-3.07	-51.18
DVA	0.82	1.97	0.08	1.08	0.82
FCA	-19.01	-0.87	-19.10	-0.97	-16.16
FVA	-18.19	1.10	-19.02	0.11	-15.34
TVA	-78.40	-1.65	-79.51	-2.96	-66.53

XVA Case Study – Interest Rate Volatility & Hazard Rate Impact

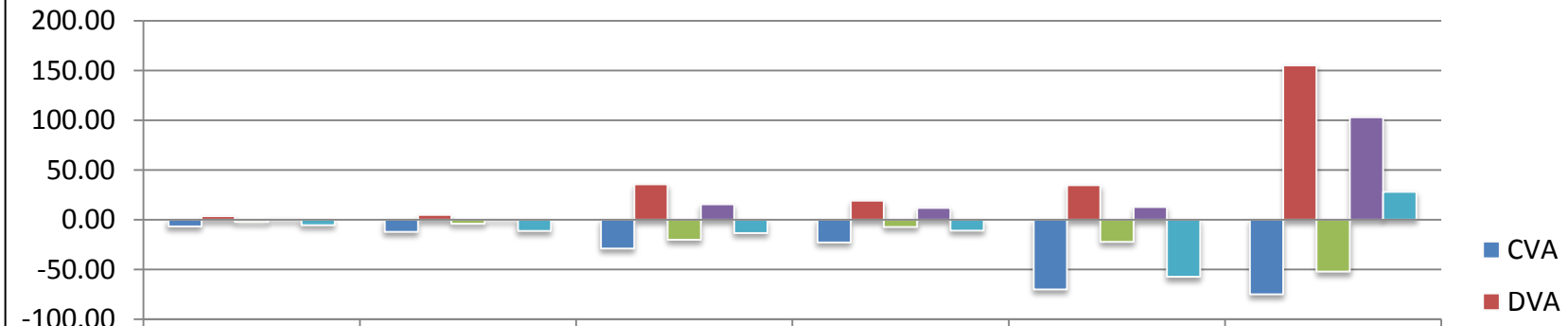
- 5 year Zero Coupon Bond with notional EUR 10k



	Two Way Collateral, Threshold = 100	Two Way Collateral IR Vol 30% bump	Self and CTPY Spread Bump 10%	No collateral	No collateral IR Vol 30% bump
CVA	-9.38	-10.10	-46.75	-832.62	-832.62
DVA	4.29	4.52	46.56	0.00	0.00
FCA	-2.96	-3.19	-32.48	-262.93	-262.93
FVA	1.33	1.33	14.08	-262.93	-262.93
TVA	-8.06	-8.77	-32.67	-1,095.55	-1,095.55

XVA Case Study – Interest Rate Volatility & Hazard Rate Impact

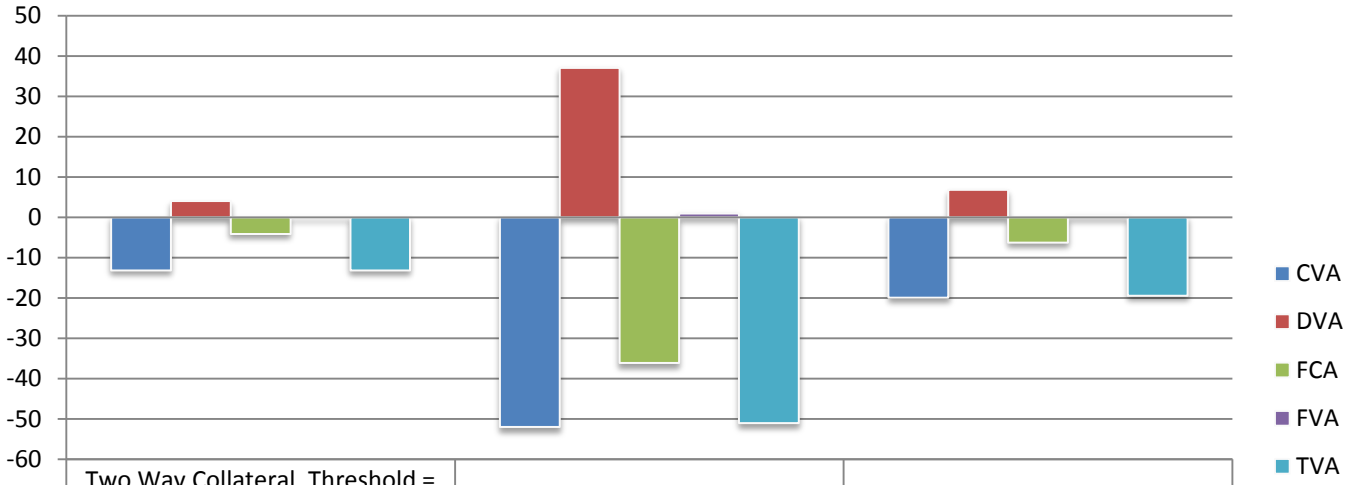
- 10 year ATM Swap with notional EUR 10k



	Two Way Collateral, Threshold = 100	Two Way Collateral IR Vol 30% bump	Self and CTPY Spread Bump 10%	No collateral	No collateral IR vol 30% bump	No Collateral Self and CTPY Spread Bump 10%
CVA	-6.84	-12.24	-28.90	-22.76	-70.11	-75.06
DVA	3.67	4.74	35.56	19.14	34.86	155.18
FCA	-2.16	-3.87	-20.08	-7.19	-22.14	-52.14
FVA	1.51	0.88	15.48	11.95	12.72	103.03
TVA	-5.33	-11.36	-13.42	-10.80	-57.39	27.98

XVA Case Study – Interest Rate Volatility & Hazard Rate Impact

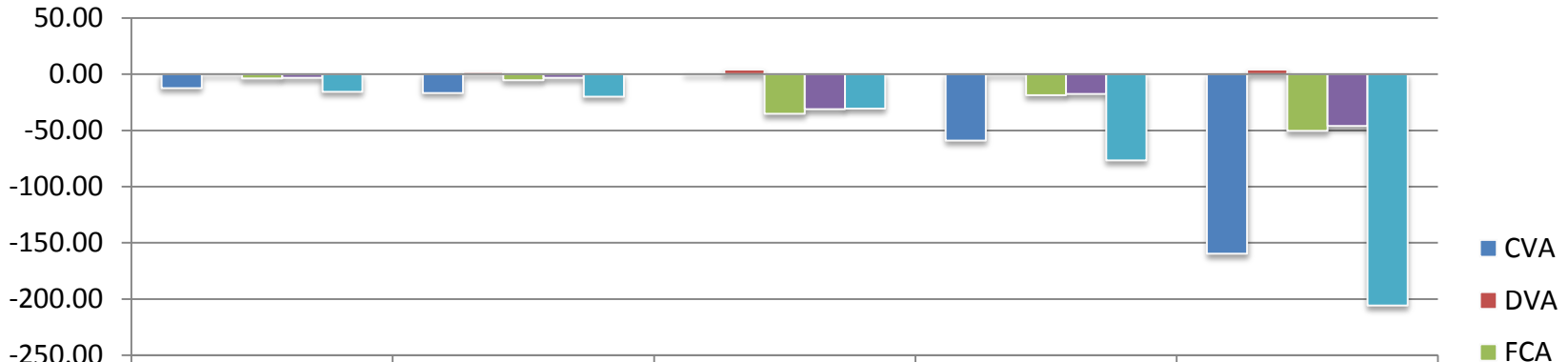
- 10 yr ATM Swap starting 5 yr Forward



	Two Way Collateral, Threshold = 100	Self and CTPY Spread Bump 10%	IR Vol 30% bump
CVA	-13.13809832	-51.98343239	-19.95239945
DVA	4.071006006	37.06020921	6.776838572
FCA	-4.148873155	-36.11480566	-6.300757721
FVA	-0.077867149	0.945403548	0.47608085
TVA	-13.21596547	-51.03802885	-19.4763186

XVA Case Study – Interest Rate Volatility & Hazard Rate Impact

- 5 yr X 10 yr ATM Swaption



	Two Way Collateral, Threshold = 100	Two Way Collateral IR Vol 30% bump	Self and CTPY Spread Bump 10%	No collateral	No collateral IR vol 30% bump
CVA	-12.30	-16.71	0.56	-59.10	-159.57
DVA	0.54	2.01	4.09	0.97	4.23
FCA	-3.89	-5.28	-35.31	-18.66	-50.39
FVA	-3.35	-3.26	-31.22	-17.70	-46.17
TVA	-15.65	-19.98	-30.66	-76.80	-205.74

No bump PV = EUR 300
IR vol bump PV = EUR 850

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Thank You

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