CVA / DVA / FVA

a comprehensive approach under stressed markets

Ipotecs

Gary Wong

References

- **C. Albanese, S. Iabichino:** *The FVA-DVA puzzle: completing market with collateral trading strategies,* available on www.albanese.co.uk

- **John hull and Alan White:** Valuing Derivatives: Funding Value Adjustments and Fair Value, working paper, Sept 2013

- **C. Albanese, D. Brigo, F. Oertel**: *Restructuring counterparty credit risk*, to appear on IJTAF and in the Working Paper Series of the Bundesbank, SSRN 1969344 (2011)

- **C. Albanese, G. Pietronero**: *A redesign for central clearing*, Credit Flux, August 2011

Markets


Last Price 3.1045
High on 11/30/94 8.2750
Average 5.0813
Low on 07/31/12 1.5885
8.0000
7.0000
6.0000
5.0000
4.0000
3.1045
2.0000
'94 '95 '96 '97 '98 '99 '00 '01 '02 '03 '04 '05 '06 '07 '08 '09 '10 '11 '12 '13
USSWAP10 Curncy (USD SWAP SEMI 30/360 10Y) Monthly 22AUG1993-22AUG2013 Copyright© 2013 Bloomberg Finance L.P. 22-Aug-2013 14:25:45

Fragile market fundamentals and sentiments

- Qexit / Tapering
  - uncertainty in timing and impact
  - Trading on sentiments, not fundamentals
- Sovereign risks
  - Europe, Japan, China, EM
  - China and Japan holding $2.4 trillion of Treasury. Domestic problems may lead to the selling pressure
- Geo-political situations
  - Syria, Iran/Israel, North/South Korea, …
  - Oil price, sentiments on investing in EM

Fragile market fundamentals and sentiments

- Any of these events could trigger market instability and reactions, leading to feedback loop that trigger other events (Risk off / rushing for the exit)

- The uncertainty surrounding the development of these events would induce volatility to the market in any case

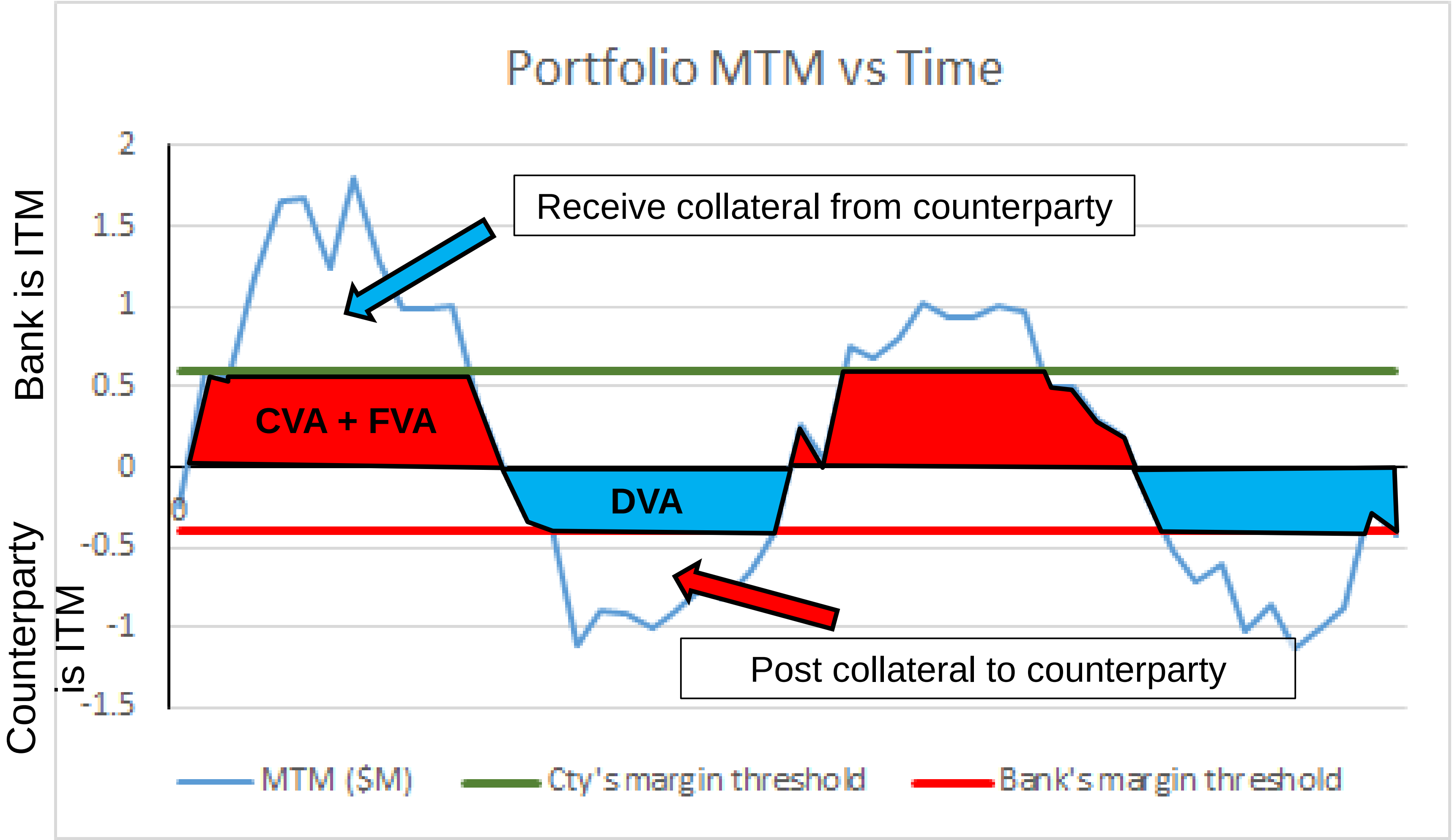
- One must look at scenarios with very volatile markets and large sell-offs

Fast-moving and gapping markets

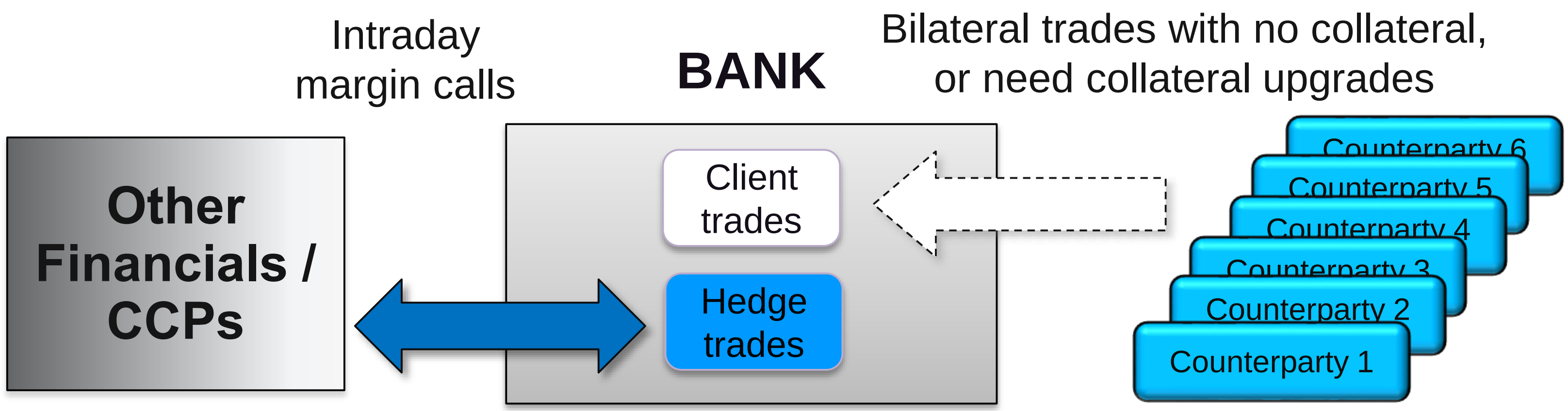
- $ 10Y Swap Rate 1994 - 2013

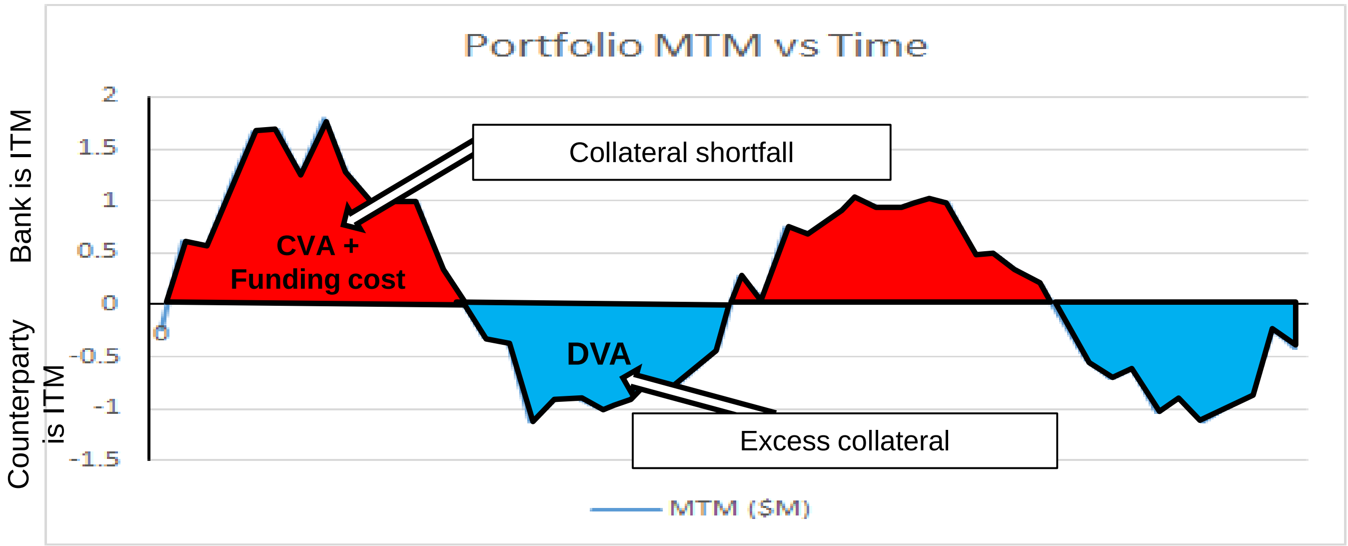
Collateral, CVA, DVA and FVA
under fast and gapping markets

Collateral, CVA, DVA and FVA

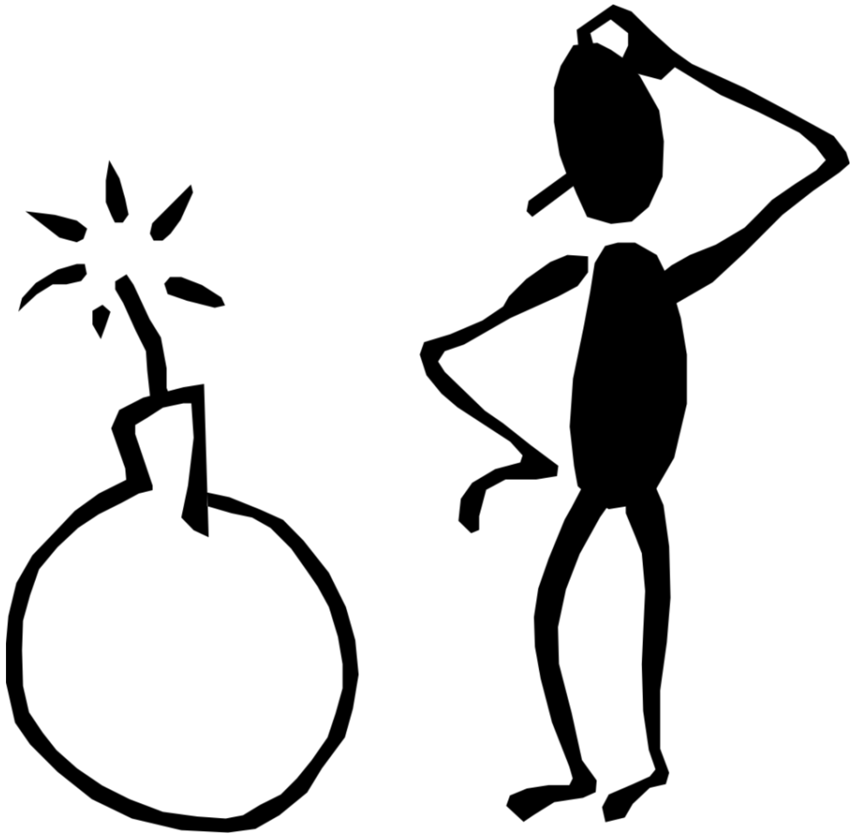


Collateral gap bias from unsecured trades





Collateral



Collateral

- Supply reduction
  - Drastic reduction of safe asset (IMF: reduction of 16% $9Tn by 2016)
- Demands increased
  - $650Tn OTC derivatives routed through CCPs, requiring IM and intraday VM
  - CCPs not centralised - reduced netting significantly
  - BASEL III Liquidity Coverage Ratio
- Collateral transformation services
  - IN: Illiquid/low quality collateral
  - OUT: High quality collateral

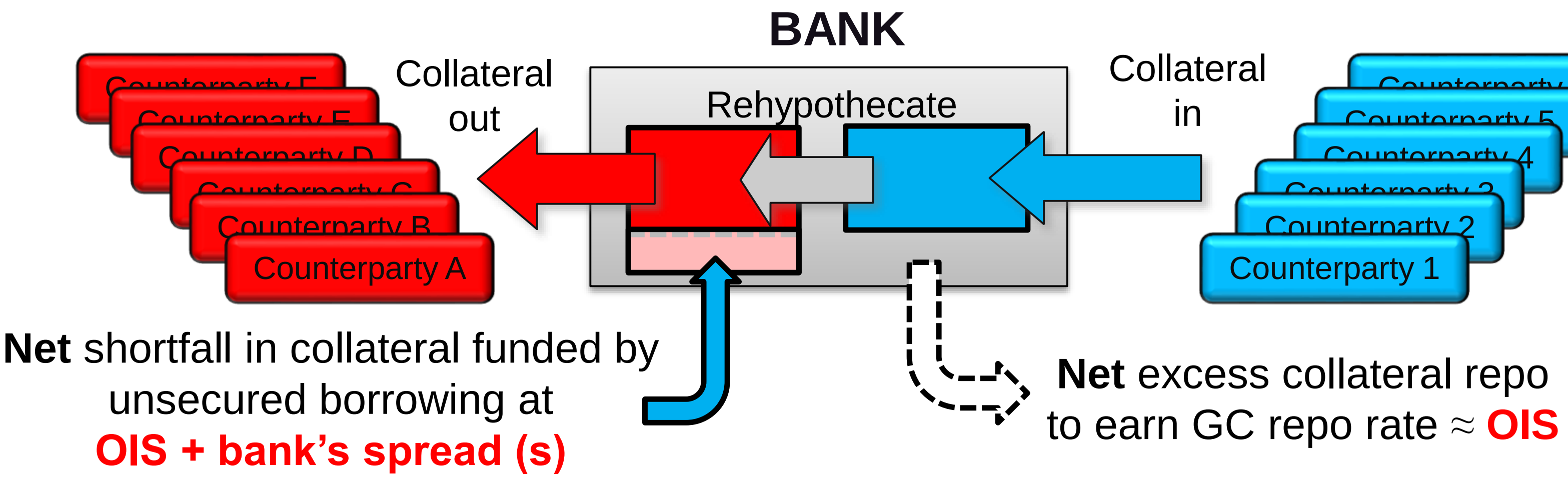
Collateral issues in times of stress

Wrong Way Risk under stressed / fast / gapping market

- Bank's credit spread ↑ and collateral posting ↑, leading to funding and liquidity issue
- Unexpected large margin calls due to gapping market
- Lowered CSA thresholds and higher haircuts as credit deteriorates
- Exposure ↑ while collateral MTM down (Bonds ↓ as r ↑)
- LCR $= \frac{High\ quality\ liquid\ assets}{Total\ net\ liquidity\ outflows\ over\ 30{-}day\ time\ period} \geq$ 100%

Rehypothecation and CSA threshold

Collateral received from counterparties are rehypothecated and posted to other counterparties



Rehypothecation and CSA threshold for each netting set are very important in determining the NET collateral level

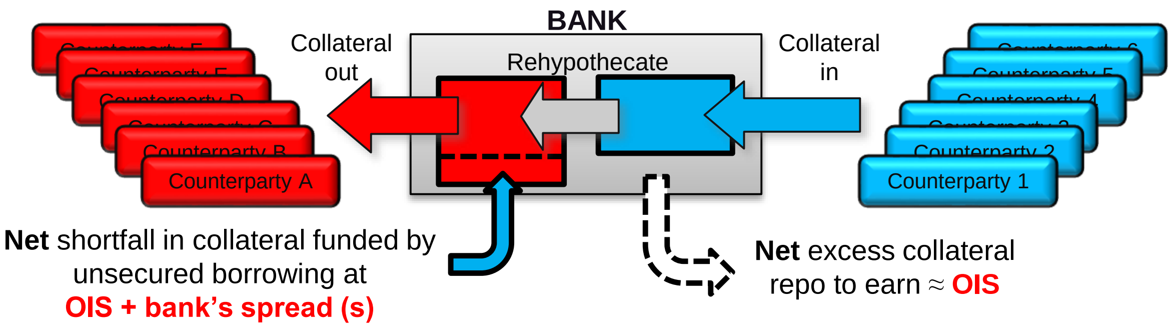
Projecting collateral requirements

Monte Carlo on the whole portfolio.

Choose a suitable time horizon (say, 3 months)

For each scenario,

- take account of the MTM of the netting set and its CSA threshold, rehypothecate any excess collateral



- After running through all netting sets we arrive at the net collateral situation

Sample portfolio calculation example

A realistic sample portfolio of 25,000 OTC derivative trades, 1,500 counterparties, 6 IR markets and 5 FX, final maturity of portfolio at 25 years

We calibrate to ICAP market data

GOODNESS OF FIT

D – market norm implied vols - model norm implied vols (in basis points)

D > 4

2 < = D <= 4

-2 < D <- 2

-4 < D <- -2

D <= -4

EXPIRIES	TENORS 1y	2y	3y	4y	5y	6y	7y	8y	9y	10y	15y	20y	25y	30y
8-Aug-2013														
8-Oct-2013														
8-Jan-2014	-6.3	-4.8	-3.5	-1.5	5.6	2.7	2.0	0.6	-0.8	-0.9	-1.7	-0.6		
8-Jul-2014	5.1	5.4	0.3	-0.4	2.2	0.3	0.0	-0.7	-1.5	-1.3	-1.0	1.4		
8-Jul-2015	7.2	-0.9	-2.4	-2.8	-1.9	-2.1	-1.6	-1.5	-1.3	-0.8	0.0	2.5		
8-Jul-2016	-1.6	-0.6	-1.3	-2.6	-3.4	-2.8	-1.9	-1.2	-0.7	0.0	0.5	2.3		
8-Jul-2017	3.3	2.6	1.1	-0.1	-1.2	-0.8	-0.1	0.5	1.2	1.9	1.7	3.0		
8-Jul-2018	4.5	4.1	2.4	0.9	-0.7	-0.3	0.2	0.8	1.3	1.7	1.2	2.2		
8-Jul-2019	1.7	2.3	1.2	0.2	-0.4	0.6	0.4	0.8	1.1	1.4	0.5	1.9		
8-Jul-2020	-0.4	0.7	0.1	-0.6	-1.0	-0.6	-0.2	0.2	0.6	0.9	-0.6	1.5		
8-Jul-2021	-0.8	0.0	-0.4	-0.6	-0.5	-0.6	-0.3	0.0	0.4	0.6	-1.0	0.6		
8-Jul-2022	-1.8	-1.4	-1.4	-1.3	-1.0	-0.9	-0.8	-0.6	-0.4	-0.1	-1.9	-0.7		
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8-Jul-2028	-3.4	-2.8	-2.3	-1.7	-1.1	-1.0	-0.8	-0.5	-0.2	0.2	-2.4	-0.3		
8-Jul-2033	-1.8	-1.5	-0.8	0.0	0.8	1.1	1.4	1.7	2.0	2.4	1.0	3.9		
8-Jul-2038														
8-Jul-2043														

Important to have good calibration as we are looking at the macro picture

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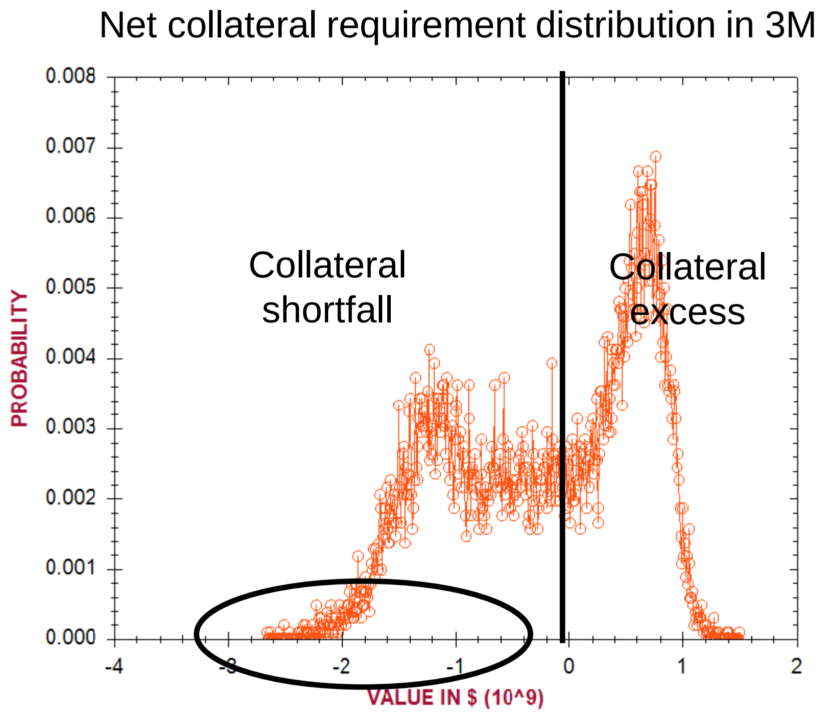
Collateral under stressed market

Project net collateral distribution forward at different times (say, 3 months, 6 months, 1 year…)



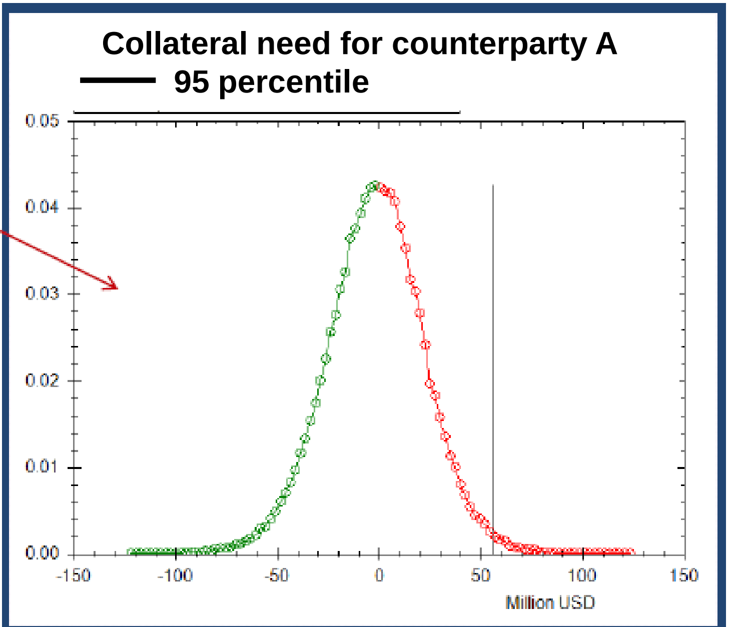
Estimate or re-calculate:

- Unexpected large margin calls and liquidity requirement
- LCR given the amount of collateral shortfall
- Lowered CSA thresholds and higher haircuts
  - for counterparties
  - for bank

Incremental collateral requirement

Investigate collateral requirement for a single netting set

Distribution of the collateral requirement for a single netting set, adjusted for CSA threshold



Incremental collateral requirement for a new trade / cancelled trade

Set of trades in the netting set

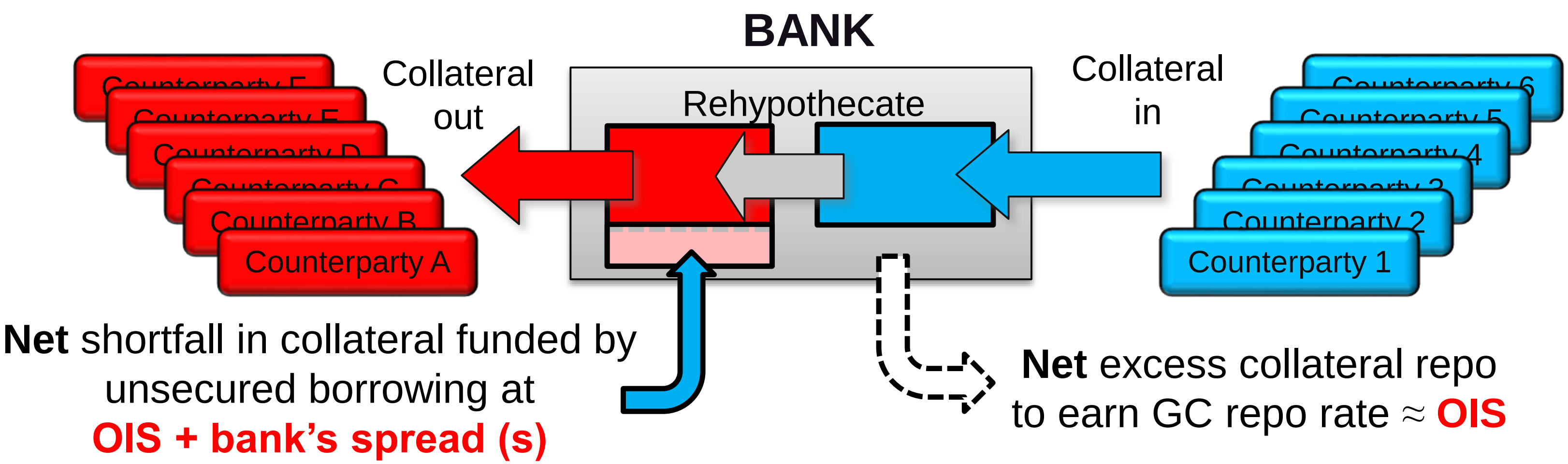
description	portfolio	reference	currency	netting set
cross currency swap	SWAPS	A0001	pays USD, receives GBP	Cty A
cross currency swap	SWAPS	A0002	pays EUR, receives USD	Cty A
cross currency swap	SWAPS	A0003	pays USD, receives GBP	Cty A
cross currency swap	SWAPS	A0004	pays EUR, receives USD	Cty A
interest rate swap	SWAPS	A0005	pays EUR, receives EUR	Cty A
interest rate swap	SWAPS	A0006	pays EUR, receives EUR	Cty A

Modelling challenges

- It is very important to model re-hypothecation at the portfolio level – not possible at transaction level or even at netting set level
- One has to simulate all relevant market risk factors but also credit qualities for all counterparties as **CSA agreement have credit dependencies**
- Dynamic credit modelling is important also to model the impact of defaults and gap risk on funding requirements, and Wrong Way Risk (WWR)

Modelling provides information and insight

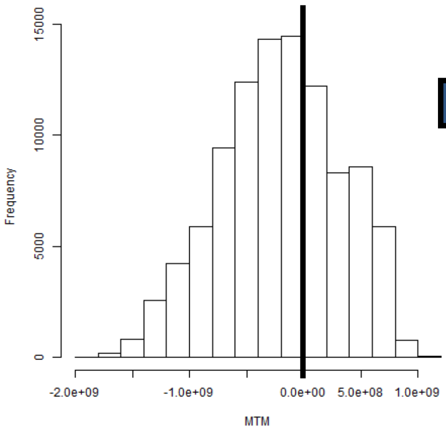
Modelling the collateral process realistically, including rehypothecation and counterparties' credit risks and CSA thresholds…



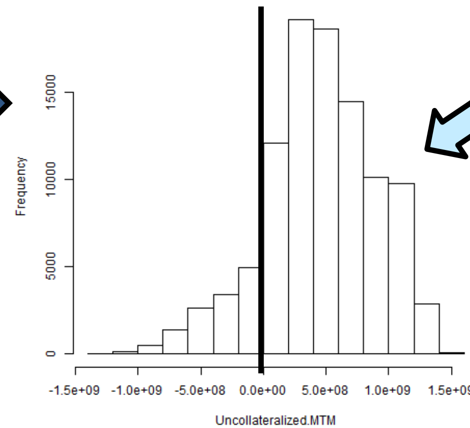
Would allow us to dissect the portfolio and the collateral requirements in great details, and enable us to ask some really important and insightful questions…

Uncollateralized MTM distribution

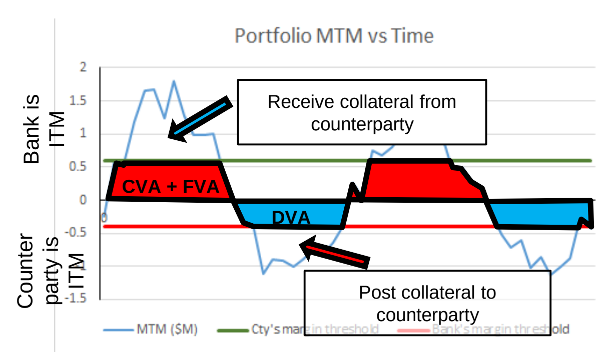
MTM distribution in 3M

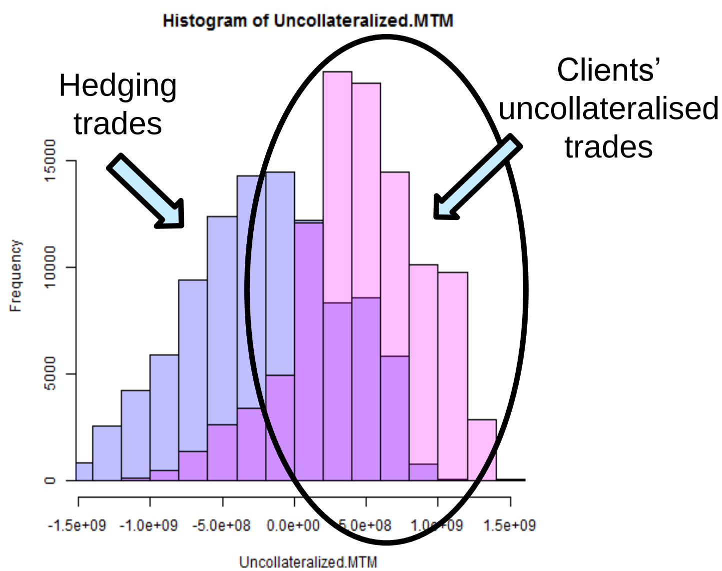


Uncollateralised
MTM distribution in 3M



collateral exposure after taking account of CSA thresholds





Overlapping the two would give us some insight into the composition of the portfolio

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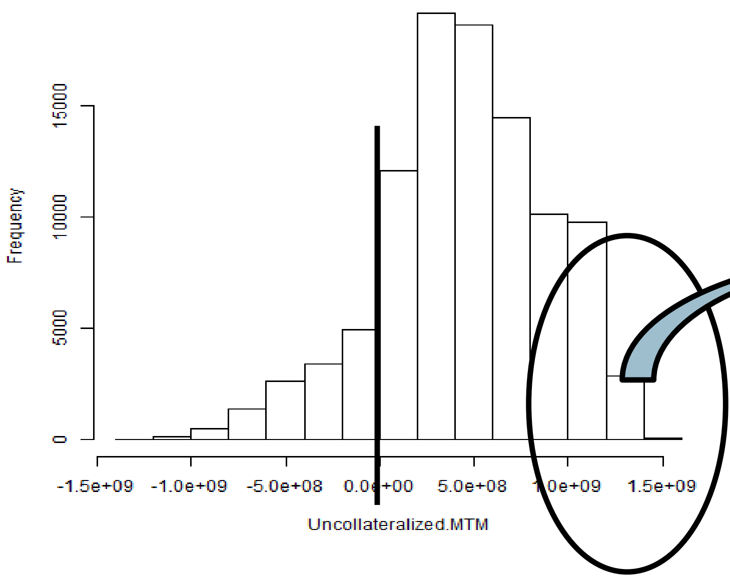
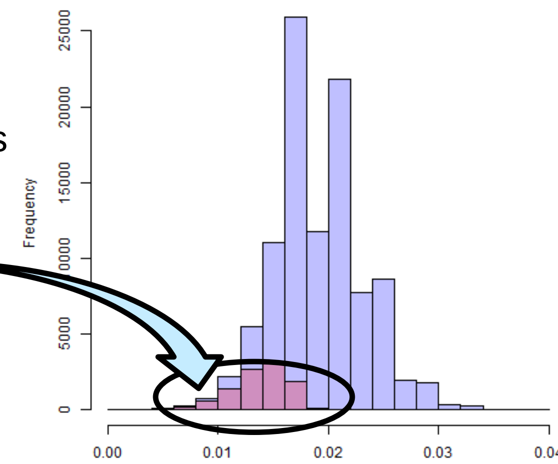
Mapping collateral requirements and exposure to markets

Uncollateralised MTM distribution in 3M



Organise the market scenarios that give rise to the tail…

Risk factor distribution in 3M



Risk factors distribution conditional on 90%-tile of uncollateralised MTM distribution

Examples:

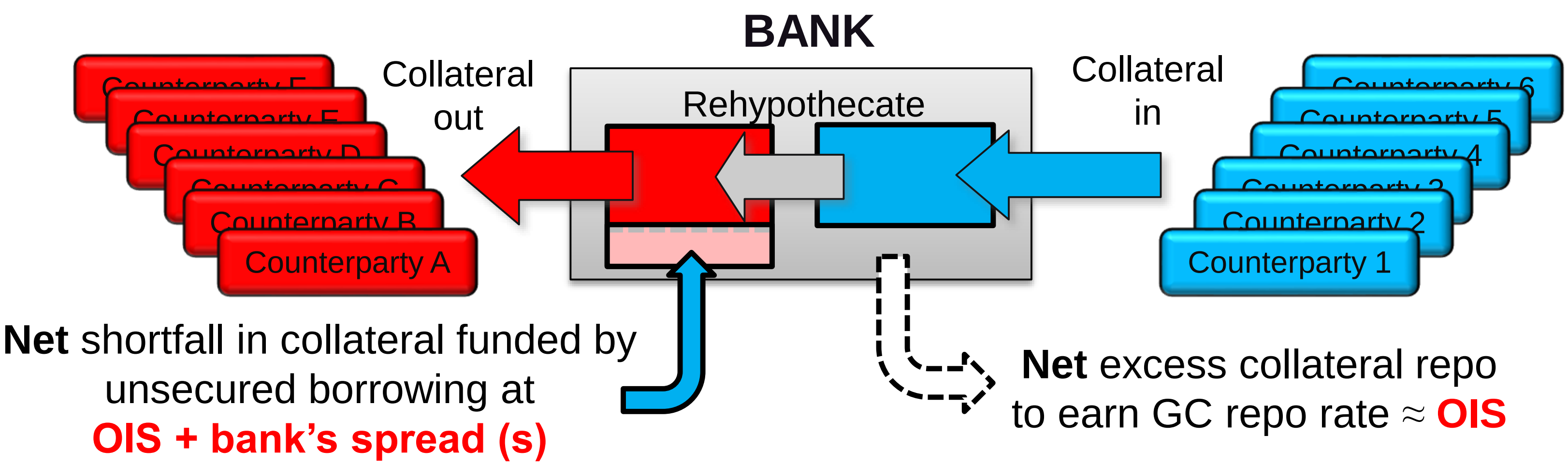
- USD rate
- EUR rate
- $/Yen FX …

Run on **portfolio level**

- to anticipate potential overall collateral shortfall under certain market conditions
- if credit conditions deteriorate and lower many CSA thresholds, or bank has to lower its CSA…

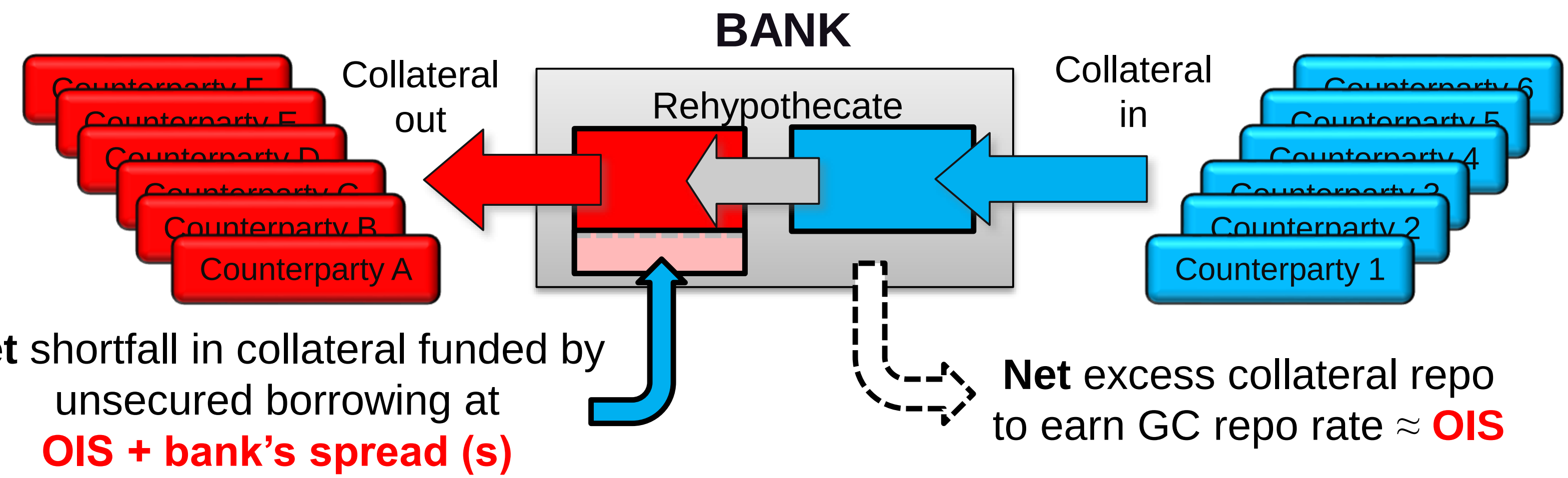
Run on **individual counterparty** to see how their credit exposure could balloon under certain market conditions

Extending the model → FVA



Rehypothecation, CSA threshold & FVA

Collateral received from counterparties are rehypothecated and posted to other counterparties



- The real FVA cost depends on **NET** collateral position at **portfolio level**
- Rehypothecation and CSA thresholds are very important in determining the NET collateral level
- **Collateral shortfall costs OIS + s; collateral excess earns only OIS.** Since 's' is not small, as the collateral position constantly changes between excess and shortfall, there will be **significant cost implications**
- Simulate until the final maturity of the portfolio

Funding under stressed market

- Wrong Way Risk under stressed / fast / gapping market
  - Bank's credit spread and FVA
  - Bank's credit and collateral / liquidity issue
  - Unexpected large margin calls
  - Lowered CSA thresholds and higher haircuts
  - Exposure ↑ while collateral MTM down (Bonds ↓ as r ↑)
  - $$\text{LCR} = \frac{\textit{High quality liquid assets}}{\textit{Total net liquidity outflows over 30-day time period}} \geq 100\%$$
  - Increasing close-out gap risk between margin calls

FVA using funding rate discounting

Some FVA formulae in the literature use funding rate for discounting.

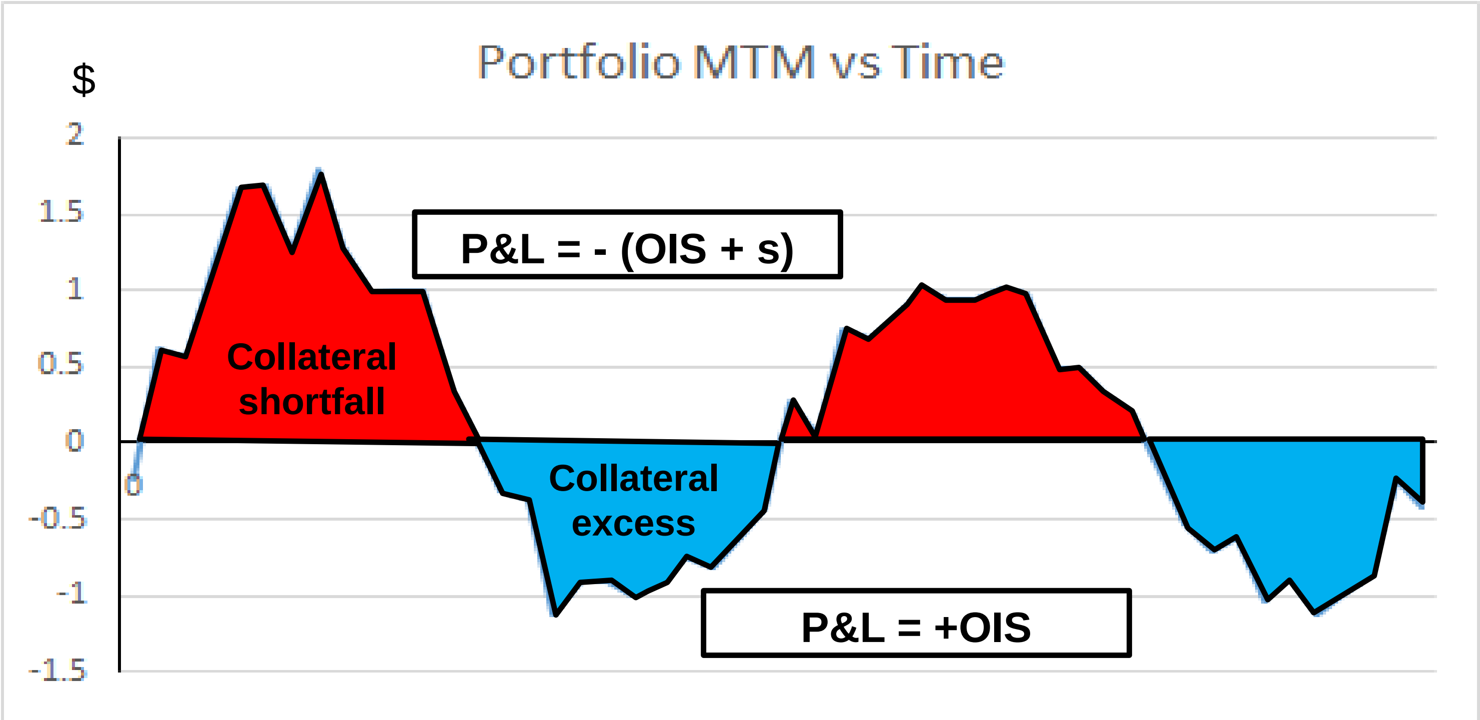
Only a good approximation if borrowing rate = lending rate, allowing costless netting of borrowing and lending cost in the portfolio replication in the derivation.

=> $FVA_{benefit}$ will net against FVA_{cost} with the same rate

That does not take into account the large cost difference between unsecured borrowing rate (OIS + bank's funding spread) and the lending rate (repo at GC repo rate).

How much does it matter?

Net collateral position vs time



Funding rate discounting → [borrow cost = lending gain]

- Significantly under-estimate FVA when ‘s’ is large
- Wrong Δ_s *FVA* (*FVA* cost exposure to bank’s own funding spread ‘s’), as spread ‘s’ is only incurred on one-side

FVA using funding rate discounting

- Assuming the lending rate to equal the funding rate is an **approximation** which is only correct in case there is never a situation with excess collateral.
- One can use any excess collateral to buy back the bank's own debt, achieving lending gain = OIS + s (then sell them the next day when requiring collateral). **BUT…**
- **ALL excess collateral** (from the portfolio) has to go towards buying back the bank's own debt. Repo-ing to get only GC repo rate would incur a loss

Can this be achieved in practice?

If not, then the FVA, the risks and stress-testing results, all could be significantly off…

Conceptual and accounting issues

- Non-unique asset exit prices – each bank has its own funding cost
- Fair value includes discounting by unobservable funding rate of the bank – under FASB 157, even simple swap would needed to be classified as **level 3 asset**, consuming much more capital
- Double counting issues between DVA and FVA
- Partially collateralized transactions - ?
- Perverse incentive to encourage funding trades (especially long-dated) with ‘phantom’ profit
- Hull and White: funding arbitrage trades

FVA by transaction

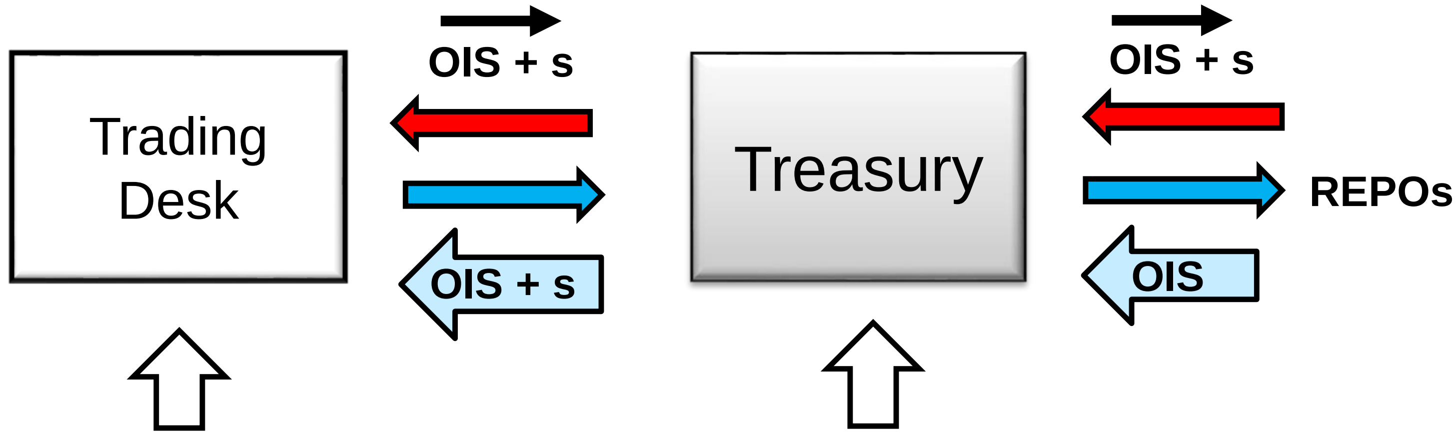
Practitioners are still interested in having an empirical notion of FVA for one individual transaction for transfer pricing purposes – for example, discount the deal at funding rate.

One cannot talk rigorously about the FVA of individual transactions, or even of individual setting sets, it is only meaningful to talk about the ***FVA of the entire portfolio***

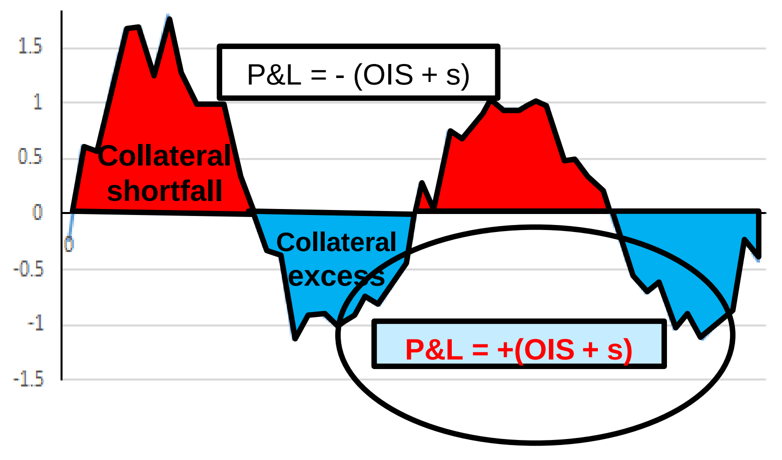
Generally, $\sum_{k}^{netting\ set} \sum_{i}^{transaction} FVA_{k,i} \neq FVA_{portfolio}$

Transfer pricing cannot be the basis for hedging and should not be included in *fair valuations* of derivative books.

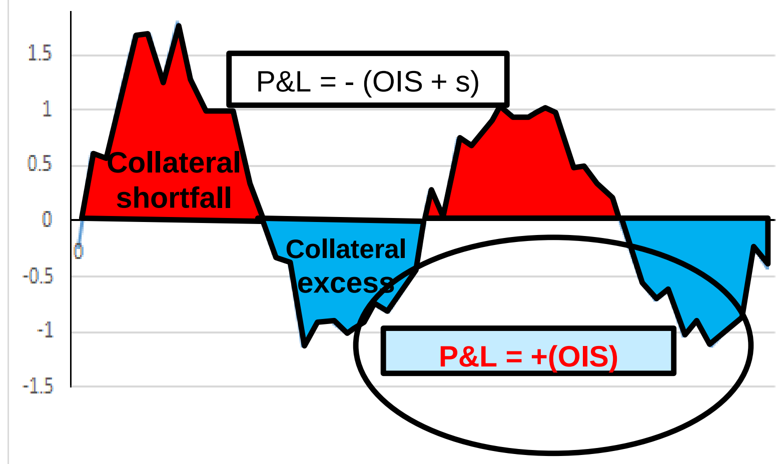
Trading and Treasury



Encourage long-dated funding trades – earning OIS + s



Does Treasury PV the cost over the long-dated trade?



Calculating *FVA* *portfolio*

The reality is that excess collateral gains OIS; shortfall costs (OIS + s)

Discounting at funding rate does not capture all the cost of FVA, gives wrong Δ_s, and lead to conceptual and accounting problems.

What is the alternative?

Suggestion:

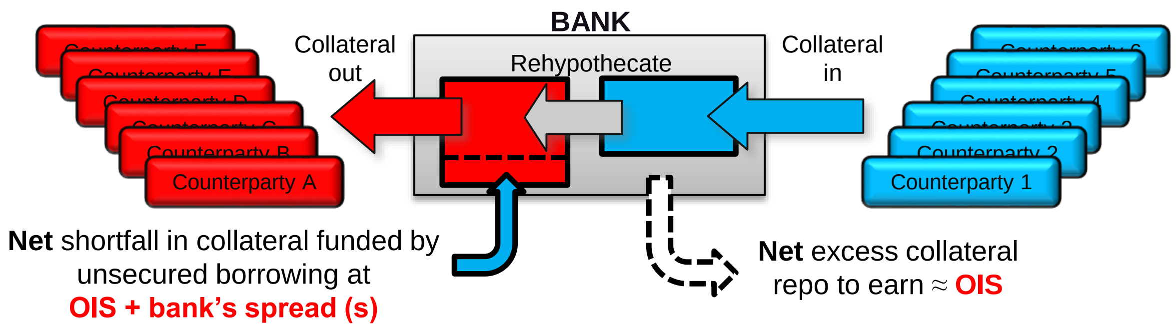
- **Model the process as it is at portfolio level, and calculate the true FVA**

Calculating $FVA_{portfolio}$

Monte Carlo on the whole portfolio.

For each scenario,

- take account of the MTM of the netting set and its CSA threshold, rehypothecate any excess collateral



- After running through all netting sets we arrive at the net collateral situation
- **Excess collateral gains OIS; shortfall costs (OIS + s)**
- **Discount using collateralised rate (i.e. OIS discounting)**
- Repeat for the next time step, until the final maturity of the portfolio

Portfolio FVA calculation example

A realistic sample portfolio of 25,000 trades, 1,500 counterparties, 6 IR markets and 5 FX, final maturity of portfolio 25 years

We assume a commercial bank, with 5Y CDS spread = 150bp, and with a portfolio with a general excess of collateral, and has 'right way risk'

We calibrate to ICAP market data

GOODNESS OF FIT

D – market norm implied vols - model norm implied vols (in basis points)

- D > 4
- 2 <= D <= 4
- -2 < D < 2
- -4 < D <= -2
- D <= -4

	TENORS													
EXPIRIES	1y	2y	3y	4y	5y	6y	7y	8y	9y	10y	15y	20y	25y	30y
8-Aug-2013														
8-Oct-2013														
8-Jan-2014	-6.3	-4.8	-3.5	-1.5	5.6	2.7	2.0	0.6	-0.8	-0.9	-1.7	-0.6		
8-Jul-2014	5.1	5.4	0.3	-0.4	2.2	0.3	0.0	-0.7	-1.5	-1.3	-1.0	1.4		
8-Jul-2015	7.2	-0.9	-2.4	-2.8	-1.9	-2.1	-1.6	-1.5	-1.3	-0.8	0.0	2.5		
8-Jul-2016	-1.6	-0.6	-1.3	-2.6	-3.4	-2.8	-1.9	-1.2	-0.7	0.0	0.5	2.3		
8-Jul-2017	3.3	2.6	1.1	-0.1	-1.2	-0.8	-0.1	0.5	1.2	1.9	1.7	3.0		
8-Jul-2018	4.5	4.1	2.4	0.9	-0.7	-0.3	0.2	0.8	1.3	1.7	1.2	2.2		
8-Jul-2019	1.7	2.3	1.2	0.2	-0.4	0.0	0.4	0.8	1.1	1.4	0.5	1.9		
8-Jul-2020	-0.4	0.7	0.1	-0.6	-1.0	-0.6	-0.2	0.2	0.6	0.9	-0.6	1.5		
8-Jul-2021	-0.8	0.0	-0.4	-0.6	-0.9	-0.6	-0.3	0.0	0.4	0.6	-1.0	0.6		
8-Jul-2022	-1.8	-1.4	-1.4	-1.3	-1.0	-0.9	-0.8	-0.6	-0.4	-0.1	-1.9	-0.7		
8-Jul-2023	-3.0	-2.7	-2.5	-2.0	-1.8	-1.7	-1.5	-1.2	-1.0	-0.8	-2.5	-1.8		
8-Jul-2028	-3.4	-2.8	-2.3	-1.7	-1.1	-1.0	-0.8	-0.5	-0.2	0.2	-2.4	-0.3		
8-Jul-2033	-1.8	-1.5	-0.8	0.0	0.8	1.1	1.4	1.7	2.0	2.4	1.0	3.9		
8-Jul-2038														
8-Jul-2043														

Portfolio FVA calculation example

Define $approximate\ FVA\ (or\ FVA_{symmetric})$

where borrow rate = lending rate (discount using funding rate)

We compare this to the real $FVA_{portfolio}$

ACTUAL FVA

51.49 m $

RWR (if realised) reduces the FVA cost to $51.5M

FVA NO WWR

62.07 m $

BUT… actual FVA cost to the bank is $62M…

AGGREGATE APPROXIMATE FVA WWR

-30.06 m $

RWR, more –*ve* FVA (i.e. P&L gain), even better!

AGGREGATE APPROXIMATE FVA NO WWR

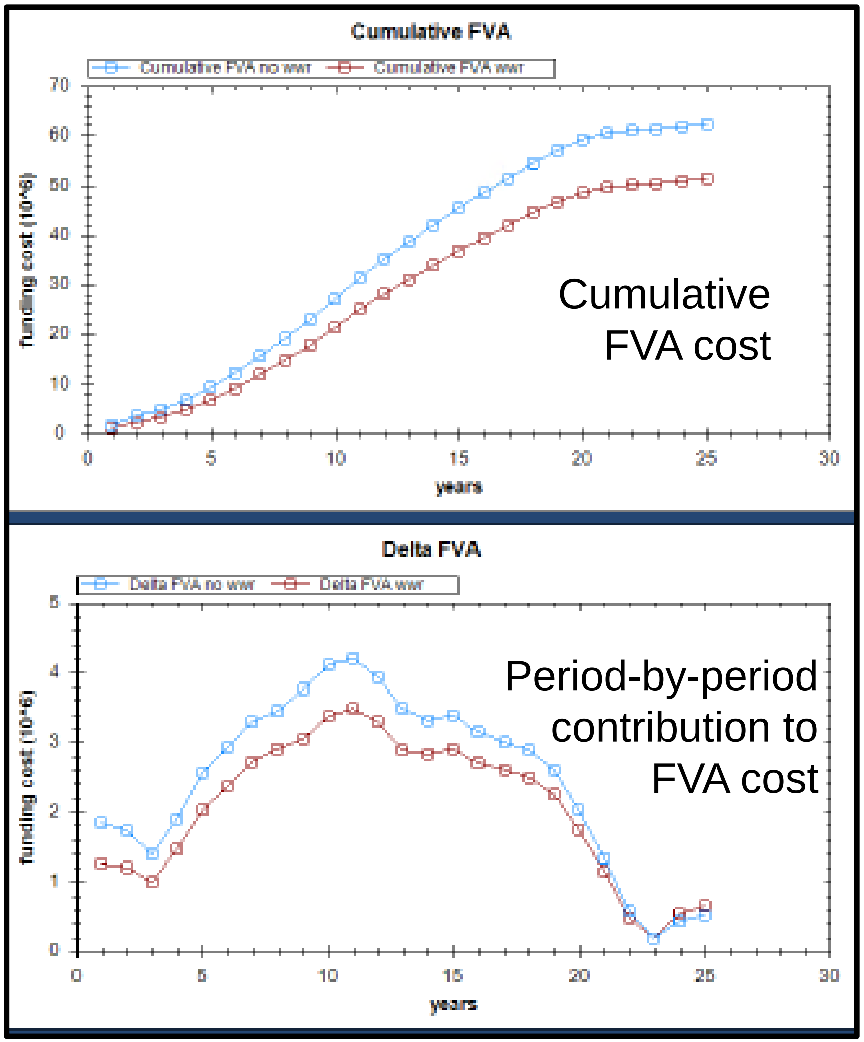
-4.67 m $

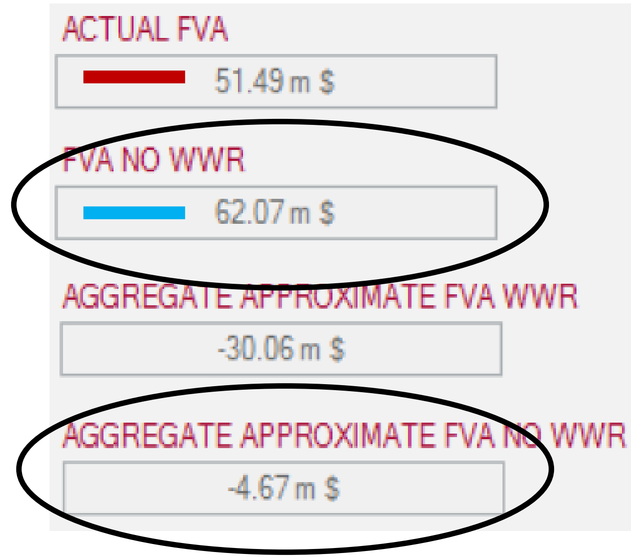
Small –*ve* FVA (i.e. P&L gain), no need to worry

The gap between the $FVA_{symmetric}$ and actual cost $FVA_{portfolio}$ can be substantial as ‘s’ is significant

Cumulative FVA cost over time

This is how the real FVA cost cumulates over time





No WWR means
Corr(credit, market) = 0

WWR means
Corr(credit, market) = -0.2

Here we only modelled mild WWR, not stressed markets

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Portfolio FVA calculation example 2

We set up a second synthetic portfolio with similar number of trades and counterparties, but with more unsecured counterparties, and generally higher CSA thresholds for the remaining counterparties.

Again we compare $FVA_{symmetric}$ to the real $FVA_{portfolio}$

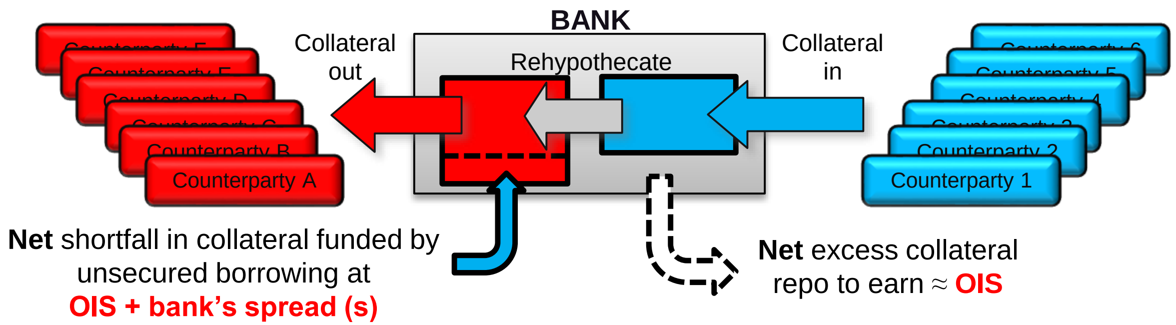
Symmetric FVA	463.87 m $
FVA ignoring WWR	632.71 m $
FVA	550.39 m $

The gap between the $FVA_{symmetric}$ and actual cost $FVA_{portfolio}$ can be substantial as ‘s’ is significant

The portfolio CVA and DVA are around $200M each, so FVA is by far the biggest cost.

FVA with initial and variation margins

In practice, we have initial and variation margins. If VM_t^n is the variation margin at time t due to the *n-th* netting set in the portfolio, then the FVA is defined as:



0

$$\mathrm{FVA}_0 = \mathbb{E}_0\left[\int_0^{\infty} e^{-\int_0^t r_u \mathrm{d}u}\left(\max\left(\sum_n \mathrm{VM}_t^n, 0\right) s_t^{\mathrm{VM}} + \left(\sum_n \mathrm{IM}_t^n\right) s_t^{\mathrm{IM}}\right)\mathrm{d}t\right]$$

$\mathrm{Max}\left(\sum_n VM_t^n, 0\right)$ is the ***net shortfall*** variation margin

$\sum_n IM_t^n$ is the sum over netting sets of initial margins

s_t^{VM} is the spread over OIS to fund VM collateral shortfalls

s_t^{IM} is the overnight rate to fund IM shortfalls

Funding under stressed market

- Wrong Way Risk under stressed / fast / gapping market
  - Bank's credit spread and FVA
  - Bank's credit and collateral / liquidity issue
  - Unexpected large margin calls
  - Lowered CSA thresholds and higher haircuts
  - Exposure ↑ while collateral MTM down (Bonds ↓ as r ↑)
  - $$\text{LCR} = \frac{High\ quality\ liquid\ assets}{\begin{array}{c}Total\ net\ liquidity\ outflows\\ over\ 30{-}day\ time\ period\end{array}} \geq 100\%$$
  - Increasing close-out gap risk between margin calls

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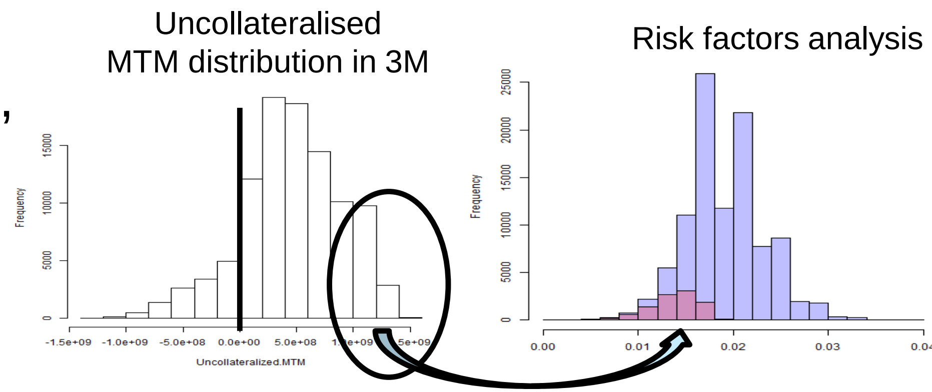
FVA distribution under stressed market

Using the same tool to model the portfolio until the final maturity, including CSA threshold, rehypothecation and the net collateral position, we can now investigate many of these issues at a macro level

For collateral requirements, we simulate the uncollateralized MTM distribution forward

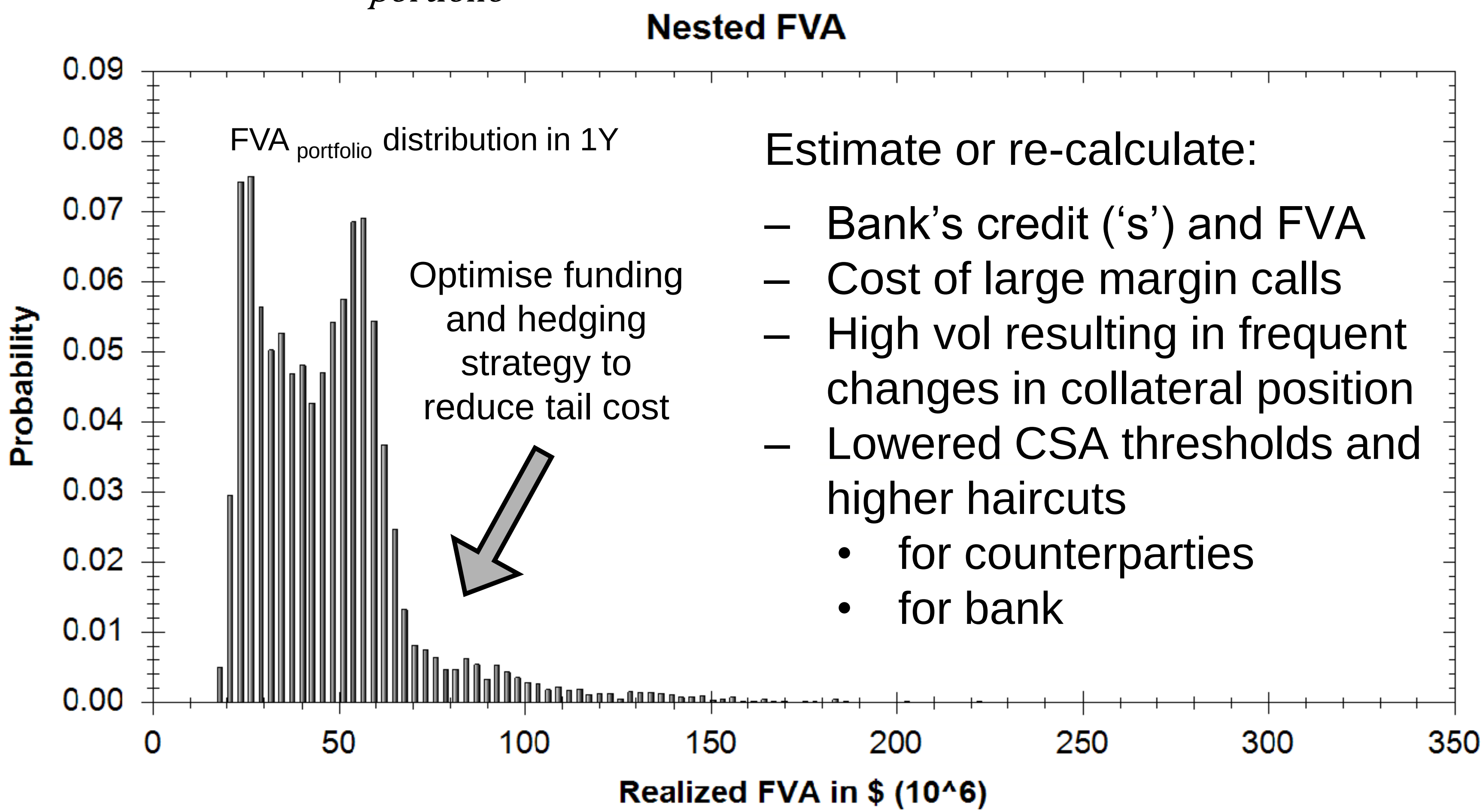


For FVA, we use the same tool to model the portfolio until the final maturity

Next step:
To perform nested simulation to project **FVA distribution** over different time horizon

FVA distribution – tail risk and macro hedging

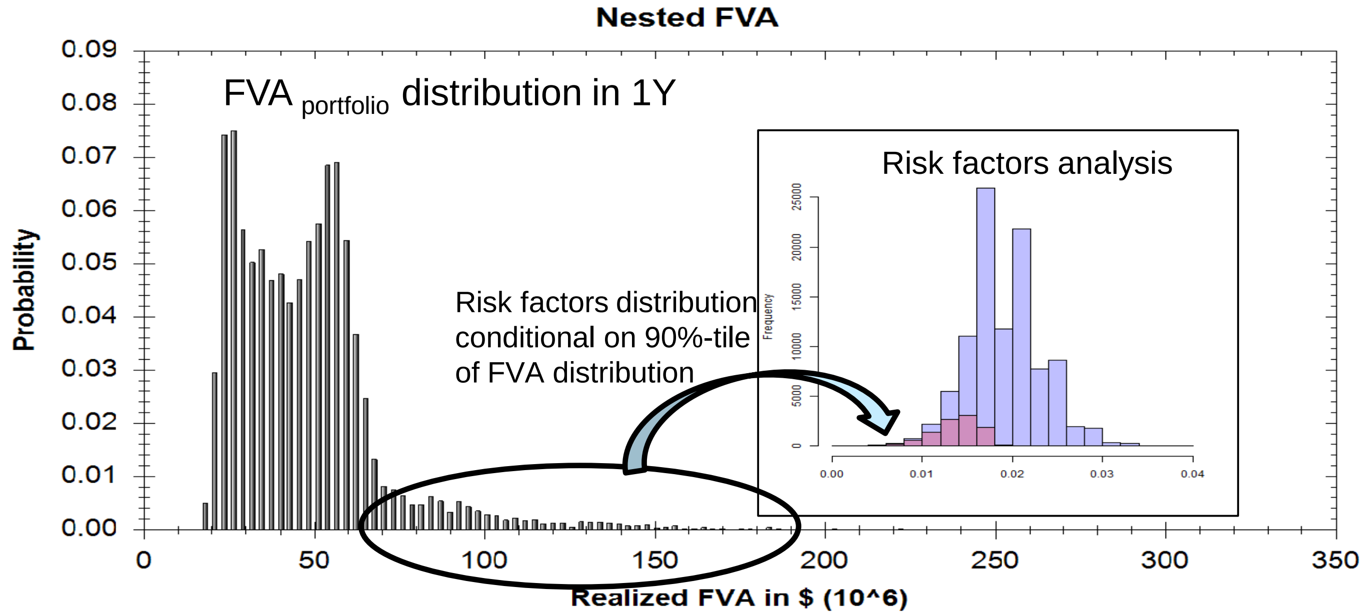
Projected $FVA_{portfolio}$ distribution (nested MC)



Estimate or re-calculate:

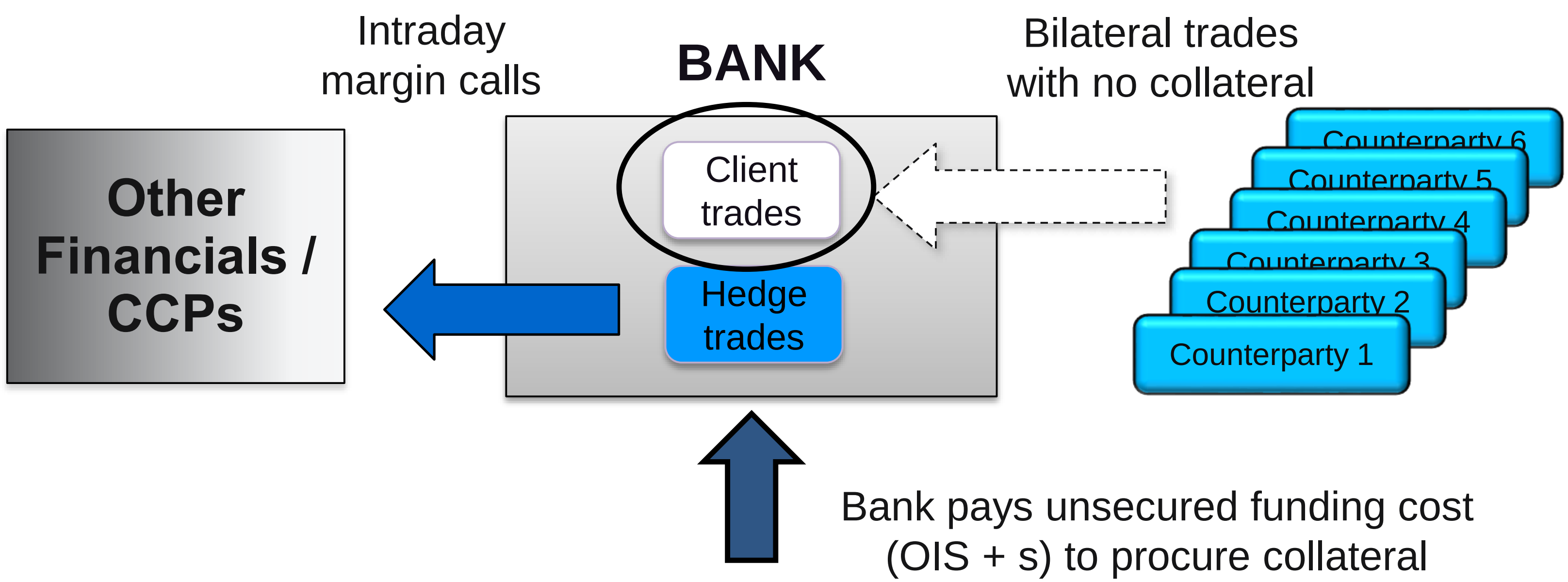
- Bank's credit ('s') and FVA
- Cost of large margin calls
- High vol resulting in frequent changes in collateral position
- Lowered CSA thresholds and higher haircuts
  - for counterparties
  - for bank

FVA tail risk – risk factors analysis



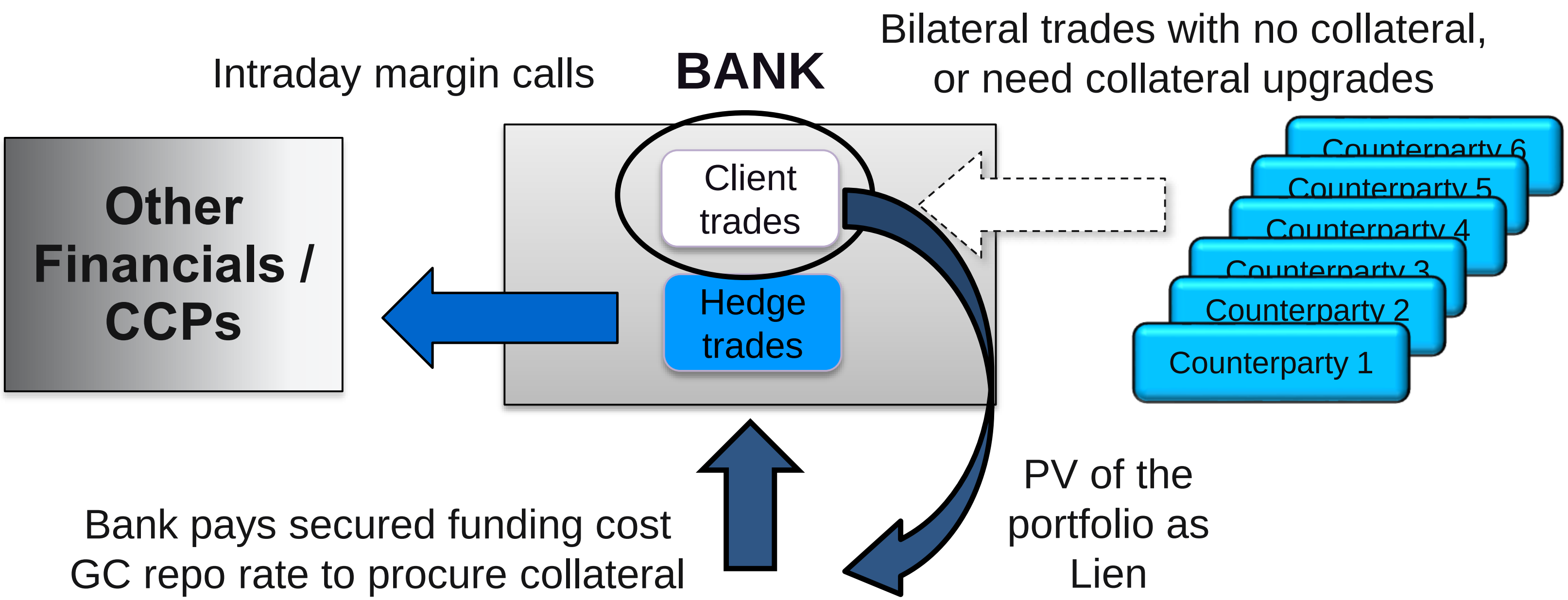
PCA:
To perform PCA on the FVA tail (X%-tile) against a number of risk factors to understand the market dependency of the bank's FVA

FVA – a necessary cost?



The client trades have PVs that are owned by the clients, but currently there is no mechanism for the bank to use them as collateral to obtain secured funding rate

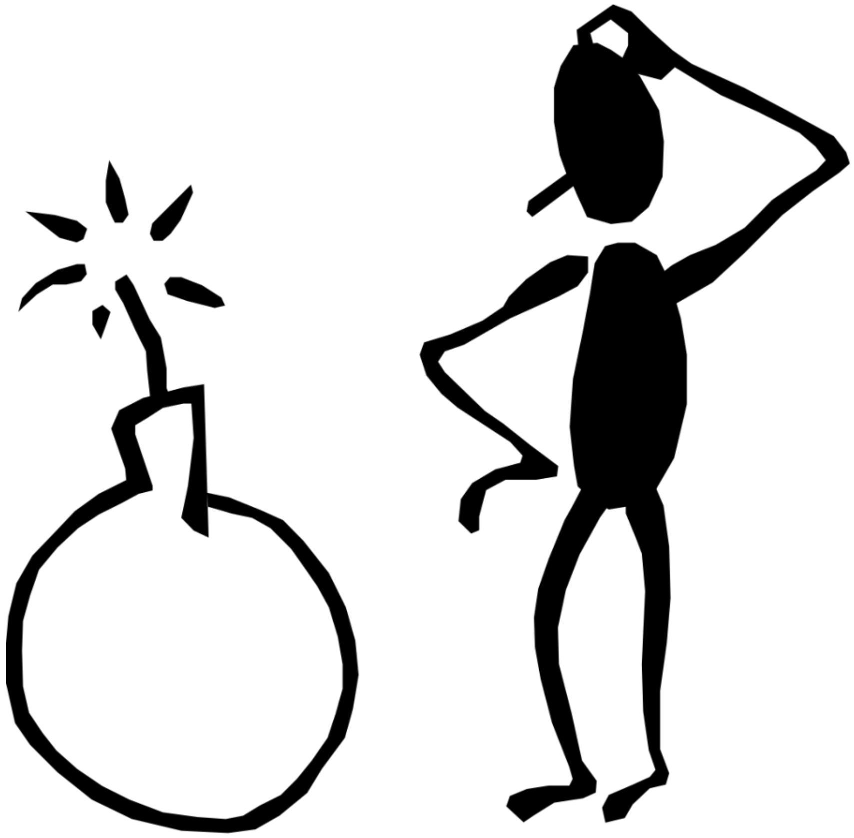
Completing the market
FVA → GC repo rate



If we can find a mechanism to ‘complete’ the market, allowing the PVs of the trades to be lien, the secured borrowing would enable the FVA to dropped to ≈ GC repo rate

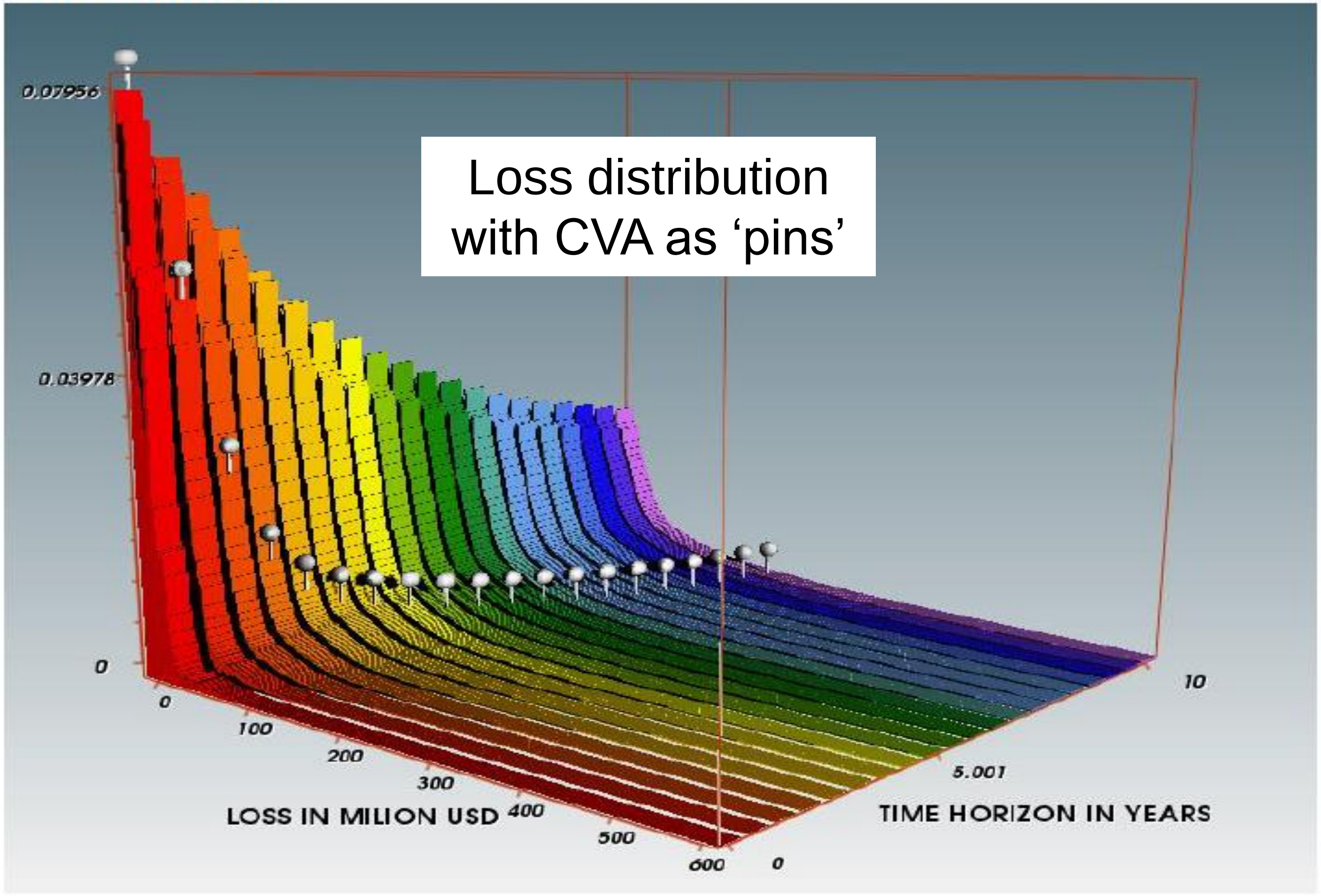
MORE LATER…

CVA under fast market



The CVA does not cover tail risk

Sample loss distribution of a global portfolio of netting sets compared to the CVA calculation



- The ‘pins’ in the graph are the CVAs across time horizon to 10 years

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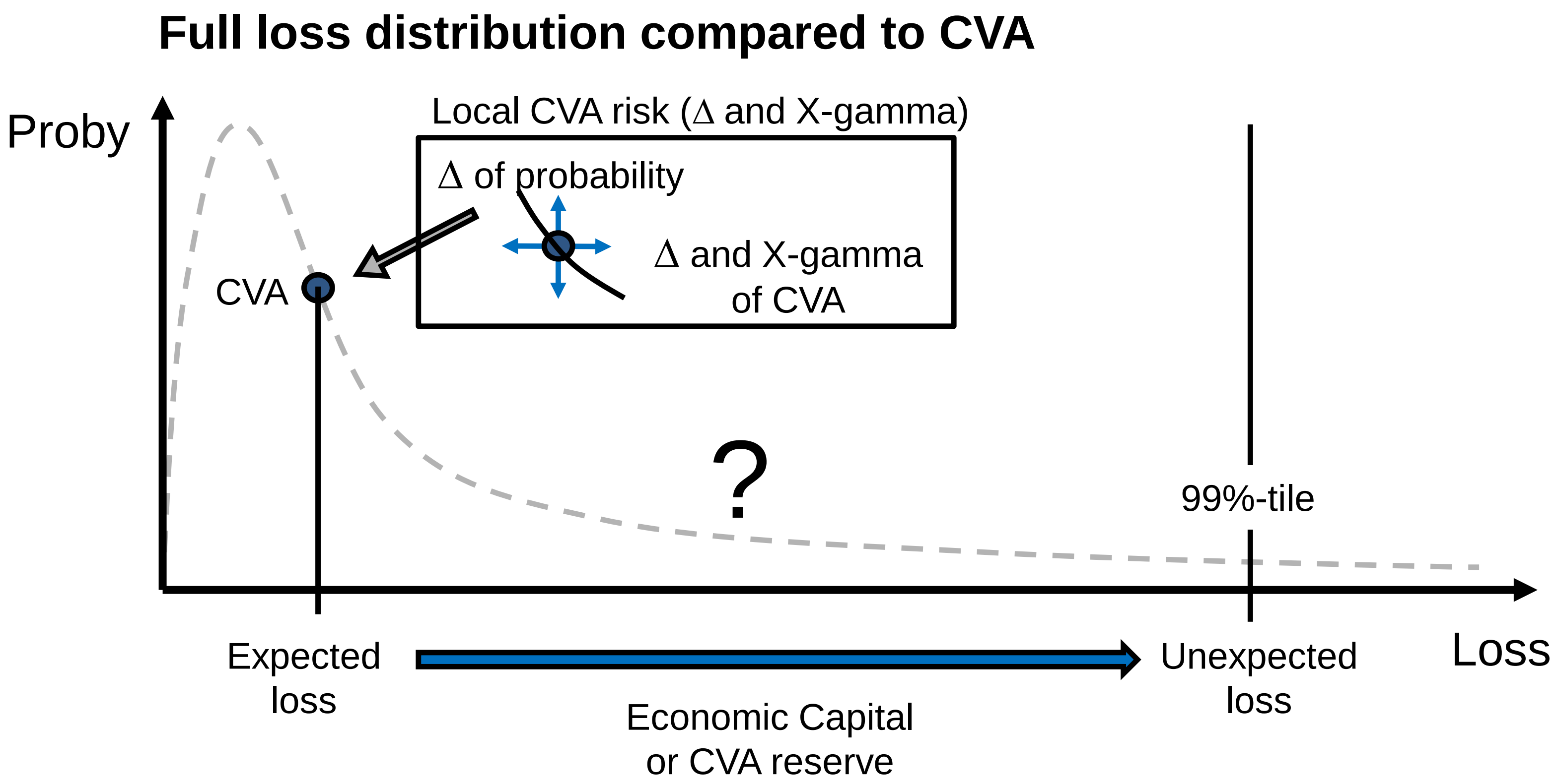
CVA + local risk does not tell much

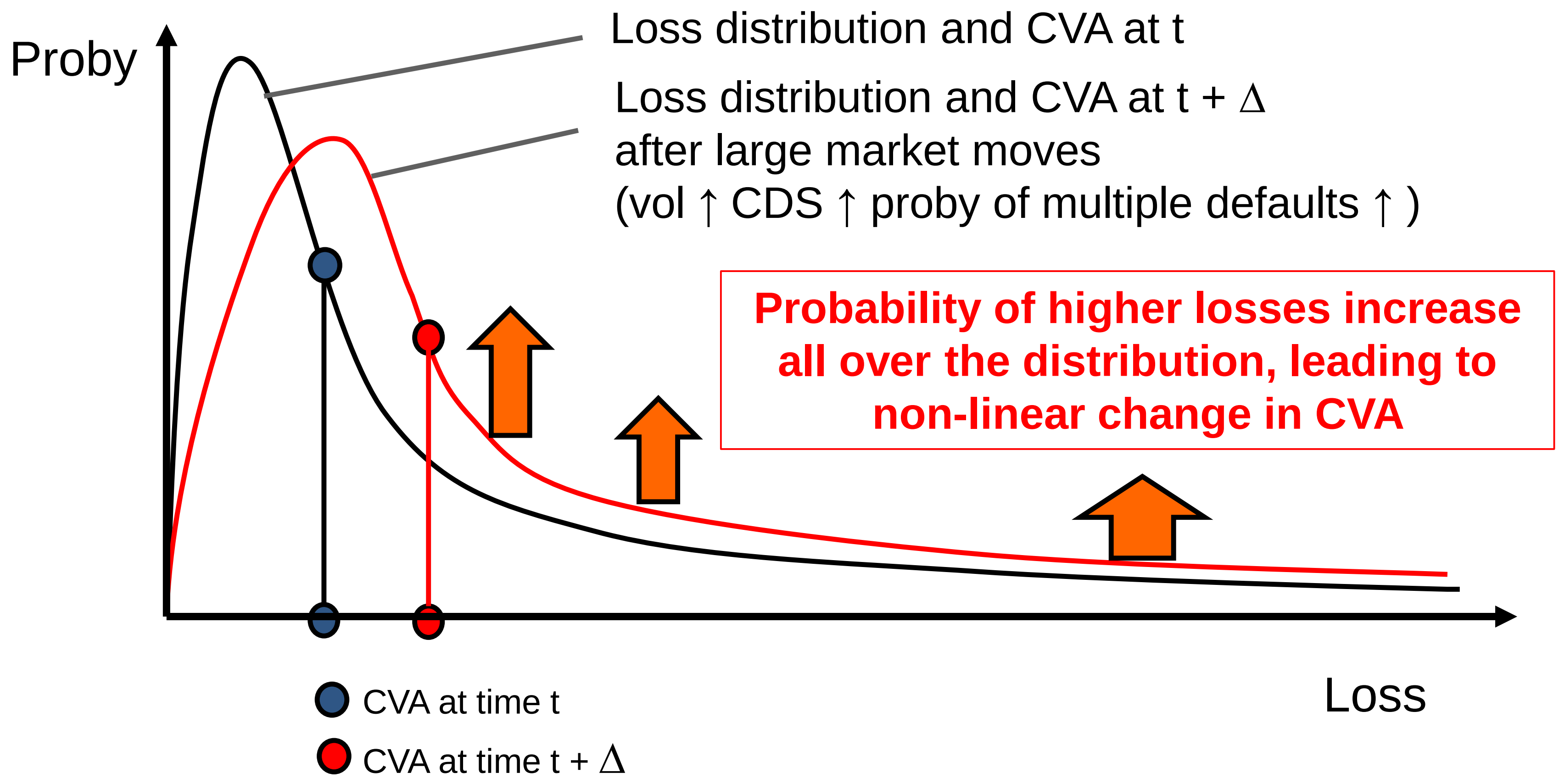


CVA is the "expected loss".

The strategy of holding the CVA in reserve leads to frequent small systematic profits and 'occasional' large unexpected loss

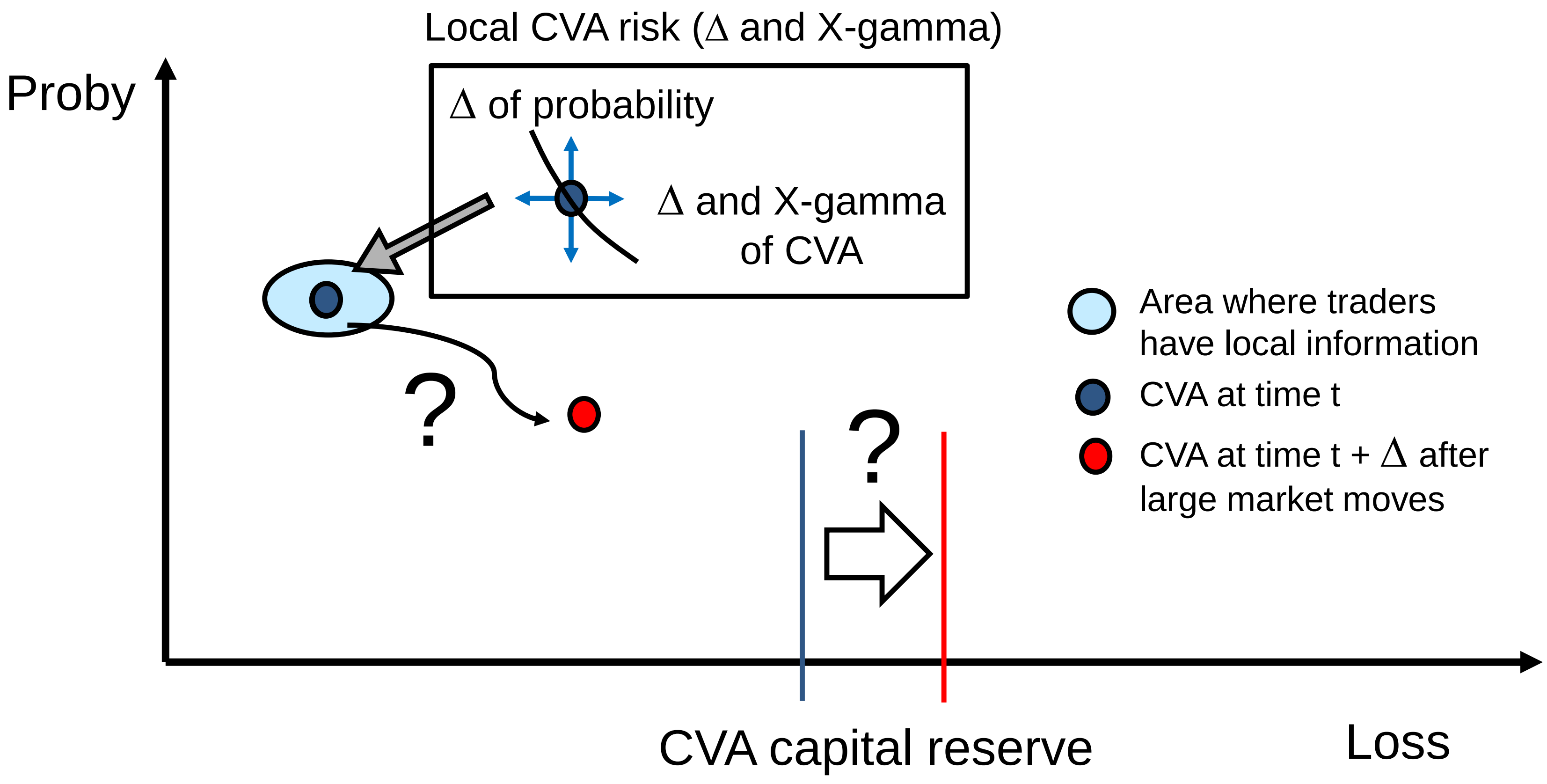
Fast moving and gapping markets

Change in loss distribution and CVA after large market moves



Fast moving and gapping markets

Using local risk report, it would be very difficult for traders to hedge or to explain the P&L and risks changes



Fast moving and gapping markets

CVA Risk

- Local delta, gamma + X-gamma cannot predict P&L and risk for large moves
- Portfolio exposure and hedges could diverge rapidly – fast expanding basis risk
- Wrong way risks become prominent

Potential large unexplained P&L and risk

Need global risk map and macro hedges

Fast moving and gapping markets

CVA Stress Test on its own inadequate to control risk

- Too many risk factors, too many combinations – for large market moves, large X-gammas, 3rd order, 4th order – so many assumptions and combinations
    - Can we afford to provision capital for ALL these scenarios
    - Can we decide on a good set of hedge trades among these huge range of 'artificial' scenarios?
- Historical VaR – too few points to analyse the tail risk. Future stress may come from different set of scenarios. Can we find effective hedges based on this analysis?

Fast moving and gapping markets

CVA Stress Test on its own inadequate to control risk

- Wong way risks prominent
  - Corr(Credit, Markets)
  - Corr(Credit, Vol)
  - Correlated defaults and downgrades

Stressed tests with static credit risk factors do not give good estimates on the actual risk and P&L

Collateral → FVA → CVA

With the tools we have developed, we now investigate the ‘macro’ picture of the exposures

- **Project loss distribution** and investigate the market scenarios contributing to different parts of the loss distribution. Devise macro hedging strategies, or simply reserve against the tail risk (“unexpected loss”/economic capital)
- **CVA distribution (the real CVA VaR)** - perform nested Monte Carlo simulation. Minimize the tail through quasi-static or macro hedging

Portfolio Loss Distribution & CVA calculation

A realistic sample portfolio of 25,000 trades, 1,500 counterparties, 6 IR markets and 5 FX, final maturity of portfolio 25 years

We use client's internal credit ratings → CDS curves, or using client's provided CDS curves

We map CDS curves for each of the 1,500 counterparties, assign CDS volatility according to a number of criteria (the geographic location, industry sector etc) – i.e. we model the credit dynamically

We calibrate to ICAP market data

GOODNESS OF FIT

D = market norm implied vols - model norm implied vols (in basis points)

D > 4

2 <= D <= 4

-2 < D < 2

-4 < D <= -2

D <= -4

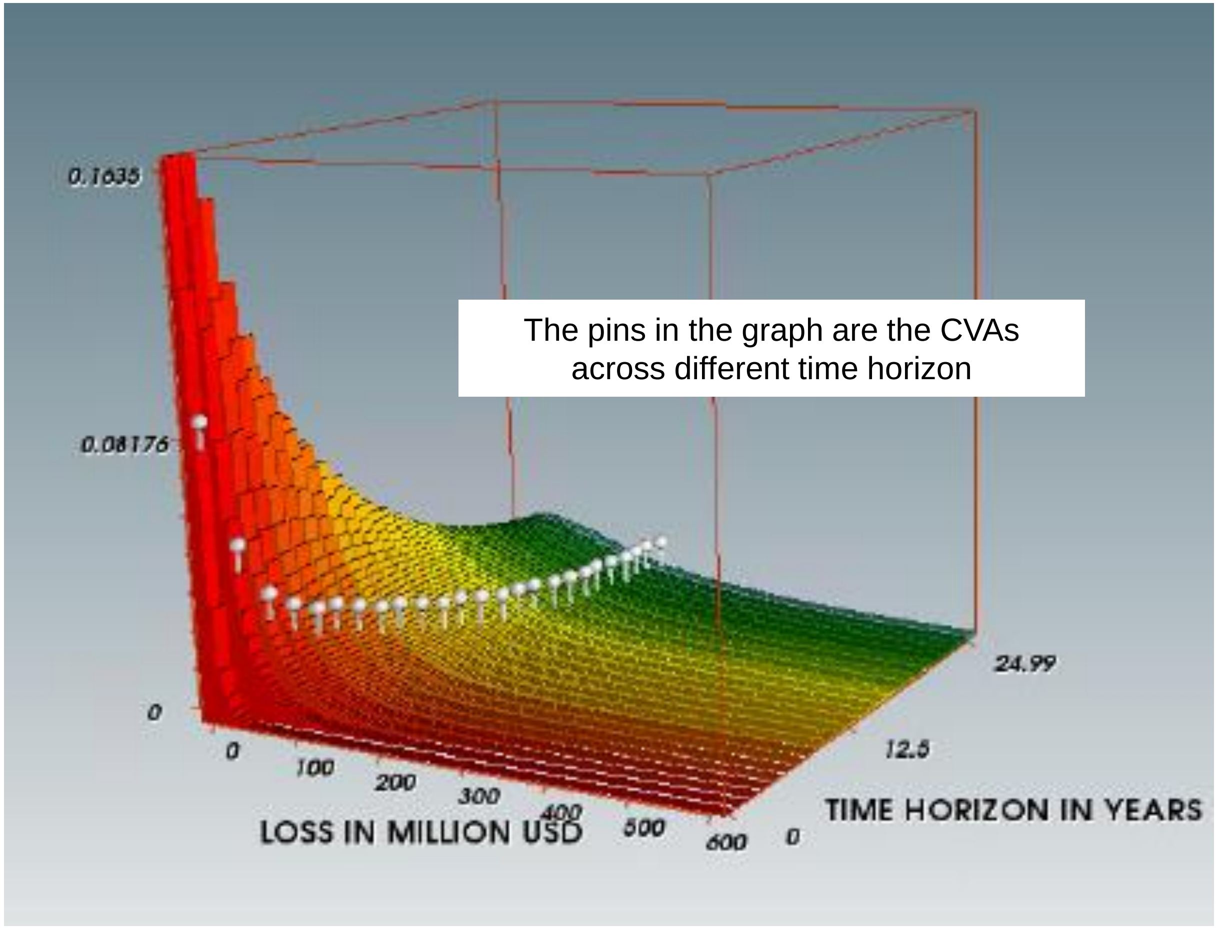
	TENORS													
EXPIRIES	1y	2y	3y	4y	5y	6y	7y	8y	9y	10y	15y	20y	25y	30y
8-Aug-2013														
8-Oct-2013														
8-Jan-2014	-6.3	-4.8	-3.5	-1.5	5.6	2.7	2.0	0.6	-0.8	-0.9	-1.7	-0.6		
8-Jul-2014	5.1	6.4	0.3	-0.4	2.2	0.3	0.0	-0.7	-1.5	-1.3	-1.0	1.4		
8-Jul-2015	7.2	-0.9	-2.4	-2.8	-1.9	-2.1	-1.6	-1.5	-1.3	-0.8	0.0	2.5		
8-Jul-2016	-1.6	-0.6	-1.3	-2.6	-3.4	-2.8	-1.9	-1.2	-0.7	0.0	0.5	2.3		
8-Jul-2017	3.3	2.6	1.1	-0.1	-1.2	-0.8	-0.1	0.5	1.2	1.9	1.7	3.0		
8-Jul-2018	4.5	4.1	2.4	0.9	-0.7	-0.3	0.2	0.8	1.3	1.7	1.2	2.2		
8-Jul-2019	1.7	2.3	1.2	0.2	-0.4	0.0	0.4	0.8	1.1	1.4	0.5	1.9		
8-Jul-2020	-0.4	0.7	0.1	-0.6	-1.0	-0.6	-0.2	0.2	0.6	0.9	-0.6	1.5		
8-Jul-2021	-0.8	0.0	-0.4	-0.6	-0.9	-0.6	-0.3	0.0	0.4	0.6	-1.0	0.6		
8-Jul-2022	-1.8	-1.4	-1.4	-1.3	-1.0	-0.9	-0.8	-0.6	-0.4	-0.1	-1.9	-0.7		
8-Jul-2023	-3.0	-2.7	-2.5	-2.0	-1.8	-1.7	-1.5	-1.2	-1.0	-0.8	-2.5	-1.8		
8-Jul-2028	-3.4	-2.8	-2.3	-1.7	-1.1	-1.0	-0.8	-0.5	-0.2	0.2	-2.4	-0.3		
8-Jul-2033	-1.8	-1.5	-0.8	0.0	0.8	1.1	1.4	1.7	2.0	2.4	1.0	3.9		
8-Jul-2038														
8-Jul-2043														

Important to have good calibration as we are looking at the macro picture

Portfolio Loss Distribution & CVA calculation

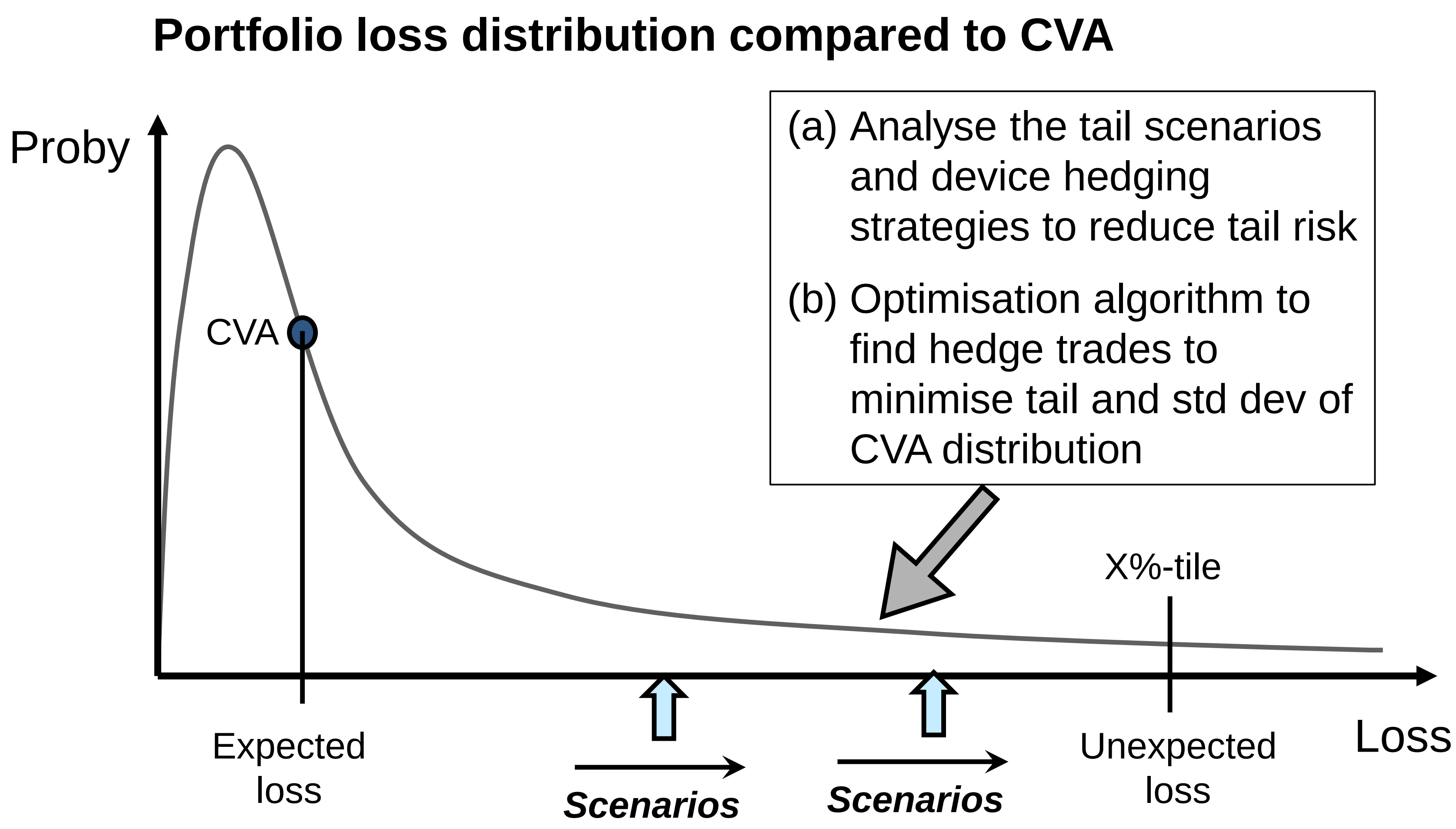
Full loss distribution of a sample portfolio compared to CVA

Sample portfolio: 25,000 trades, 1,500 counterparties,
6 IR and 5 FX markets, final portfolio maturity 25 years



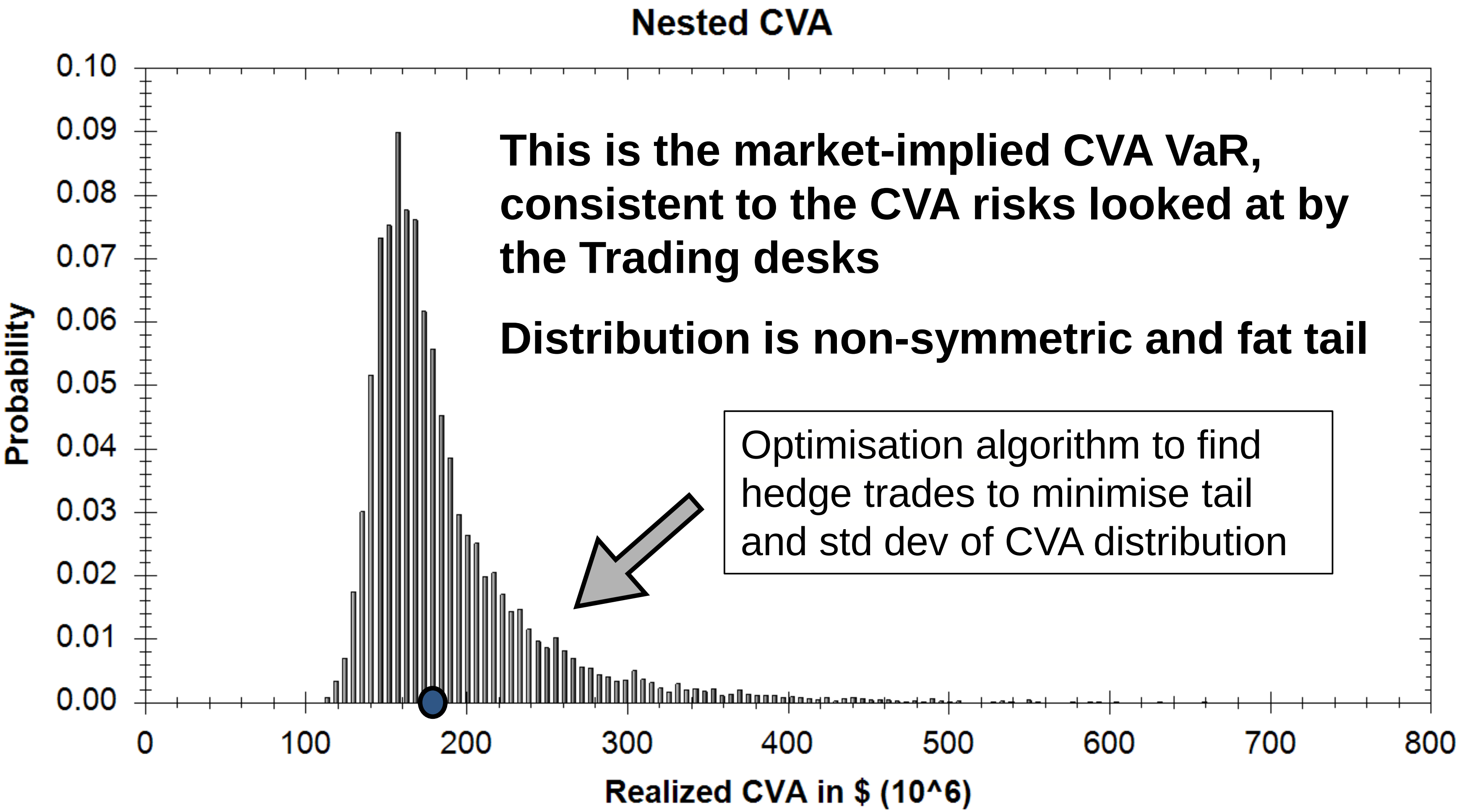
The pins in the graph are the CVAs across different time horizon

Managing loss distribution tail risk



CVA distribution over 1 year horizon

Nested Monte Carlo simulation to calculate forward CVA distribution + expected default loss



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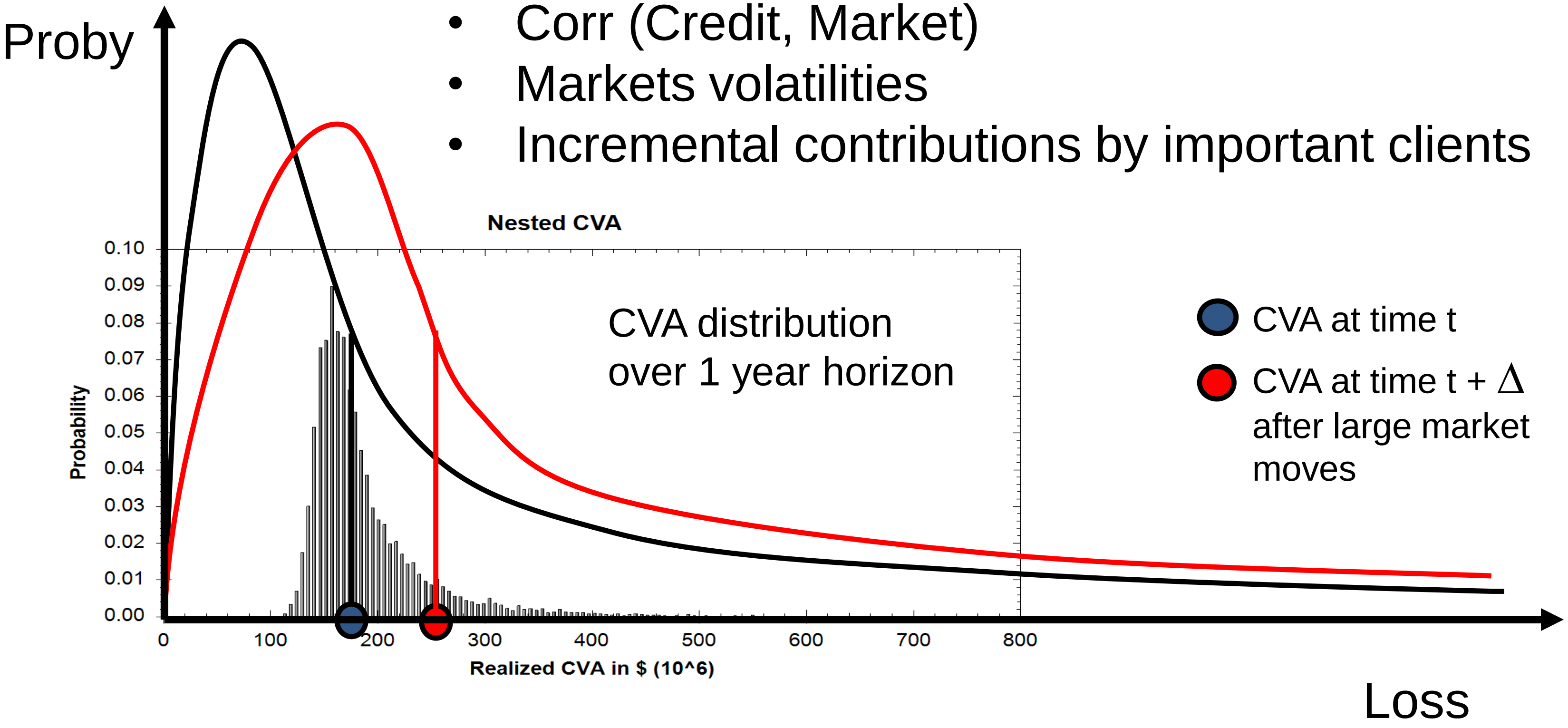
Managing CVA distribution tail risk

Run sensitivities of the CVA distribution to:

- Overall CDS levels and volatilities
- Industry sectors or geographical locations
- Corr (Credit, Market)
- Markets volatilities
- Incremental contributions by important clients



Static and dynamic CVA hedging

- Best risk management strategies combine
  - Static hedging based on total return analysis over a short time period (6m-1y)
  - Dynamic hedging based on sensitivities

- Static hedging is useful because of the gamma negative nature of the exposure

- Static hedging is useful because it dampens the non-linear behaviour of the portfolio and ‘slows down’ the change in risks, enable traders to manage through local hedgings

Combining Risk Management
CVA, DVA and FVA

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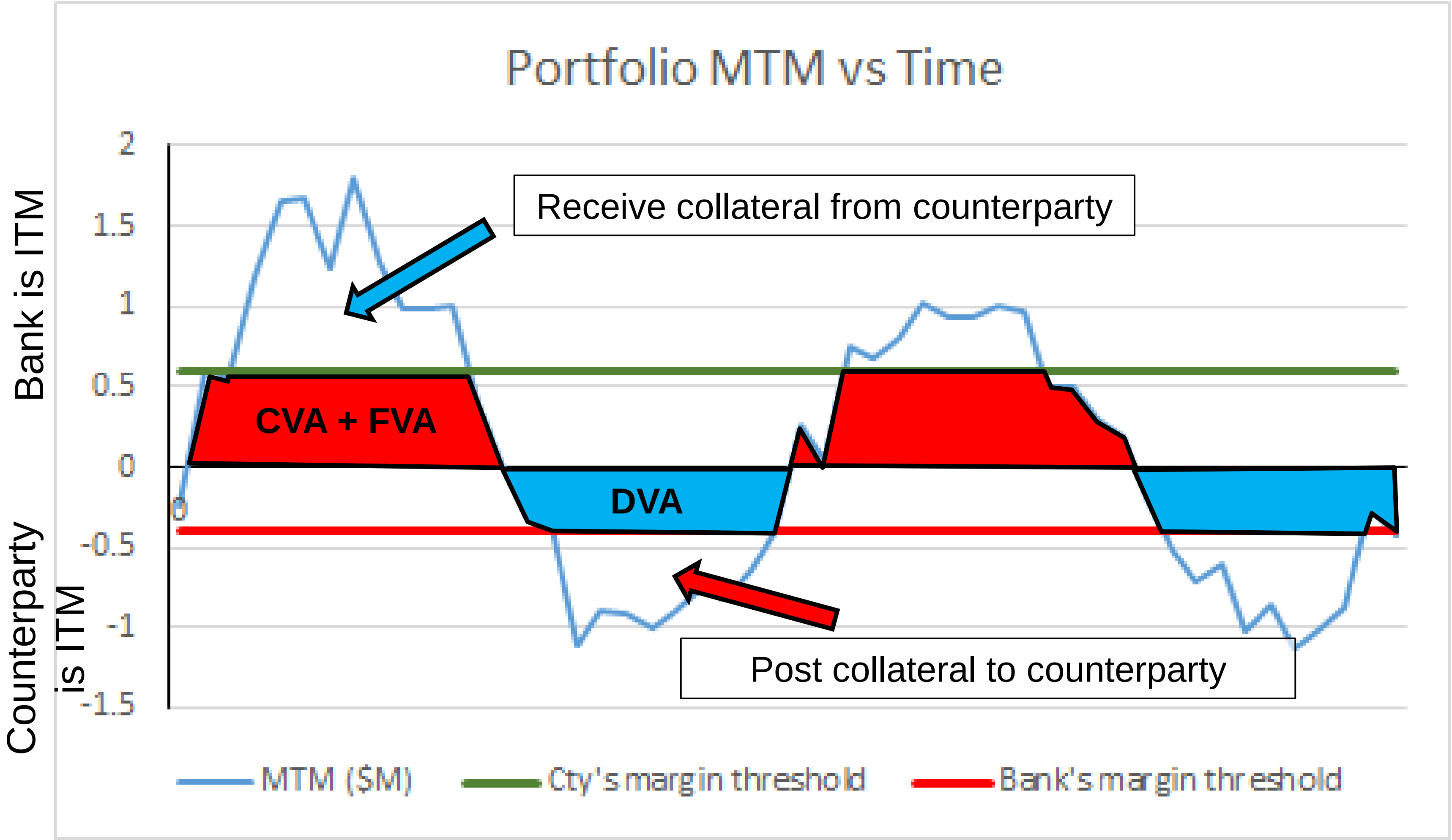
Collateral, CVA, DVA and FVA



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Combining CVA, DVA and FVA risks

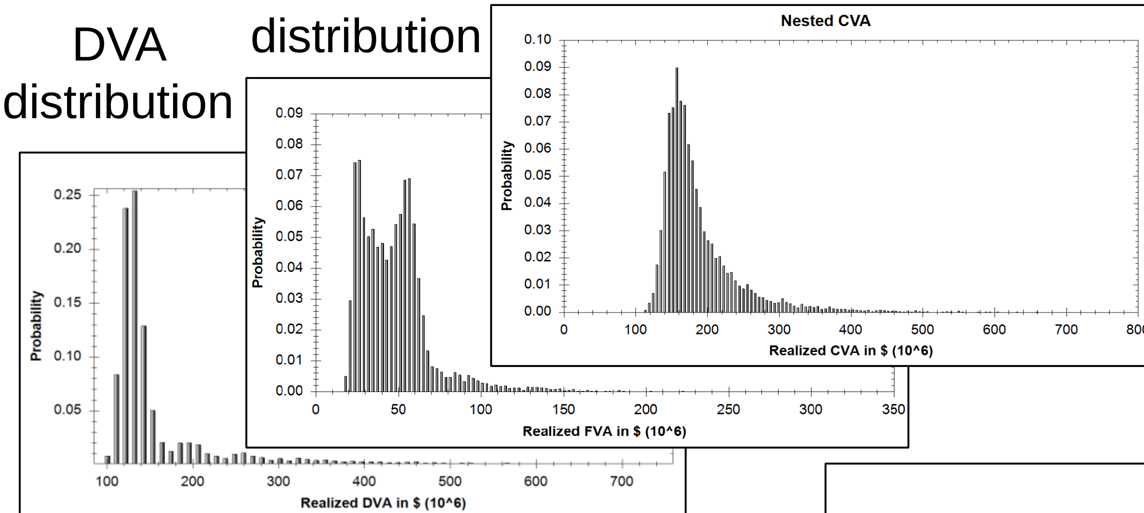
- The CVA, FVA and DVA change over time, are highly correlated and could be more efficiently risk managed together
- Important to have ***consistent*** modelling framework for collateral, FVA, CVA and DVA, so risks can be consistently aggregated and netted
- Best risk management strategies combine
  - Static hedging based on total return analysis over a short time period (6m-1y), to reduce the non-linearity of the risk profile
  - Dynamic hedging the ‘residual’ risks based on sensitivities

Macro hedging for CVA, DVA and FVA

DVA distribution

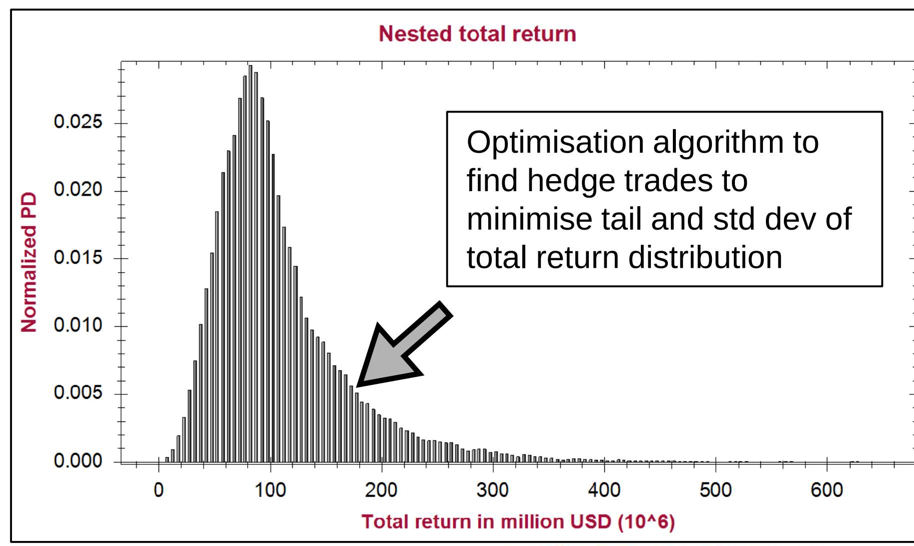
FVA distribution

CVA distribution



Expected default loss + CVA - DVA + FVA

Total Return distribution



Dynamic hedging for CVA, DVA and FVA

Scenario ID	Portfolio Δ CVA	Portfolio Δ DVA	Portfolio Δ FVA
IR scenario bump 1	$ -457	$ 67	$ -1,643
IR scenario bump 2	$ -593	$ 132	$ -1,838
IR scenario bump 3	$ -518	$ 104	$ -1,232
IR scenario bump 4	$ -522	$ 153	$ -1,594
IR scenario bump 5	$ -1,33		
IR scenario bump 6	$ -1,36		
IR scenario bump 7	$ -98		
IR scenario bump 8	$ -89		
IR scenario bump 9	$ -38		
IR scenario bump 10	$ -53		
IR scenario bump 11	$ -9,45		
IR scenario bump 12	$ 1,68		
IR scenario bump 13	$ 14,76		
IR scenario bump 14	$ 1,87		
IR scenario bump 15	$ 4,88		
IR scenario bump 16	$ 8,73		
IR scenario bump 17	$ 15,82		
IR scenario bump 18	$ 9,44		
IR scenario bump 19	$ 2,30		
IR scenario bump 20	$ 68		
FX bump 1	$ 187,357	$ -288,391	$ -39,486
FX bump 2	$ -87,450	$ 2,108	$ -23,861
FX bump 3	$ -56,132	$ 17,644	$ -8,892
FX bump 4	$ -4,895,197	$ 13,845,937	$ 3,688,947
FX bump 5	$ -39,781	$ 18,046	$ -682
FX bump 6	$ -24,398	$ 13,907	$ -458

Run same modelling framework and scenarios for

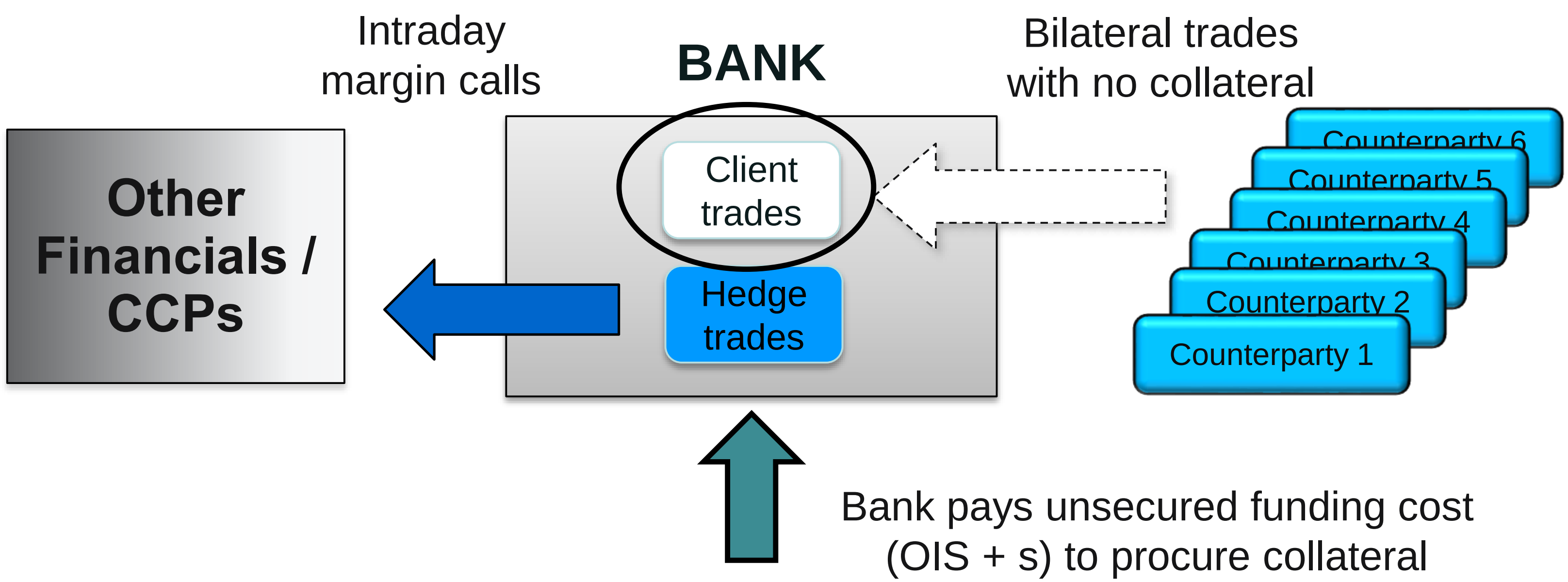
CVA, DVA and FVA

Obtain consistent risks and net hedging for

CVA, DVA and FVA

Sourcing collateral and restructuring away the FVA costs

FVA from unsecured counterparties

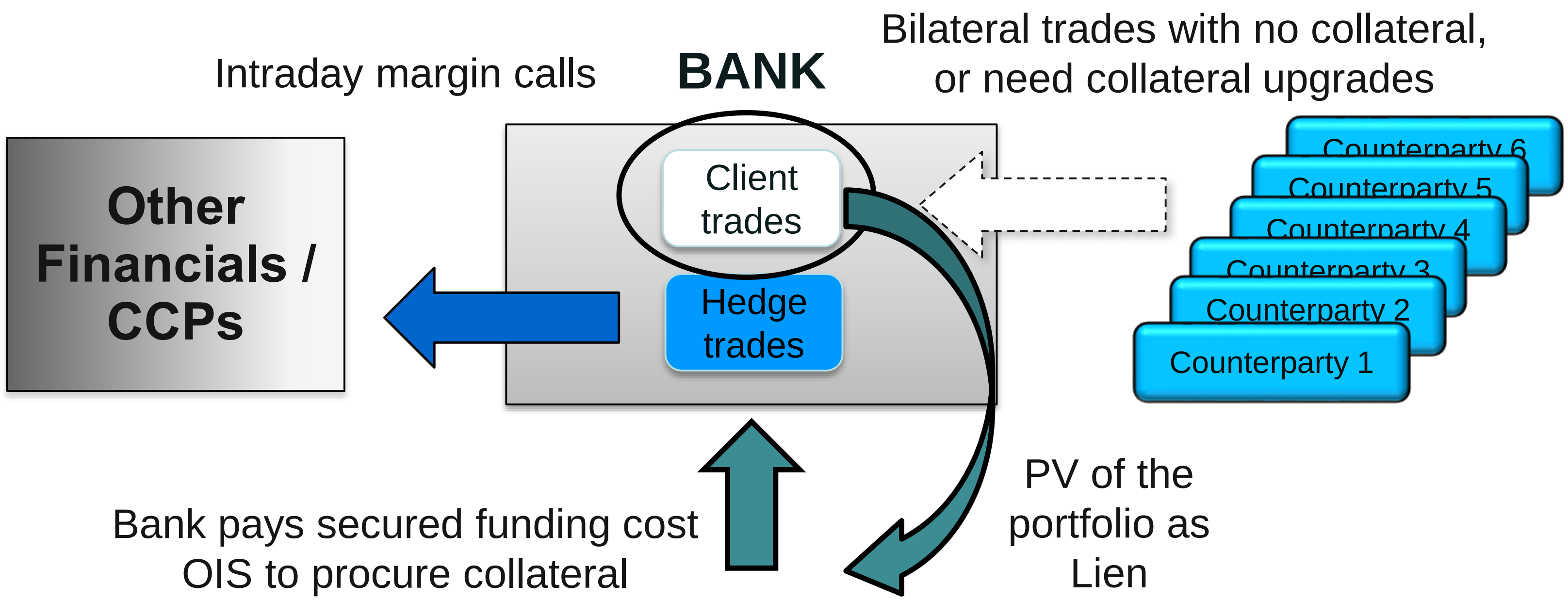


The client trades have PVs that are owned by the clients, but currently there is no mechanism for the bank to use them as collateral to obtain lower funding rate

A mortgage analogy

- Consider a firm that wishes to buy real estate but there is no mortgage market
- Not being able to pass on a lien to the lender, the firm takes out an unsecured loan, at a high rate
- Upon defaulting, the firm still owns the title to the asset
- The liquidation process then redistributes wealth and losses among all creditors according to seniority
- The key difference between the two scenarios is that, while the mortgagor would have recovered the asset value in full, the unsecured lender may only recovers partially
- Hence, the fair value rates for unsecured lending normally exceed mortgage rates

Completing the market
FVA → GC repo rate



If we can find a mechanism to ‘complete’ the market, allowing the PVs of the trades to be lien, the secured borrowing would enable the FVA to dropped to ≈ GC repo rate

i.e. FVA is a market inefficiency, not an intrinsic feature

Completing the market
FVA → GC repo rate

If we completing the market allowing the PVs of the trades to be lien, the secured borrowing would enable the FVA to dropped from bank's funding spread 's' to ≈ GC repo rate

Secured borrowing rate = lending rate = GC repo rate ≈ OIS
Now $FVA_{benefit}$ will net against FVA_{cost} with the same rate
All assets can be discounted at the same rate at OIS.

Resolve a number of complicated issues:

- Unique price for the asset
- No FVA and no double counting DVA/FVA
- No perverted incentive to engage in funding trade for 'phantom' profit

Completing the market

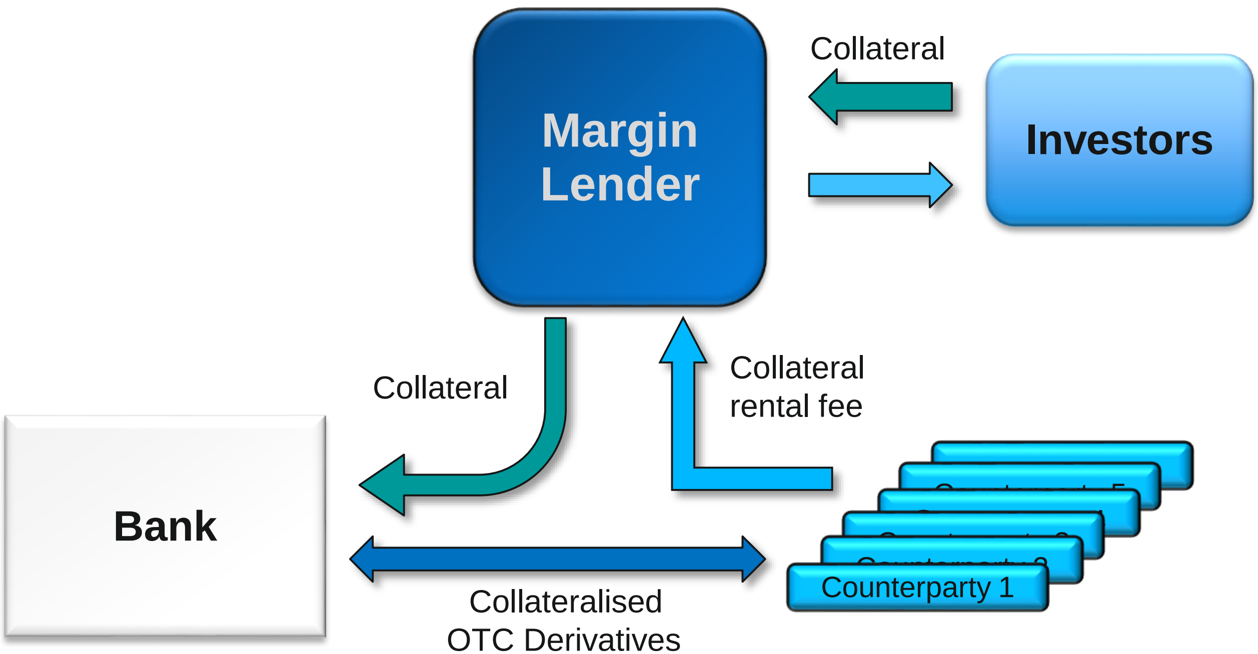
Securitization

Banks attempt to securitize their OTC derivatives portfolio, with very limited success. We examine the general features of such securitization scheme:

- Long-dated (5Y+)
- By necessity need substitutions as portfolio evolves over term (new deals, new counterparties to replace those dropping out, matured and terminated trades, option expiry and exercised, cancellations etc)
- For investors, the risks are difficult to quantify, and there is information asymmetry and advantage (the bank determines the portfolio contents)
- Potential exposure could balloon vs fixed coupon over term
- Liquidity risk – difficult to unload
- Regulatory charge for securitization

Completing the market

Concept of Margin Lending



Investors provide a collateral pool in return for the collateral rental fee. MTM of the portfolio (asset) is the lien from the bank to the investors.

If any counterparty defaults, the bank would seize the collateral , so investors are also providing credit risk insurance

Benefit in completing the market

- Convert uncollateralised trades into fully collateralised trades, no more FVA and its complications
- New sources of inexpensive eligible collaterals (secured borrowing cost at GC repo rate $\approx$ OIS)
- Balance the collateral supplies and demands of the trading portfolio, eliminating a lot of potential costs, and particularly multitude of risks and exposures during stressed market conditions
- Add liquidity to the bank
- With fully collateralised trades, the bank can free up regulatory capital in reduced CVA and CVA VaR charge
- Collateral providers are taking on the portfolio of a diversified counterparties credit risk, not the credit risk of the bank. Hence they are not limited by concentration credit risk to the bank
- Collateralising trades would free up unsecured client credit lines, and would also make it easier to apply for new lines

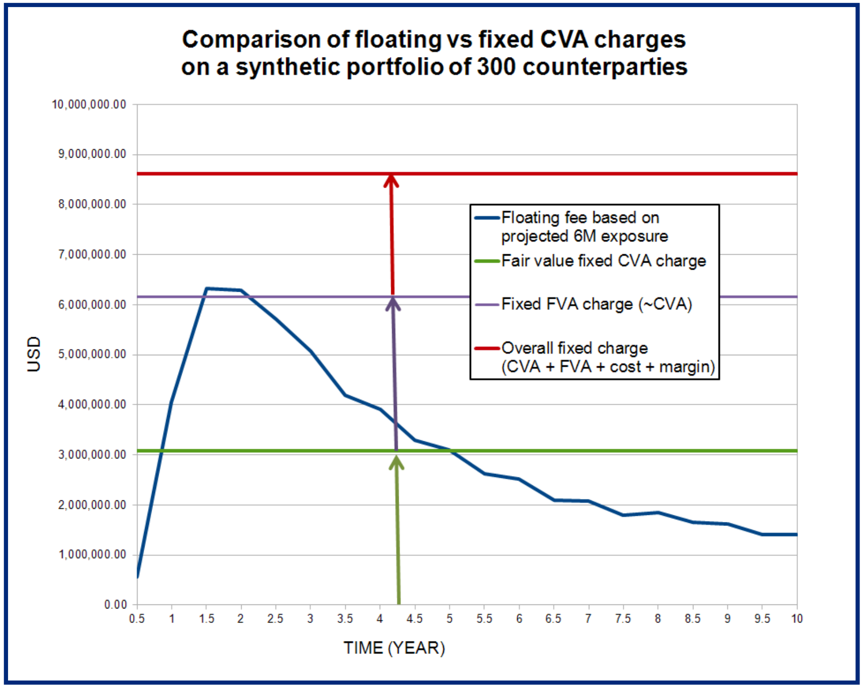
Ecomonics of margin lending

Collateral fee for margin lending is floating (say, reset every 6 months), and based on short term CVA which is much lower than long dated CVA

There are structural cost advantages for margin lender/investors:

- Floating collateral fee << fixed long-dated charges (see right)
- Banks have high funding cost (FVA) compared to investors, making it expensive for them to fund uncollateralised trades and to upgrade collateral
- Reduced regulatory capital of CVA and CVA VaR charges

Simulated floating fees paid by counterparties going forward compared to fixed CVA + FVA charges



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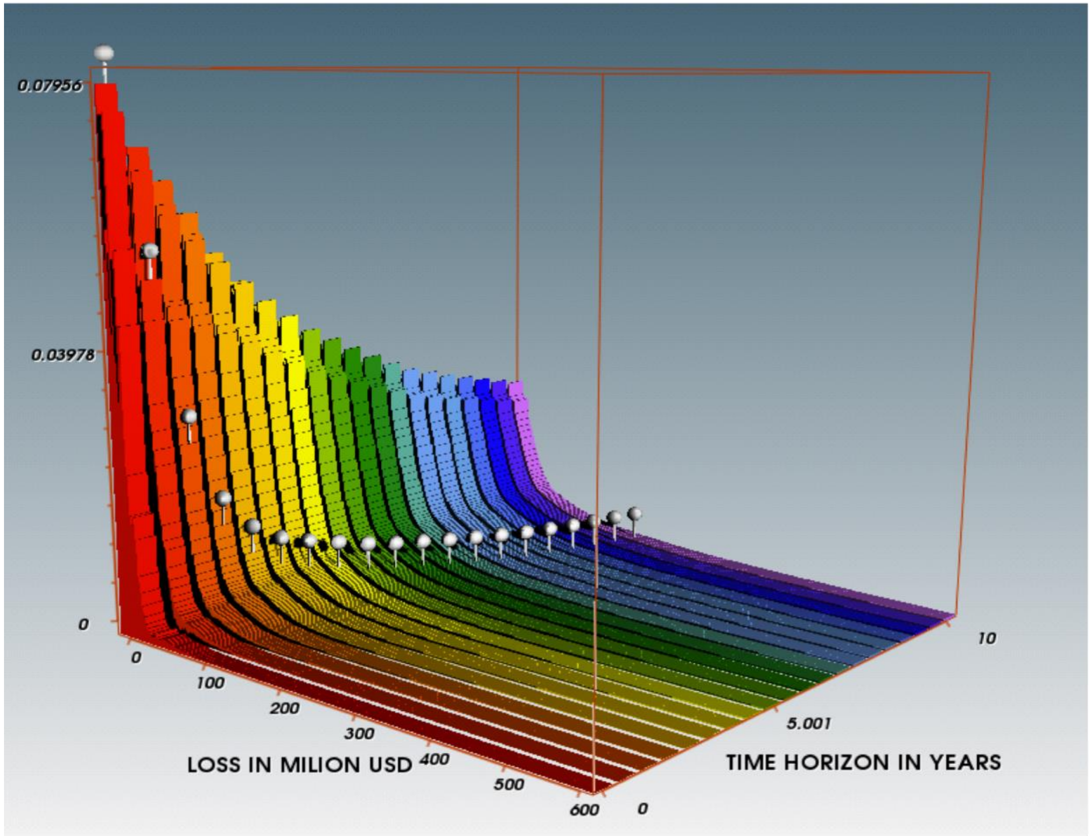
Methodology and Technology

Full loss distribution of a global portfolio of netting sets for tranching calculations, compared to the CVA calculation



- The 'pins' in the graph are the CVAs across time horizon to 10 years

Portfolio loss distribution + forward projections in time

Collateral / Margin Lending

- To procure these collateral, margin lender would securitize the bank’s portfolio of counterparty credit risk and **perform maturity transformation**

- To analyse margin lending portfolios one needs to
  - Project out variation margin distributions
  - Find cumulative loss distributions for the portfolio
  - Find tranche loss distributions

- The analyses is based on the same technology developed for loss distribution, CVA/DVA/FVA distribution, and for collateral requirement projections

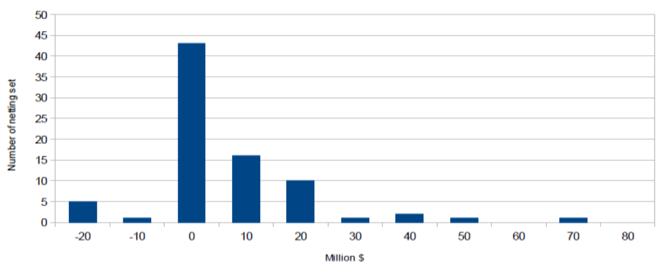
Example: single-B portfolio with 80 counterparties

Selected portfolio statistics

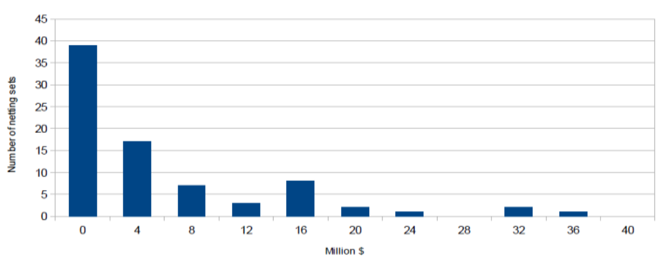
Margin lending test case for a portfolio of 80 single-B names

Total notional of the portfolio is 36 bn $.

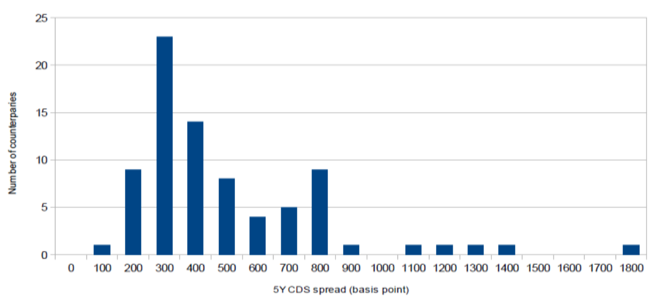
Histogram of the mark to market of the 80 netting sets



Histogram of the positive expected exposure over 6 months of the 80 netting sets



Histogram of the 5Y CDS spread for the 80 counterparties



Sample securitization structure

CVA charge assumption

	Pre Basel III (5 basis point on the notional)	Post Basel III (10 basis point on the notional)
CVA charge for the portfolio	9 million USD	18 million USD

Securitization structure

Notional: 800 m $
Maturity: 6 months
Total premium collected: 10,84 m $

	Notional	Premium	IRR
Senior 4% - 100 %	768 m $	5,74 m $	149 bp
Mezz 2% - 4%	16 m $	1,2 m $	13,80%
Equity 0 - 2%	16 m $	3,9 m $ (discount)	28,86%

Collateral / Margin Lending

Advisory service to banks on margin lending methodology, to set up their internal margin lending operation

Ipotecs also works with banks, investors and regulators as an arms-length 3rd party facilitator to

- *Provide risk analytics*
- *Arrange margin lending transactions*
- *Manage operations*

Consultancy, Structuring and Arranging

Advanced technology to provide software-data-hardware solution for the valuation and simulation of OTC portfolios. It processes portfolio FVA, full loss distribution (vs CVA) and forward projection in minutes.

Provide technology and risk analytics used for margin lending. It includes functionalities on pricing, analysing risks, and structuring tranches of OTC derivatives portfolio.

Technology and Risk Analytics

Contacts

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In 2006 he founded Global Valuation Limited (GVL), and introduced a novel approach to consistent portfolio processing based on cutting edge computer engineering and an innovative mathematical framework. He has been consulting on complex financial modelling issues and technology with a number of top financial institutions including Morgan Stanley, Credit Suisse, Merrill Lynch/Bank of America, Mitsubishi UFJ Securities, HSBC and Bloomberg amongst others.

He holds a PhD in Theoretical Physics from ETH Zurich and held professorships at the University of Toronto and Imperial College London.

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Prior to starting Ipotecs, he spent many years trading complex structured derivatives and developing risk management techniques and infrastructure to control risks. His latest role was Managing Director and Business Head of Structured Trading Group in Mitsubishi UFJ Securities International (MUSI), responsible for the P&L and business development of all structured derivatives. He and his groups developed sophisticated models and high-end technology as a platform for financial trading and risk reporting, and for many years was the most profitable group in MUSI.

Prior to this, he was a trader and developed the exotic derivatives trading capability in Mizuho International. Before that, he was in JP Morgan Asset Management, working on asset allocation models, and IT infrastructure including real-time derivatives and options pricing system. He has both BSc (1st class) and PhD in Physics from Imperial College, London University.

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