Advances in Valuation Adjustments

Topquants – Autumn 2015

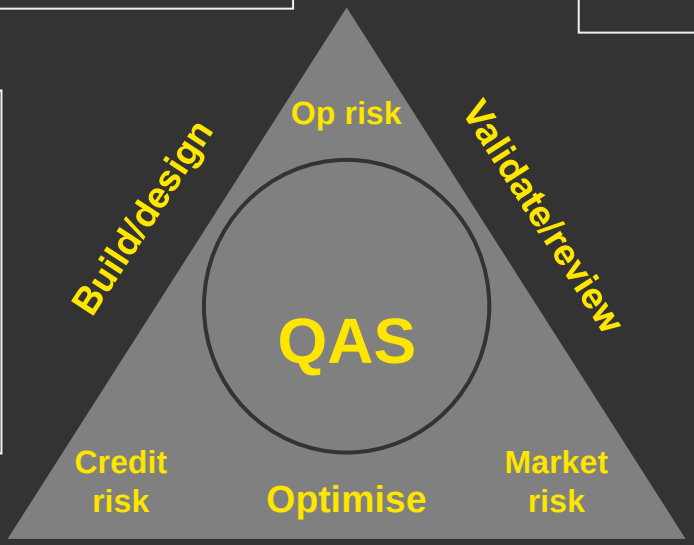
Building a better working world

Quantitative Advisory Services

EY QAS team
- Modelling methodology design and model build
- Methodology and model validation
- Methodology and model optimisation

Market risk
- VaR modelling
- Derivatives valuation
- Liquidity
- IDRC

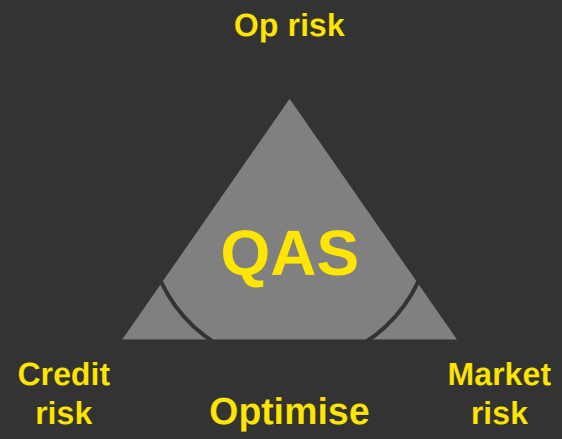
Credit risk
- Impairment
- Capital
- Valuation
- Forecasting and stress testing
- Behavioural modelling



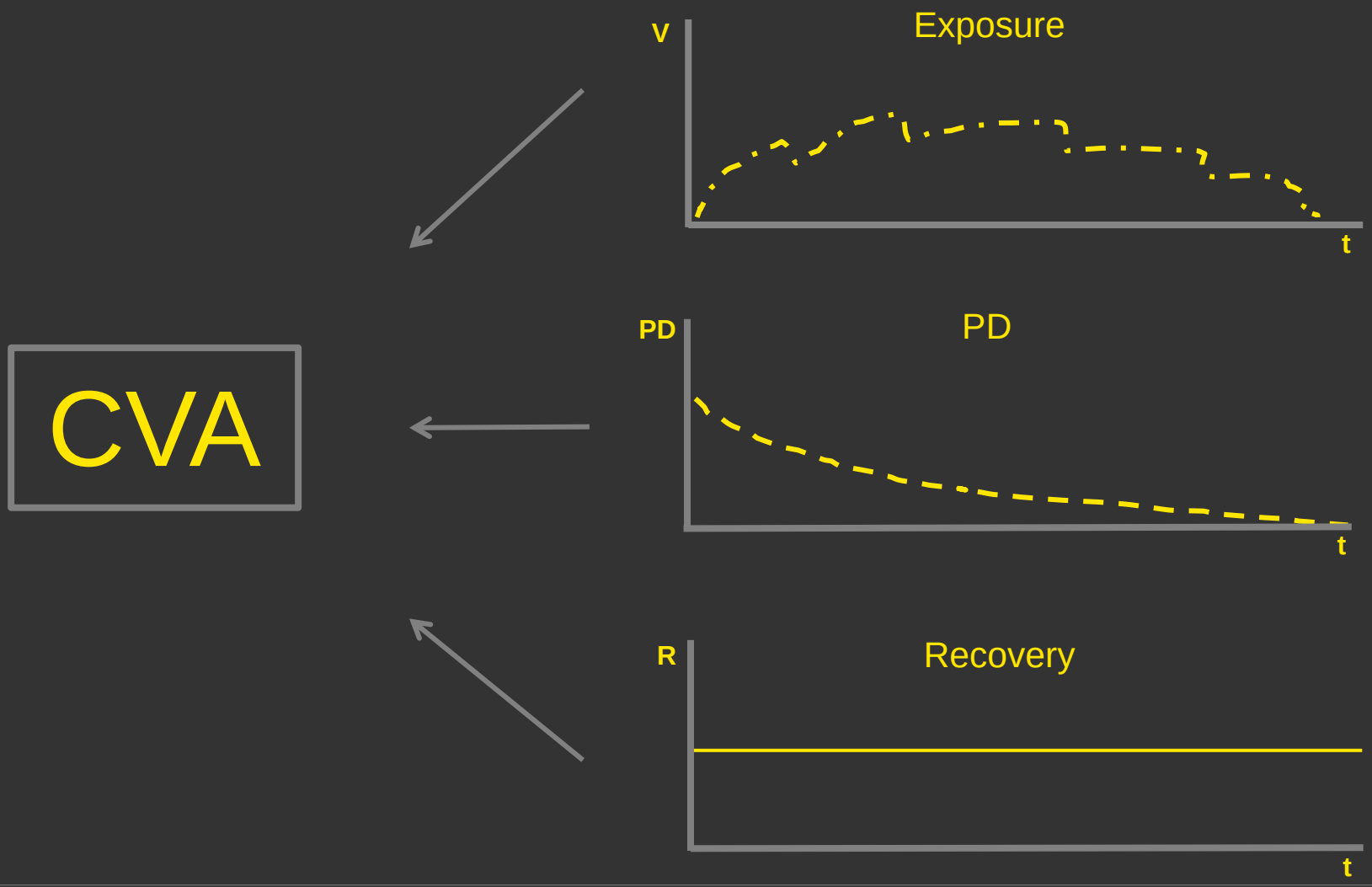
Operational risk
- Quantitative Op Risk Modelling

Credit Valuation Adjustment (CVA)

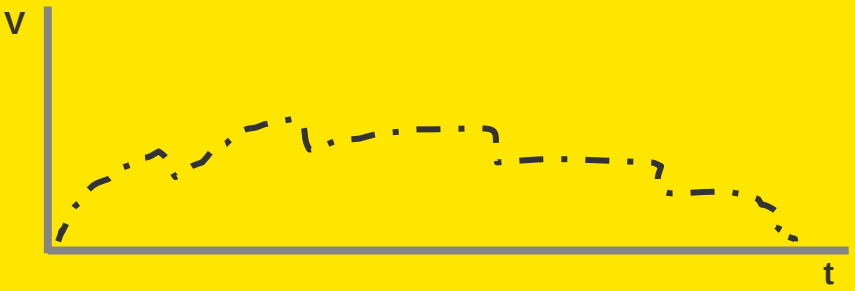
- Regulatory CVA; capital charge
  - Basel/FRTB
- Accounting CVA; pricing adjustment
  - IFRS
  - US GAAP
  - …



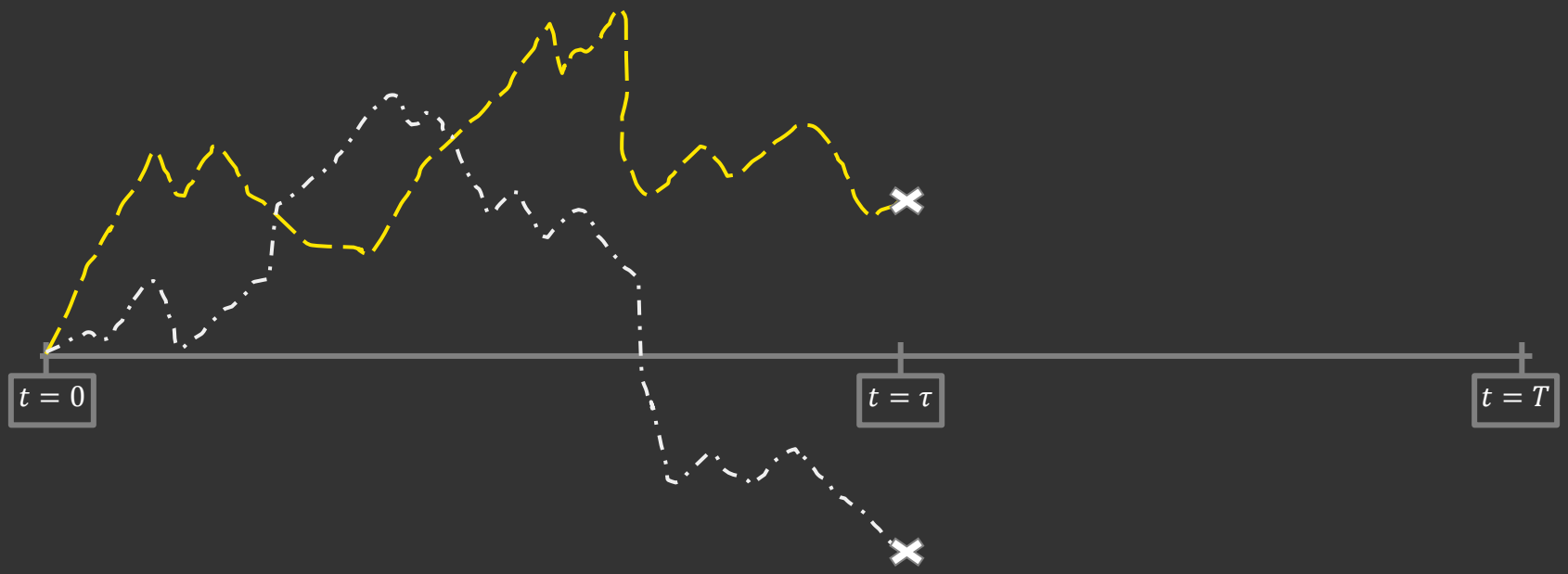
Introduction



Exposure



Contract-Level Exposure



The counterparty defaults at time $t = \tau$. The incurred loss depends on the value of the contract.

Counterparty-Level Exposure

CVA is measured on a counterparty-level. The counterparty-level exposure is given by

$$E(t) = \max\left[\sum_{i \in NA} V_i(t), 0\right]$$

where NA is the netting set.

A netting set allows a positive and a negative value to set-off and cancel each other out.

Counterparty-Level Exposure

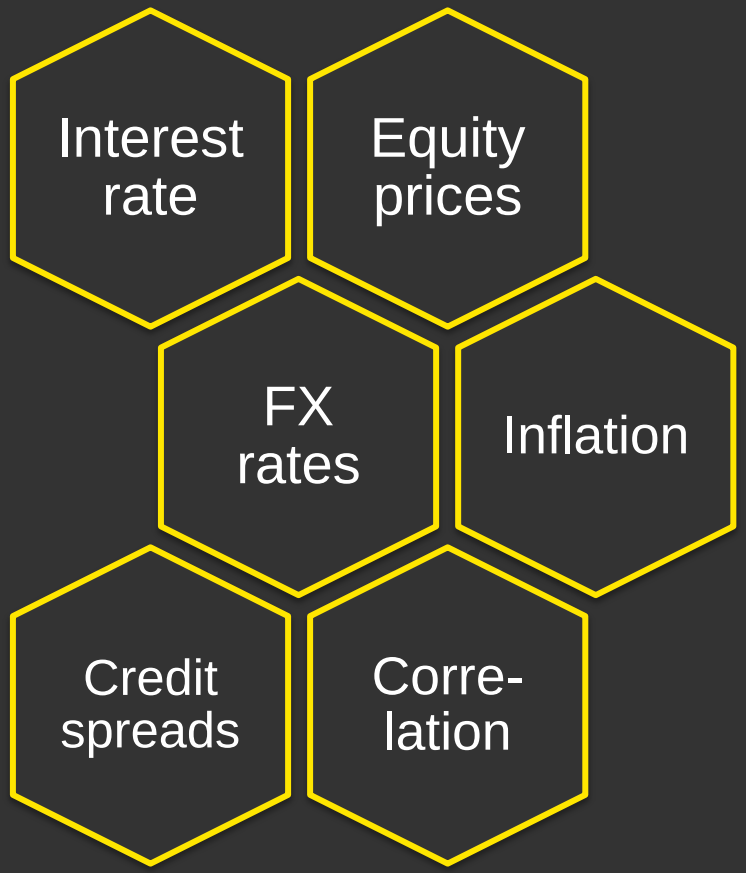
CVA is measured on a counterparty-level. The counterparty-level exposure is given by

$$E(t) = \max\left[\sum_{i \in NA} V_i(t), 0\right]$$

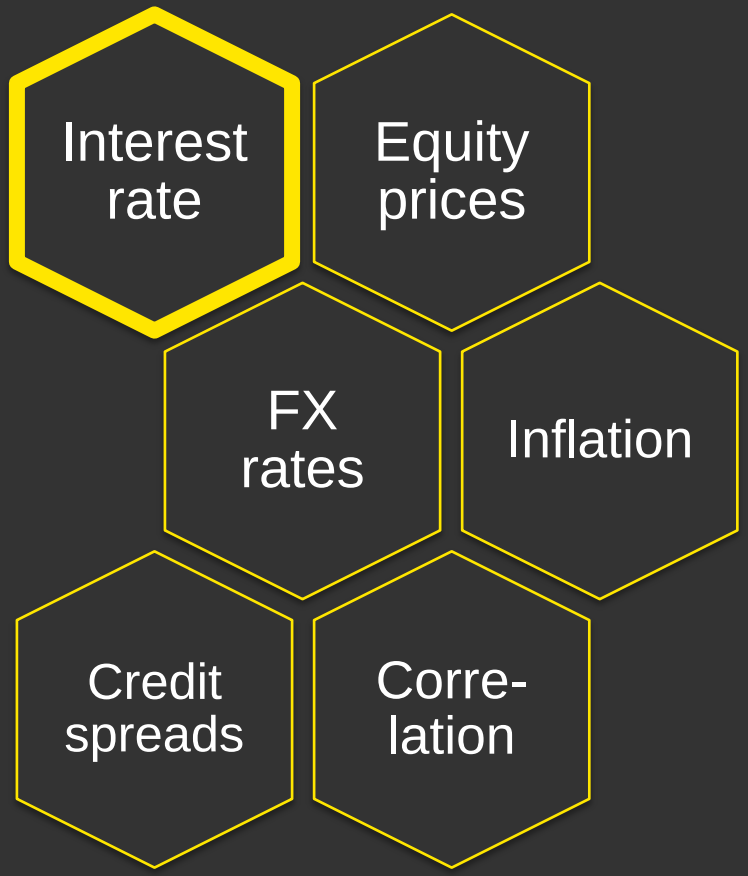
where NA is the netting set.

A netting set allows a positive and a negative value to set-off and cancel each other out.

Portfolio risk drivers



Portfolio risk drivers



Model choice:

- Short rate models:
  - One factor (Vaciek/CIR/HW)
  - Multiple factors (HW, G2++)
- HJM
- LMM
- …

Calibration method:

- Historical (P-measure)
- Market-implied (Q-measure)
  - Yield curve
  - Caps
  - Swaptions
  - …

Questions

Choice of model?

How to calibrate?

How to simulate?

How to assess the accuracy?

Model choice

Question:

What are the key considerations for model selection?

For example:

- *Model dynamics*
- *Complexity*
- *Market practice*

Model choice

For the simulation of future interest rates, one possibility is to describe the *short rate* r_t with an SDE:

$$dr_t = a(b - r_t)dt + \sigma dW_t \textit{(Vasicek)}$$

Model choice

For the simulation of future interest rates, one possibility is to describe the *short rate* r_t with an SDE:

$$dr_t = x_t + y_t + \varphi_t \qquad \textit{(G2++)}$$
$$dx_t = -ax_t dt + \sigma_1 dW_1$$
$$dy_t = -b\, y_t dt + \sigma_2 dW_2$$

Calibration method

Question:

On what set of instruments do you calibrate your model?

For example:

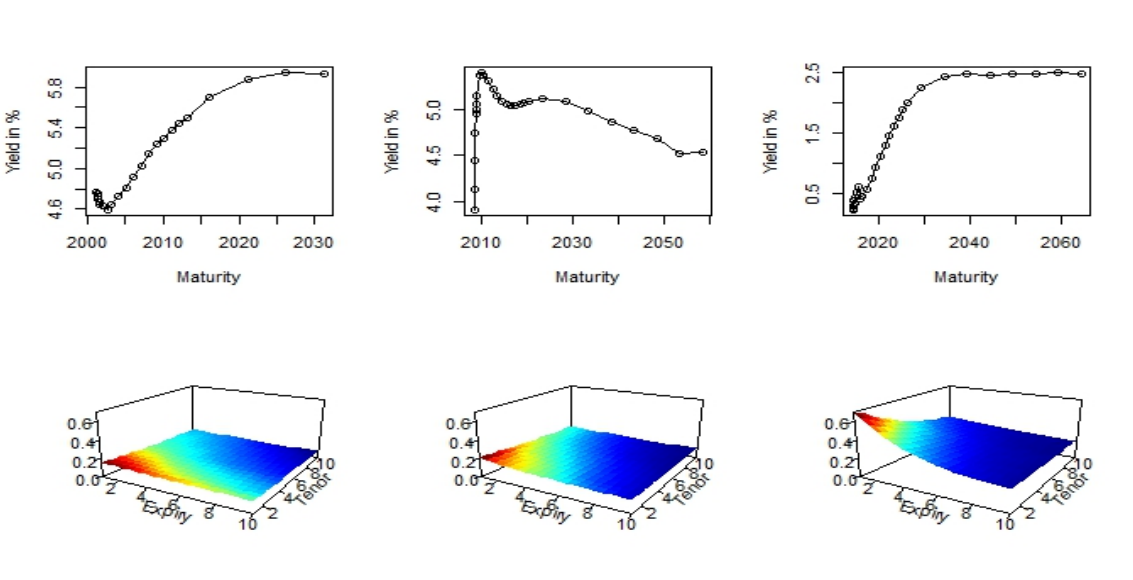
- *Yield curve / bonds*
- *Caps / Floors*
- *Swaptions*
- *Combination*

Calibration method

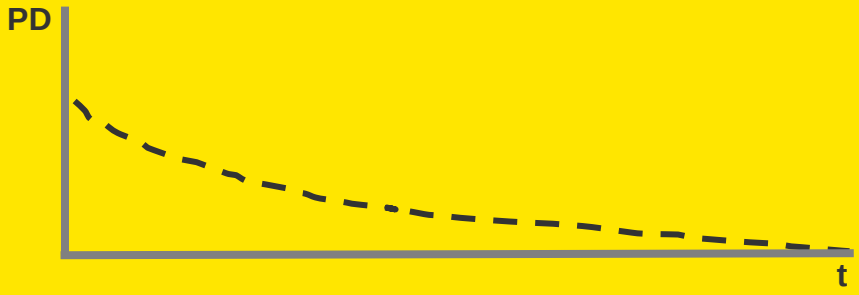
Market conditions change.

In the figure below, a yield curve and implied swaption volatility is given for:

- February 2001 (left)
- July 2008 (middle)
- May 2014 (right)

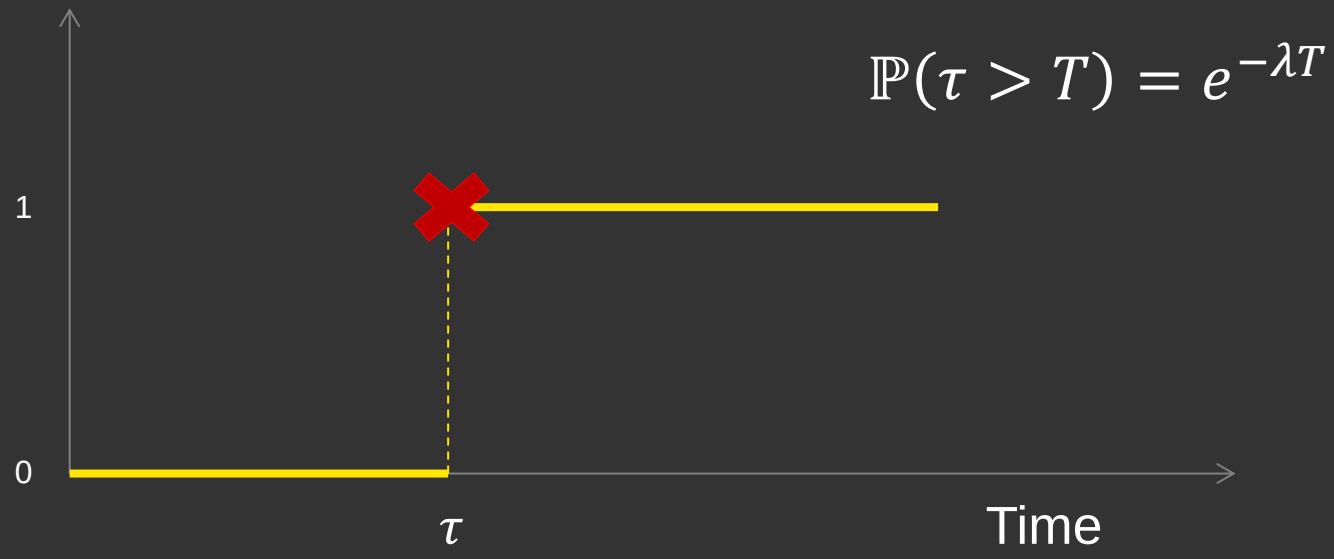


Probability of default



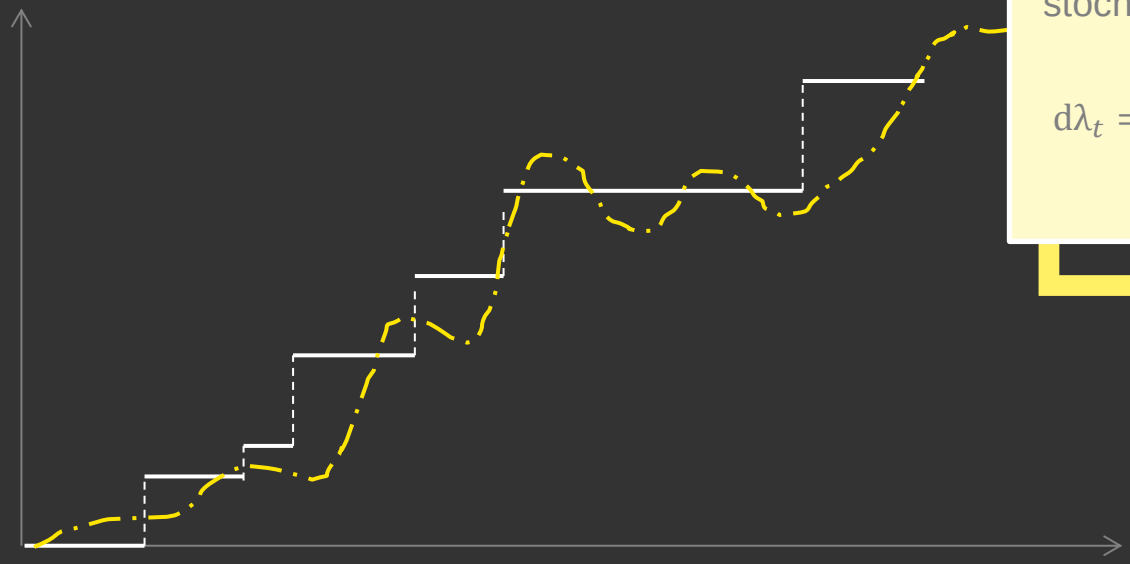
Probability of default

- Structural models
- Reduced form models
  - First jump Poisson(λ) process
  - …



Default intensity model

- Piecewise Constant Intensity (Market Practice)
- Piecewise Linear Intensity
- Stochastic Intensity
- …

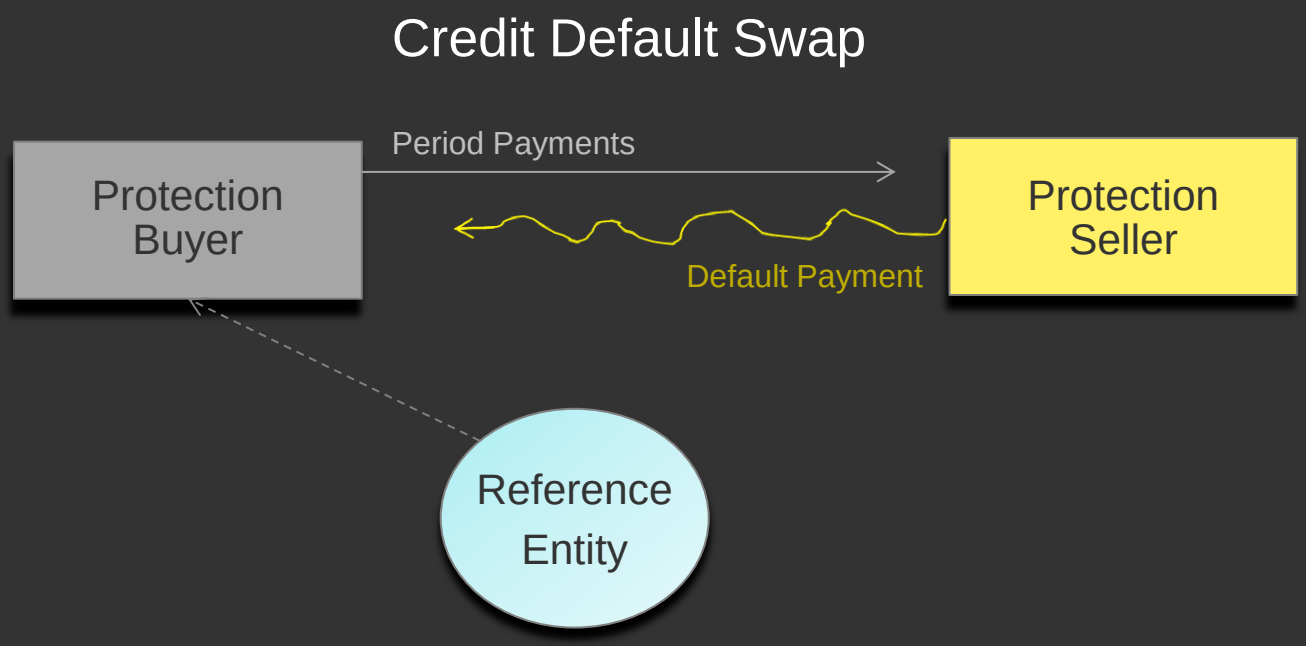


Default is the first jump of a Poisson process with stochastic intensity λ.

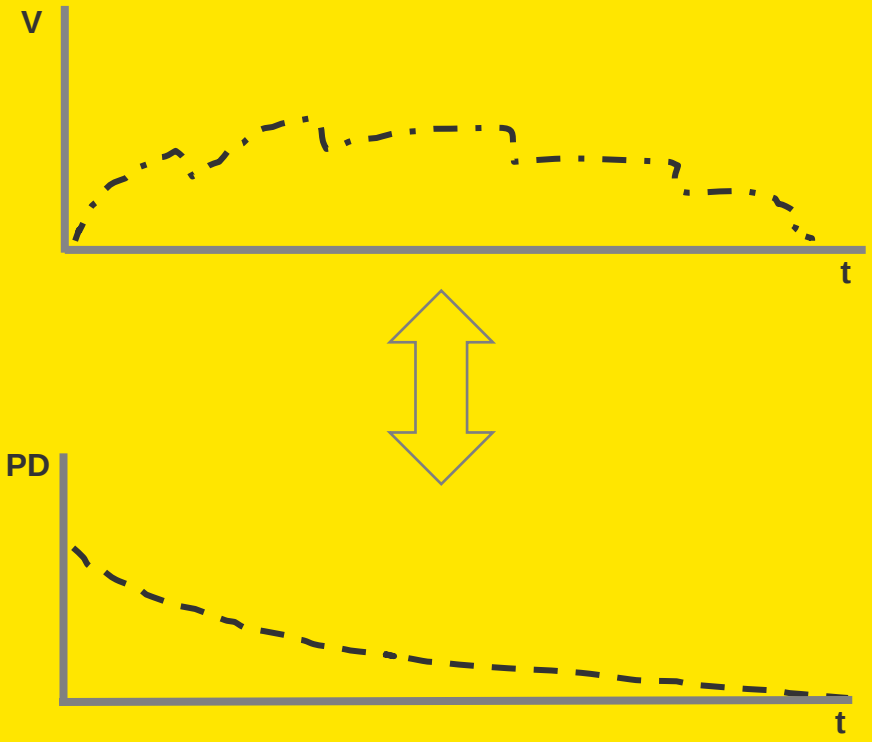
$$d\lambda_t = \alpha(\beta - \lambda_t)dt + \sigma\sqrt{\lambda_t}dW_t$$

Calibration Default Probability

- Historical
- Market Implied
  - CDS
  - Defaultable Bonds

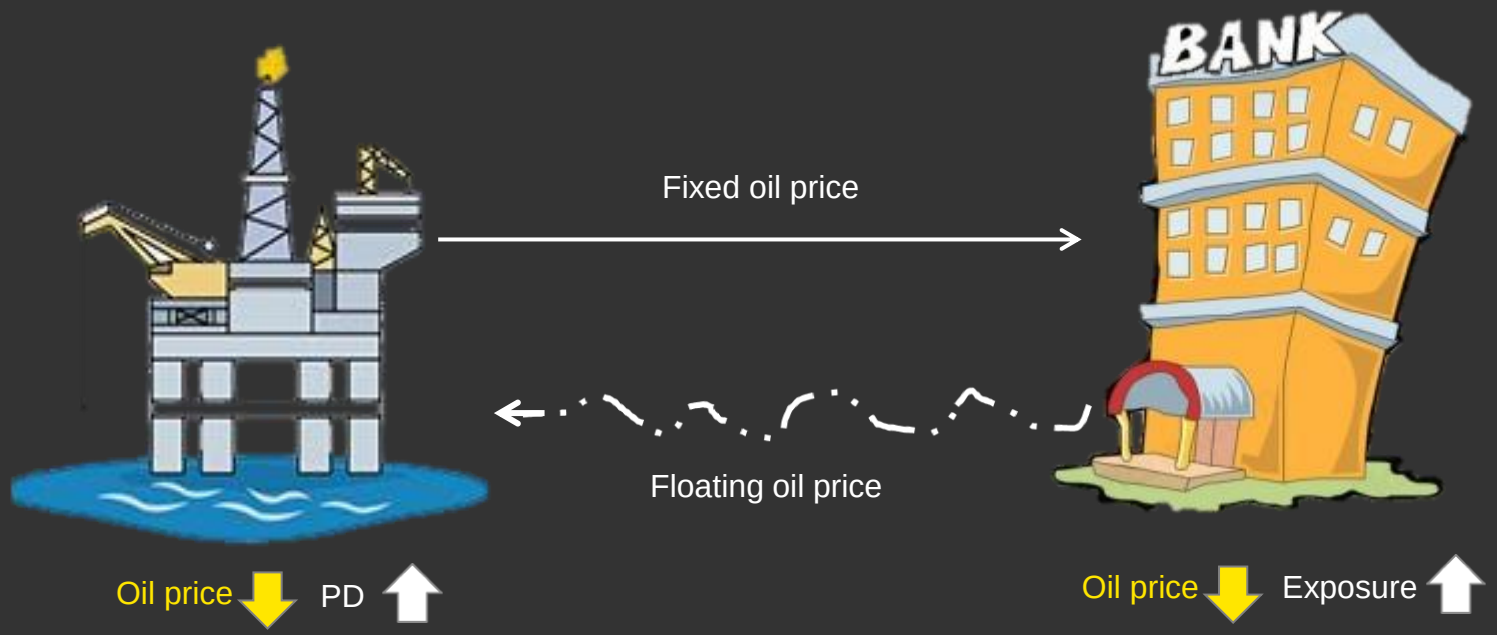


Wrong Way Risk



Wrong Way Risk

Wrong-Way Risk: positive correlation exposure and probability of default



Modeling Wrong Way Risk

Question:

How would you model Wrong Way Risk?

For Example:

- **Alpha Multiplier** (Basel).
- **Copula method**: Couple exposure and default distribution through a copula.
- **Brigo's approach**: Two correlated stochastic models, one for exposure and one for default.

Modeling Wrong Way Risk

Default Intensity:

$$d\lambda_t = \mu(\beta - \lambda_t)dt + \nu\sqrt{}$$

Wrong Way Risk:

$$dW_t dZ_t = \rho dt$$

:

$$(b - r_t)dt + \sigma dZ_t$$

Calibration Correlation

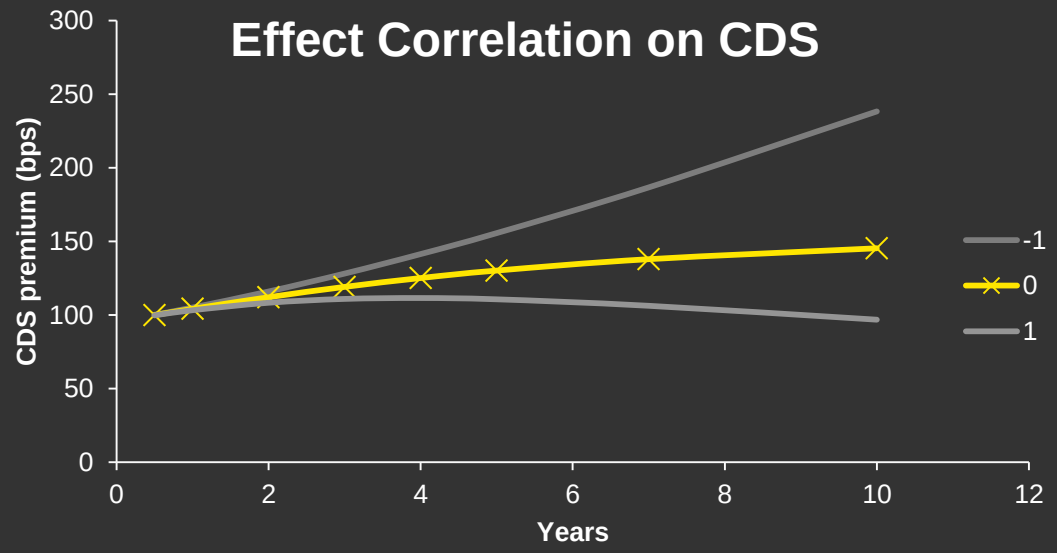
Question:

How would calibrate the correlation parameter?

For Example:

- Subjective Judgement
- Historical calibration
- Calibration to market observables (CDS)
  - Results in a risk-neutral pricing framework

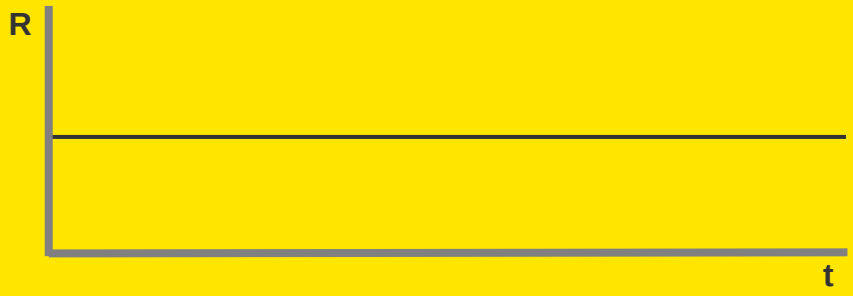
Calibration Correlation



- Calibration of WWR to CDS prices requires computationally intensive calibration techniques.
  - Analytical approximations
  - Efficient numerical techniques (efficient trinomial tree)

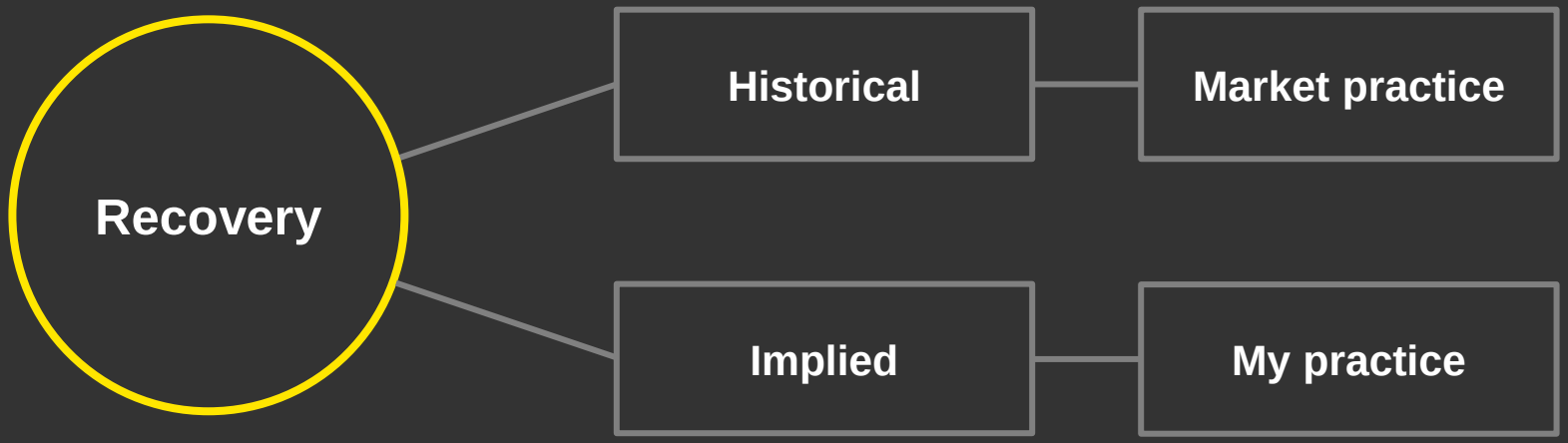
- More details: Master thesis *Wrong Way Risk for Interest Rate* – G. Delsing

Recovery



What is implied recovery?

Recovery is the expected return on a defaulted instrument at time of default. The realized recovery will only come at a later stage.



Question

Have you used this market convention?

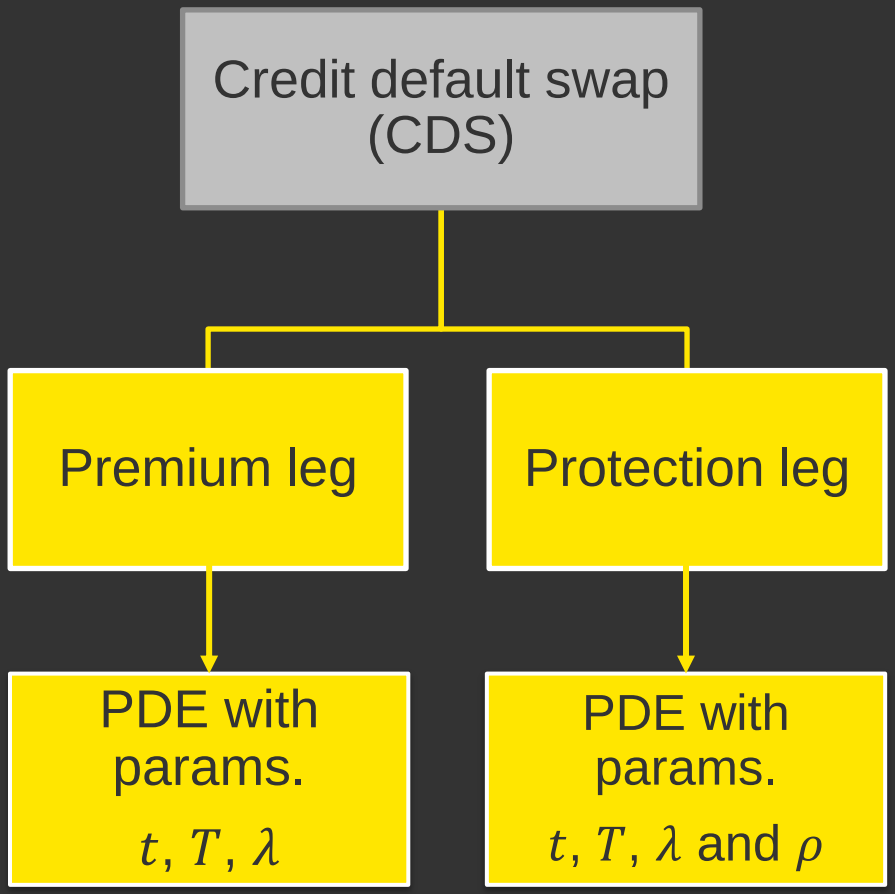
My model requirements

Implied recovery is **not** the same as historical recovery nor is the recovery constant

My model should take into account

- Mutual **calibration** on both senior and subordinated **CDS spreads**
- Negative **correlation** between recovery and default
- Recovery **continuously** defined over time

My model setup



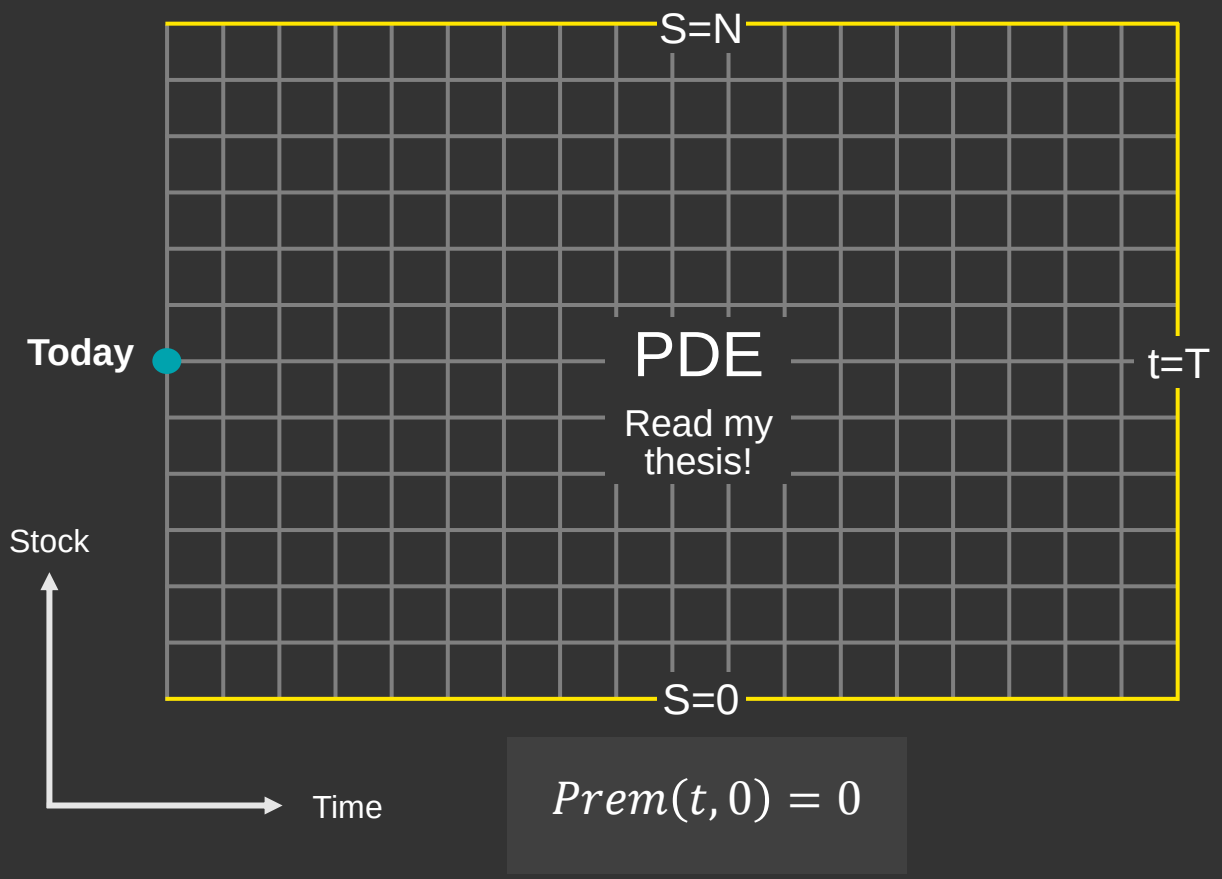
- S_t the stock process
- λ_t the default intensity
- ρ_t the recovery

$$\begin{cases} \lambda_t = \frac{1}{S_t^b} \\ \rho_t = \left(a_0 + a_1\left(\frac{\lambda_t - \lambda_0}{\lambda_0}\right)\right) \end{cases},$$

where $b \in \mathbb{R}_{\geq 0}, a_0 \in \mathbb{R}$ and $a_1 \in \mathbb{R}_{<0}$.

What's the trick?
An example - The premium leg

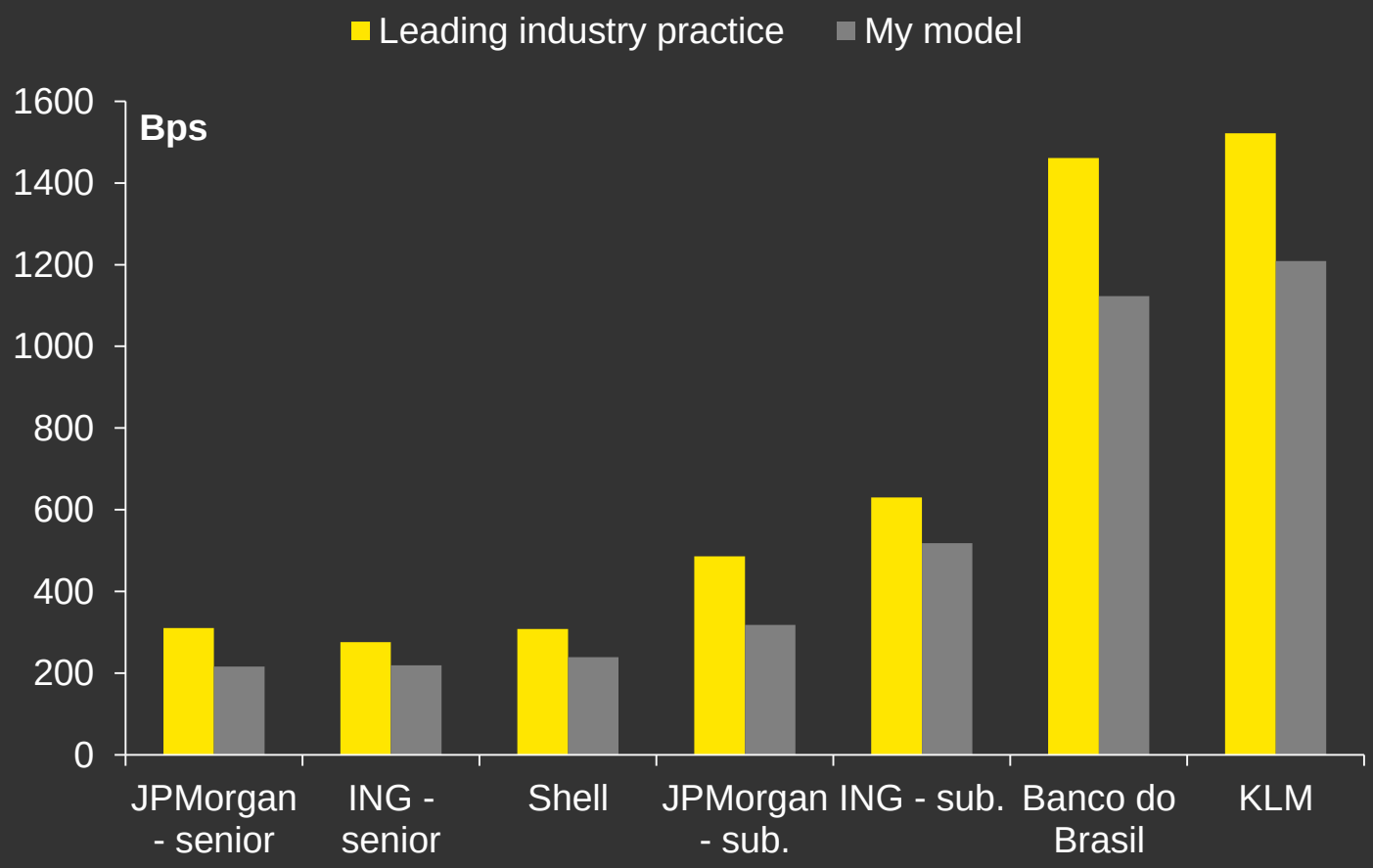
$$Prem(t,N) = \int_t^T \left(e^{\int_t^s r_u du} \cdot C \right) ds$$



$$Prem(T, S_T) = 0$$

$$Prem(t,0) = 0$$

A CVA comparison
My model vs Industry practice



Valuation adjustments survey

Results as of August 2015

Building a better working world

Valuation adjustments survey

A range of possible valuation adjustments – also referred to as XVA – have been subject of many discussions and still ongoing debate in the financial industry.

For this survey ten European and one Asian bank were questioned on the application of:

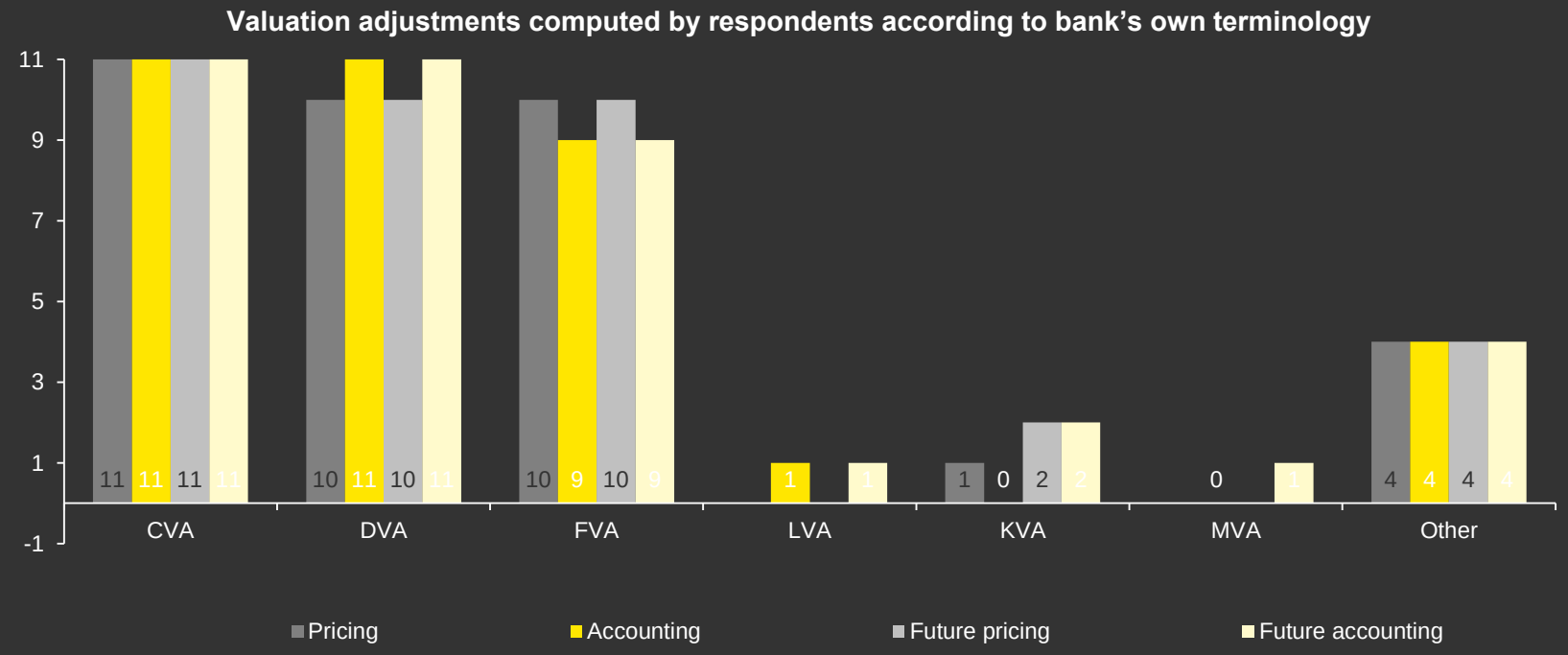
- Credit Valuation Adjustment (CVA)
- Debit Valuation Adjustment (DVA)
- Funding Valuation Adjustment (FVA)
- Liquidity Valuation Adjustment (LVA)
- Capital Valuation Adjustment (KVA)
- Additional Valuation Adjustment (AVA)
- Margin Valuation Adjustment (MVA)
- Other Valuation Adjustments (XVA)

Risk-free valuation excluding adjustments

- There is a clear consensus about the methodology to calculate the risk-free value of a collateralized derivative. All banks use the Overnight Indexed Swap (OIS) curve to discount future expected cash flows on derivatives
- For uncollateralized derivatives, the majority of banks (70%) use LIBOR curves
- Large banks and investment banks typically use currency specific curves for different CSA currencies or the Cheapest-to-Deliver (CTD) curve for multi currency CSAs

Corrections added to the value of a derivative

There is clear consensus about CVA. All but one bank also compute DVA and FVA for both pricing and accounting. There seems to be not much support (yet) for other explicit adjustments.



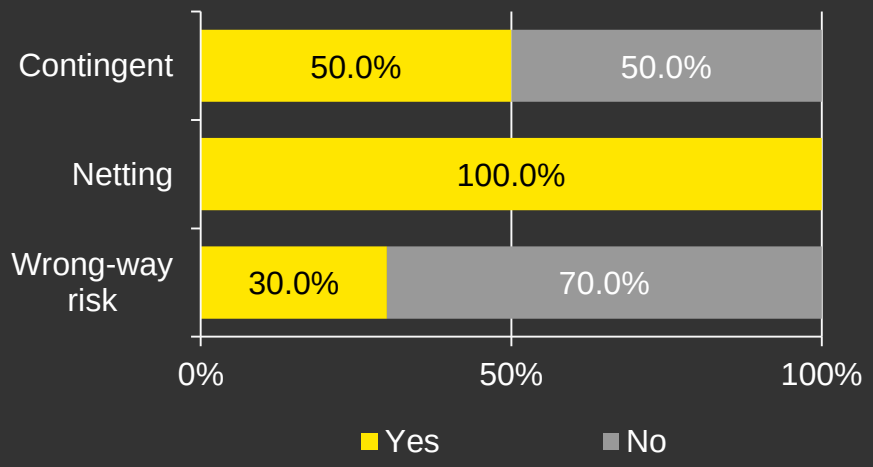
Credit and Debit Valuation Adjustments CVA/DVA (1)

Valuation adjustment for counterparty credit risk.

We see many similarities when it comes to CVA modelling:

- All banks use a simulation based approach
  - 1 factor Hull-White, Libor BGM
- Inputs are similar
  - CDS and ASW spreads
  - Internal PD estimates
  - Contract terms
  - Market data required for exposure calculation such as interest rate curves and swaption volatilities
- Computation of CVA/DVA on a bilateral basis
- Dependency of valuation on collateral threshold and minimal transfer amount

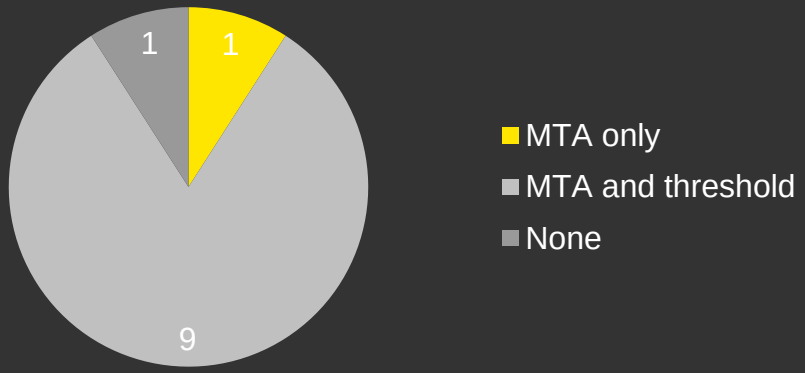
CVA/DVA (2)



- Half of the banks account for bilateral/contingent CVA/DVA
- All banks apply netting
- The majority of the banks does not (yet) account for wrong way risk

- All but two banks account for both the minimum transfer amount (MTA) and the threshold in the CSA agreement, when computing CVA/DVA on collateralized trades

Incorporation of collateral agreement

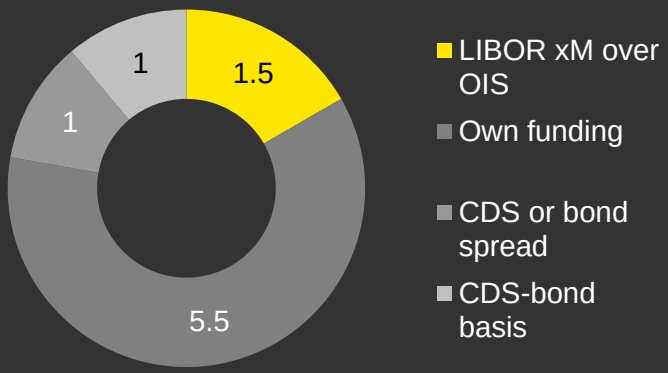


FVA

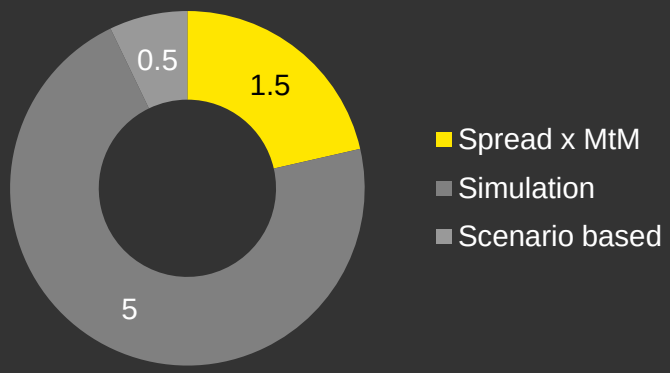
All banks compute an FVA but methodologies differ significantly

- Some banks use multiple spreads or multiple methodologies, depending on portfolio and CSA characteristics
- Some banks perceive a double counting between FVA and DVA and apply only the CDS-bond basis spread

Spread



Methodology



Other valuation adjustments

- Liquidity Valuation Adjustment (LVA)
  - One respondent states it does not compute an FVA, but computes an LVA which in our definition also is an FVA
  - Two respondents state there is no difference between LVA and FVA
- Capital Valuation Adjustment (KVA)
  - Two respondents plan on accounting for KVA
  - One respondent states that the cost of capital is already reflected in its own credit curve
- Margin Valuation Adjustment (MVA)
  - One respondent states that the cost of posting initial margin is already reflected in its own credit curve
  - One respondent considers adjusting for Initial Margin but does not see adjustments in market prices yet

Q&A