



Stochastic processes for counterparty credit risk

On the move

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What is counterparty credit risk

- Counterparty credit risk is the credit risk between derivatives counterparties, OTCD and SFT derivatives.
- *Example: Bank A has entered a derivative contract with bank B. Suppose the market value of the contract today is 100. When bank B defaults the potential loss for Bank A is 100.*
- Counterparty credit risk can be seen as subset of total credit risk.
- The value of derivatives, exposure, is highly uncertain in the future.

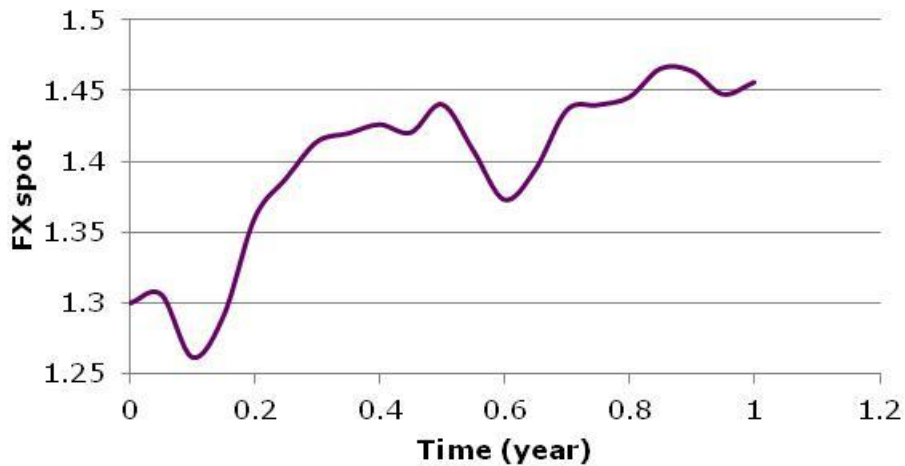
Basel II

- In the Basel II regulations three methods are given for the calculation of exposure for counterparty credit risk:
- Current exposure method (CEM)
- Standardized method (SM)
- Internal model method (IMM)

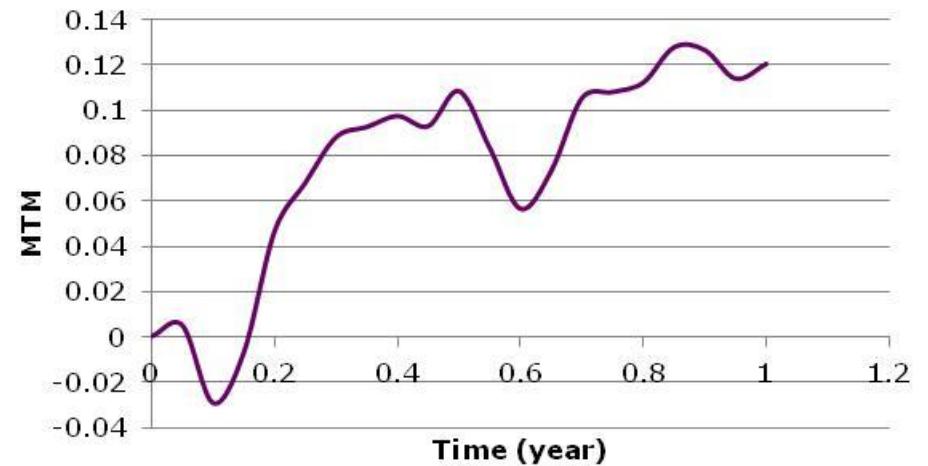
Counterparty credit risk: example

- Take an FX forward. Pay USD 1.3 receive EUR 1. Maturity is one year. Assume flat FX forward curve. Current FX spot is 1.3.
- Examine one possible future scenario

Possible future path of FX spot



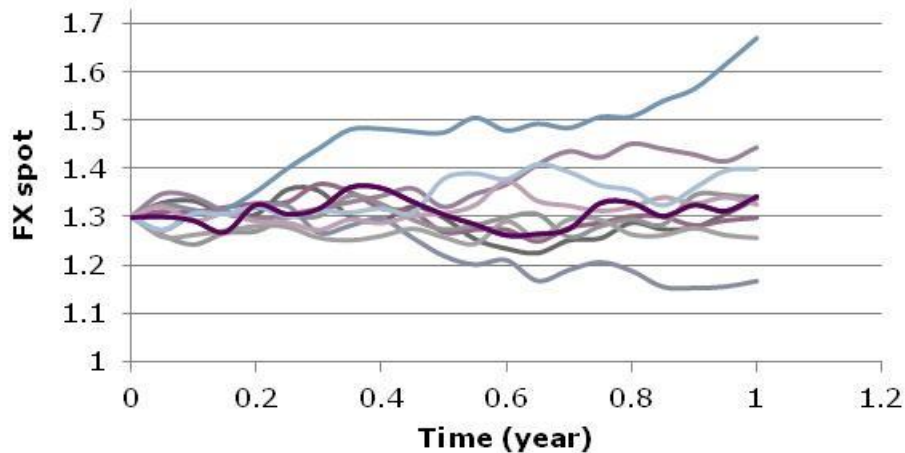
Possible future path of MtM



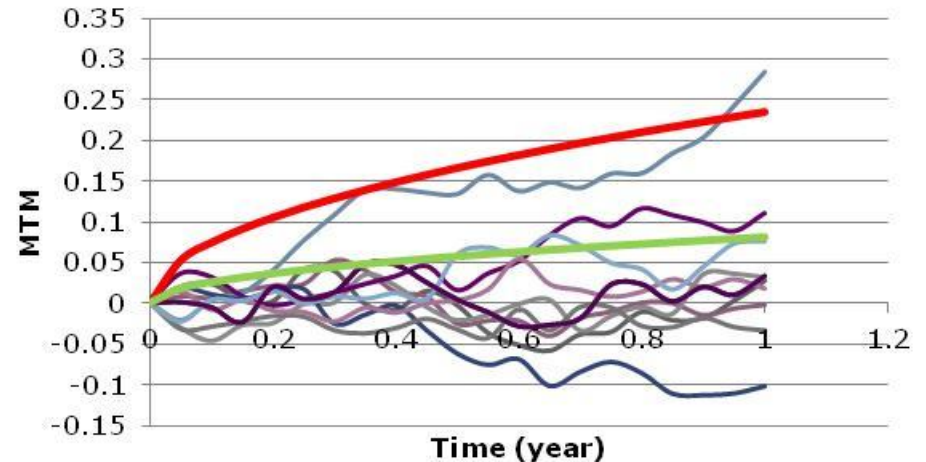
Counterparty credit risk: example

- Take an FX forward. Pay USD 1.3 receive EUR 1. Maturity is one year. Assume flat FX forward curve. Current FX spot is 1.3.
- Multiple future scenarios

Possible future paths of FX spot



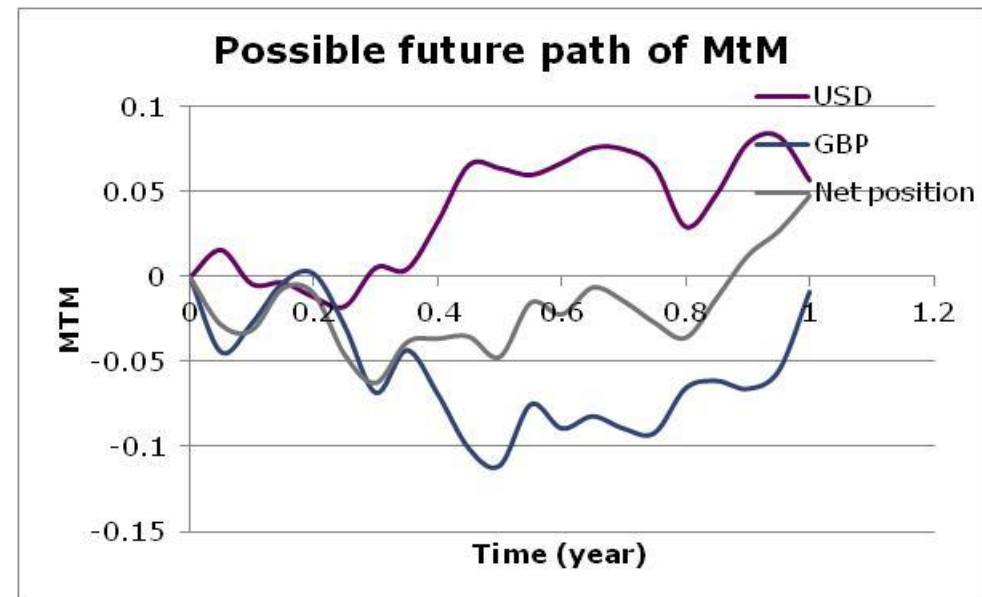
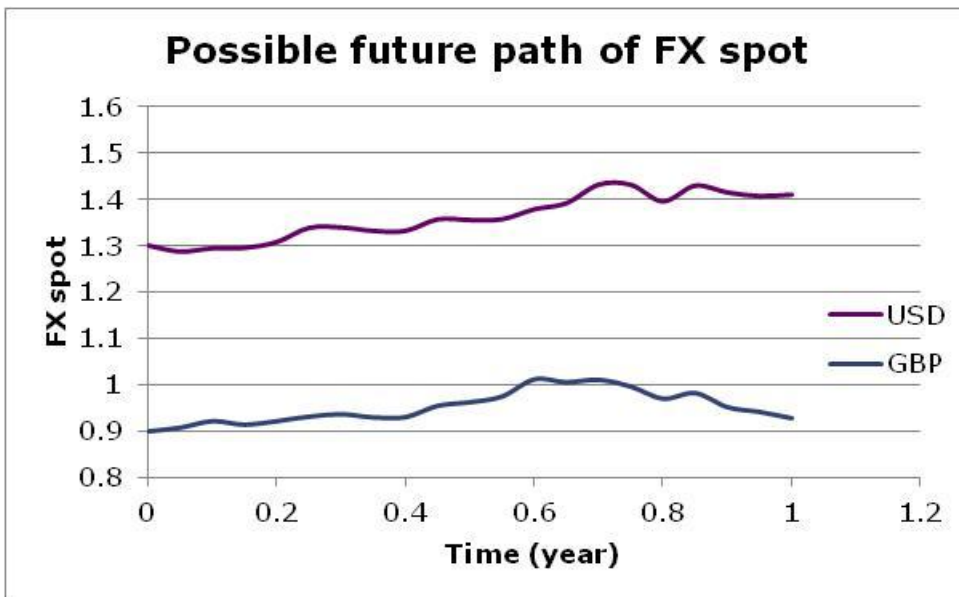
Possible future paths of MtM



- Red line PFE: 97.5% quantile of exposure through time
- Green line EE: expected exposure through time

Counterparty credit risk: example

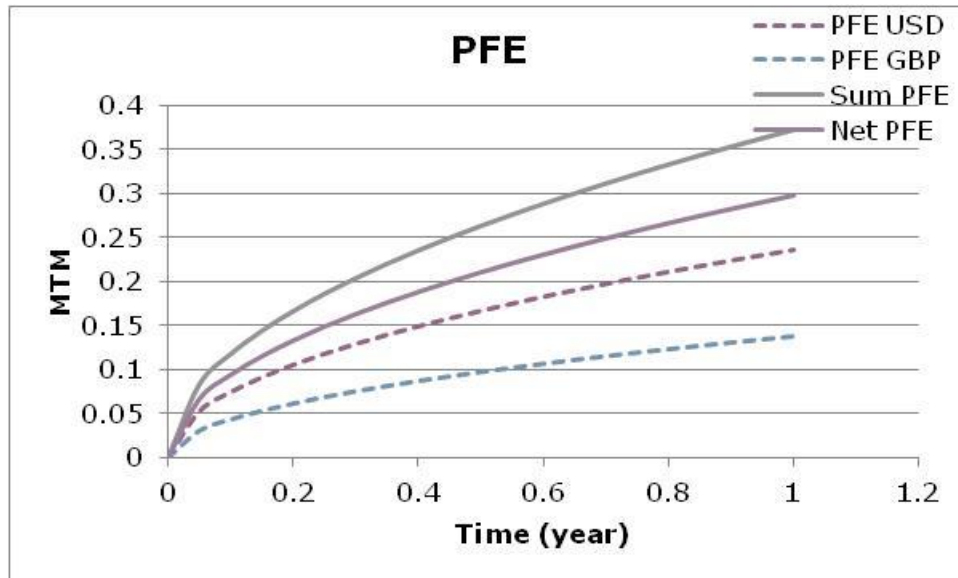
- Netting: in case of default MtM of different trades can be added
- Take 2 FX forwards
 - Pay USD 1.3 receive EUR 1. Maturity is one year. Current FX spot is 1.3.
 - Pay EUR 1 receive GBP 0.9. Maturity is one year. Current FX spot is 0.9.



- FX USD and GBP are positively correlated.

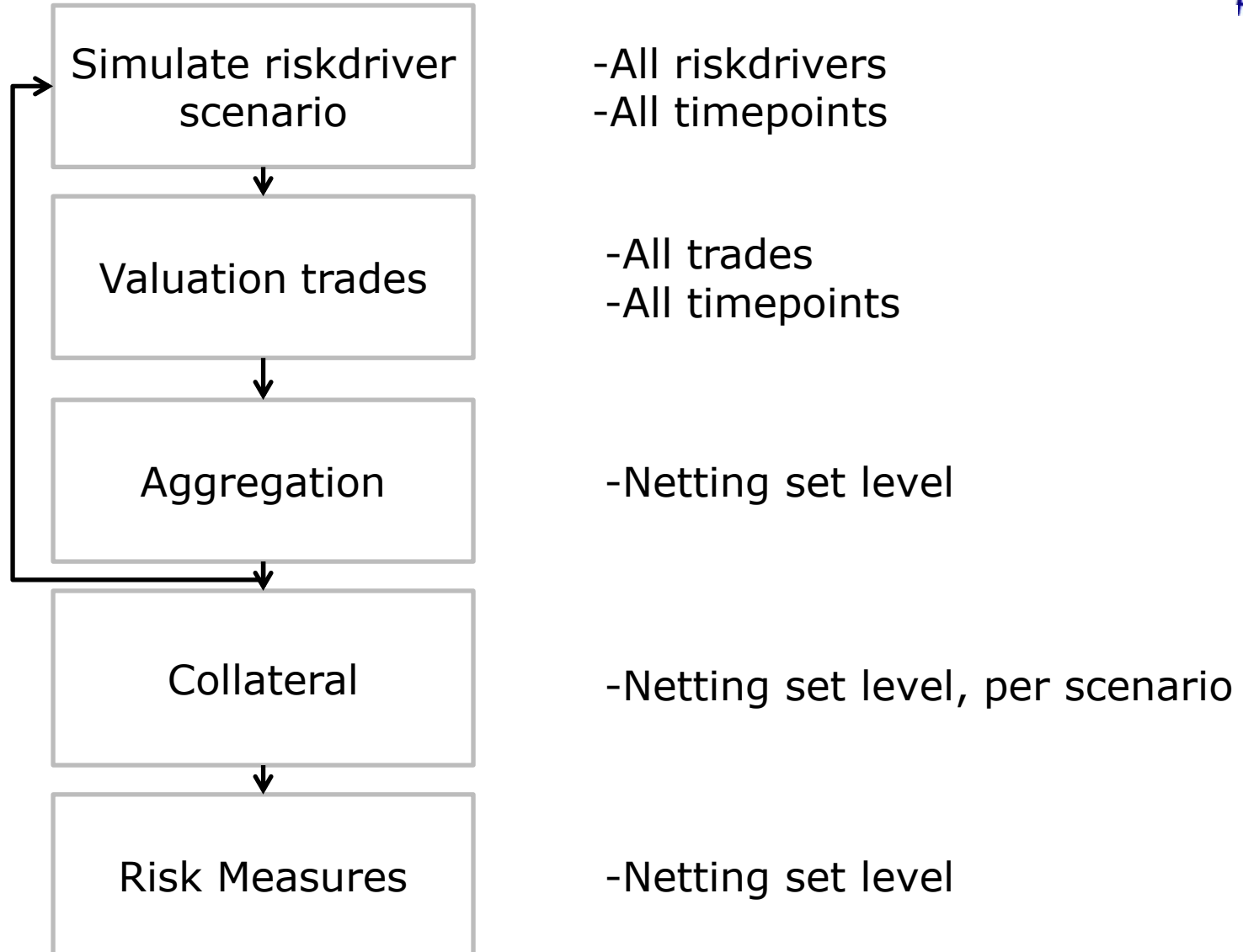
Counterparty credit risk: example

- Netting: in case of default MtM of different trades can be added
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- Netting reduces future exposure of the portfolio

Monte Carlo setup for IMM



Stochastic process for interest rates

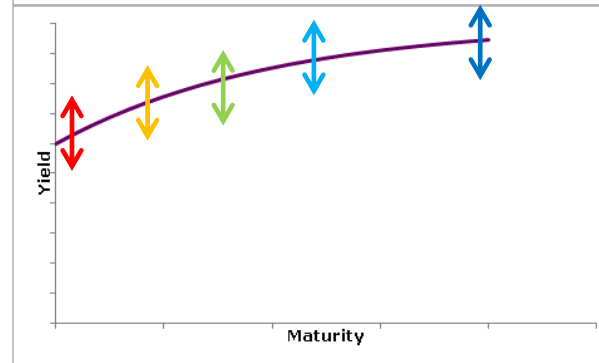
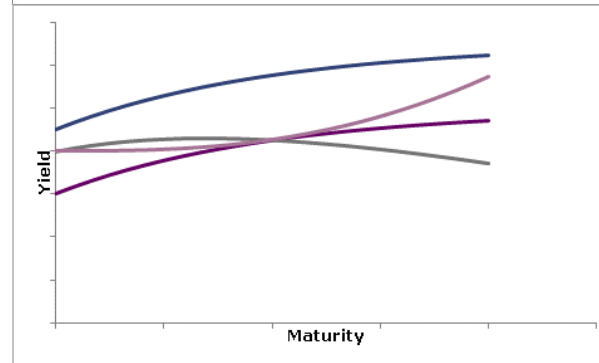
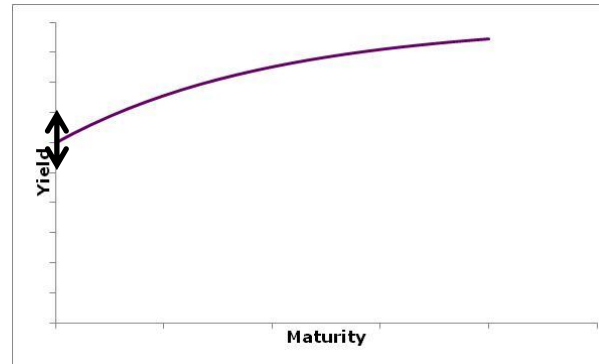


- Riskdriver selection. What to simulate?
- Spot rates at different tenors
- Multiple currencies
- Correlations
- Implied volatilities
- Forwards

Yield curve simulation: what to simulate



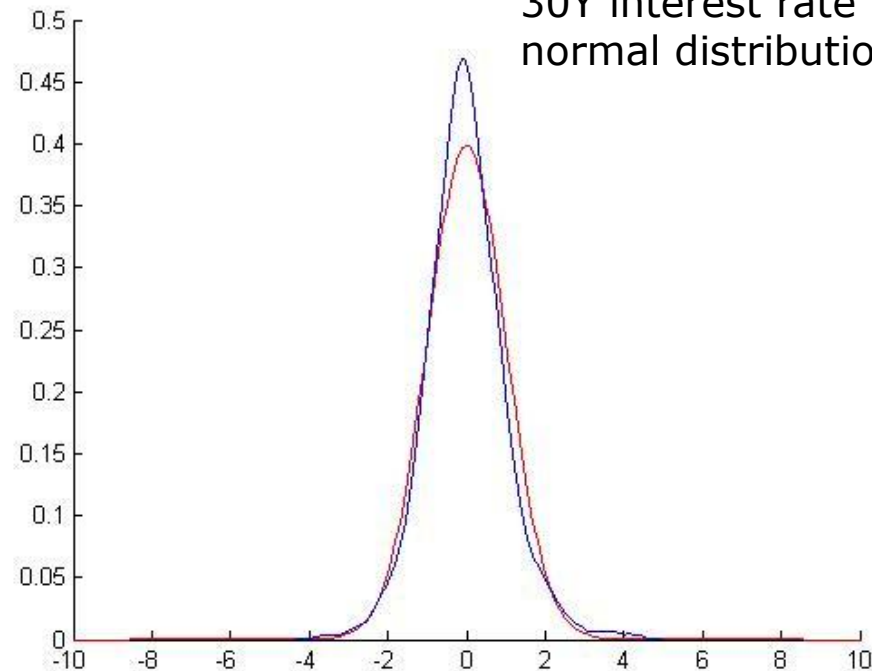
- Investigate one currency yield curve. How to simulate?
- Use short rate
 - For example Vasicek
- PCA approach
 - Model behavior of the curve, parallel movements, twist, butterfly
- Tenor point simulation



Yield curve simulation: what behavior I



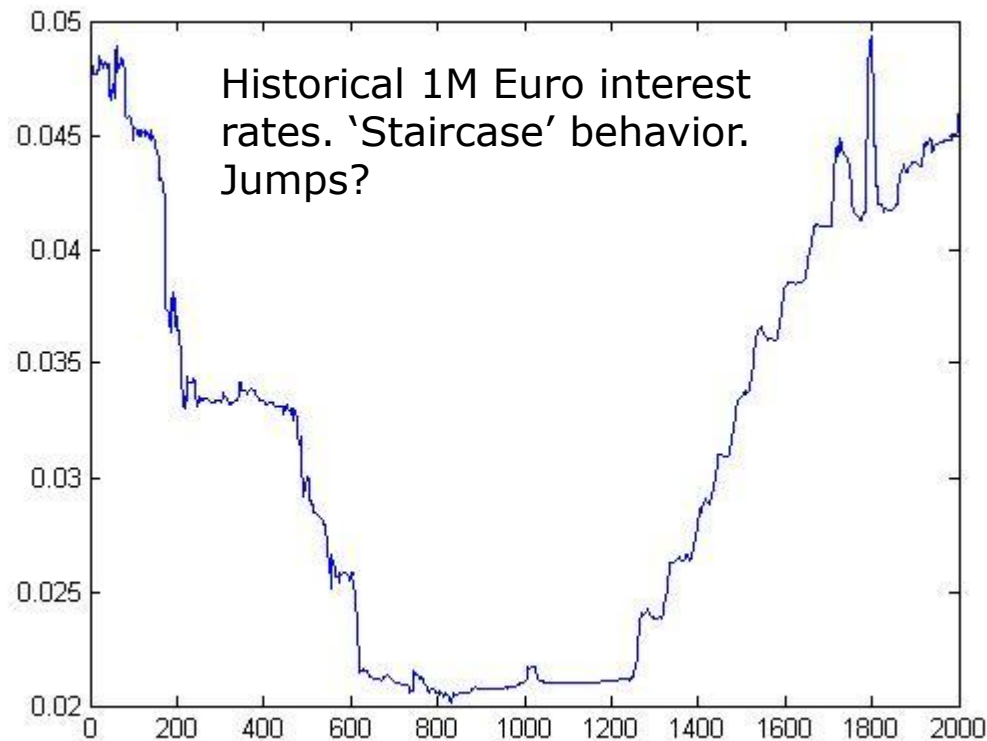
- Investigate one currency yield curve. What kind of behavior?
- Diffusion
 - Normality versus non normality



Yield curve simulation: what behavior II



- Investigate one currency yield curve. What kind of behavior?
 - Jumps (Poisson process)



Yield curve simulation: what behavior III

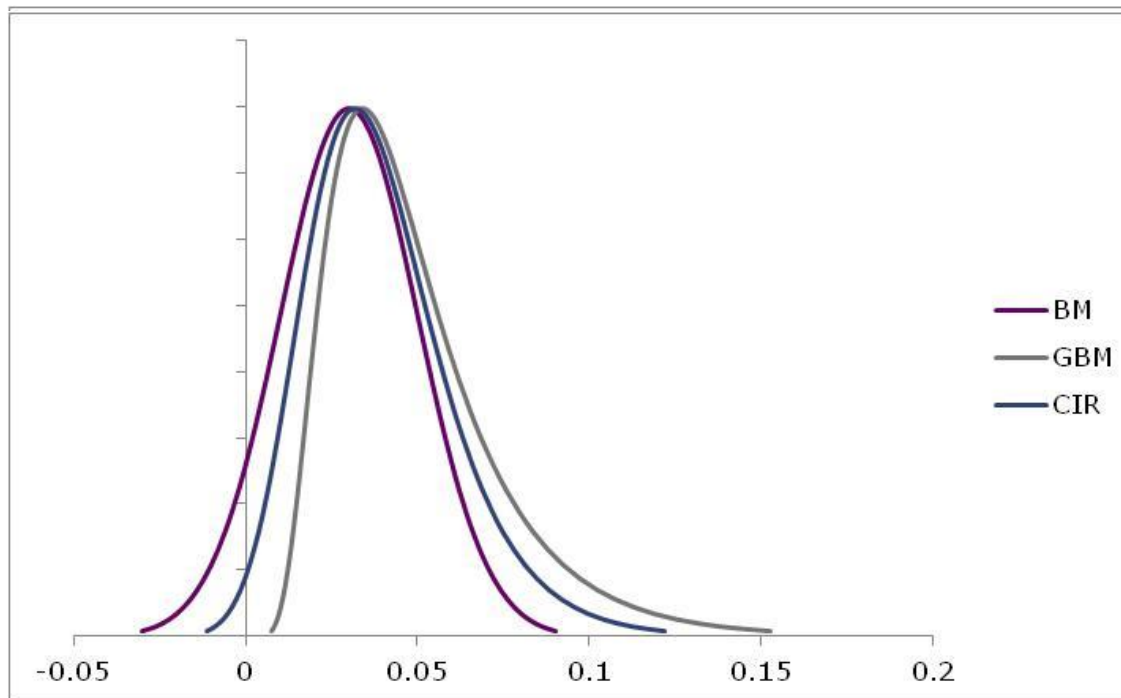


- Investigate one currency yield curve. What kind of behavior?
- Relative shocks vs absolute shock
 - Brownian Motion
 - Geometric Brownian Motion
 - CIR

$$dr = \sigma dz$$

$$dr = \sigma r dz$$

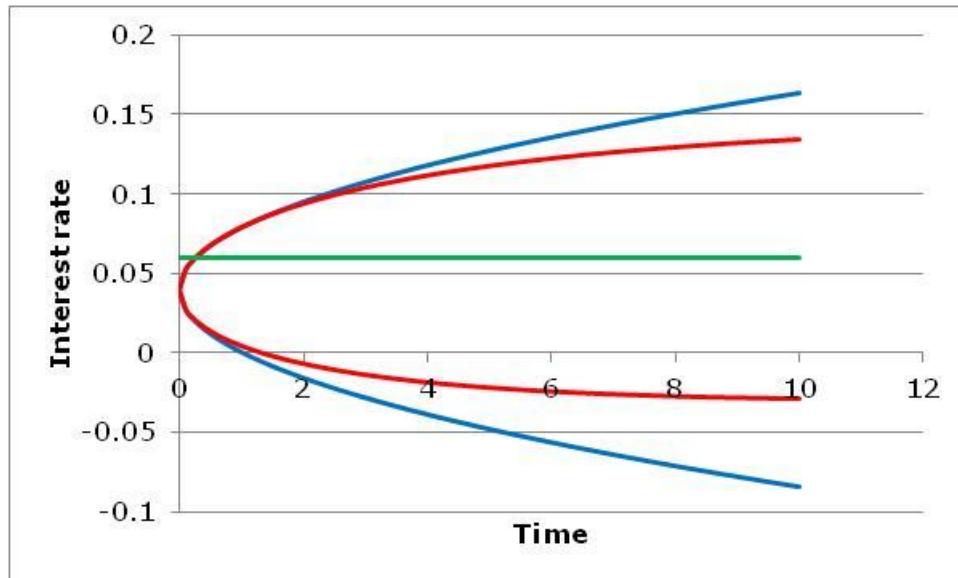
$$dr = \sigma \sqrt{r} dz$$



Yield curve simulation: what behavior III



- Investigate one currency yield curve. What kind of behavior?
- Mean reversion $dr = k(\theta - r)dt + \sigma dz$



Quantiles of interest rate with increasing simulation horizon for MR (red) and without MR (blue)
Long term mean, theta (green)

Criteria for selection of the process

- Calibration
 - Historical data
 - Data availability
- Feasibility for simulation
 - Is approximation needed for simulation of the SDE?
- Correlation structure
 - Is a clearly defined correlation structure possible?
- Economic feasibility
 - Do the results of the simulation make economic sense?

Conclusion

- Lot of choices have to be made
- Outcome of the choices is organization specific
 - Depending on portfolio
 - Level of sophistication
 - Consensus

