Quaternion
Risk Management

Initial Margin

Roland Lichters

Risk Management for Banks 2017, Köln

7. November 2017

Agenda

About Quaternion

Open Source Risk Project Update

Initial Margin

Optimising Initial Margin

Forecasting Initial Margin, Credit Exposure and MVA

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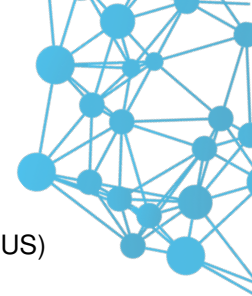

Risk analytics solution provider: Risk analysis, management, optimisation

Founded in 2010, global presence in four countries (Ireland, UK, Germany, US)

40 staff, deep risk management expertise in the financial industry

Hybrid approach based on specialist consultancy services and software solutions

Focus on transparency: risk analytics software released in part as open source

Partner based approach to analytics distribution

Clients

FMS Wertmanagement

EUROPEAN CENTRAL BANK
EUROSYSTEM

COMMERZBANK

Aareal Bank Group

UBS

LLOYDS BANKING GROUP

citibank

Allianz Global Investors

IKB Deutsche Industriebank

CREDIT SUISSE

HSBC

المجموعة المالية هيرميس
EFGHERMES

kfw BANKENGRUPPE

HSH NORDBANK

MünchenerHyp

InCol

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

tullett prebon

ACADIASOFT

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Open Source Risk Project

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First release October 2016, second release May 2017, **third release November 2017**

Open Source Risk Engine

Products Scope (release 2): IR, FX (with Equity and Inflation)

- Bonds/Loans
- Interest Rate Swaps
- Caps/Floors
- European and Bermudan Swaptions
- Cross Currency Swaps
- FX Forwards and Options
- Equity Forwards and Options
- CPI and Year-on-Year Inflation Swaps

Open Source Risk Engine

Analytics Scope (release 2)

- Portfolio pricing and cash flow projection
- Derivative portfolio analytics based on a Monte Carlo simulation framework
  - Credit exposure evolution with netting and collateral
  - Collateral modeling with **Dynamic Initial Margin (DIM)**
  - Derivative value adjustments (CVA, DVA, FVA, COLVA, **MVA**)
- Market risk measures, sensitivity analysis, stress testing

What's new in Release 3

- CMS Swaps with Caps/Floors
- Amortization structures (fixed, percentage, annuity)
- Inflation simulation and XVA, calibration to CPI Caps/Floors
- Credit derivatives (CDS)
- Extended sensitivity framework (adding inflation, equity and credit)
- Basic parametric Value at Risk (Delta and Delta-Gamma Normal VaR)
- Additional unit tests and examples
- Extended user guide

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Background

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- trading of standardised derivatives through **exchanges** and cleared through **central counterparties (CCPs)**
- reporting of OTC contracts to trade repositories
- higher capital requirements for non-cleared derivatives

Background

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- called upon BCBS and IOSCO to develop a global standard
- initial proposal in 2012 (BCBS 261)
- latest version March 2015

BCBS 261

Key features:

- Variation and Initial Margin (VM/IM) for non-cleared derivatives
- Margin to cover counterparty risk at a high level of confidence
- Collateral to be highly liquid
- **IM to be exchanged without netting, to be held default-remote, no rehypothecation**
- Because IM will impact market liquidity, it is phased in between 2016 and 2020, and have a threshold of 50 Mio. EUR
- IM model to be calibrated to historical data that contains a period of stress

BCBS/IOSCO Timeline

Initial Margin is phased in based on group aggregated average notional exceeding

- Sep 2016: 3 trillion EUR (from Feb 2017 in the EU)
- Sep 2017: 2.25 trillion EUR
- Sep 2018: 1.5 trillion EUR
- Sep 2019: 0.75 trillion EUR
- Sep 2020: 8 billion EUR

In September 2016, about 20 US and and Japanese banks started posting IM

Phase 2, 2017

- Danske
- ING
- Nordea
- Santander
- ANZ (Australia)
- SMBC (Japan)

Phase 3, 2018 (excerpt)

- Banca IMI
- Bank of New York Mellon
- Commonwealth Bank Australia
- Commerzbank
- HSBC Security Services and HSBC Life
- Lloyds Bank
- HBOS
- National Australia Bank
- State Street
- Uni Credit AG
- Toronto Dominion
- Wells Fargo
- WestPac

BCBS/IOSCO - IM Calculation

- **Equivalent to VaR at 99% confidence level, 10 business day horizon**
- Based on historical data with a period of stress
- Model to be approved by the regulator
- Alternative: **Standardised IM** schedule, i.e. fixed percentage of notional based on asset class and maturity
- Model may account for diversification within asset classes, but not across
- risk.net reported in June 2016 that **Standardized IM** is **12-15 times higher** than ISDA SIMM (see next slide) in some scenarios.
- Similar estimate by BCBS-IOSCO for US banks, SIMM: 315bn $, Standard: 3600bn $.

ISDA SIMM

- ISDA has published the **Standard Initial Margin Model (SIMM)**
- SIMM defines how to compute sensitivities and vegas
- SIMM consists of 3 components, Delta, Vega and Curvature Margin
- Delta/Vega Margin are computed analogously to FRTB standard, with prescribed correlations between buckets and risk factors
- SIMM's Curvature Margin is "implied" from vegas
- Aggregation of SIMM margin types similar to FRTB
- Model was approved by US regulator contingent on enhancement
- Risk factors added by March 2017: Dividend swaps, Cross-currency basis, Inflation volatility, Credit base correlation

Initial Margin Impact, Bank's Perspective

- IM reduces credit risk, but does not eliminate it completely, reduces CVA/DVA and CVA risk charge, computational burden remains
- IM increases funding cost: Gives rise to the Margin Value Adjustment (MVA)
- Experts expect CVA/DVA/FVA to become very small, KVA and MVA to become the new drivers of XVA P&L

Initial Margin Impact, New Processes

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- Option: Outsource SIMM calculation, reconciliation, backtesting and benchmarking ($\rightarrow$ AcadiaSoft Service, ORE+)

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Optimising Initial Margin

To minimise funding cost for IM, a consortium of banks is establishing a SIMM optimisation process where a central party (AcadiaSoft) is provided with the required information (sensitivities) by all banks involved.

This central party then performs an analysis across all participants and suggests transactions between the participants which reduce the amount of posted collateral by the consortium and the overall funding cost.

Objective Function

Optimisation over the total initial margin to be posted, objective function

$$f(x) = \sum_{i \neq j} [SIMM_{ij}(x) - T]^+$$

where

- T is a constant threshold given by the regulator
- $SIMM_{ij}$ is the SIMM as seen by party i due to business with party j
- x represents a parameter vector

Task: Vary x and find the minimum of $f(x)$

Problem: Dimension of x is large, quadratic in the number of entities N, proportional to the size of the sensitivity vector

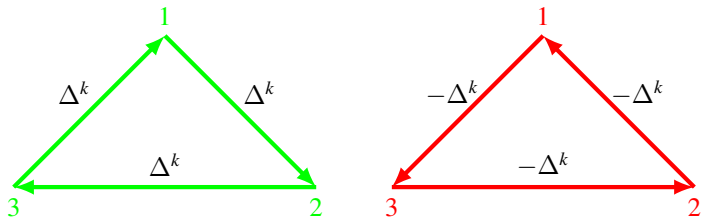
Constraints

Assumptions

1. Net sensitivity position per party facing all others must not change
2. SIMM can increase for some if the overall objective is met, i.e. we do not have additional constraints on the individual entity IM amounts
3. Ignore individual risk limits that might inhibit some risk transfers within the consortium

Example: Three Entities

Δ^k is a shift in the k'th component of a sensitivity vector



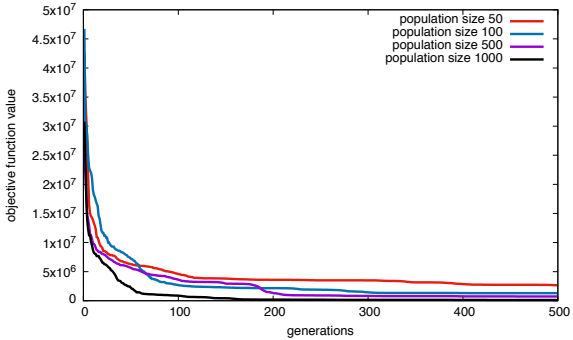
Applying the same sensitivity shift in a loop of entities keeps the net sensitivity positions unchanged.

This case can be generalised to N entities.

Example

Three entities with randomly generated sensitivity vectors that can be compressed to zero.

Solution:
Global optimisation with a genetic algorithm (Differential Evolution) $\rightarrow$ ORE+



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Initial Margin Impact

To quantify the

- desired credit exposure and credit capital **reduction**
- undesired **increase** in future funding cost (MVA)

one needs to **forecast Initial Margin in a Monte Carlo simulation framework**

Credit Exposure

Future dynamic $IM(t)$ needs to be computed **on each simulation path** to adequately offset future credit exposure $E(t)$:

$$E(t) = [\, NPV(t) + U(t) - VM(t) - IM(t)]^{+}$$

where

- $NPV(t)$ is the simulated nettings set NPV at time t
- $U(t)$ is the value of unpaid cashflows up to time t
- $VM(t)$ is the variation margin collateral value covering the portfolio value $NPV(t)$

$\rightarrow$ ORE

Funding Cost, Margin Value Adjustment

Expected discounted future Initial Margin is required to compute MVA

$$MVA = \sum_{i=1}^{n} (f_b - s_I)\, \delta_i \times S_C(t_i) \times S_B(t_i) \times \underbrace{\mathbb{E}\left[IM(t_i)\, D(t_i)\right]}_{\text{expected discounted IM}}$$

with

- borrowing spread f_b and spread s_I received on initial margin
- $S_{B,C}(t)$ cumulative survival probability of the two parties
- $D(t)$ stochastic discount factor

$\rightarrow$ ORE

Forecasting Initial Margin

Approaches:

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- **Project today's SIMM** into the future as 'lowest order' estimate. Overestimates IM, unlikely to pass backtests and regulatory approval
- **Sensitivities and SIMM under Monte Carlo** simulation ($\rightarrow$ ORE+). Possible, but challenging
  - Monte Carlo simulation frameworks in Banks typically do not provide simulated sensitivities
  - Calculation of "bump and revalue" sensitivities in a Monte Carlo framework is a computational challenge
  - More sophisticated approaches to produce sensitivities efficiently (e.g. *Adjoint Algorithmic Differentiation*, AAD) require a complex revision of the entire Monte Carlo Simulation system

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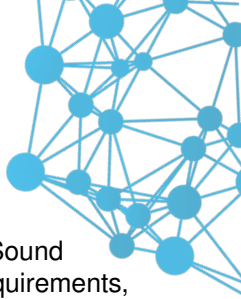
- **Regression approaches** leveraging existing Monte Carlo infrastructure ($\rightarrow$ ORE)

References

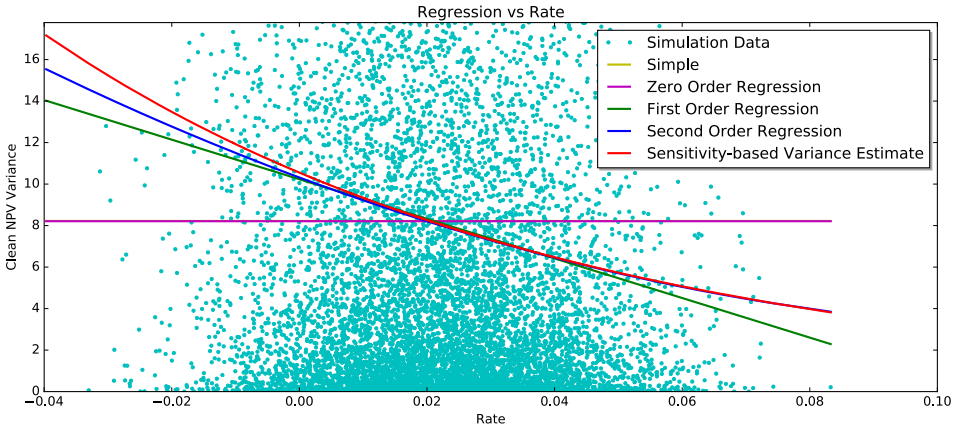


- Fabrizio Anfuso, Daniel Aziz, Paul Giltinan, Klearchos Loukopoulos: A Sound Modelling and Backtesting Framework for Forecasting Initial Margin Requirements, RISK (May 2017)

- Peter Caspers, Paul Giltinan, Roland Lichters, Nikolai Novaczyk: Forecasting Initial Margin Requirements - A Model Evaluation; Journal of Risk Management in Financial Institutions Volume 10 Number 4 (September 2017)

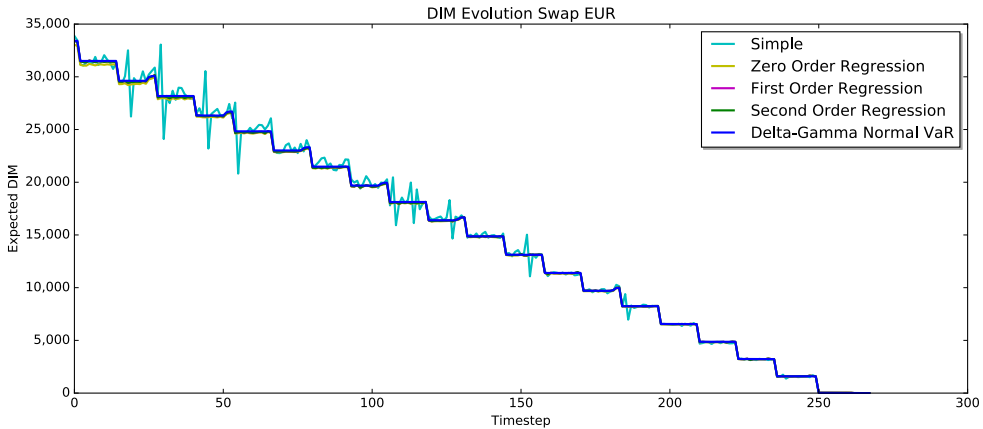
Regression: EUR Swap

ATM Vanilla Swap in EUR, 10Y maturity, flat market, regression in 4Y



Evolution of Expected DIM

ATM Vanilla Swap in EUR, 10Y maturity, flat market



Thank you

Firm locations and details

Quaternion™ Risk Management is based in four locations:

Ireland	**London**	**USA**	**Germany**
54 Fitzwilliam Square	29th floor	24th floor	Maurenbrecherstrasse 16
Dublin 2	Canada Square	World Financial Centre	47803 Krefeld
Ireland	Canary Wharf	200 Vesey Street	Germany
	London E14 5DY	NY 10281-1004	
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