



London
Stock Exchange Group

CC&G

A New Approach to the Validation of Risk Models

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- 1) Introduction**
- 2) The Model Validation Tool (MoVE)
- 3) Model Benchmarking
- 4) 2016 Stress Test Objective

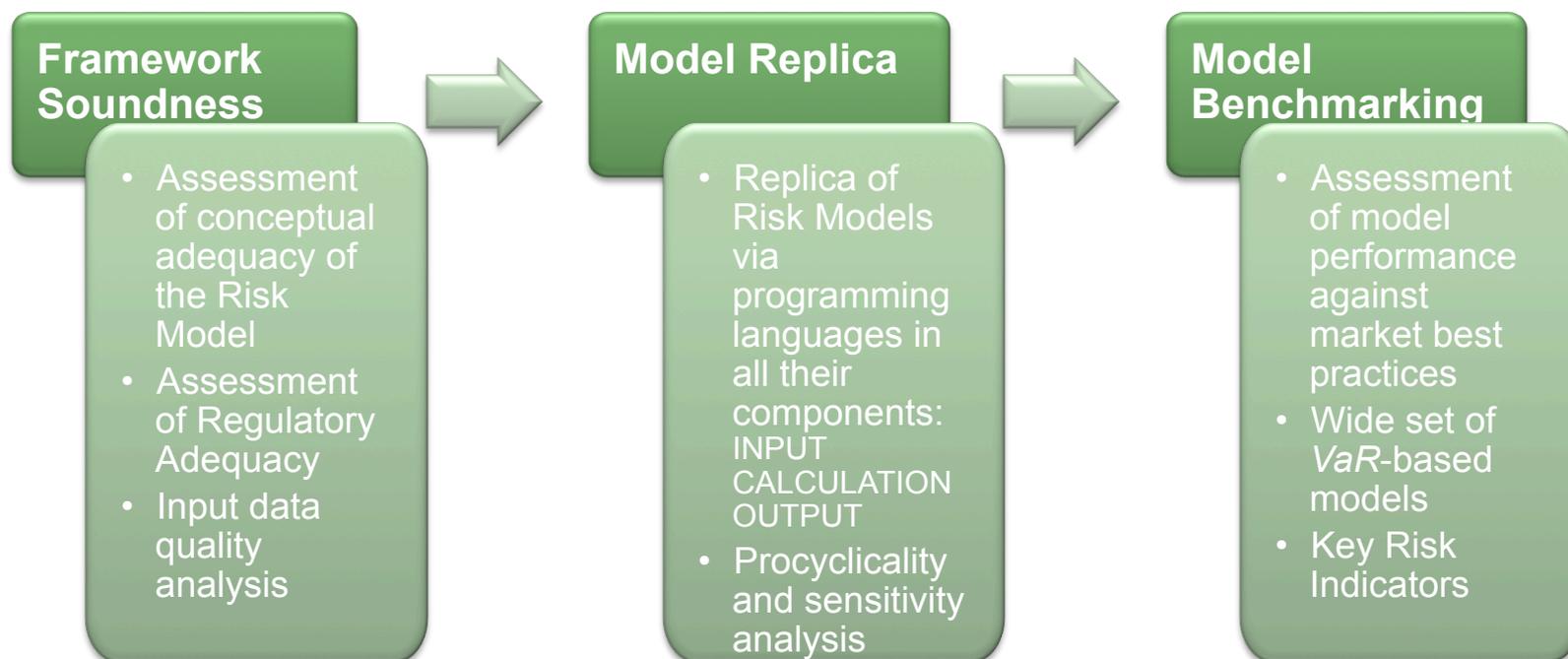
- As part of the focus on CCPs in the wake of the Lehman's Default, European and Worldwide Financial Authorities have requested CCPs to include a **Model Validation Framework** in their Risk Management processes:
 - 1) **EMIR**, Article 49 (1) (Review of models, stress testing and back testing)
 - 2) **ESMA**, Section 1 (Models and Programmes), Article 47 (1) (Model Validation)
 - 3) **CPSS-IOSCO** Recommendations Principles (3.2.16)
- **Model Validation** is a key **Model Risk Mitigant**, i.e. reduces the risk that a model:
 - is not providing accurate output
 - is being used inappropriately

“Remember that all models are wrong; The practical question is how wrong do they have to be to not be useful?”

*George Box, from *Empirical Model-Building and Response Surfaces*, 1987”*

- CC&G has set up a dedicated office to perform an independent analysis of all the components of Risk Models, in compliance with regulatory requirements
- **A web-based tool** has been developed to allow the
 - **replica of the existing risk methodologies** on the main asset classes
 - **performance analysis** through a wide set of **Benchmark Models**
- **Benchmark Models** help to evaluate models performance with market best practices
 - **comparison with CC&G's peers**
 - **strategic decision facilitator**
- Risk Models are ranked in terms of relevance and complexity to ensure that the actual validation process is coherently prioritized:
 - core models validated first (***Priority Principle***)
 - effort dedicated is proportionate to significance (***Efficiency Principle***)
- CC&G Model Validation is based on **quantitative analysis** rather than on qualitative grounds

The Model Validation Process





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The Model Validation Tool

- CC&G Internal Model Validation:
 - is based on a configurable web-based graphical interface (**MoVE**)
 - allows for a full recalculation of risk algorithms
 - creates a parallel environment for risk calculations

Calculation Engine

- Risk models are developed in Matlab
- More than eight risk models developed for Fixed Income and Cash / Equity Derivatives asset classes
- Possibility to add new ad-hoc models

- End users run models through a web-based interface
- Output results available as spreadsheets and charts

Web-based Interface

Development Kit

- Power users can easily integrate new models in the interface through a dedicated backend

MoVE Web Interface - Input



Batched execution or manual run of models

Input parameters automatic validation

Model parameters customizable at every run

Option to run additional checks on input data

Model input data automatically retrieved from database

Option to upload data via input files

Models Runs Data Compare

New run for Bond Historical / Exp. Shortfall

✖

- Holding period field is required.
- Lookback period field is required.
- Confidence level: the value may be no greater than 100.

The distribution of profits and losses is constructed by taking the current portfolio, and subjecting it to the actual changes in the key factors experienced during each of the last *n* historical periods. Once the hypothetical mark-to-market profit or loss for each of the last *n* historical periods have been calculated, the distribution of profits and losses and the Value at Risk can then be determined from the percentiles of the full distribution of payoffs.

Model parameters

Analysis date * 16/11/2015
E.g., 17/11/2015

Lookback period * -- Select a value --

Holding period * days

Confidence level * 120 %
Insert a percentage number without the % sign.

Custom label
 standard test01
 test02 Other...
This label will be used to simplify results filtering.

Model Assessments

Input

▾ Data freshness

Input time series are compared against current market calendar to identify potential static prices over a time range (e.g. 1 day, 2 days, ...) that can be selected by the user. Static prices are still taken as inputs, but are marked and recorded in a log file.

Run

Range

▸ Data swings

▸ Data gaps

Run

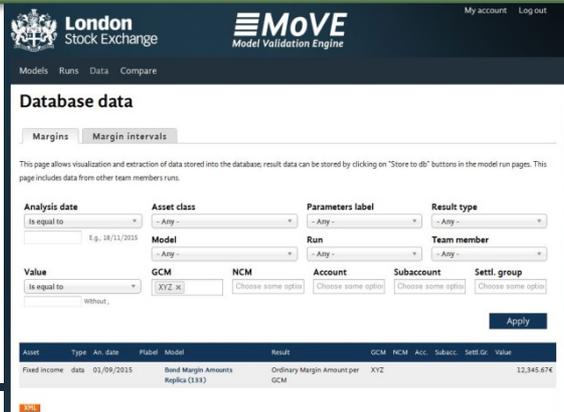
MoVE Web Interface - Output

Model results available as table, dynamic chart or .xls file

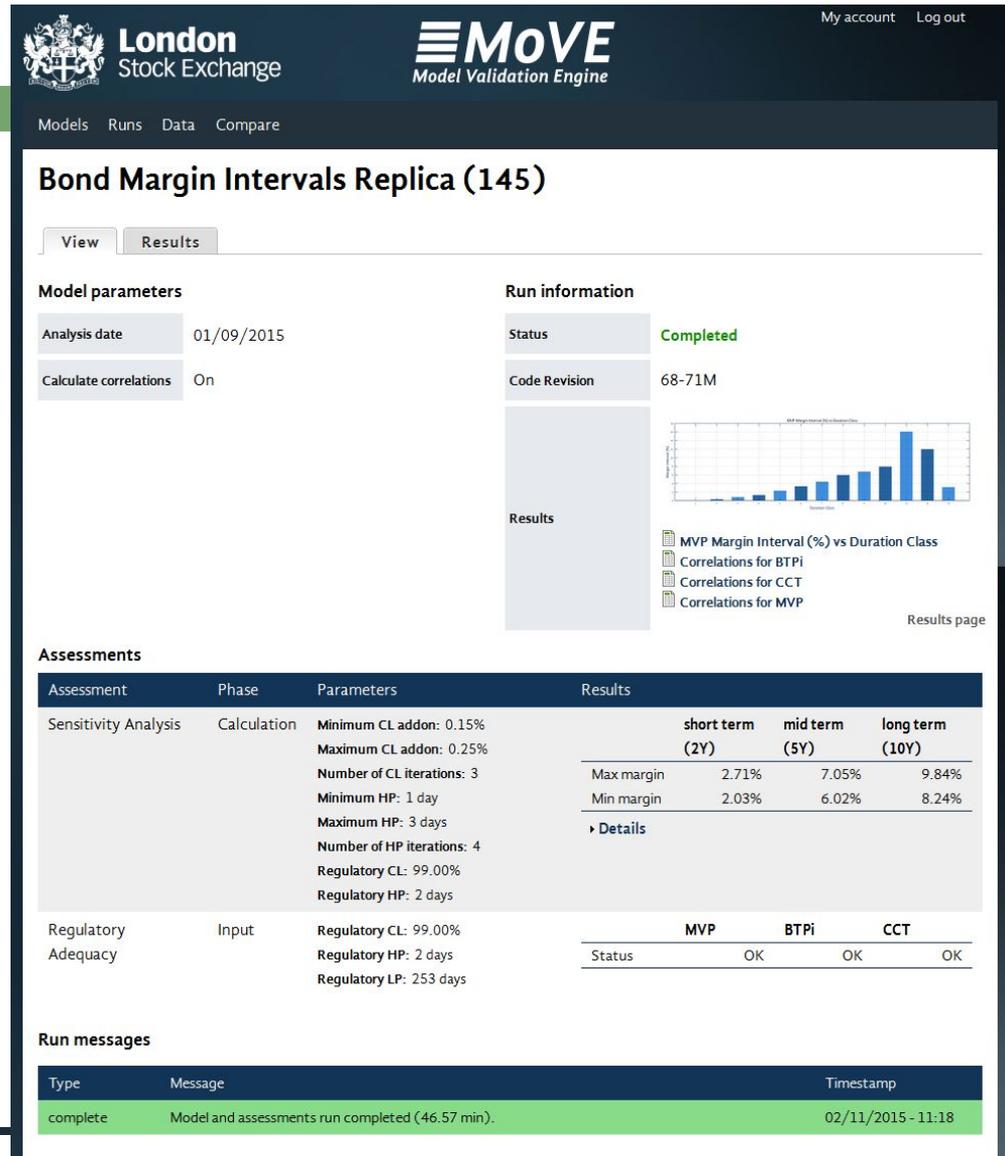
Comparison of different models or same model with different parameters

Results data storable in database

User friendly interface for database data extraction



The screenshot shows the 'Database data' section of the MoVE interface. It includes a navigation bar with 'Models', 'Runs', 'Data', and 'Compare'. Below the navigation, there are tabs for 'Margins' and 'Margin intervals'. A descriptive text states: 'This page allows visualization and extraction of data stored into the database, result data can be stored by clicking on "Store to db" buttons in the model run pages. This page includes data from other team members runs.' The main area contains a form with several sections: 'Analysis date' (set to 01/09/2015), 'Asset class', 'Parameters label', 'Result type', 'Model', 'Run', 'Team member', 'Value', 'GCM', 'NCM', 'Account', 'Subaccount', and 'Settl. group'. An 'Apply' button is at the bottom of the form. Below the form is a table with columns: Asset, Type, An. date, Label, Model, Result, GCM, NCM, Acc., Subacc., Settl Gr., Value. A single row is visible with the following data: Fixed income, data, 01/09/2015, Bond Margin Amounts Replica (133), Ordinary Margin Amount per GCM, XYZ, 11,345.67€.



The screenshot shows the 'Bond Margin Intervals Replica (145)' results page. The header includes the London Stock Exchange logo, the MoVE logo (Model Validation Engine), and user options 'My account' and 'Log out'. Navigation links 'Models', 'Runs', 'Data', and 'Compare' are present. The page title is 'Bond Margin Intervals Replica (145)'. There are two tabs: 'View' and 'Results'. The 'Results' tab is active.

Model parameters

- Analysis date: 01/09/2015
- Calculate correlations: On

Run information

- Status: **Completed**
- Code Revision: 68-71M

Results

A bar chart titled 'MVP Margin Interval (%) vs Duration Class' is displayed. Below the chart are three legend items:

- MVP Margin Interval (%) vs Duration Class
- Correlations for BTPi
- Correlations for CCT
- Correlations for MVP

Assessments

| Assessment | Phase | Parameters | Results | | |
|----------------------|-------------|---|------------------------|----------------------|------------------------|
| Sensitivity Analysis | Calculation | Minimum CL addon: 0.15% Maximum CL addon: 0.25% Number of CL iterations: 3 Minimum HP: 1 day Maximum HP: 3 days Number of HP iterations: 4 Regulatory CL: 99.00% Regulatory HP: 2 days | | | |
| | | | | | |
| | | | short term (2Y) | mid term (5Y) | long term (10Y) |
| | | | Max margin | 7.05% | 9.84% |
| | | | Min margin | 6.02% | 8.24% |
| | | | Details | | |
| Regulatory Adequacy | Input | Regulatory CL: 99.00% Regulatory HP: 2 days Regulatory LP: 253 days | MVP | BTPi | CCT |
| | | | Status | OK | OK |

Run messages

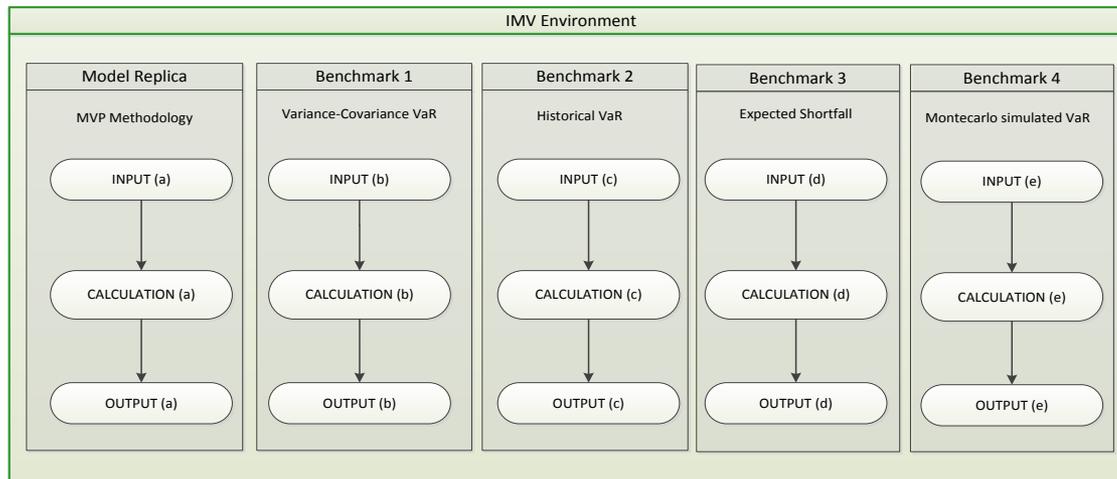
| Type | Message | Timestamp |
|----------|--|--------------------|
| complete | Model and assessments run completed (46.57 min). | 02/11/2015 - 11:18 |



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- Four Value at Risk (VaR) Benchmark Models have been implemented for both Fixed Income and Equities/Equity Derivatives asset classes:
 - 1) Parametric VaR
 - 2) Historical VaR
 - 3) Expected Shortfall
 - 4) Monte Carlo Simulated VaR
- The web-based tool allows to run both the model replica and each benchmark model

Performance Analysis



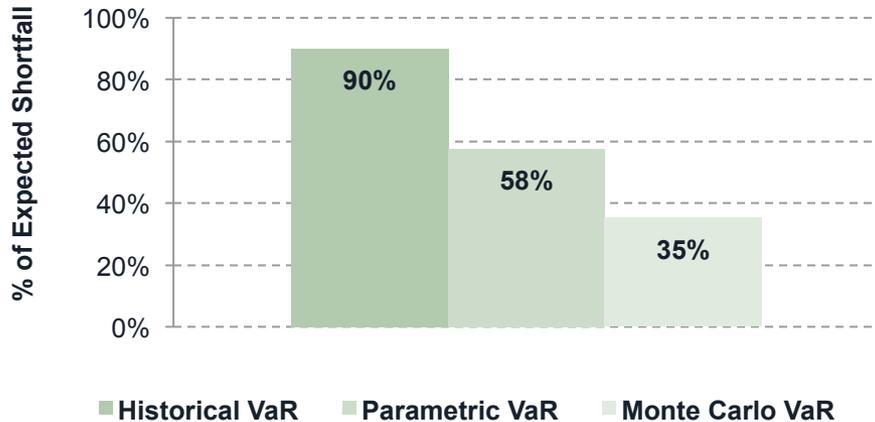
Benchmark Models Description



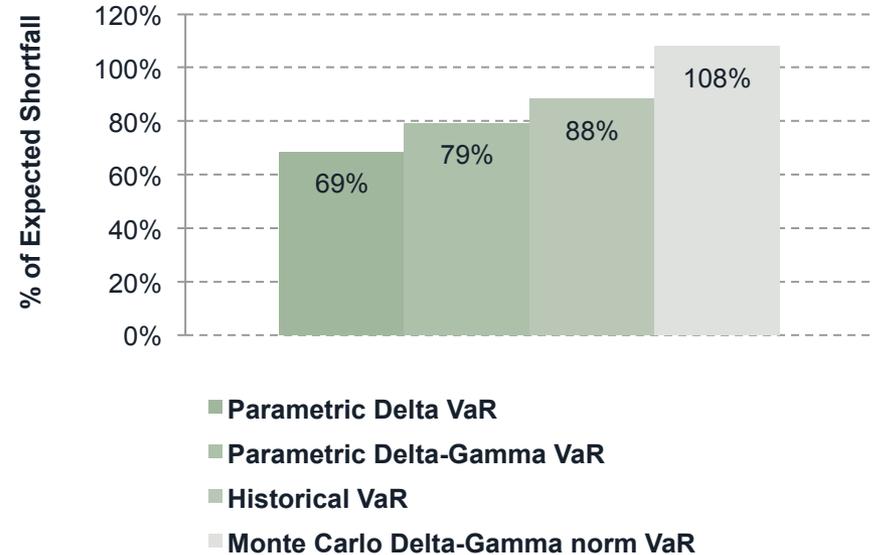
| Name | Variance-Covariance | Historical | Expected Shortfall | Monte Carlo |
|---------------|---|---|--|--|
| Description | For each portfolio, determines the amount of potential loss (VaR) that can occur with probability 1-CL over HP days | For each portfolio, determines the amount of potential loss (VaR) that can occur with probability 1-CL over HP days, by ranking historical returns from lowest to highest | Given a quantile-level q , calculates the expected loss of the portfolio given that a loss is occurring at or below the q -quantile | Estimates VaR by simulating random scenarios, revaluing instruments in the portfolio and selecting the CL-percentile of simulated values |
| What's inside | <p>Cash-flow mapping: Map every instrument (principal and coupon amounts) of the portfolio in the appropriate nodes based on Duration</p> <p>VaR calculation: Given the present value of x of the future cash payments and the portfolio variance-covariance matrix Σ, $VaR = \alpha \sqrt{x' \Sigma x}$, where α is the normal distribution quantile</p> | <p>All yield input data are converted into prices p</p> <p>For each node $j=1, \dots, n$ and $t=1, \dots, m$ day of the time series, given the current price p_{curr}, the following price variations are computed</p> $p_{curr}^j \frac{p_t^j}{p_{t-hp}^j}$ <p>oThe portfolio is fully re-evaluated by multiplying the notional amount allocated to each node by the related price scenario and then selecting the CL-percentile</p> | <p>Same assumptions as Historical VaR</p> <p>Given the loss function X, ES is given by:</p> $E(X X < q) = \frac{\int_{-\infty}^q xf(x)dx}{\int_{-\infty}^q f(x)dx}$ | <ol style="list-style-type: none"> 1) Select a stochastic process for yields: $y \downarrow t = f(t) + \epsilon \downarrow t$ 2) Compute yields at T+1 for N_{sim} times (Nelson Siegel Model) 3) VaR is the CL-percentile of the N_{sim} portfolio value variations |
| Advantage | <ul style="list-style-type: none"> • Fast and simple to calculate • Needs only correlations of risk factors as input | <ul style="list-style-type: none"> • No assumptions on distribution | <ul style="list-style-type: none"> • More conservative than Historical VaR • Coherent risk measure | <ul style="list-style-type: none"> • Converges to the solution • Future can behave differently from the past |
| Disadvantage | <ul style="list-style-type: none"> • Normality assumption on portfolio returns | <ul style="list-style-type: none"> • No distribution to help determine future returns • Assumes future will behave like the past | <ul style="list-style-type: none"> • No distribution to help determine future returns • Assumes future will behave like the past | <ul style="list-style-type: none"> • High computational effort • Needed calibration of parameters |

Performance Analysis Results

Fixed Income Benchmark Models



Equities & Derivatives Benchmark Models



The Model Validation Software can allow CC&G to:

- Compare its positioning with its competitors
- Perform a procyclicality assessment of different margining models
- Anticipate market trends in CCP Risk Management
- Create the «ecosystem» for excellence in new Risk Models for different asset classes
- Decide whether the risk models applied need to be re-discussed

By the way: incidentally we also happen to fulfil the regulatory requirement of validating our risk models!



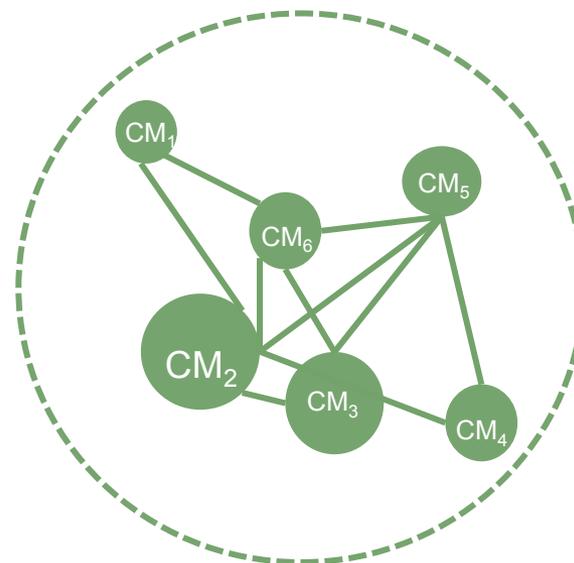
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2016 Stress Test Objective

- Best practices for CCPs stress tests are still under discussion
 - ESMA has initiated and coordinated the first EU-wide stress exercise that assessed the resilience of 17 CCPs
 - CC&G is looking at some **innovative stress test methodologies** which could integrate the existing methodology
 - A collaboration with **Institute for Complex Systems (ISC-CNR)** has started on this topic

DebtRank Network

- The innovation could lie in combining together **credit and liquidity risk** and **stressed scenarios** through a **network-based model of interbank markets**
- Network-based models aim at describing mutual impacts among Clearing Members (CMs)
- Links between Clearing Members show their inter-dependency and the ways a shock could propagate in the financial system
- Systemic risk is measured by potential losses within the financial network after reverberation of shocks





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Questions? Thank You!