Proxy Modelling – An "in-cycle" solution with Least Squares Monte Carlo

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- LSMC – Actuarial techniques.

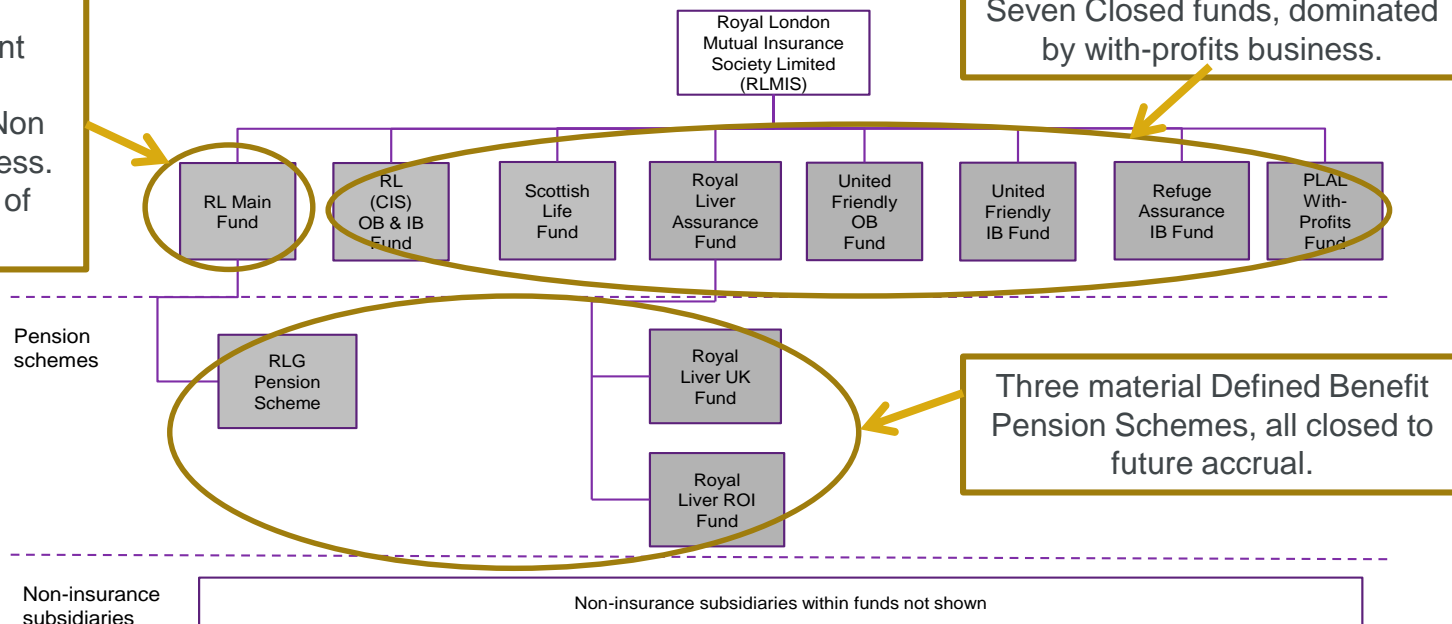- LSMC – systems and process architecture.

- Royal London's experience to date.

Introduction

Royal London is the UK's largest Mutual Insurer.

One Open fund ("RL Main") writing significant volumes of new Unit Linked Pensions and Non Profit Protection business. Also significant legacy of with-profits business.

Seven Closed funds, dominated by with-profits business.

Three material Defined Benefit Pension Schemes, all closed to future accrual.

Royal London Mutual Insurance Society Limited (RLMIS)

RL Main Fund

RL (CIS) OB & IB Fund

Scottish Life Fund

Royal Liver Assurance Fund

United Friendly OB Fund

United Friendly IB Fund

Refuge Assurance IB Fund

PLAL With-Profits Fund

Pension schemes

RLG Pension Scheme

Royal Liver UK Fund

Royal Liver ROI Fund

Non-insurance subsidiaries

Non-insurance subsidiaries within funds not shown

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Reporting requirements and timescales have changed massively:
It was 20 years ago today………..

Item:	1997	2002	2007	2012	2017
Measure	Solvency I	Solvency I	Solvency I	Solvency I	Solvency II
Pillar 1 Available Capital	NPV	GPV	RBS	RBS	BEL/RM/TMTP
Ease of Calculation	☹	☹	☹☹☹	☹☹☹	☹☹☹☹
Pillar 1 Required Capital	RMM	RMM	LTICR (WPICC)	LTICR (WPICC)	(SF) IM SCR
Ease of Calculation	☹	☹	☹☹	☹☹	☹☹☹☹☹
Frequency	Annual	Annual	Half Yearly	Half Yearly	Quarterly
Timetable	26 weeks	13 weeks	13 weeks	13 weeks	≤13 weeks
Pillar 2 Required Capital	n/a	n/a	ICA	ICA	ORSA
Ease of Calculation	n/a	n/a	☹☹☹☹	☹☹☹☹	☹☹☹☹☹

"Twice as much; twice as fast; twice as often."

- RL performed its first Market Consistent Realistic Balance Sheet in 2002.
- RL built its first proxy model in 2007 (using Replicating Portfolios) to monitor capital.
- RL is currently a SF firm. Internal capital is derived using the capital correlation matrix approach, with the proxy models calculating an all-risk Market and Credit element.

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Economic and Business Conditions get ever more challenging:

Liability modelling developments, i.e. Asset Shares, Cost of Guarantees and Options determined stochastically and Market Consistent ESGs.

Mergers and Acquisitions – additional legacy systems, harmonising methods and assumptions, reporting value added.

Search for yield – investments in new asset strategies.

Hedging strategies, particularly for with-profits business Guarantees and Options.

Increased desire for more granular management information – an acronym soup covering internal (MTP, EEV, SST), external (IFRS, EEV) and Regulatory (SII, BMA).

Industry developments in capital methodologies, such as the move to "All-Risk" modelling.

Gilt Yields (%)

The fall in interest rates……..

Term 5   Term 15   Term 25
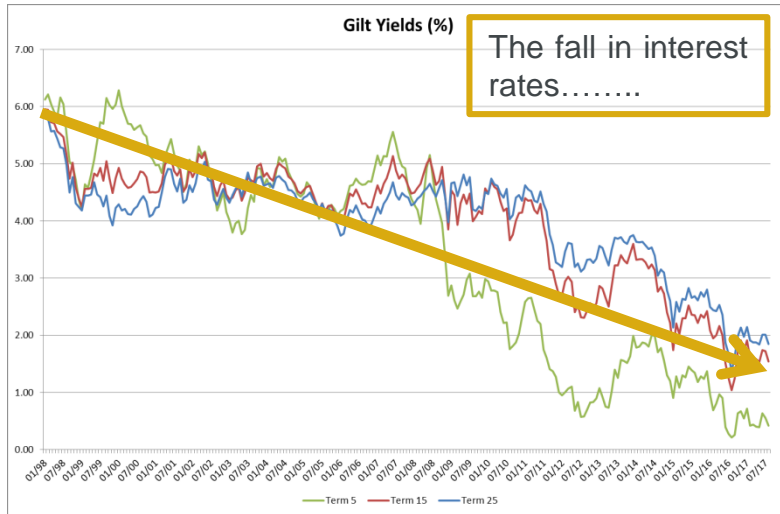
RL concluded that all its legacy actuarial systems - cashflow and capital - needed replacing to meet these more challenging conditions. For capital, we are moving to an All-Risk approach using an LSMC proxy model.
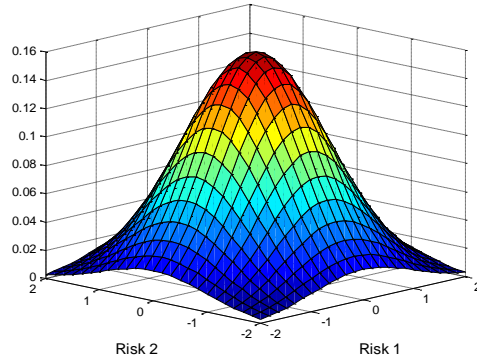
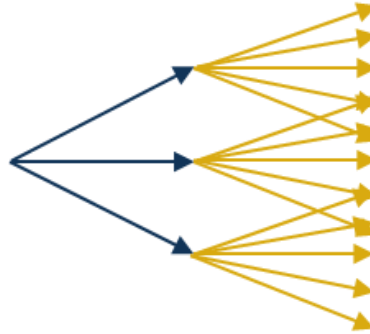Institute and Faculty of Actuaries

Enablers: Actuarial techniques

The modelling challenge

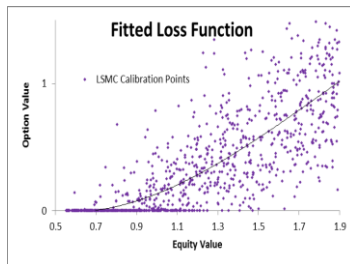Multivariate distribution of profit & loss

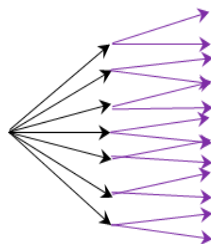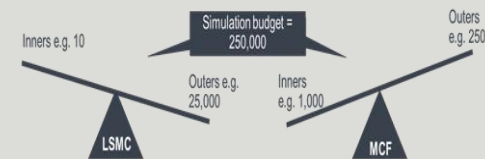Stochastic liability valuation

Solvency II timescales

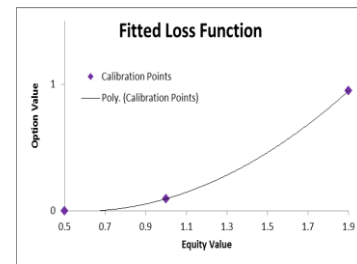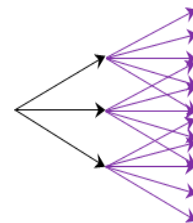# Choosing a curve fitting approach

LSMC

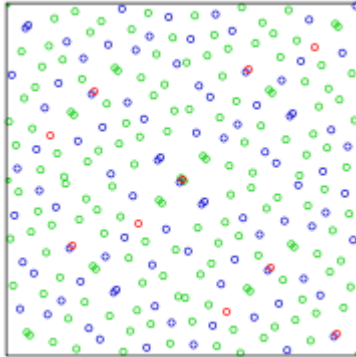LSMC uses a very large number of outer scenarios, each with very few inner scenarios

Sliding scale choice between outer fitting scenarios and inner valuation scenarios

Manual Curve Fitting

MCF uses a very large number of outer scenarios, each with very few inner scenarios

# LSMC Enablers (1) – Quantity and Quality of outer points

Sobol sequence in 2D

- Sobol is a pseudo-random technique for generating multi-variate fitting points
- Risk-space is efficiently covered
- User defined limits (avoid points outside cash flow model boundary)
- No reliance on expert judgement
- Automatically adjusts to business dynamics
- Quantum dependent on number of risks modelled – range 10k – 50k

LSMC Enablers (2) – ESG Rebasing
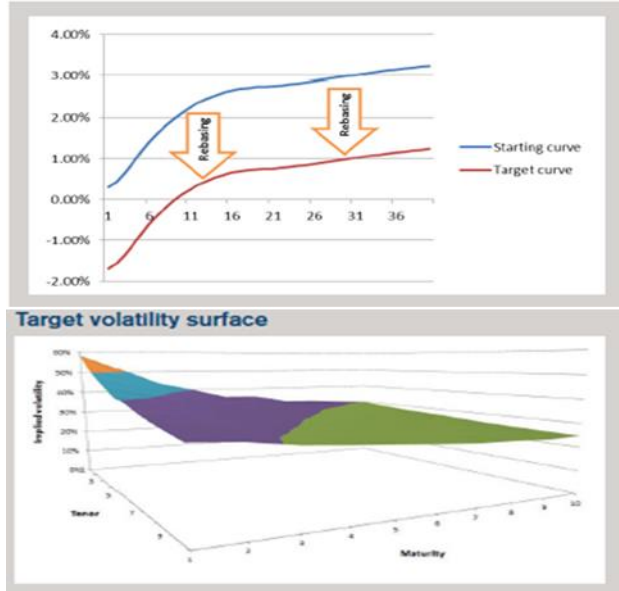
- Each outer scenario represents a new market condition
- So new ESG required
- Traditional method = full recalibration of ESG from new base
- Alternative = rebased ESG, where each new ESG is an adjustment to base ESG
- Interest rate, inflation curves are directly scaled
- Risk premia scaled to reflect new volatilities
- Re-weighting of scenarios to achieve target volatilities
- Result = quicker

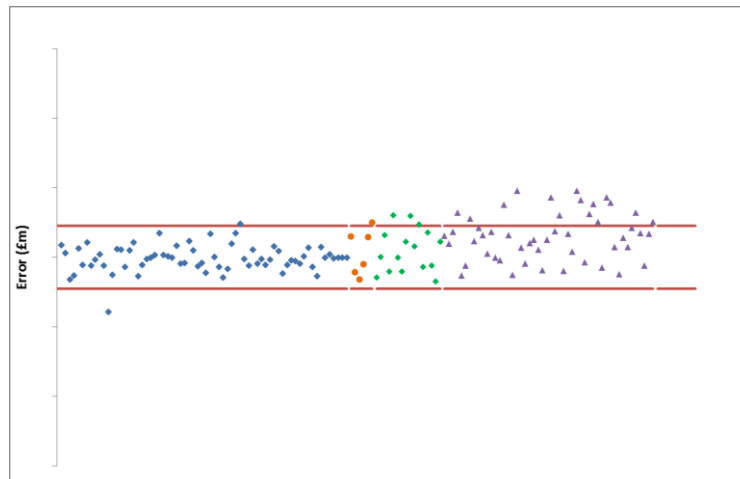# LSMC Enablers (3) – Automated Fitting
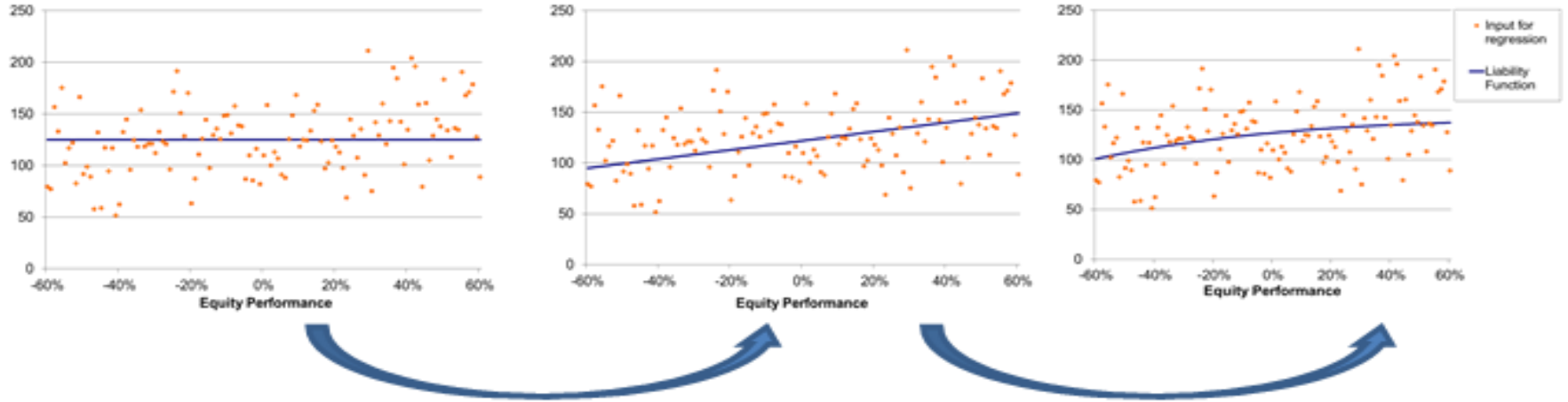
- Forward stepwise approach (start from constant)
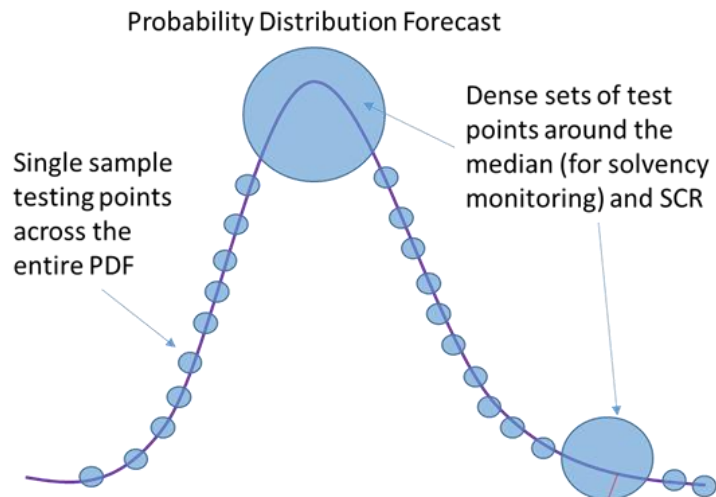- R-squared to Identify next most important term
- Refit the model
- Uses information criterion as penalty function to avoid overfitting

LSMC Validation (1) – Goodness of Fit
Out of Sample Testing

Probability Distribution Forecast

Single sample testing points across the entire PDF

Dense sets of test points around the median (for solvency monitoring) and SCR

Error (£m)

LSMC Validation (2) – Diagnostic tests

In-Sample Testing
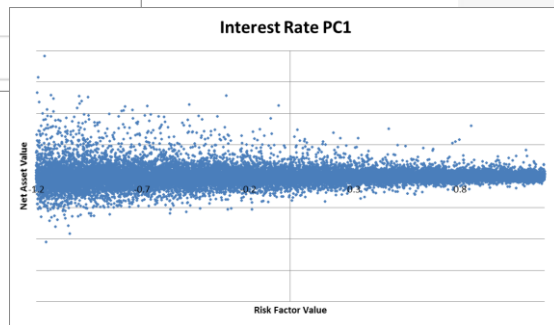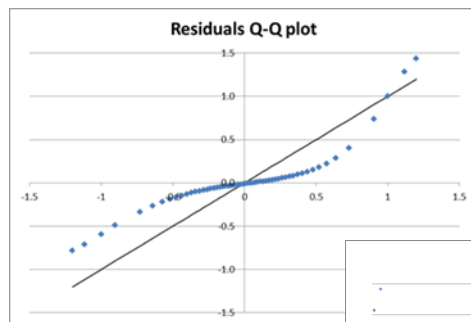
Does analysis of fitting residuals indicate the model could be better specified?

Charting
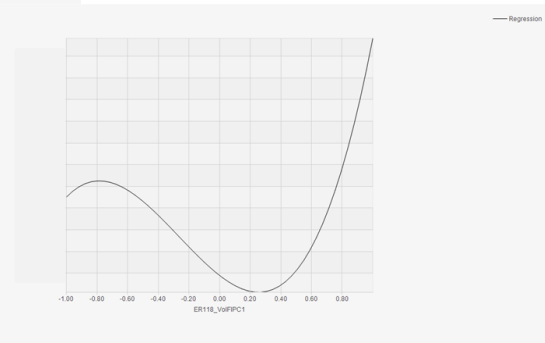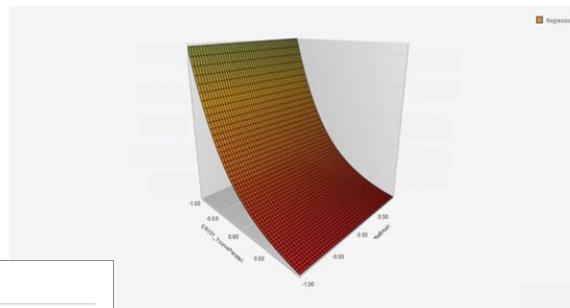
Visual inspection for unwanted curves e.g. turning points

LSMC Validation (3) – Optimisation tests

No. outer scenarios

No. inner scenarios

Stability of the fit can be tested through k-folds testing
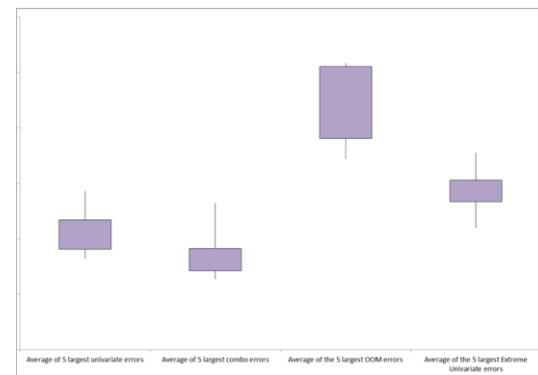
Choices made for fitting can be tested by re-fitting on alternative bases

Enablers: Systems and process architecture

Actuarial modeling platform

Overview - an integrated process

Integrated modeling platform

- Admin systems
- Data exchange interface
- Inforce translation / ETL
- Parameter & assumption overlay
- Scenario generation
- Calculation engine(s)
- Post processing
- Database
- Reporting
- Custom extracts
- Analytics
- Data exchange interface
- Financial ledger

Area of focus for today

Reduced operational risk and cost effective maintenance

- **Coherent business processes**
- **Efficient cash-flow modelling**
- **Seamless capital modelling**
- **Operational governance**
- **Enterprise level management and reporting**

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Integrated capital modelling

Overview - outputs

- SII metrics: SCR, MCR, Risk Margin, impacts of management actions and deferred tax

- Drilldown: views across different parts of the corporate structure, impacts of individual risks or combinations, non-linearity analysis, capital allocation

- What-if scenarios: current balance sheet impacts & solvency projections

- Frequency: formal results say quarterly but solvency reassessed say daily

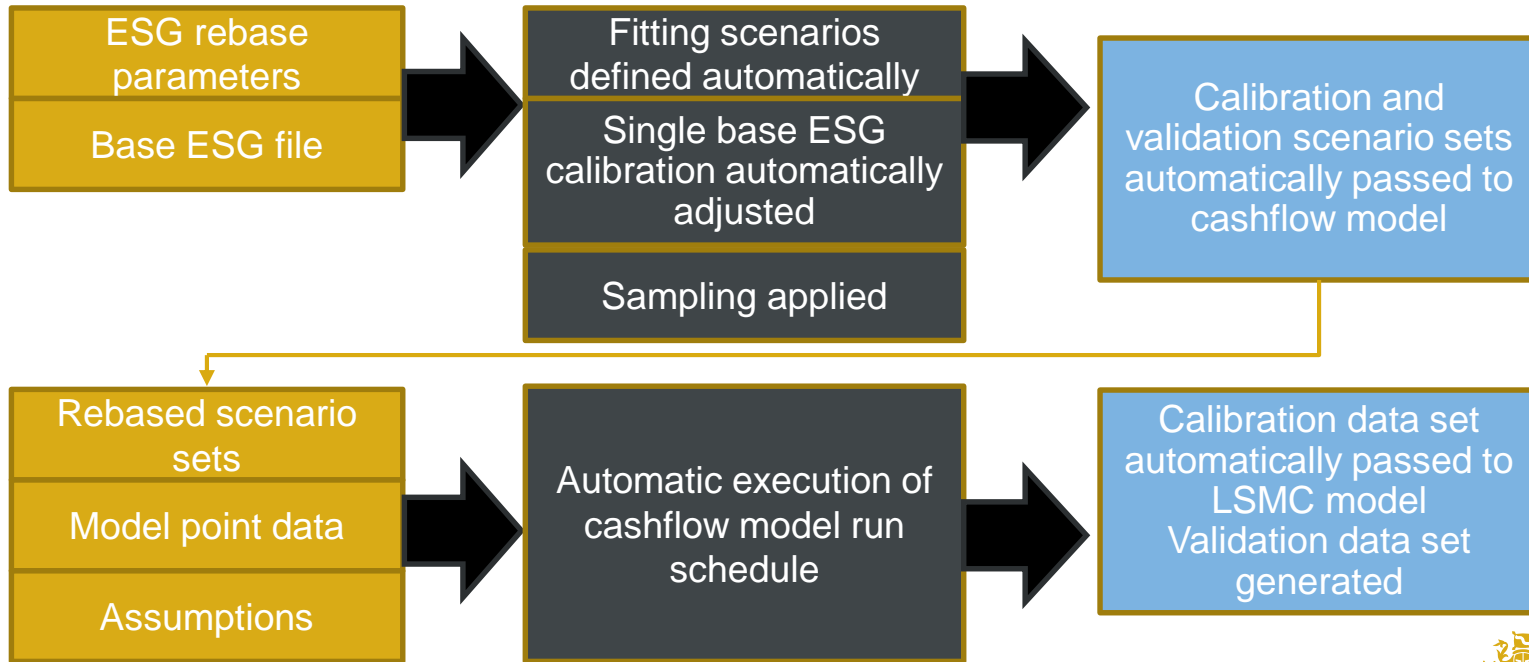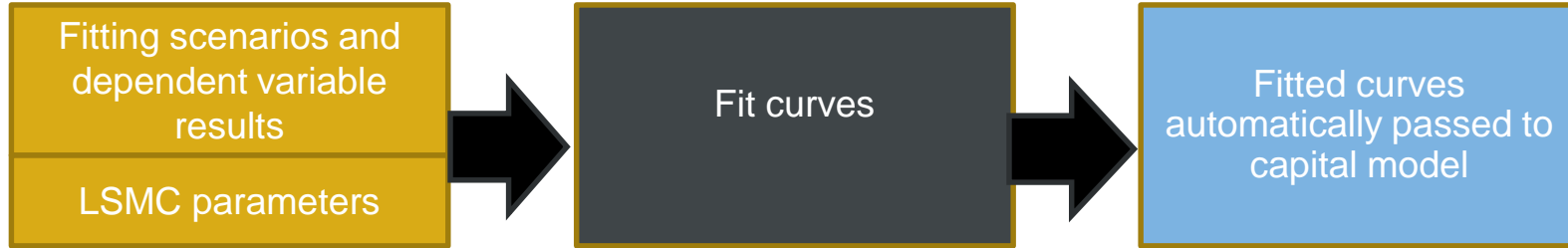**A brief look at the process for the SCR**

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Process overview

Generate fitting data

Process overview

Calibrate curves using LSMC

Fitting scenarios and dependent variable results		
LSMC parameters	Fit curves	Fitted curves automatically passed to capital model

Automated model selection & fitting
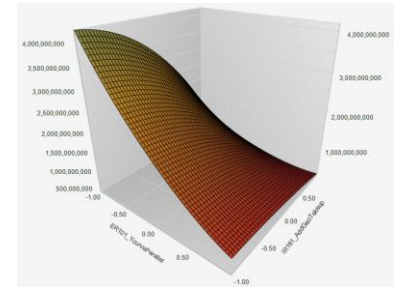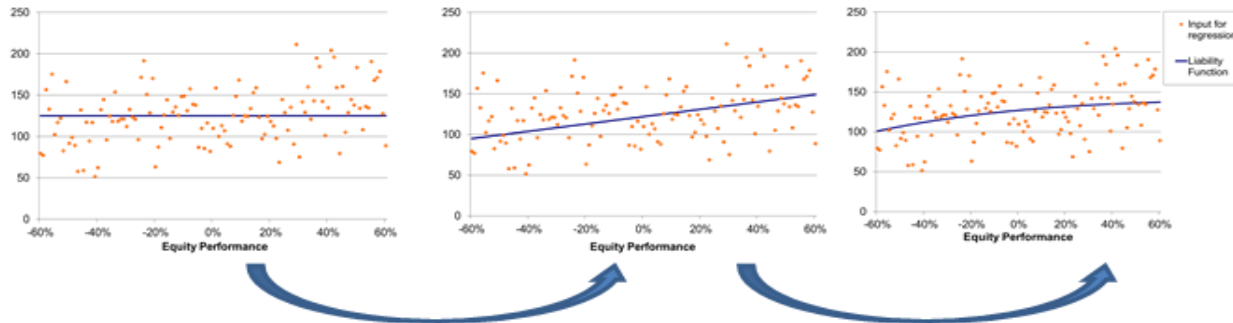
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Process overview

Produce results

Fitted curves
Capital model assumptions
Multivariate risk scenario set
Daily data (DSM)

DSM pre-processing
Evaluate curves over risk scenarios
Apply adjustments e.g. LADT
Aggregate and rank results

Scenario level results
SCR
Risk Margin
MCR
etc
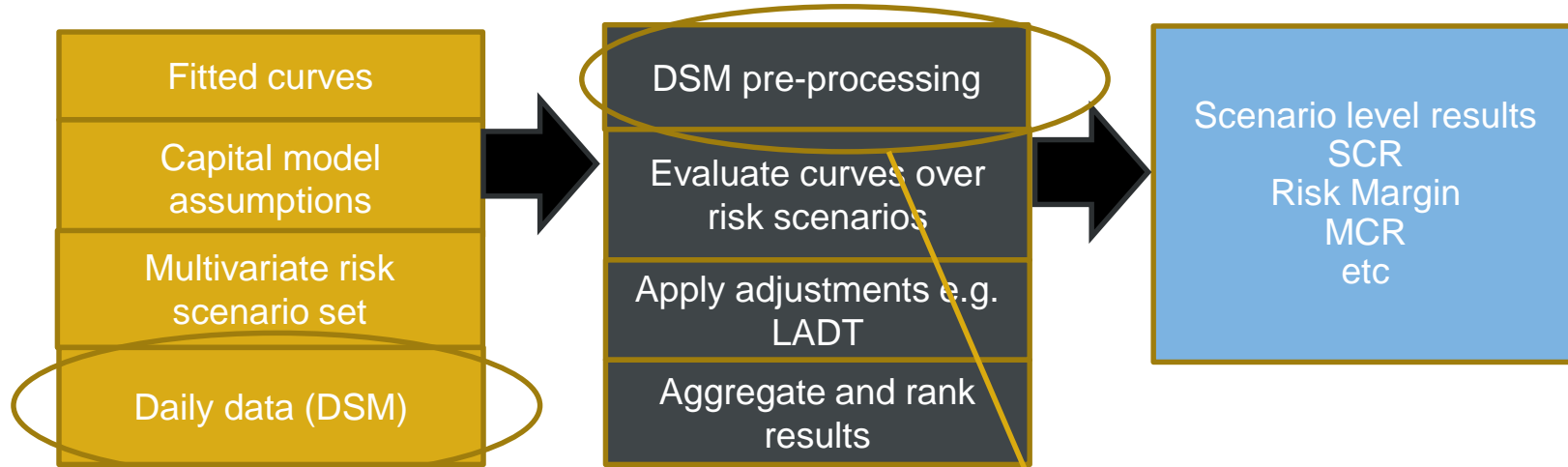
Current market data via automated extract

Base position and risk scenarios updated to reflect current market conditions = high frequency monitoring of solvency position

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Process overview

Key features

- **Actuarial techniques** – ESG Rebasing and LSMC are key enablers of automation

- **Process** – whole end-to-end process is managed via an automated workflow with execution via a single click

- **Manual intervention** – none required

- **Computing resources** – work is parallelised and automatically distributed across cores in the "Cloud" which provides significant scalability, think 30,000+

- **Resilience** – work automatically reassigned if any core fails

- **Monitoring** – visibility on progress of each step in the workflow

- **Audit trail** – full reproducibility of results

- **Reporting** – integrated post-processing and report generation (external / internal MI)

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Process overview

Working Timetable

- Time to complete the full end-to-end process:
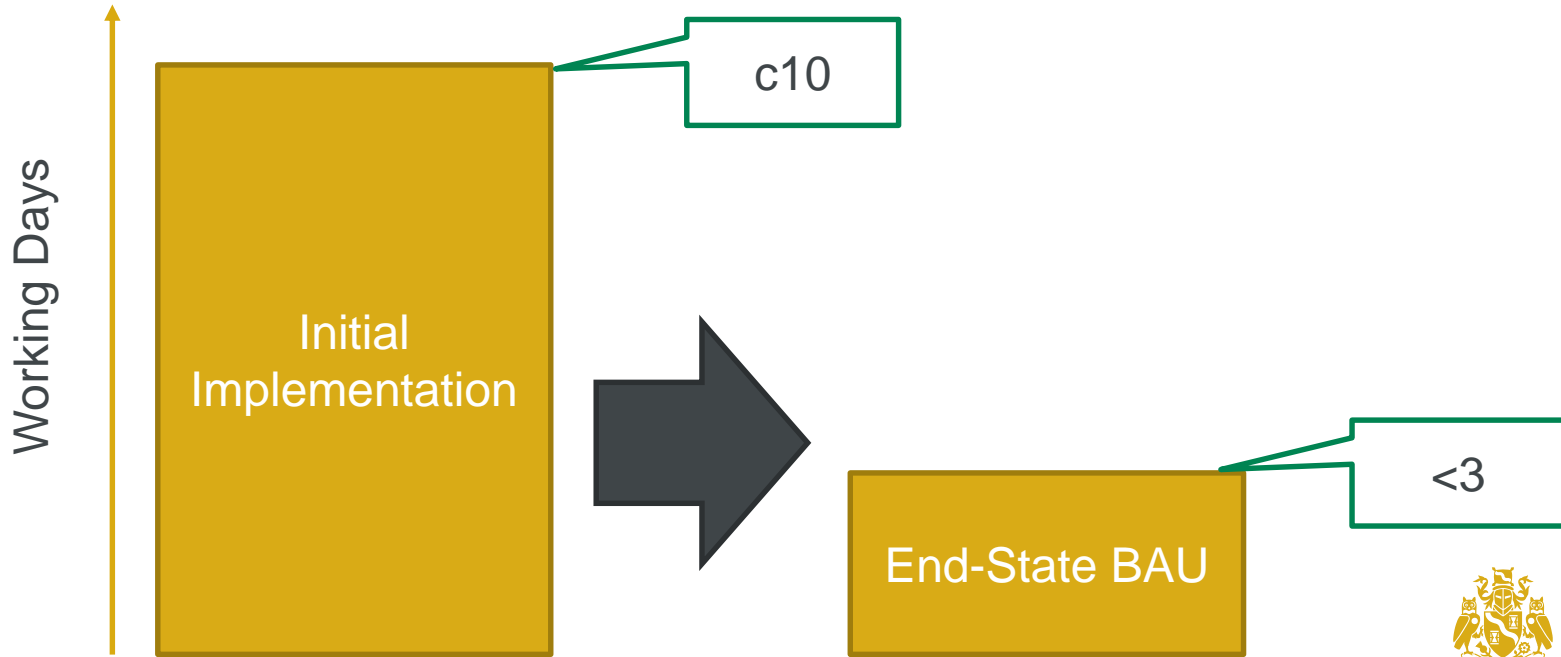
Experience to date

Why RL have chosen LSMC to fit their all-risk proxy model…..

1. **Best fits complex liabilities** – the large range of fitting scenarios allows identification of complex risk behaviours. RL faces a wide range of risks over eight with-profits funds, including GAOs;

2. **Enables robust validation** – the calibration fitting data and out-of-sample scenarios are different, meaning that we can readily demonstrate independence of validation;

3. **Reduces expert judgement** – it is a data driven approach with an automated model choice. This reduces the requirement for expert judgement and the reliance on prior theoretical views;

4. **Enables automation** – LSMC facilitates a fully automated process. This reduces run times, enables on-cycle calibration of proxy models and removes the need for roll-forward methodologies together with their associated required expert judgements; and

5. **Is scalable** – LSMC can be readily applied to new blocks of business and/or reflect the addition of new risks without major changes to the process.

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Challenges remain:

1. **Run Budget** – Cloud is scalable, but you are on a "pay-as-you-go" model. Be ruthless with your coding efficiency and run scheduling;

2. **Fitting** – The move to a data-driven approach leads to new ways of Validating your curve fits, impacting both first and second lines. Plus new education for your Executive teams and NEDs; and

3. **Cashflow Model** – This is critical for ensuring the success of your LSMC project. You will be running this process many, many thousands of times for all-risk stresses. The RL implementation involves a full replacement of its cashflow models.

Bearing in mind the well known saying…...

> **"All models are wrong, but some are useful."**
> **George Box, Quality and Statistics Engineer.**

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……it's not just about producing the IM SCR using LSMC. This End-to-End Solution gives the following additional business benefits:

1. **Cloud-based computing** – gives scalability and the potential to run huge numbers of scenarios;

2. **Stress and Scenario Testing** – leverages the LSMC fit to determine stresses to both Available and Required capital elements of the balance sheet;

3. **Daily Solvency Monitoring** – leverages the LSMC fit to provide regular updates of the capital position for market movements and/or demographic changes. Combine with SST functionality to update "what-ifs" on current market conditions; and

4. **Consistent Cashflow Model methodologies** – LSMC can be applied to new blocks of business and/or reflect the addition of new risks without major changes to the process. Also benefits from consistent cashflow coding when considering future changes, e.g. IFRS17.

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Questions

Comments

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