

The Actuarial Profession
making financial sense of the future

Life Conference 2011
Will Machin and Nick Warr

**Prudential and Solvency II
Internal Model Calibration Challenges for With-Profits**

20-22 November

© 2010 The Actuarial Profession • www.actuaries.org.uk



Agenda

- Introduction
- Least Squares Monte Carlo (LSMC)
- Prudential's experiences and challenges
- Questions or comments

Introduction



© 2010 The Actuarial Profession • www.actuaries.org.uk

2

Challenges facing Prudential in 2007

- In 2007, Prudential considered re-attributing its multi-billion inherited estate
- Assessment of future market-consistent balance sheets were needed to measure future financial strength on Pillar 2 basis
- Using a brute-force “nested stochastic” approach, a single run would take approximately 7 years (using a grid of 1,000 computers)
- Conventional Monte Carlo modelling is therefore unsuitable.

© 2010 The Actuarial Profession • www.actuaries.org.uk

3

Life firms face the same challenges now as Prudential did in 2007

Challenges faced by Prudential in 2007	Challenges faced by life insurers in 2011
Modelling impact of estate reattribution	Solvency II internal model calibrations
Market-consistent balance sheets in base and stress positions at both T=0 and in run-off	Market-consistent balance sheets in base and stress positions at both T=0 and for short to medium-term projections
Monte Carlo modelling not feasible	Monte Carlo modelling not feasible

© 2010 The Actuarial Profession • www.actuaries.org.uk

4

How Prudential overcame these challenges in 2007

- Looked for advanced modelling techniques giving:
 - Rapid calculation of market stresses to market-consistent balance sheet
 - Projection of Pillar 2 balance sheets
 - Runtime less than 7 years
- Least-Squares Monte Carlo (LSMC) chosen
- Alternatives
 - Closed-form solutions
 - Curve-fitting
 - Replicating Portfolios
- LSMC was best at modelling path-dependent nature of with-profits liabilities
 - Bonus declarations
 - Smoothing
 - Dynamic setting of EBR.

© 2010 The Actuarial Profession • www.actuaries.org.uk

5

Alternatives – Closed-form solutions

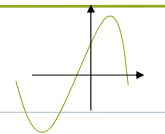
$$E = mc^2$$

- Replaces the liability model by assets that have an explicit, closed-form solution
- Advantages
 - Easy to understand compared to other alternatives
 - Can be easy to implement within stochastic models to base management actions on realistic solvency measures
- Disadvantages
 - Hard to derive closed-form solutions for complicated liabilities
 - Can lead to significant increases to model run-times
 - More difficult to model path-dependency, especially smoothing.

© 2010 The Actuarial Profession • www.actuaries.org.uk

6

Alternatives – Curve-fitting



- Adopted by many economic capital aggregation systems
 - Polynomials modelling effect of instantaneous stresses
 - ...and interactions between risks too
- Advantages
 - Easy to understand and implement
 - Can give accurate results for simple risks
- Disadvantages
 - Accuracy heavily linked to calibration
 - Can be difficult to model full complexity of management actions
 - Can require many runs to calibrate
 - Even more onerous for projections.

© 2010 The Actuarial Profession • www.actuaries.org.uk

7

Alternatives – Replicating portfolios



- Replaces the liability model by (an approximate) replicating basket of assets for which calculation and projection is quick and easy
- Advantages
 - Replicating portfolio modelling reasonably mature
 - Relatively easy to revalue portfolio under market stresses
 - Accurate, especially for dependencies between risks
 - Easy to understand and communicate
- Disadvantages
 - Difficult to choose assets for the replicating portfolio
 - Difficult to project replicating models with accuracy
 - Difficult to model smoothing.

© 2010 The Actuarial Profession • www.actuaries.org.uk

8

Least Squares Monte Carlo (LSMC)



© 2010 The Actuarial Profession • www.actuaries.org.uk

9

What is LSMC?

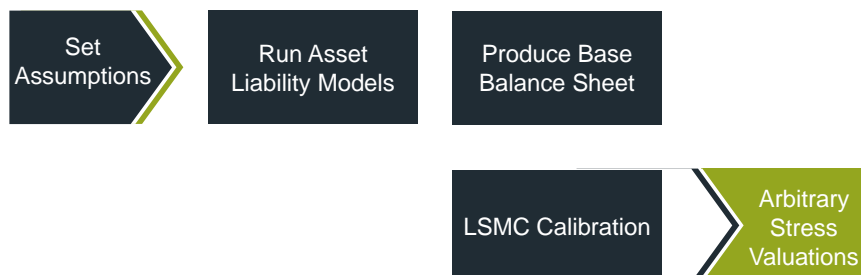
- LSMC invented by banks to model American options where path dependency exists in value of option
- Advantages
 - Can model path dependency
 - Can be fast to run once calibration completed
- Disadvantages
 - Calibration process can be difficult
 - Does not easily model non-market stresses, e.g. persistency stresses.

© 2010 The Actuarial Profession • www.actuaries.org.uk

10

How LSMC can be used

- LSMC can fit into the business-as-usual (BAU) valuation process.

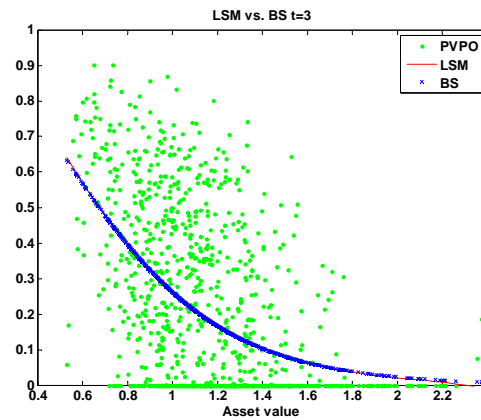


- LSMC allows for re-valuation of balance sheet without returning to the liability models.

© 2010 The Actuarial Profession • www.actuaries.org.uk

11

How LSMC works

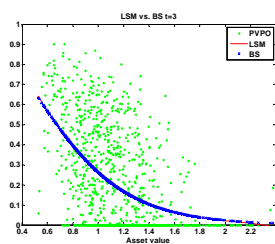


- LSMC vs. Black-Scholes example

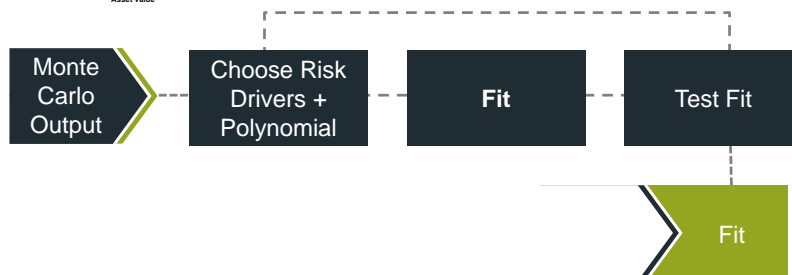
© 2010 The Actuarial Profession • www.actuaries.org.uk

12

LSMC workflow



- Risk drivers – key variables
- Polynomial equation?



© 2010 The Actuarial Profession • www.actuaries.org.uk

13

Prudential's experiences and challenges



© 2010 The Actuarial Profession • www.actuaries.org.uk

14

Challenges and benefits

Challenges	Benefits
Modelling	Better understanding – models Methodologies challenged
LSMC Calibration	Improved processes and efficiency Demonstrate stability
Communication & documentation	Senior management understanding Buy-in from wider actuarial teams
Time constraints	Conflict management Prioritisation of development
Moving world	New challenges Increased development
People	Better understanding – processes Fewer errors or easier to identify
IT	Rationalisation of models Improved management of resources

© 2010 The Actuarial Profession • www.actuaries.org.uk

15

LSMC calibration (1)

- Test metrics
 - Relative vs. absolute
 - Tolerance for error
 - Target cost of guarantees or capital charge?
 - Distribution of errors
- Stresses
 - May not be practical to model all possible risks accurately
- Range over which to test
 - 1-in-200 for each risk
 - Joint 1-in-200 critical scenario
- Number of runs
 - Enough runs to ensure a good fit
 - Risk interactions covered
- Undertake runs
 - Need efficient, robust process.

© 2010 The Actuarial Profession • www.actuaries.org.uk

16

LSMC calibration (2)

- Sense-check the Monte Carlo results
- Calibration to single risks
 - Visual analysis of results
 - Find simplest model
- “Guess” risk drivers and polynomial
 - Visual inspection
 - Knowledge of liabilities
- Fit model
 - Check test metrics
 - Balance parsimony and over-fitting.

© 2010 The Actuarial Profession • www.actuaries.org.uk

17

LSMC calibration (3)

- Attempt more complex polynomials & risk drivers
 - Improvement to fit
 - Parsimony of LSMC model
- Add risk interactions
 - Assess extent of cross terms
 - Add polynomial terms where necessary.

© 2010 The Actuarial Profession • www.actuaries.org.uk

18

Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.



© 2010 The Actuarial Profession • www.actuaries.org.uk

19