MOODY'S ANALYTICS

ORSA and Multi-year Capital Projection

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Own Risk and Solvency Assessment (ORSA)

- ORSA is emerging as a global regulatory standard
  - Pillar II of Solvency II
  - US and Canada have each proposed ORSA frameworks for 2014 implementation
  - Core part of International Association of Insurance Supervisors (IAIS) Common Framework

- ORSA implementation approaches may have local differences, but in all cases they require insurance firms to make assessments of their current and future solvency capital requirements

Quantitative modelling requirements of ORSA

Modelling requirements of ORSA could be considered in three categories:

- Backward-looking

  Analysis of annual change in Pillar 1 regulatory reserves

- Current-looking

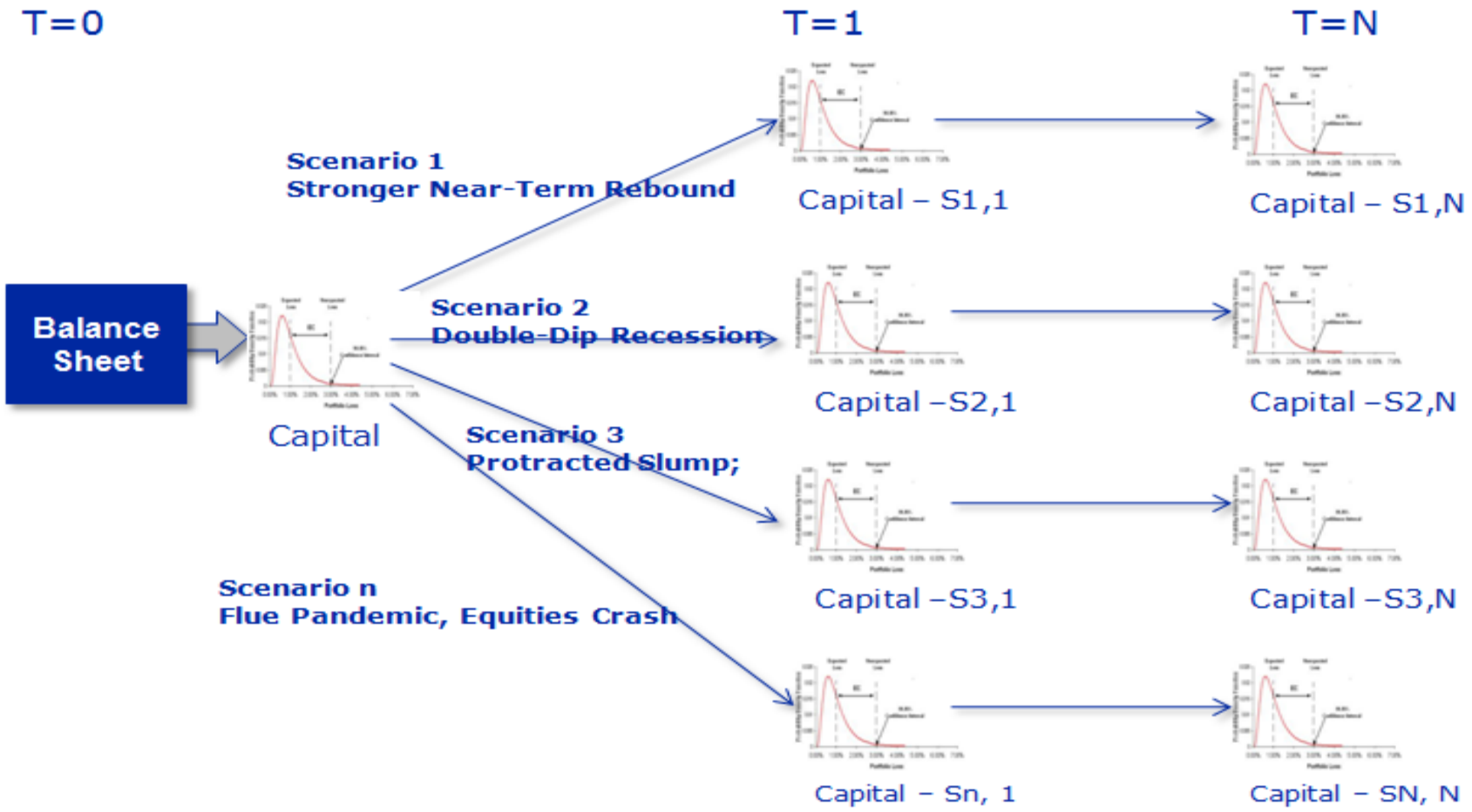
  Real-time monitoring of Pillar 1 regulatory capital requirements

  Own assessment of current solvency capital requirements

- Forward-looking

  Multi-timestep forward projection of solvency capital requirements (regulatory capital and / or economic capital)

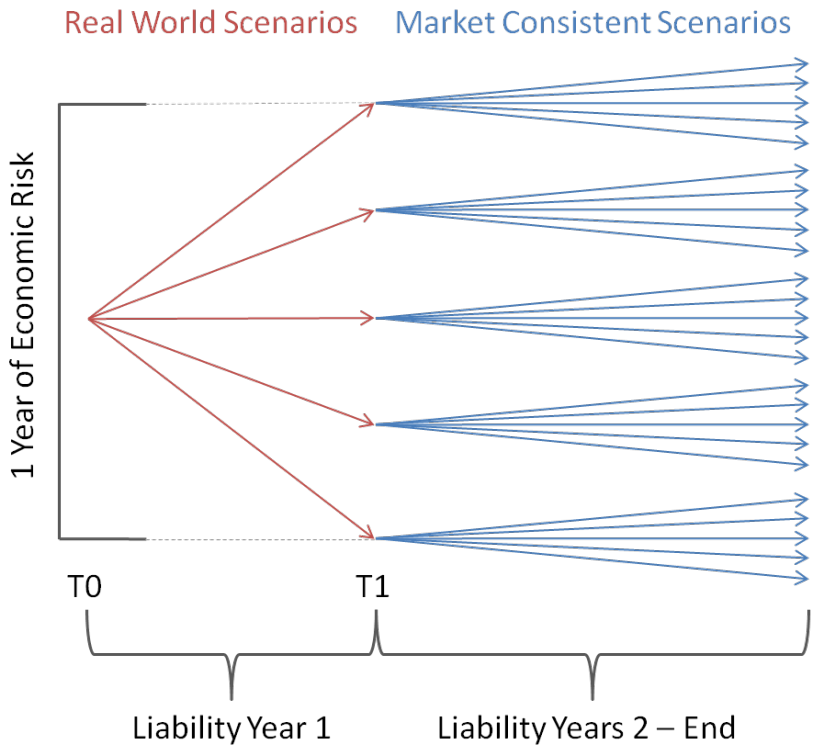
Capital & Solvency Projection (ORSA)



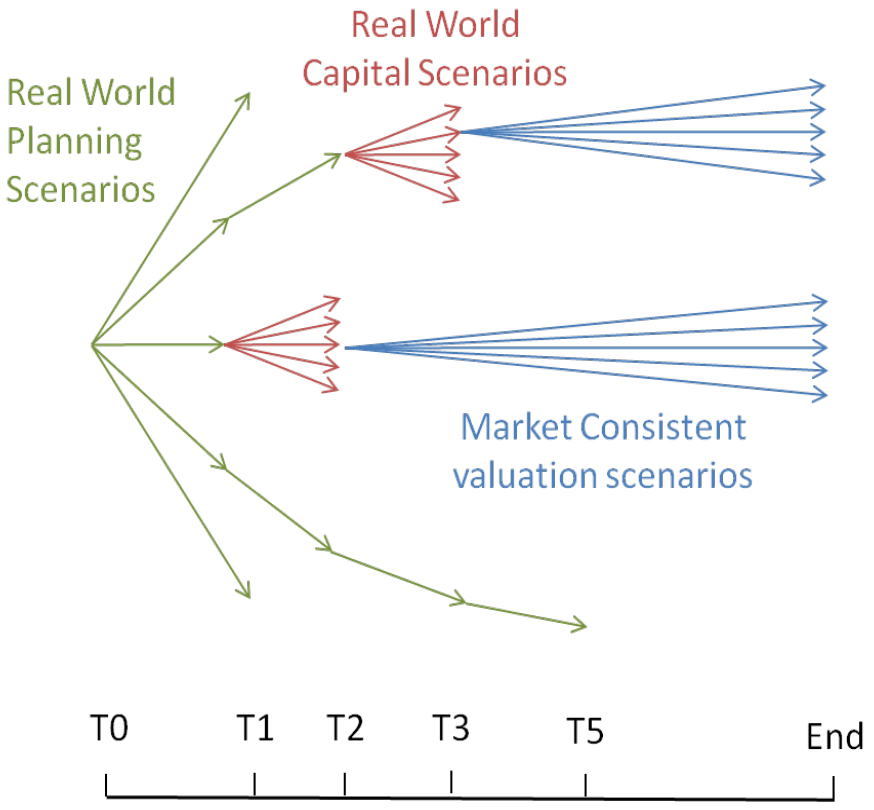
Calculating solvency capital along the path

Multi time-step projection is orders of magnitude more calculation intensive than a capital calculation

Capital calculation

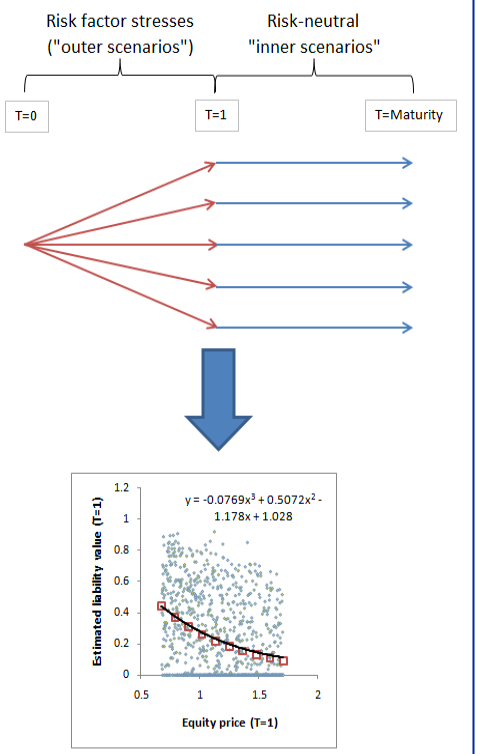


Multi-timestep capital projection

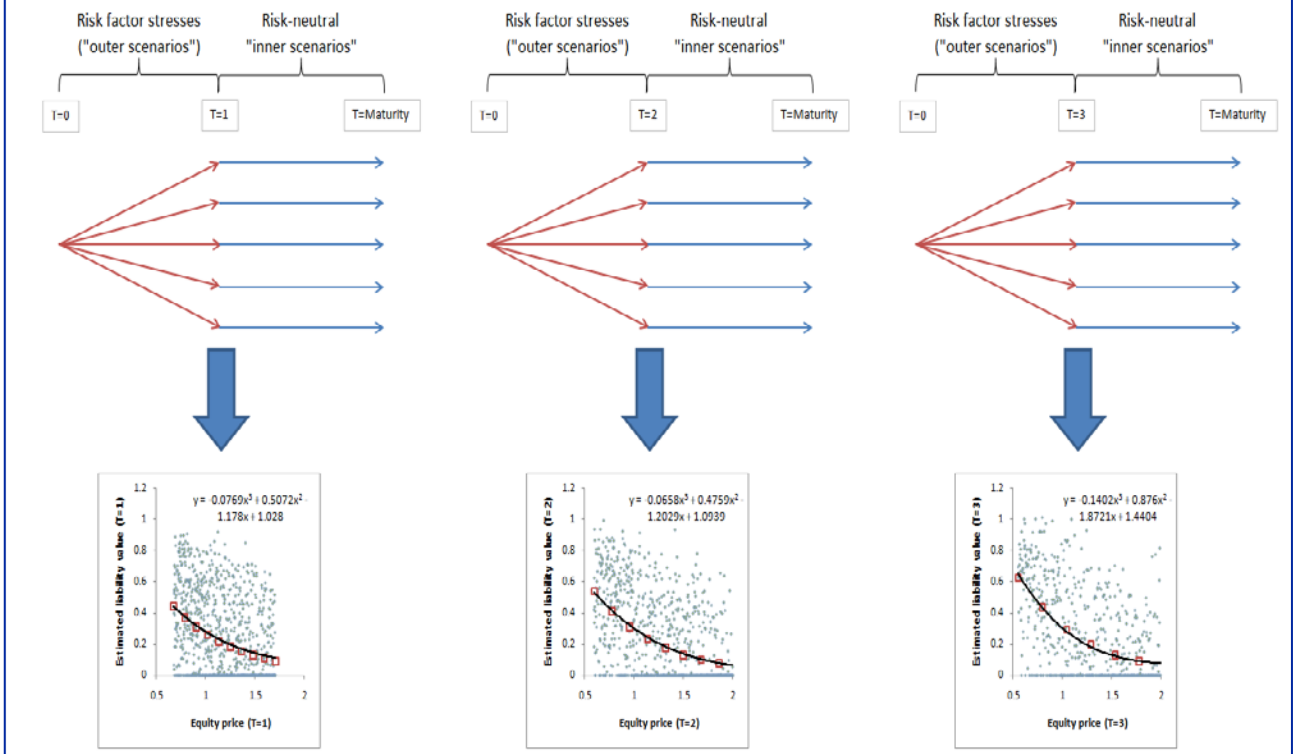


LSMC: From One Year to Multiple Years

One year LSMC



Multi-year LSMC



‘Local’ vs ‘Global’ fitting

1. ‘Local’ fitting

Separately calibrate different proxy functions for each time *t*:

Market-consistent value(t)

$$= f_t \textit{ (risk factors)}$$

A potential drawback with this fitting method is that certain coefficients in the polynomial may vary widely over time.

2. ‘Global’ fitting

Include time as an additional variable and calibrate once:

Market-consistent value(t)

$$= f_{global}\textit{(time, risk factors)}$$

Equivalent to assuming that the coefficients of the ‘local’ polynomials f_t are themselves polynomials.

Multi-Year Fitting Example

Product Example

- Annual return credited to policyholder is calculated as
  - Credited return (t) = max (Fund return (t) – 1.5%, 2%)
  - i.e. Policy Account (t) = Policy Account (t-1) * { 1+ credited return (t) }
  - Policy Account (0) = Asset Portfolio Value (0)
  - Product pay-out at time 10 is Policy Account (10)

- Asset fund invested in diversified portfolio of investment-grade corporate bonds
  - 70% A-rated
  - 30% BBB-rated
  - Term of 8 years
  - Re-balanced annually

- No allowance for taxes, expenses, lapses, mortality

Market-consistent liability valuation

- The policy pay-out is path-dependent, i.e. it is a function of the 10 annual returns, not the 10-year return
  - Market-consistent simulation required to produce the time-0 valuation

- Market-consistent liability value at time 0 was calculated to be **119%** of the starting fund value in end-2012 market conditions
  - Calculated using market-consistent scenario set for interest rates and corporate bond returns

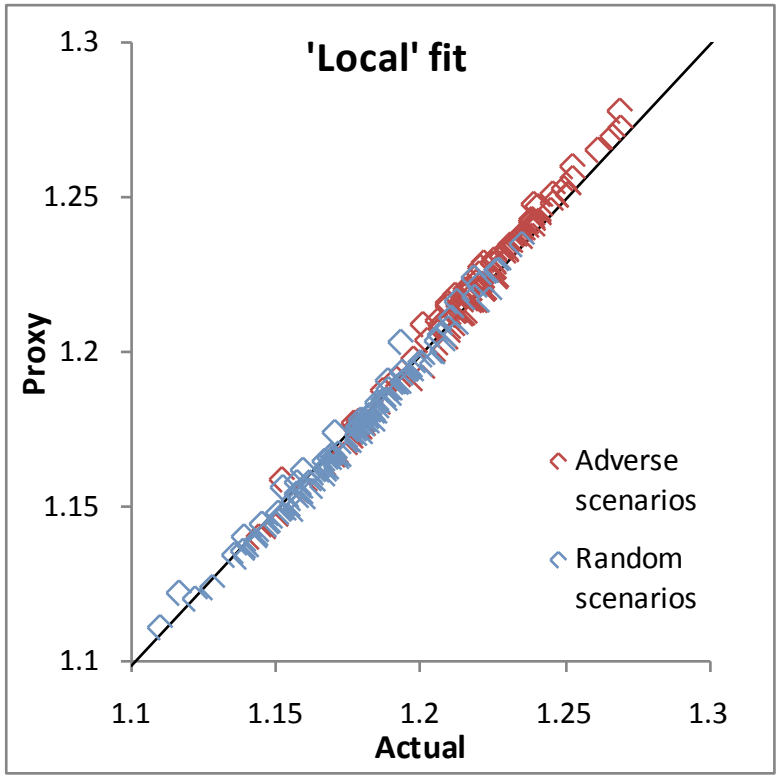
- How will this market-consistent liability value behave over the 10-year lifetime of the product?

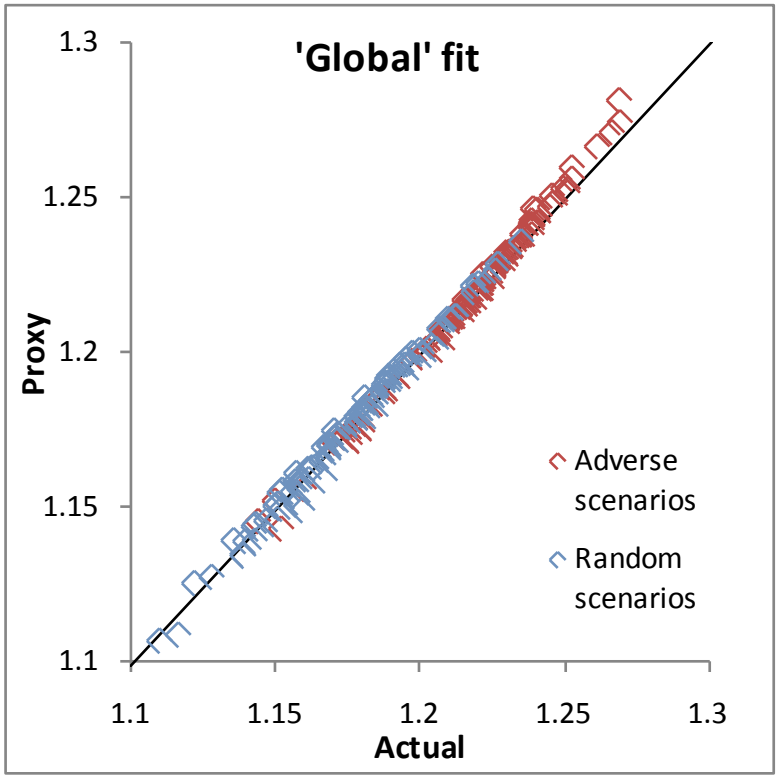
Proxy Function Fitting

- Proxy functions produced using 5 risk factor variables
  - Two risk-free yield curve factors
  - Interest rate volatility factor
  - Credit return factor
  - Policy account value (i.e. roll-up of credited returns)

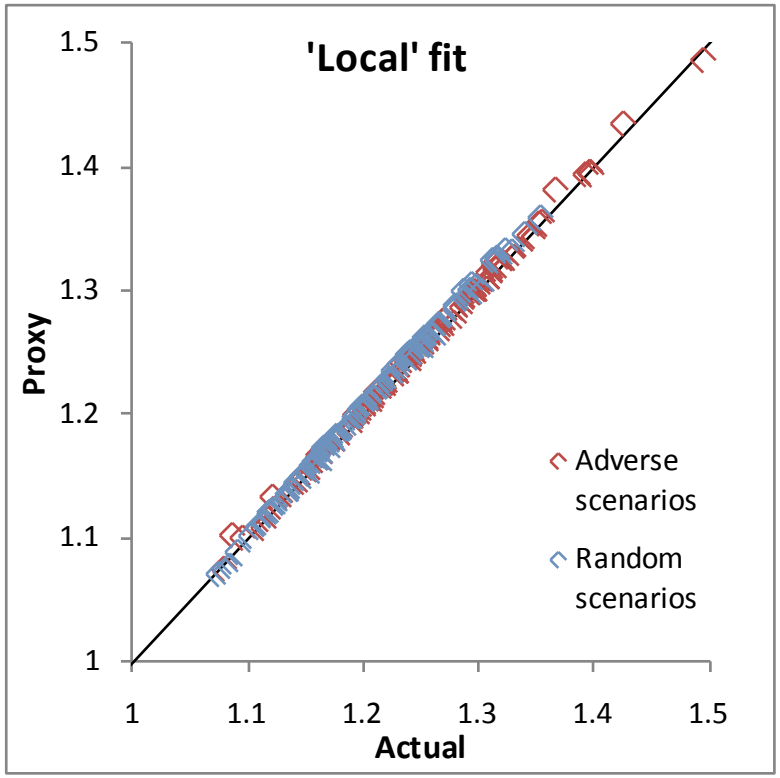
- Proxy functions produced for valuation at each time-step using the ‘global’ and ‘local’ methods described earlier
  - Functions fitted to quadratic term in individual risk factors and cross-terms
  - Fitted local functions had around 10 statistically significant parameters
  - Global function had 32 statistically significant parameters

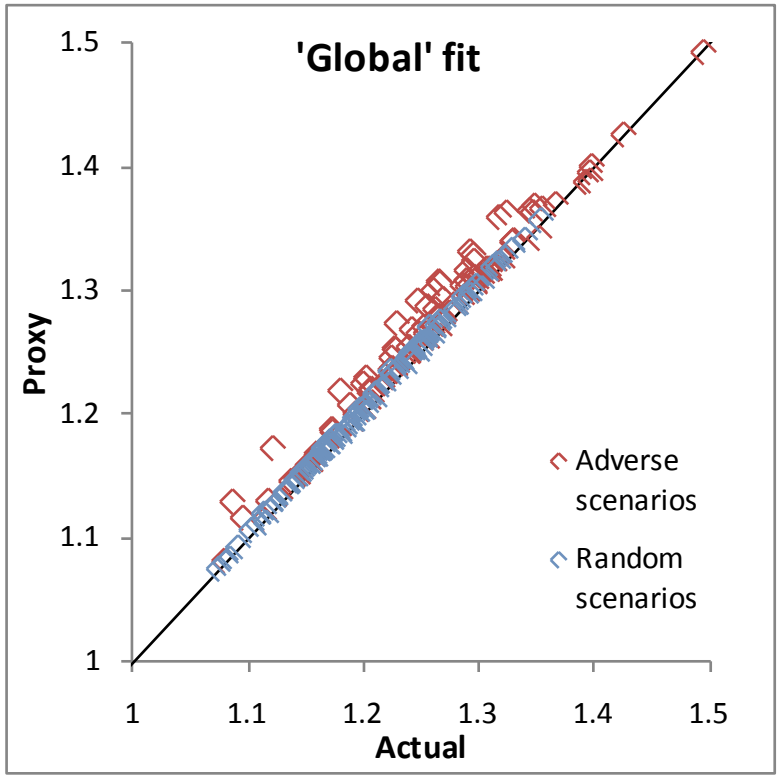
Validation Results – Year 1



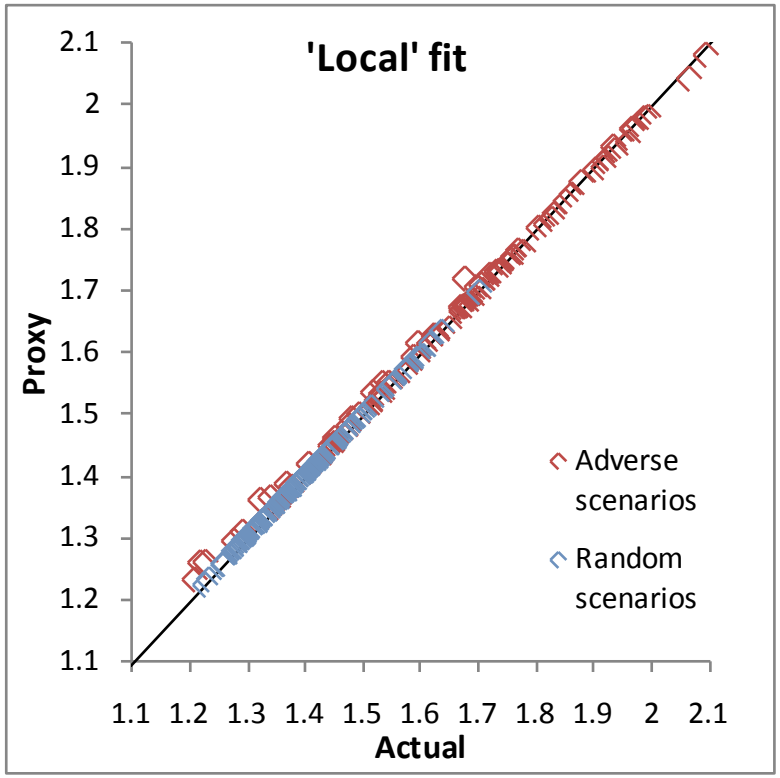


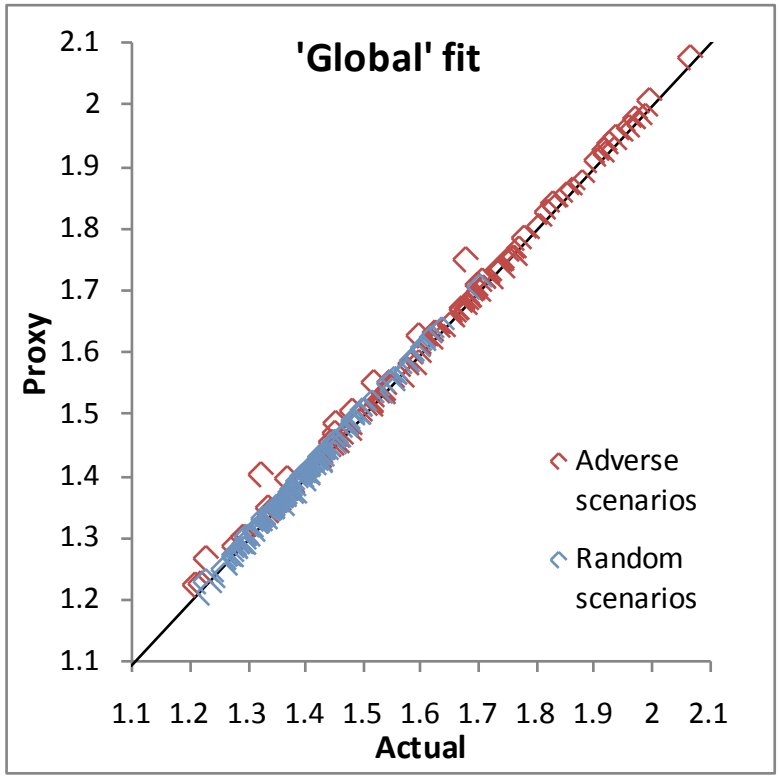
Validation Results – Year 5





Validation Results – Year 9

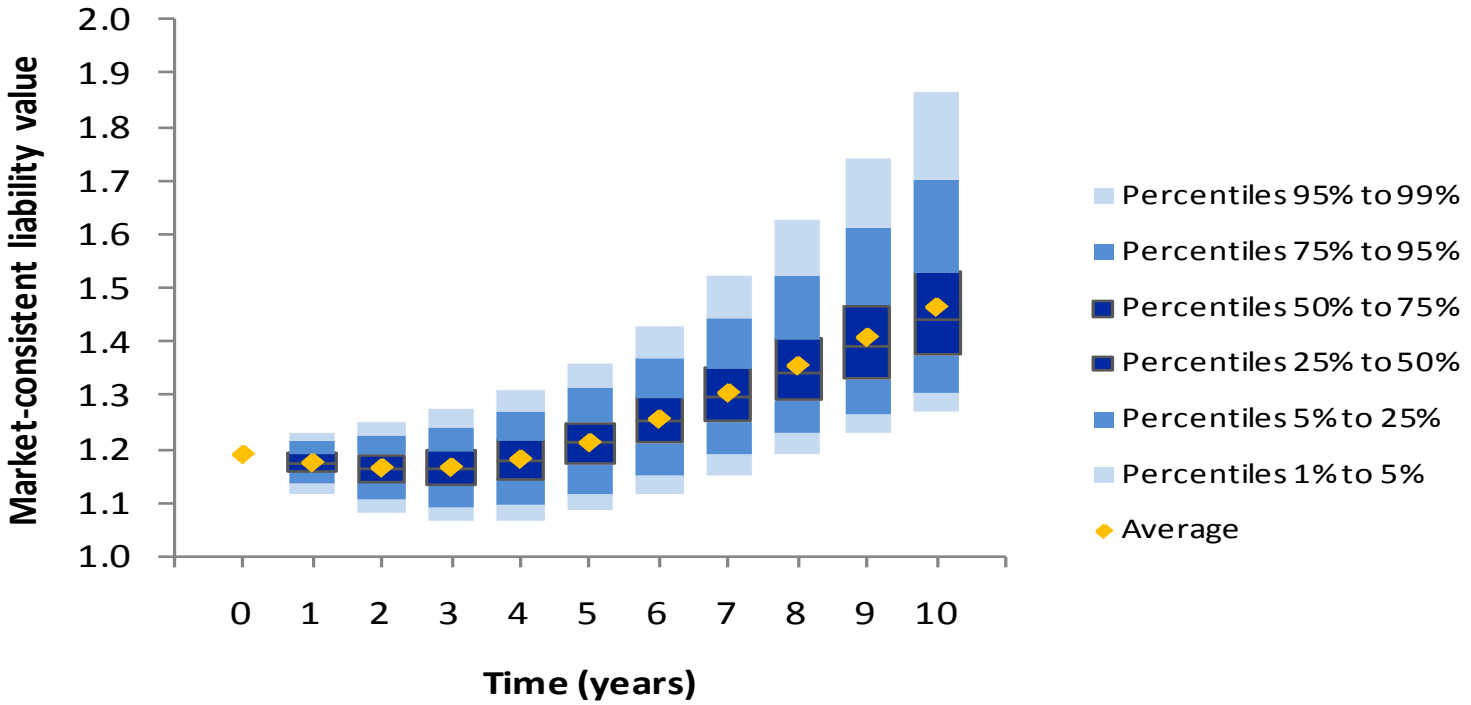




Multi-Year Proxy Function Applications:

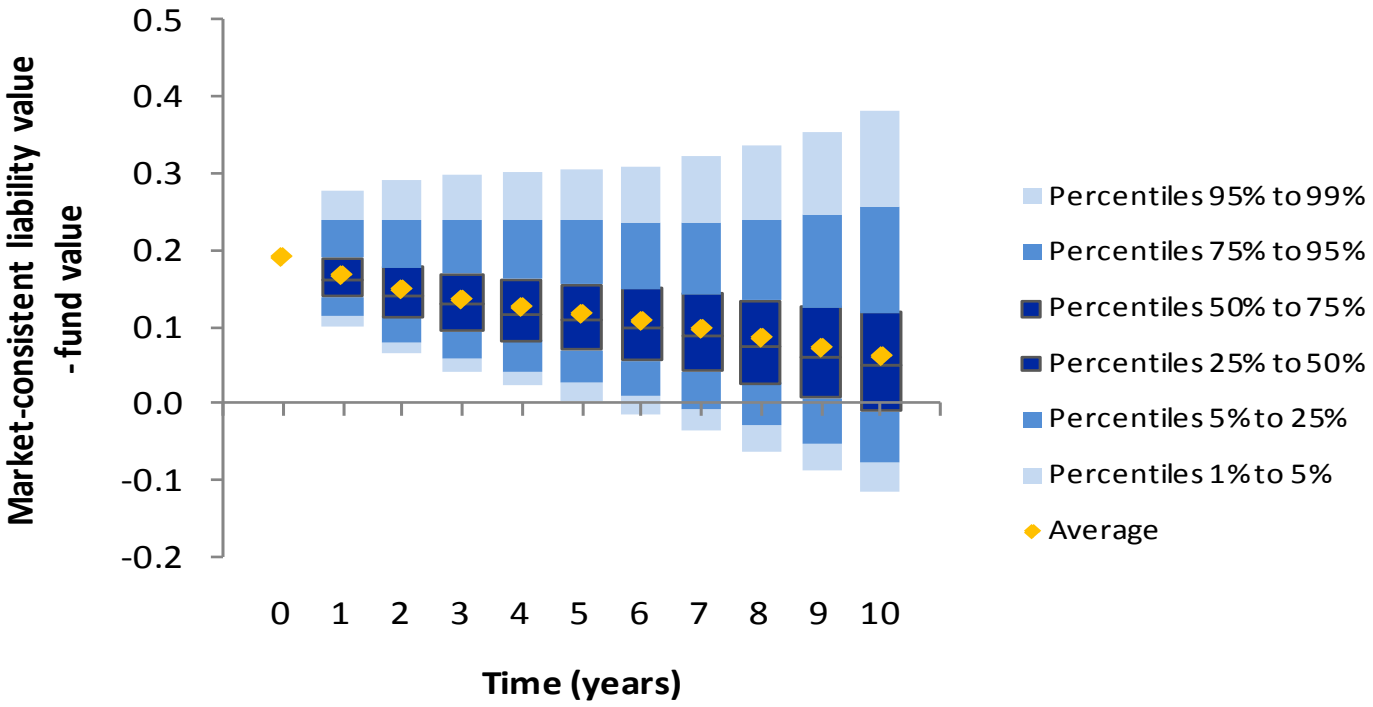
1. Stochastic Projections
2. Reverse Stress Testing
3. Scenario Testing

Multi-Year Stochastic Projections: Liability Value



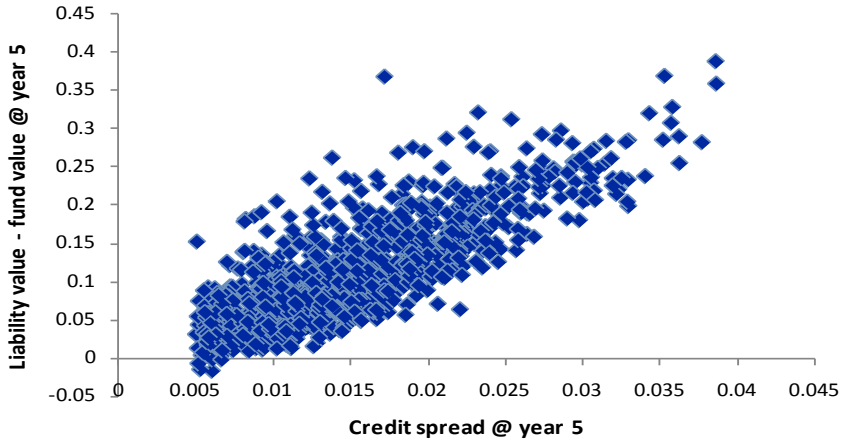
- Time 0 valuation produced by set of market-consistent scenarios
- Time 10 valuation is simply the product payout in the real-world scenario
- Proxy function used to estimate market-consistent values in years 1-9

Multi-Year Stochastic Projections: Liability Value – Asset Portfolio Value



- M-C deficit is *expected* to reduce over time due to risk premium in asset fund
- c30% probability of product pay-out being less than final asset portfolio value

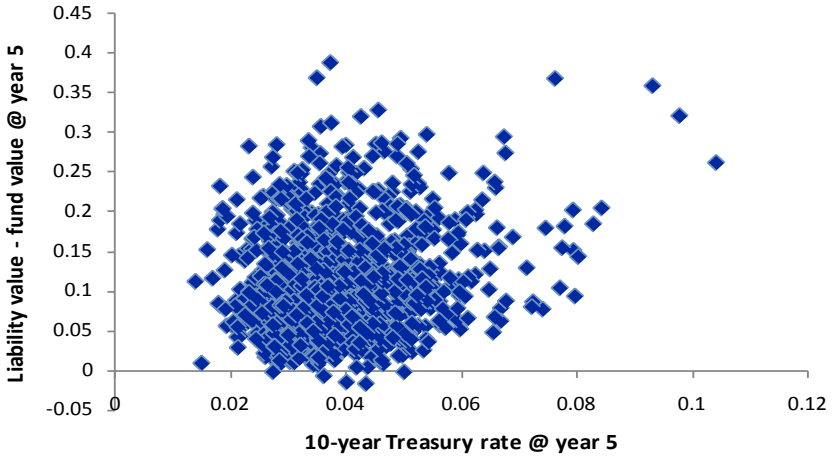
Multi-Year Stochastic Projections: Liability Value – Asset Portfolio Value in Year 5



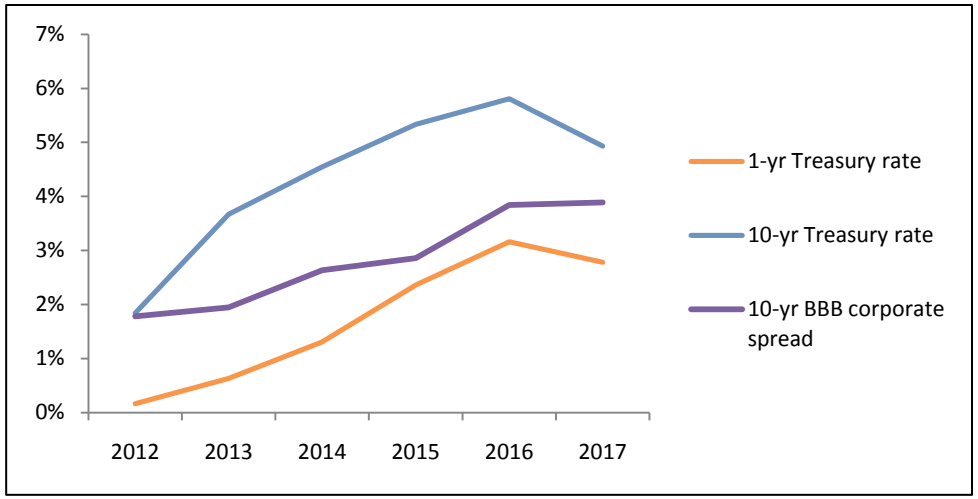
Strong exposure to credit spread behaviour

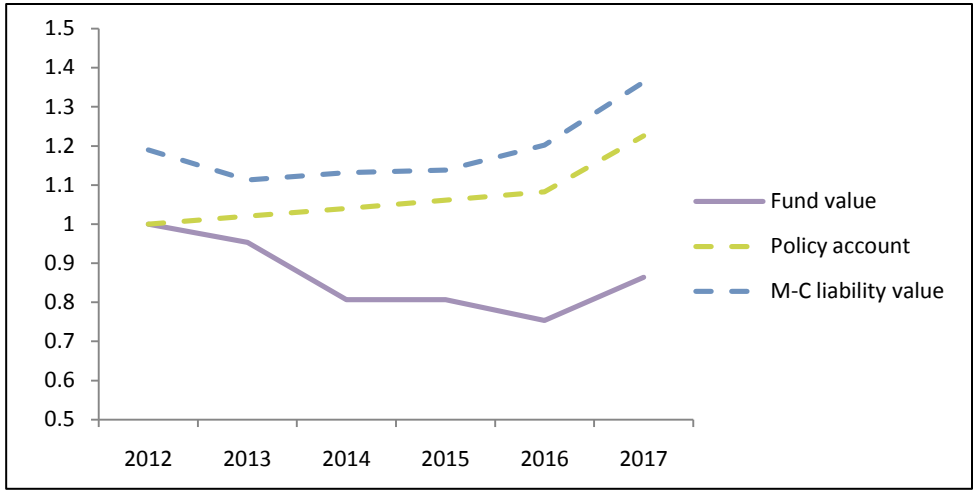
High risk-free rates also bad for shareholder in this product

But not so significant as high rates also reduce liability value



Reverse Stress Test:
Economic scenario path for worst ranking simulation

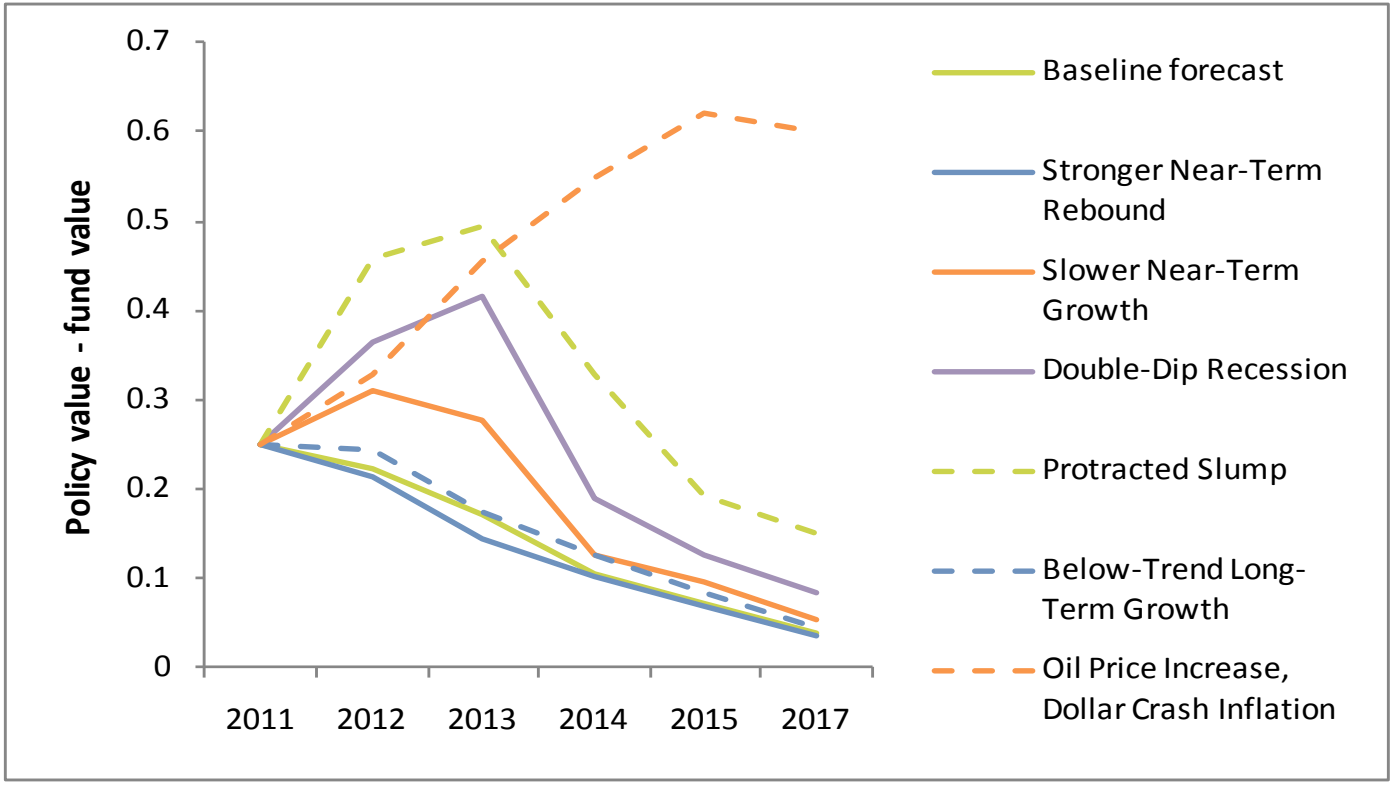




- Rank year 5 real-world scenarios by market-consistent deficit
- This scenario has the biggest deficit at year 5
- The economic scenario is consistent with previous scatterplots

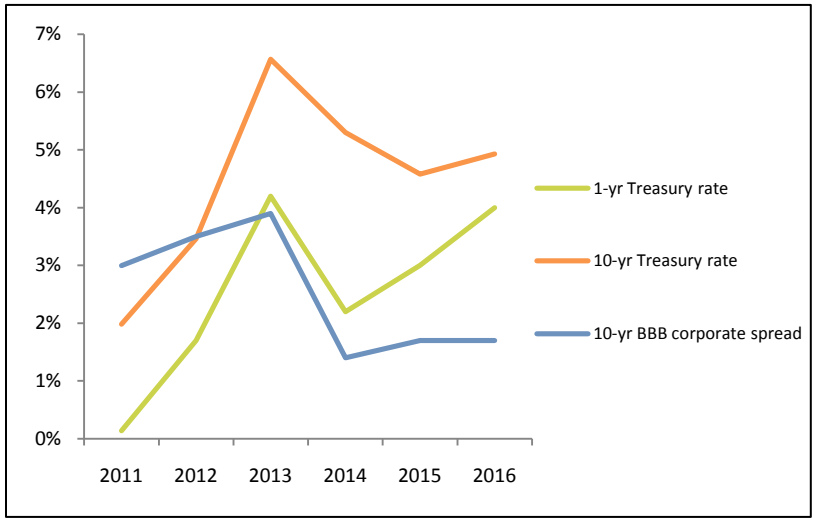
- M-C deficit at year 5 is 0.60 (99th percentile in earlier chart was 0.30)

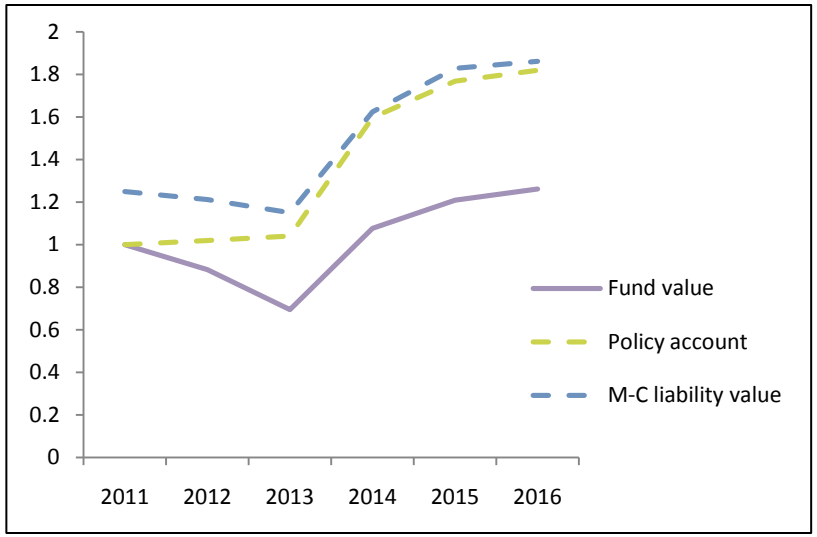
Scenario Testing:
Apply 7 macro-economic stress tests



- 7 macro-economic, multi-year stress tests specified by Moody Analytics ECCA team
- Proxy function used to project liability valuations through these scenarios
- What is happening in the oil price scenario?!

Oil Shock Scenario





- Very significant yield curve increases in the early years of the product. Asset fund value falls by 40% after two years
- Followed by very strong bond returns in later years

- This down-then-up path is very bad for the product (shareholders)
  - Early poor returns clearly hurt due to 2% minimum guarantee
  - Later strong returns also hurt as they are applied to the policy account value, which is much greater than the asset portfolio value

Conclusions

- LSMC extendable to multi-timestep proxy function fitting
- In the case study we have produced proxy functions for a path-dependent, complex guaranteed product, and the proxies perform very well in out-of-sample validation testing at all time horizons
- These functions enable a wide variety of projection analytics such as stochastic projection, reverse stress testing and stress and scenario testing
- This is extremely useful for firms who need to consider the medium-term behaviour of their solvency requirements as part of ORSA