Session 5B: Developments in the Use of Proxy Generators for EC Calculations and Projection: Life Insurance

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Moody's Analytics

ERM Symposium Session 5B: Economic Capital – Life Insurance

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Agenda

1. Definitions of Capital
2. Why Economic Capital
3. Ways to Define Economic Capital
4. Applications and Implementation
5. Final Words

1

Definitions of Capital

Definitions of Capital

- Available Capital
  - Excess of assets over liabilities held by the insurer
- Required Capital
  - Amount of assets in excess of liabilities held to withstand future adverse outcomes
    - Capital Ratio = Available Capital / Required Capital
- Regulatory Capital
  - Required capital as defined by the regulatory body
- Rating Agency Capital
  - Required capital as defined by the rating agency
- Economic Capital
  - A measure of risk that provides a realistic economic quantification of the amount of capital a firm needs to cover losses at a certain risk tolerance level
    - The terminology is not standardized → lots of confusion
    - Realistic projection of risk and how they impact the company's financials
    - It intends to replace traditional regulatory capital rules with internally consistent, risk-sensitive calculations

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Why Economic Capital

Why Economic Capital

Current methods (RBC, MCCSR, and S&P)

- Are mostly factor based with reasonably static factors that have become stale over years and varying markets
- Do not reflect the true distribution of the risk
- Provide little management information
- Promote a reactive, as opposed to proactive, environment

Rating agencies demand more from management to grant strong and excellent ratings

Why Economic Capital

Economic Capital:

- Should be aligned with company goals and management's view of risk
  - Meant to be a useful internal measure
- Should be part of comprehensive risk management framework
- Is calculated stochastically (e.g., market risk)
  - Reflects the distribution of the risk which allows appropriate hedging strategies thereby creating a proactive environment
  - Could be used to assess the impact of management actions (e.g., hedging) at all levels of the company
- Addresses most of rating agencies' demands from management to create a risk aware environment

Economic Capital addresses most, if not all, of current methods' shortcomings

3

Ways to Define Economic Capital

Ways to Define EC

- Decisions to be made
  - Time horizon used
  - Measure(s) of risk used (e.g., percentile, CTE)
  - Risks to include
  - Level of confidence to target
- Implementation Decision
  - Stress testing vs. stochastic
- Approach
  - Liability run-off approach
  - Risk horizon approach (e.g., 1-yr VaR)

Ultimately the goal is to evaluate the level of assets needed to cover P/H benefits at the chosen confidence level

Liability Run-off Approach

- EC = Market value of assets less some measure of liabilities
  - Liability is to pay all future P/H benefits and related expenses (i.e., over the life of business) at the required confidence level
- Approach
  - Calculate the minimum amount of assets needed to defease all liabilities by the end of the projection under every scenario
    - Scenarios could be stochastically determined or a few stressed scenarios
  - Rank scenarios to create a distribution of the initial required asset amounts
  - Calculate initial asset required based on the desired measure (e.g., VaR, CTE) and confidence level; this is total asset required (TAR)
  - EC = TAR less some measure of the liabilities

Liability Run-off Approach

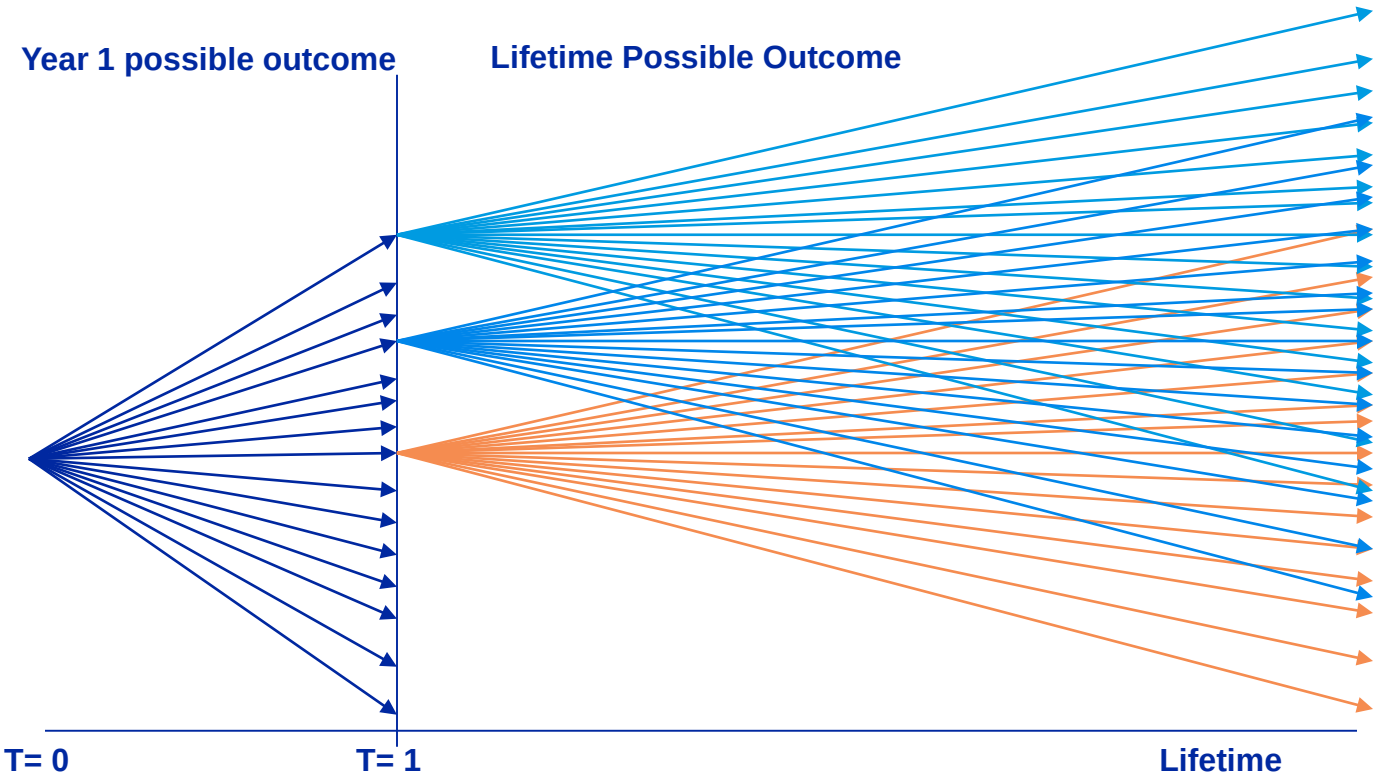
EC value depends on the measure of liability but TAR does not change

- Liability valuation basis
  - Statutory vs. economic vs. best estimate basis
- Is interim solvency important or not
  - While interim solvency creates a more stringent EC requirement, it may be more aligned with reality
- Projection period

Risk Horizon Approach

- Most common is 1-year risk horizon approach
  - The amount of assets needed to remain solvent over a one-year time horizon at a required confidence level
- Approach
  - Evaluate the market value of existing assets backing liabilities at year 1 under a number of real world (RW) scenarios
  - Calculate the liability values at the end of year 1 under the same RW scenarios
    - For interest rate sensitive products need to use stochastic scenarios (RW or RN)
    - This is called deterministic/stochastic on stochastic (DoS or SoS) (see graph on next slide)
  - Calculate net asset values under each RW scenario
  - Discount the value of net assets to the valuation date
  - TAR = Current market value of assets less the required confidence level of the discounted net asset values

1-Year Risk Horizon Approach



Risk Horizon Approach

- Scenarios over year 1
  - Stress testing: A limited number of stress scenarios are run
    - Generally calibrated to result in the expected confidence level of the capital
  - Instantaneous stress: EC is the difference between current and stressed net assets at time 0
  - Stochastic approach:
    - Becoming more common yet, usually more complex
    - Proxy models used to address computation challenges

Comparing the Approaches

	Liability Run-off	1-Year Risk Horizon
Horizon	Measures risk over the period risk is held, with a more direct link to risk emergence over time	More natural alignment with the reality of risk management, in which capital levels will be reevaluated on an annual basis
Decision Making	Longer-term decision making not distorted by volatility of economic assumptions over short term	Short-term volatility to economic assumptions may be very relevant when assessing risk management options currently available
Regulation	Generally consistent with approaches used by the NAIC	Generally consistent with approaches used globally
Management Action	Management actions may be important to consider when evaluating long-term solvency needs	Less dependent on implementing subjective assumptions (e.g., with respect to management actions) over time
Performance Management	Runoff horizon may promote longer term performance management	Risk quantification and risk management linked to performance management over the typical annual performance reporting cycle
Risk Calibration	Target confidence levels may be defined from long term default studies or other data	Generally easier to calibrate risks to target confidence levels over one year
Aggregation	Integrated scenarios support risk aggregation for individual products	Measuring all risks over the same time horizon facilitates aggregation

* Source: SOA Research Report: Economic Capital for Life Insurance Companies. September 2016

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Applications and Implementation

Applications of EC

- Capital adequacy
- Capital allocation
- Capital optimization
- Risk appetite
- Performance measurement
- Strategic planning
- Pricing
- Mergers & acquisitions

Implementation of EC

- Objectives
  - Insurer's objectives influences the approach
  - Consider the trade-offs between accuracy and the timeliness of result
- Constraints
  - Resource constraints impacts the design and framework
    - Consider use of proxy methodology
  - May wish to start with simple models then expand to reflect increasing sophistication
  - Lack of experienced staff
- Governance
  - Tone at the top is key to the success of EC implementation
  - Ensure broad buy-in from internal stakeholders early on
  - Corporate level decision: High level methodology and aggregation
  - Business unit decision: How risks interact with product features

Implementation of EC

- Validation
  - Generally use current cash flow projection models
  - Ensure validation processes consider unique situations as tail scenarios
  - Back testing against historical data
  - Ensure forward looking views are reasonable (e.g., long-term equity return)
- Reporting
  - The usefulness of EC is dependent on the timeliness of results
  - Need the ability to report across business units, geographies, risk categories, etc.
  - Reports should be aligned with objectives (i.e., only produce the necessary information)

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Final Words

Final Words

A successful EC implementation requires buy-in at the highest level with clear objectives.

Further, clear and effective communication with all stakeholders could not be emphasized more.

References

https://www.soa.org/research-reports/2016/research-econ-cap-life-ins-co/

2016 Economic Capital for Life Insurance Companies – Complete Report

2016 Economic Capital for Life Insurance Companies – PowerPoint Presentation

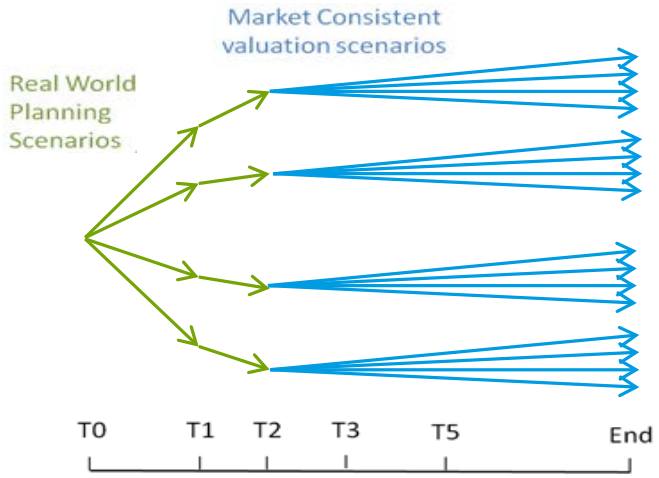
MOODY'S ANALYTICS

ERM Symposium Session 5B: Proxy Functions for EC Calculation & Projection

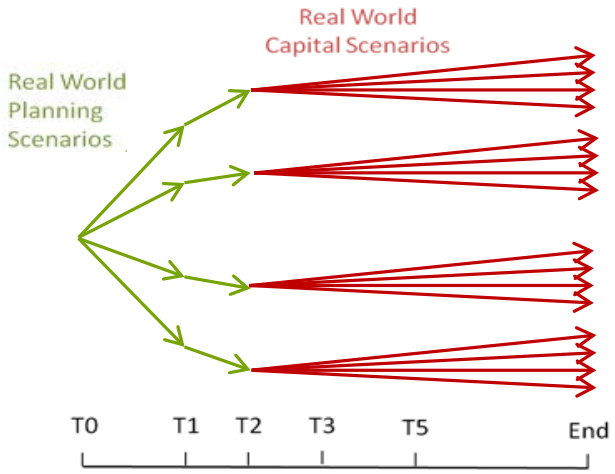
Aubrey Clayton
April 20, 2017

Types of nested stochastic problems related to EC

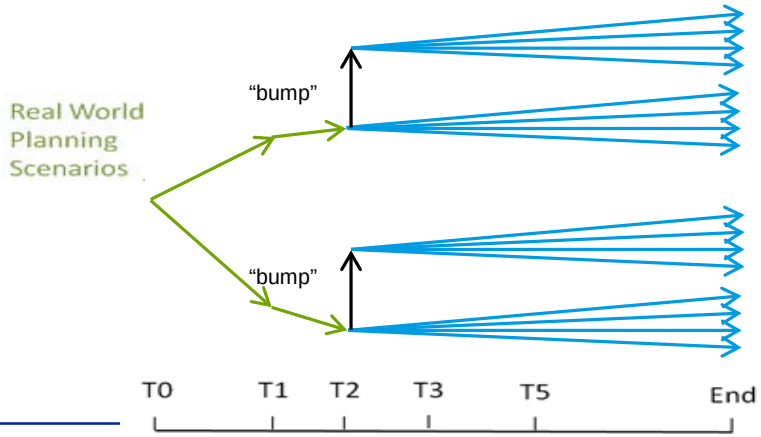
Projecting mark-to-market value



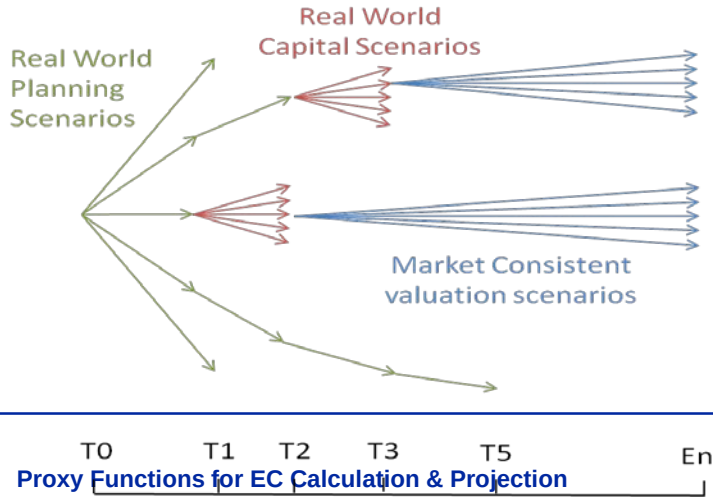
Projecting required run-off capital/reserves



Projecting hedge positions



Projecting capital net of hedging



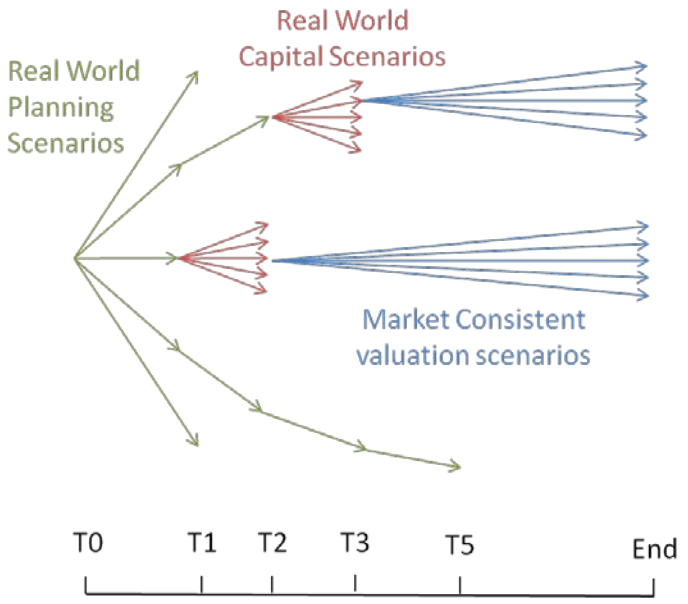
Large scenario requirements with limited resources

Scenario requirements for a complex capital planning exercise:

6 planning scenarios * 9 quarters * 1,000 run-off scenarios * 480 months * 10,000 valuation scenarios * 3 sensitivities * 1 million policies

= 777.6 quadrillion policy-scenarios

Is a full revaluation *really* needed?



Why use proxy functions?

Proxy methods are a scenario reduction technique

» Similar **outer scenarios** should produce similar **inner results**
→ smooth functional relationship

$$Value_t = f(RiskFactors_t)$$
$$Capital_t = g(RiskFactors_t)$$

» It can be more efficient to **pre-compute** this function before it's needed.

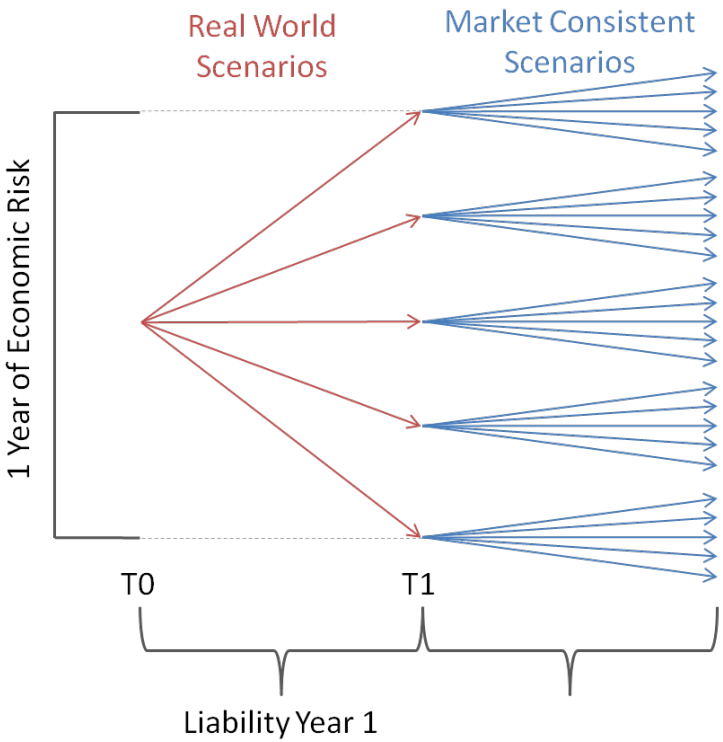
» Fewer total scenarios

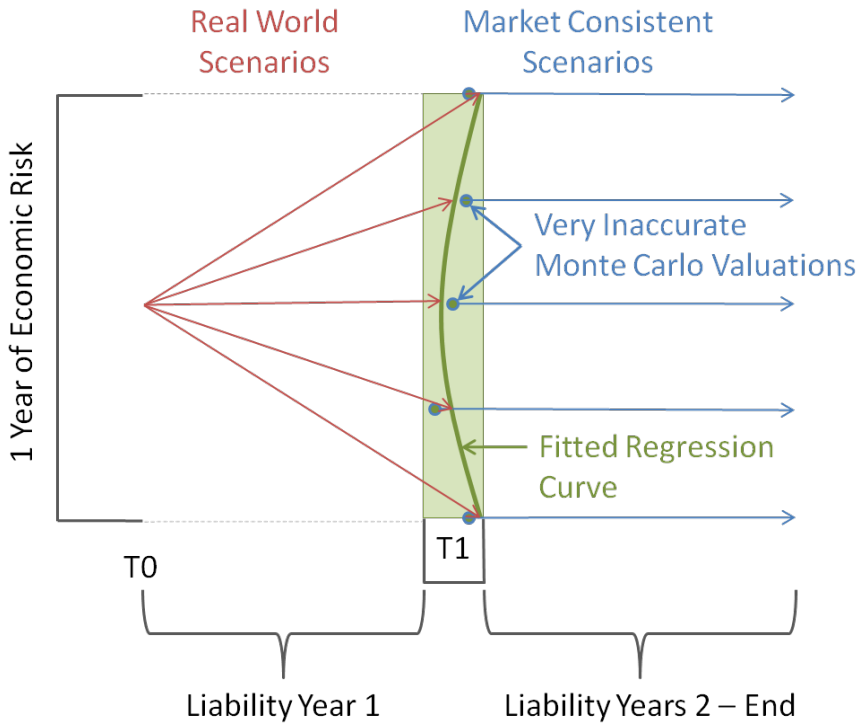
» Scenarios run before the reporting date

Least Squares Monte Carlo (LSMC)

» Instead of doing full nested simulation, do only a **few** inner simulations

Regression through inaccurate valuations to get function which approximates true nested stochastic valuation





Proxy fitting procedure

There are four main steps followed to derive the liability proxy function

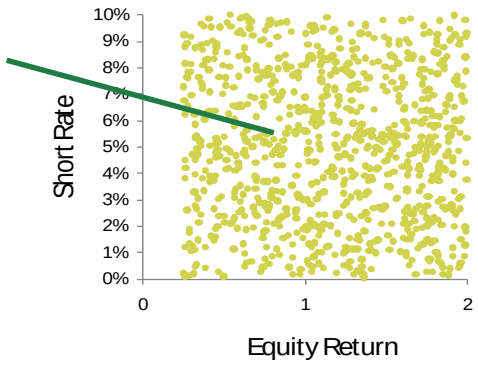
Identify risks and generate fitting points

Outside model

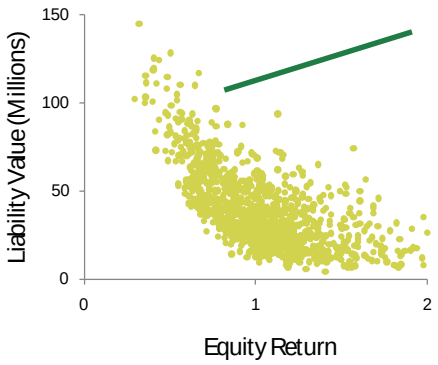
Run regression to fit proxy functions

Outside model

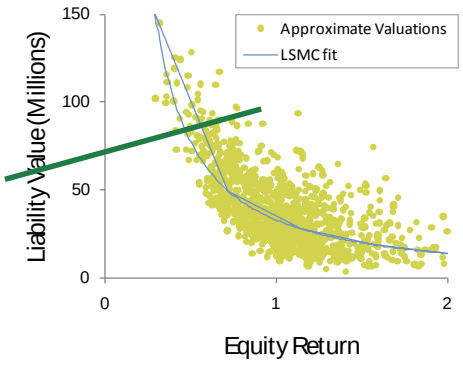
Step 1



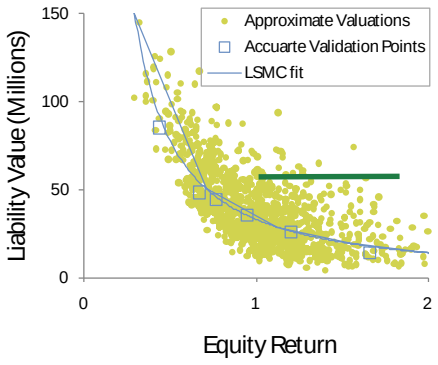
Step 2



Step 3



Step 4



Inaccurate valuation

"Heavy" model

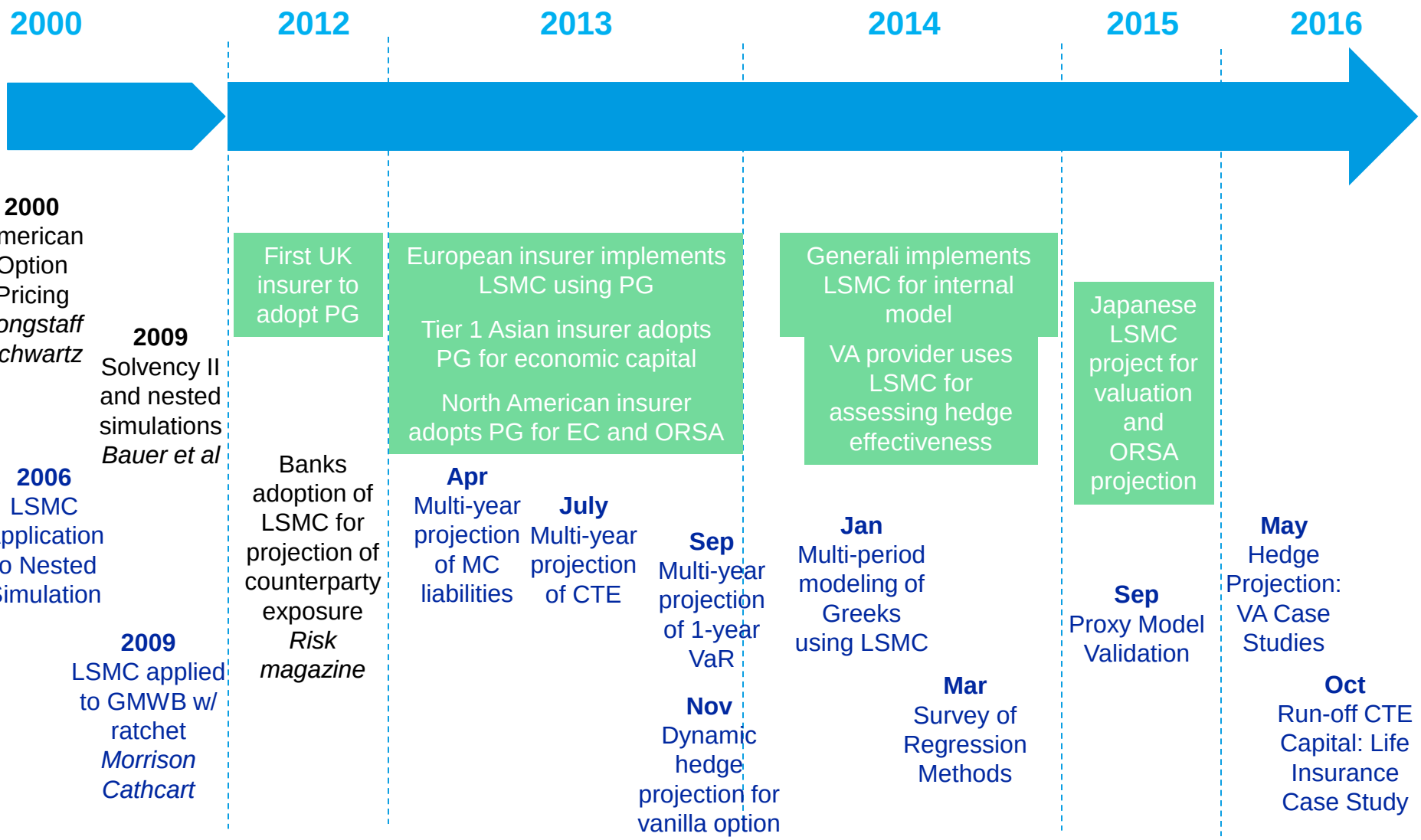
Validate proxy function

Outside model

Ingredients for a proxy function

- A definition of **outer scenarios** in terms of a “smallish” number of key variables
- A way of calculating **unbiased estimates** of the metric of interest
- A **functional form** that allows for the right kinds of dependency
- **Automated interaction** between stress scenario definitions and actuarial models

Evolution and adoption of LSMC



What about path-dependency?

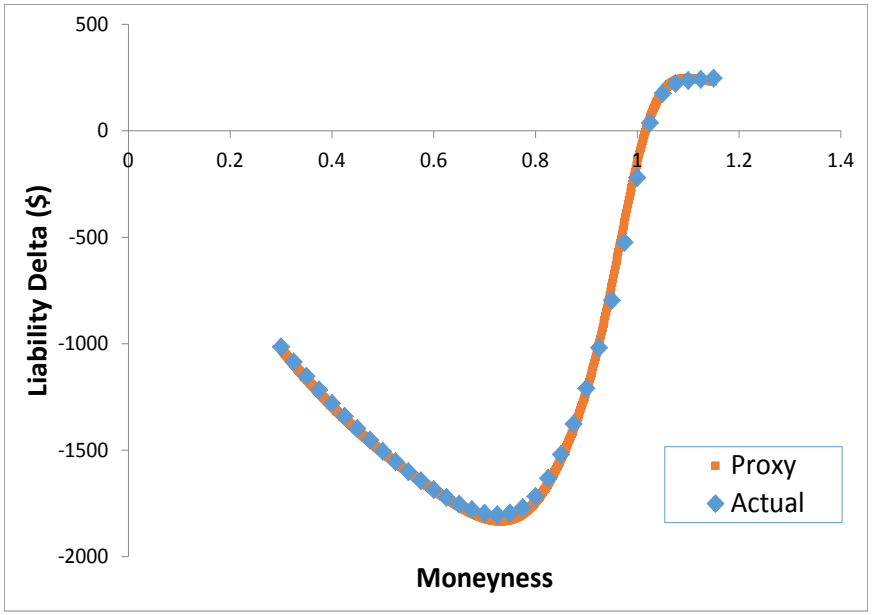
- For complex products, the value will depend on the **path** of economic risk factors up to that point.

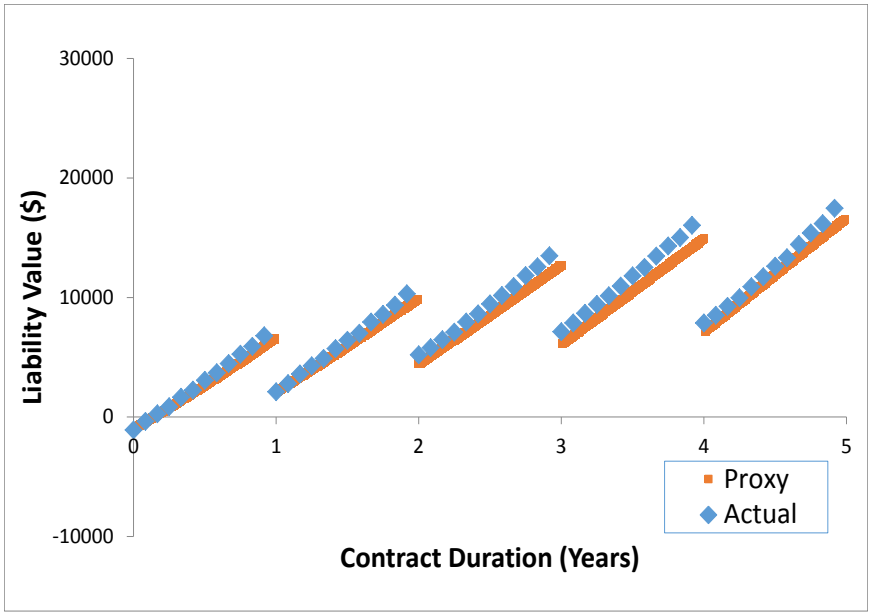
- **Summarise** important features of the path in a small number of variables
  - Lookback option value depends on ‘running maximum’
  - VA guarantee value depends on moneyness of guarantee, etc.

- May need to develop proxy functions at the **policy-level**

Example: VA Greeks

- Flexible premium deferred VA in waiting period
  - GLWB and annual ratchet, deferral bonuses
  - Three possible fund allocations: Conservative, Moderate, Aggressive
- Policy variables (gender/moneyness/etc.) & market risk variables (yield curves/etc.)





Proxy Methods for Hedge Projection: Two Variable Annuity Case Studies (June 2016)

What about tail percentiles?

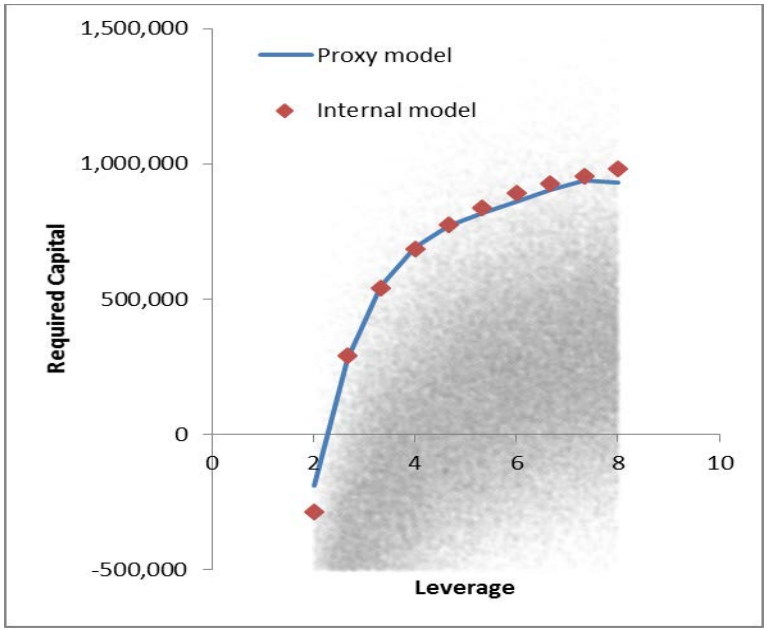
» Capital could be defined by a **percentile** of value distribution, e.g., VaR(99.5)

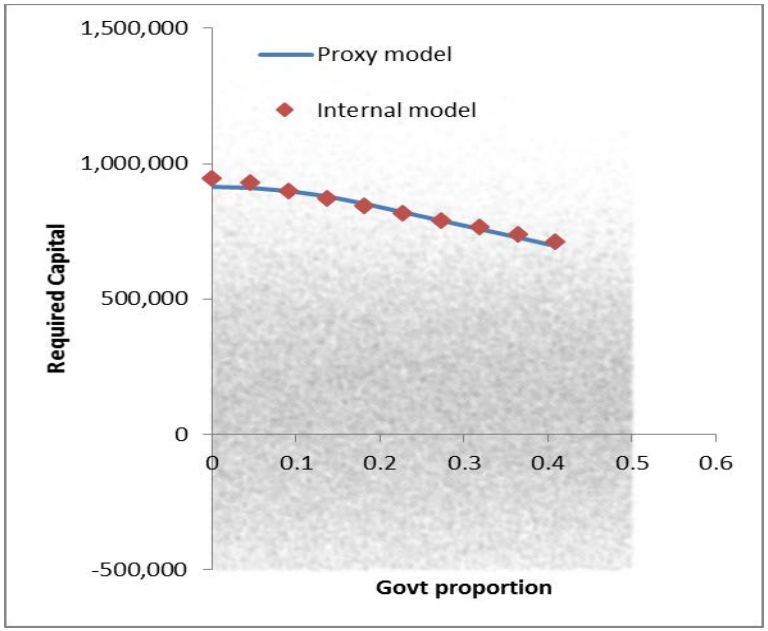
» **Quantile regression** can extract functional behavior from **1 inner scenario**

Instead of this…	Use this…
$argmin_{\boldsymbol{\beta}} \sum (Y_i - \boldsymbol{X}_i \cdot \boldsymbol{\beta})^2$	$argmin_{\boldsymbol{\beta}} \sum \rho_\tau(Y_i - \boldsymbol{X}_i \cdot \boldsymbol{\beta})$ $\rho_\tau(y) = y * (\tau - I_{y<0})$

Example: VaR(99.5) for a fixed annuities portfolio

- Liabilities: Fixed cash flows with longevity risk
- Assets: Corp & Govt bonds, chosen to approximately match liability cash flows
- 1-year VaR(99.5) as a function of leverage, allocation, avg. corporate credit rating





What about CTE measures?

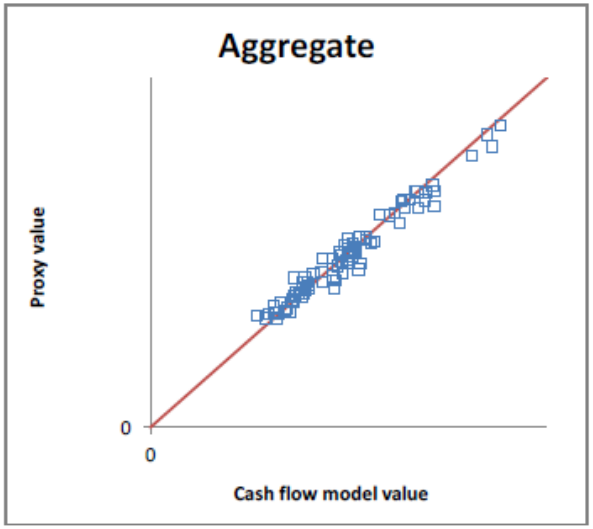
- Reserves/capital typically defined by run-off **Conditional Tail Expectation**
- Requires a change in scenario allocation and **bias-corrected CTE estimators**
  - Can also apply clever scenario filtering…

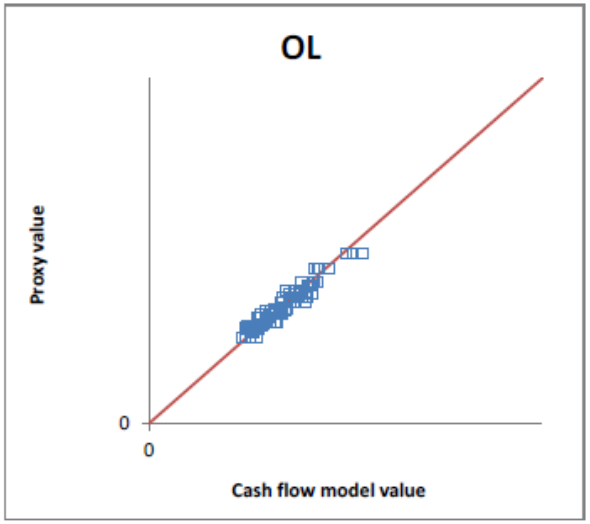
Instead of this…	Use this…
$\widehat{CTE_\alpha} = \frac{1}{n(1-\alpha)} \sum_{i=n\alpha+1}^{n} X_{(i)}$	$\widehat{CTE_\alpha} = \sum_{i=1}^{n} w_i X_{(i)}$

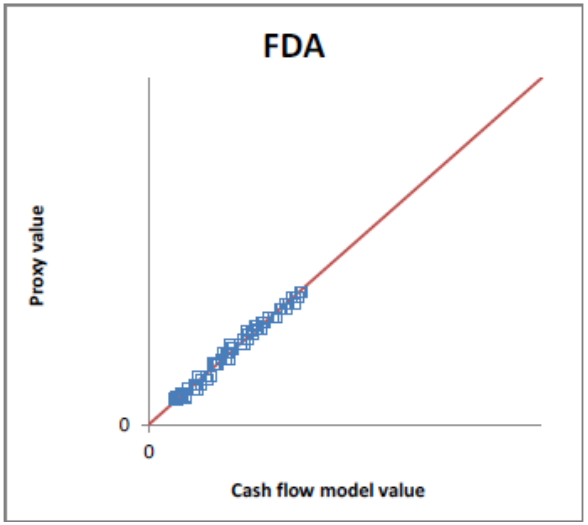
Kim and Hardy. "Quantifying and Correcting the Bias in Estimated Risk Measures." ASTIN Bulletin 37 (2007): 365-386.

Example: Life insurance case study

- Capital = CTE(99) of accumulated deficiencies in 40 year run-off of assets and liabilities
- Products:
  - Participating Whole Life (“OL”)
  - Fixed Deferred Annuities (“FDA”)
  - Aggregate







Proxy Methods for Run-off CTE Capital Projection: A Life Insurance Case Study (Oct. 2016)

Double-nested stochastic capital proxy functions

- Layer 1: Replace market-consistent scenario calculation with proxy function for value and Greeks

Market-consistent value = f(risk factors)

Greek = g(risk factors)

- Layer 2: Replace capital scenario calculation with proxy function

Capital = F(risk factors)

Summary

- Proxy methods can make dramatically more efficient use of available computing resources.
- The proxy calibration effort can be pre-computed at a more advantageous time.
- All assumptions present in actuarial models will still be there!
- Calibration requires good automation of stress/scenario generation.
- Different methods of function fitting may be required for different nested stochastic problems.