



18TH EAST ASIAN ACTUARIAL CONFERENCE

12-15 October 2014

Taipei International Convention Center in Taipei Taiwan

Implementing Economic Capital in APAC

Kevin Ito Low (kevin.low@moodys.com)

MOODY'S
ANALYTICS



Agenda

- Update on APAC development
- Quick recap of Economic Capital
- Building blocks of Economic Capital
- Challenges in implementing Economic Capital

What is happening in APAC



Australia

- ICAAP requirement
- Principle-based approach with standard formula, similar to SII
- Internal model

China

- Economic Capital reporting requirement
- C-ROSS expected in 2016/17

Japan

- Field Tests of Economic Value-Based Solvency Regime

Singapore

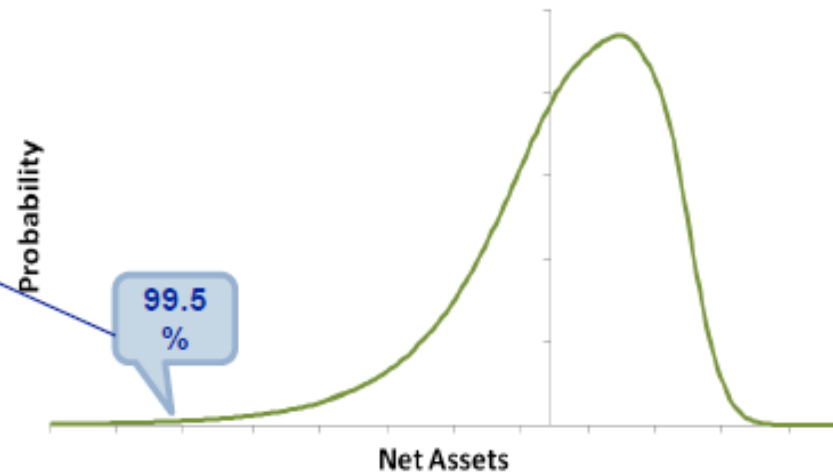
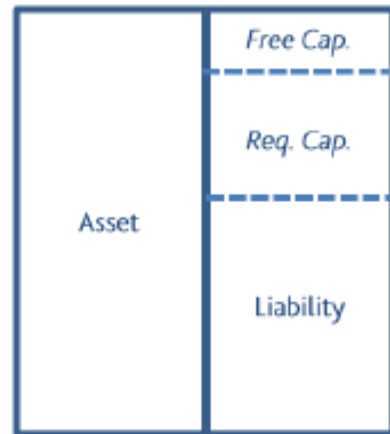
- RBC-2 Review
- Own Risk and Solvency Assessment

Other economies

- Group requirement on Economic Capital

Recap of Economic Capital

1-year Value-at-Risk of a market consistent balance sheet



Main Challenges:

- A probability-based risk measure (A view of the future)
- Market-consistent liability valuation (Estimating the fair value)
- Technology (What technology do we need for the calculation of the Economic Capital?)

Measuring probability

Economically coherent stochastic modelling of the paths of a wide array of risk

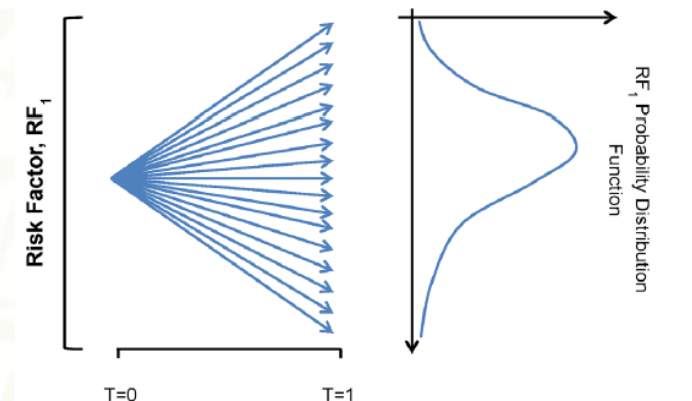
Marginal distributions

- Models should capture stylized facts
- What is the likelihood of extreme events for each individual variable?

Dependence structures

- Traditional correlation measures of dependency are limited, it doesn't uniquely specify the dependency structure
- Need a measure which captures the entire dependency structure (Copulas)
- What is the likelihood of extreme events occurring simultaneously?

Variability of Risk Factor over 1 year time horizon



Consistent modeling framework

Interest rates

- » Bonds
- » Nominal/real rates

Equity markets

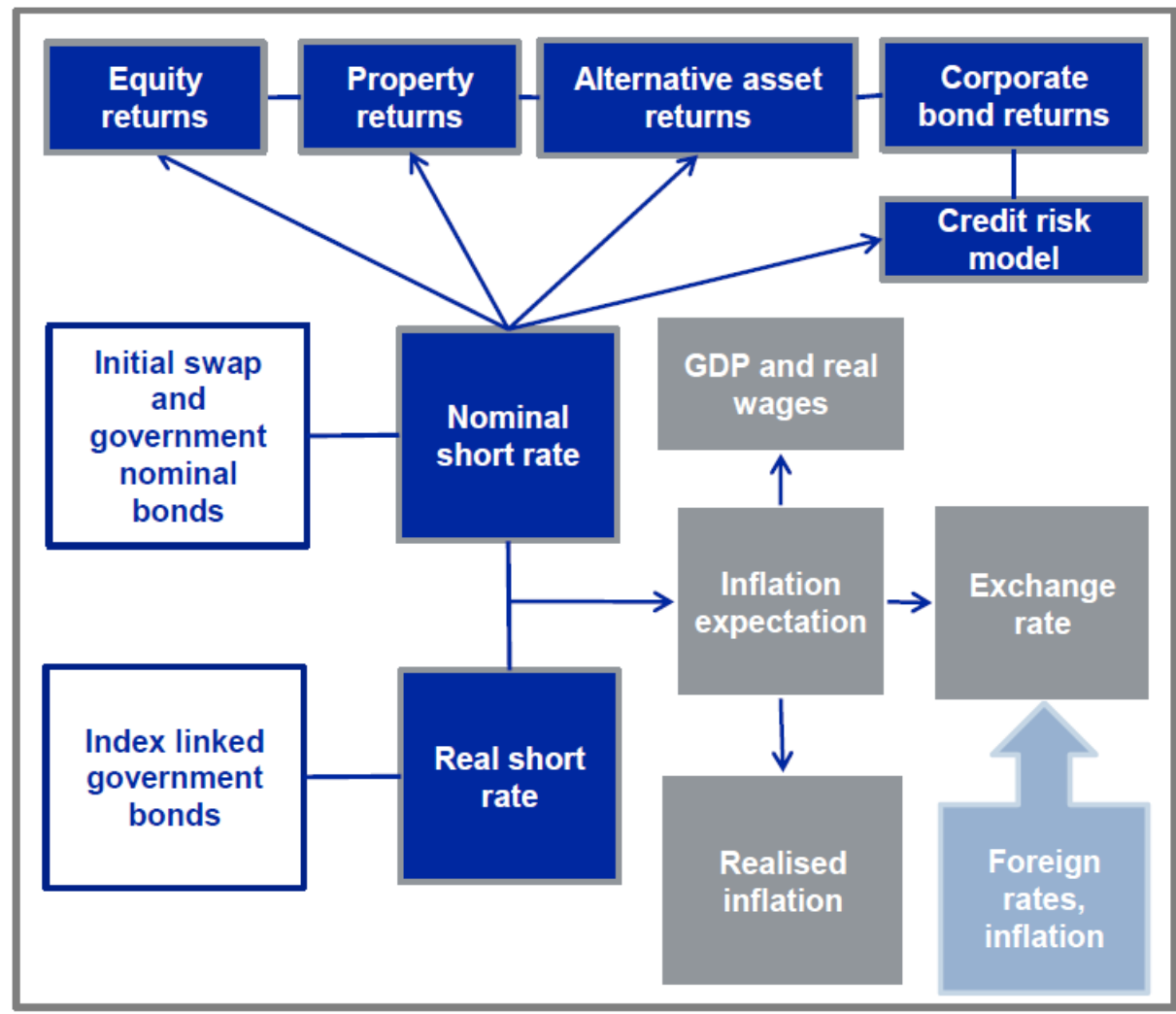
- » Sectors
- » Broad market indices

Credit

Real estate

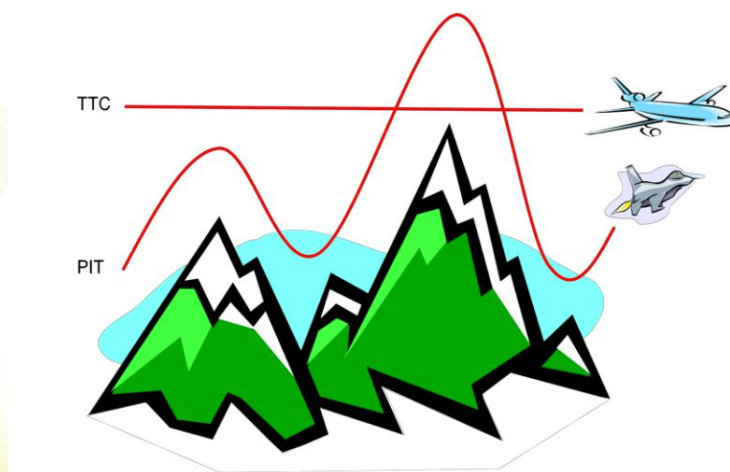
Currency

Inflation



TTC vs PIT view

Calibration	Characteristics	Consideration
Point-in-time (PIT)	Reflects current market conditions	1-in-200-year event, or 1-in-200-event next year? - Volatile in capital/risk measures?
Through-the-cycle (TTC)	Distributions calibrated to long data series, relatively stable calibration over time	- Risk-factor distributions, expected return and volatility over very long horizons? - Consistency with market pricing and risk management incentives?

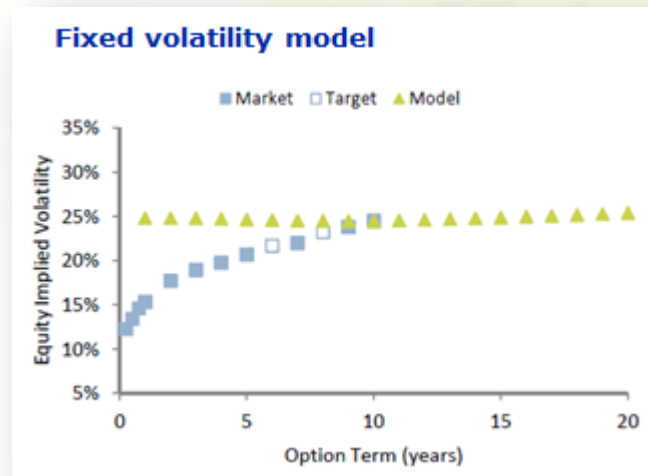


Liability valuation

Life insurance liability valuation cannot be obtained from a data screen...

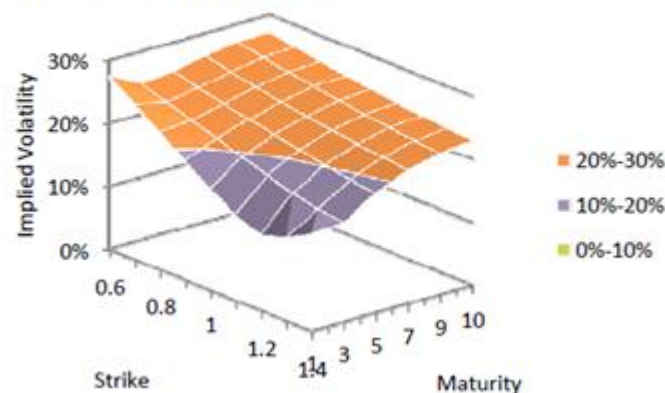
Economic Valuation

Aim	Fair Valuation
Complexity	Long-term path-dependent guarantees
Valuation methods	Monte Carlo simulation
Sensitivity to market	High
Model choice	Consistent with observable market prices as much as possible

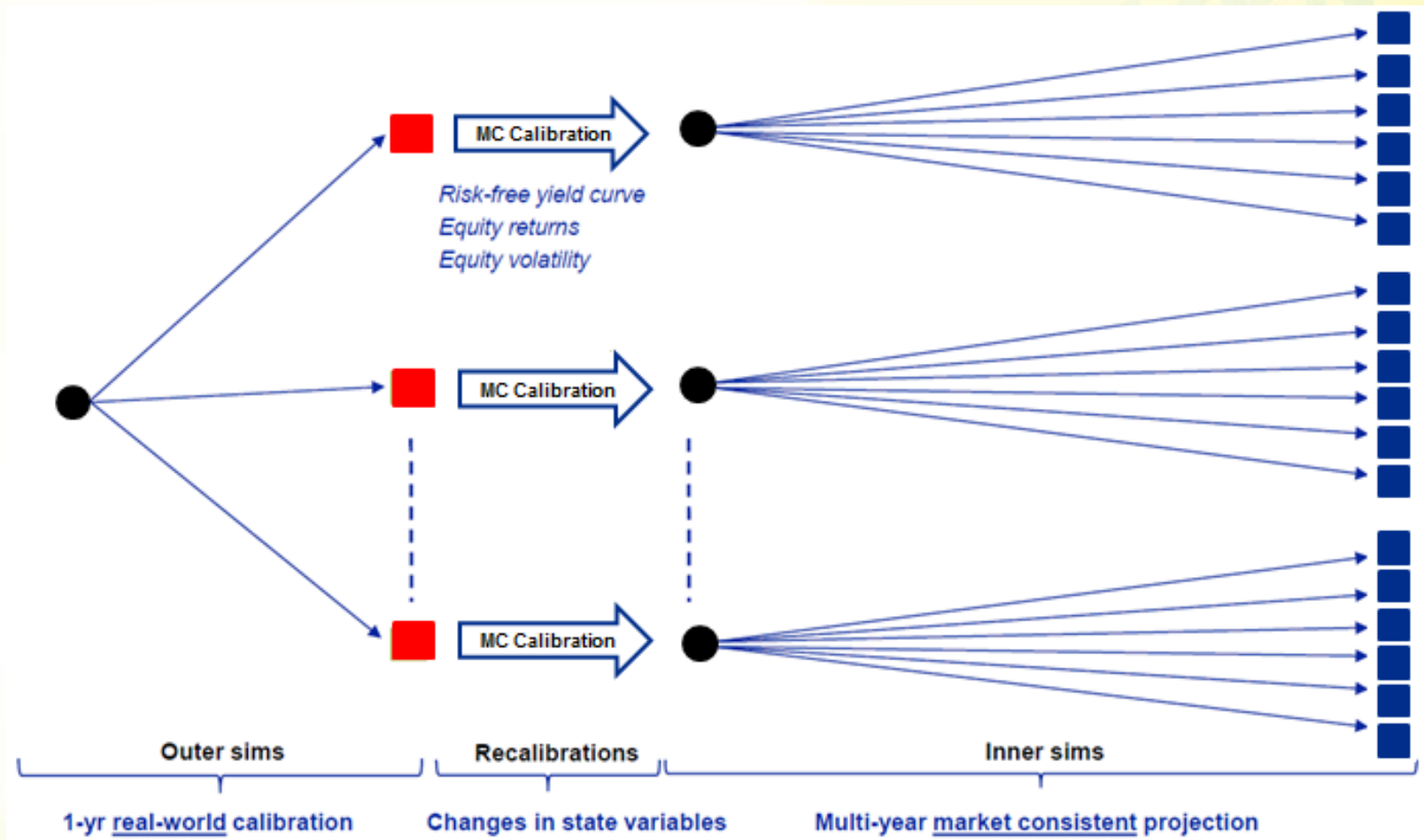


Stochastic Volatility Jump Diffusion model (SVJD)

Model Implied Volatility Surface

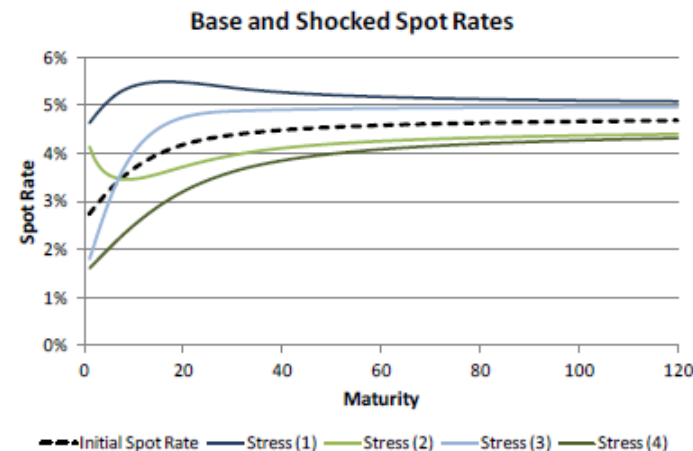
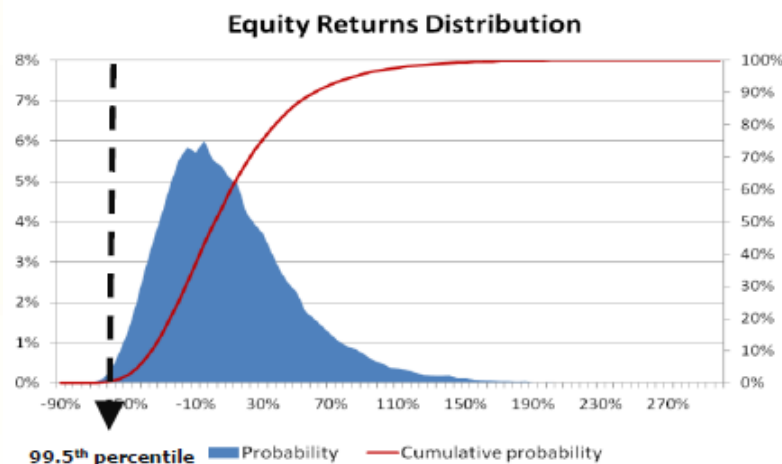


A nested stochastic problem



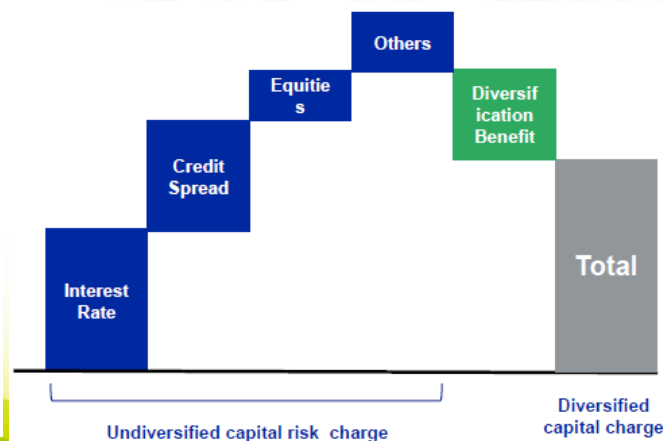
Stress-and-correlate

Identify the 99.5th percentile of each risk factor and the capital charge



Determine diversification and overall capital by a correlation matrix

	RF1 stress -X%	RF2 stress -Y%	RF3 stress -Z%	RF4 stress -AA%	RF5 stress -BB%
RF1 stress -X%	1	0.25	-0.25	0.5	0.25
RF2 stress -Y%		1	0.75	-0.5	0
RF3 stress -Z%			1	0	-0.25
RF4 stress -AA%				1	0.5
RF5 stress -BB%					1



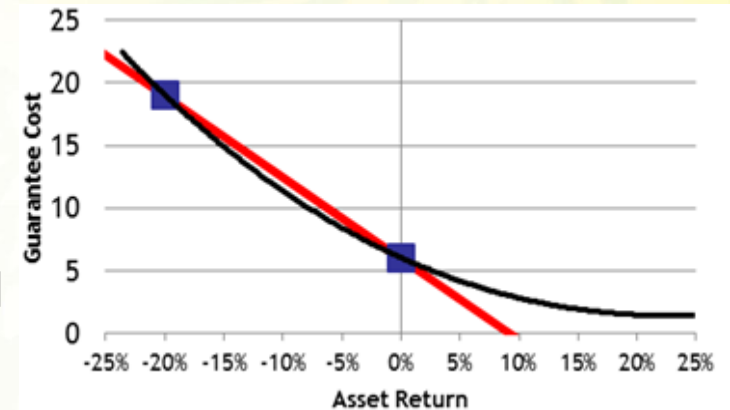
Total Capital

$$= \sqrt{\sum_{ij} \text{Corr}_{ij} \times \text{Capital}_i \times \text{Capital}_j}$$

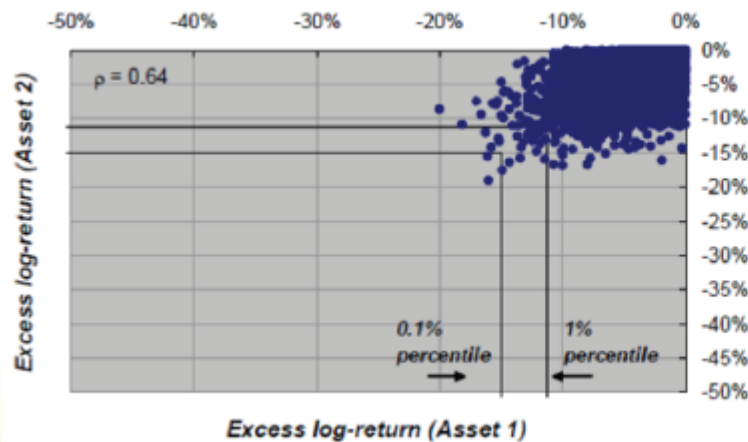
Stress-and-correlate

Simplest method, BUT with big assumptions:

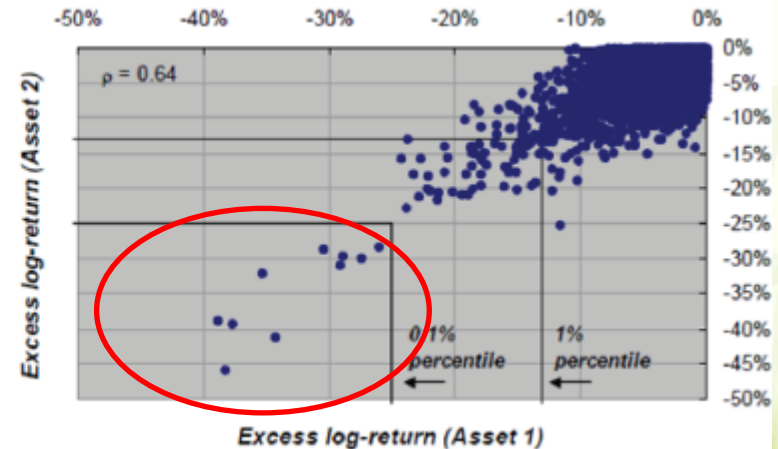
1. Loss is a linear function of the risk factors
2. Risk factors are jointly normally distributed



Bivariate Normal Distribution



Fat Tail, Tail Dependency?

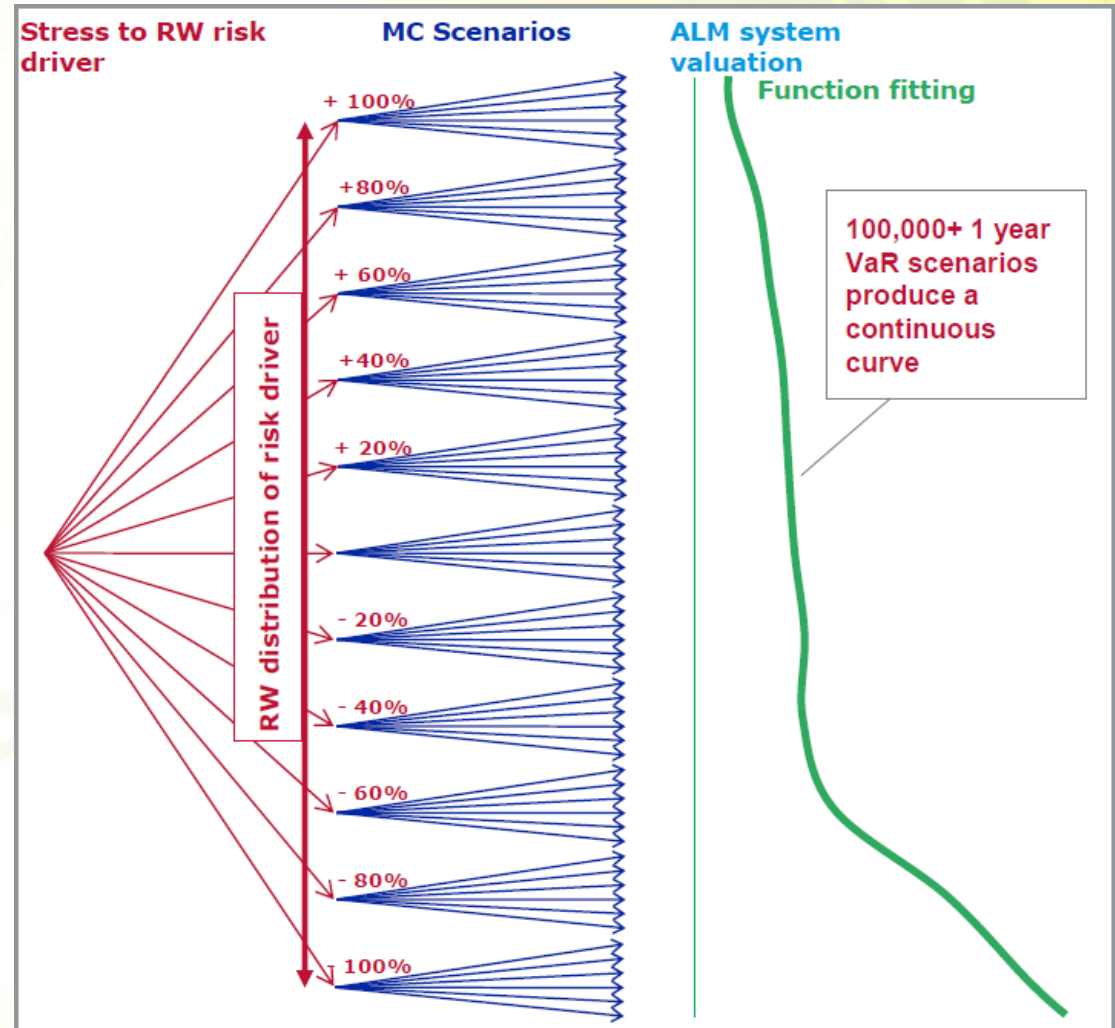


Nested Stochastic

The full nested stochastic approach requires a full set of market consistent scenarios for each 1 year VaR scenario.

This is not practical for life insurer ALM model

Scenario Budget	
1 year VaR Scenarios	100,000+
Market Consistent Scenarios	5,000
Total Scenarios	500,000,000+

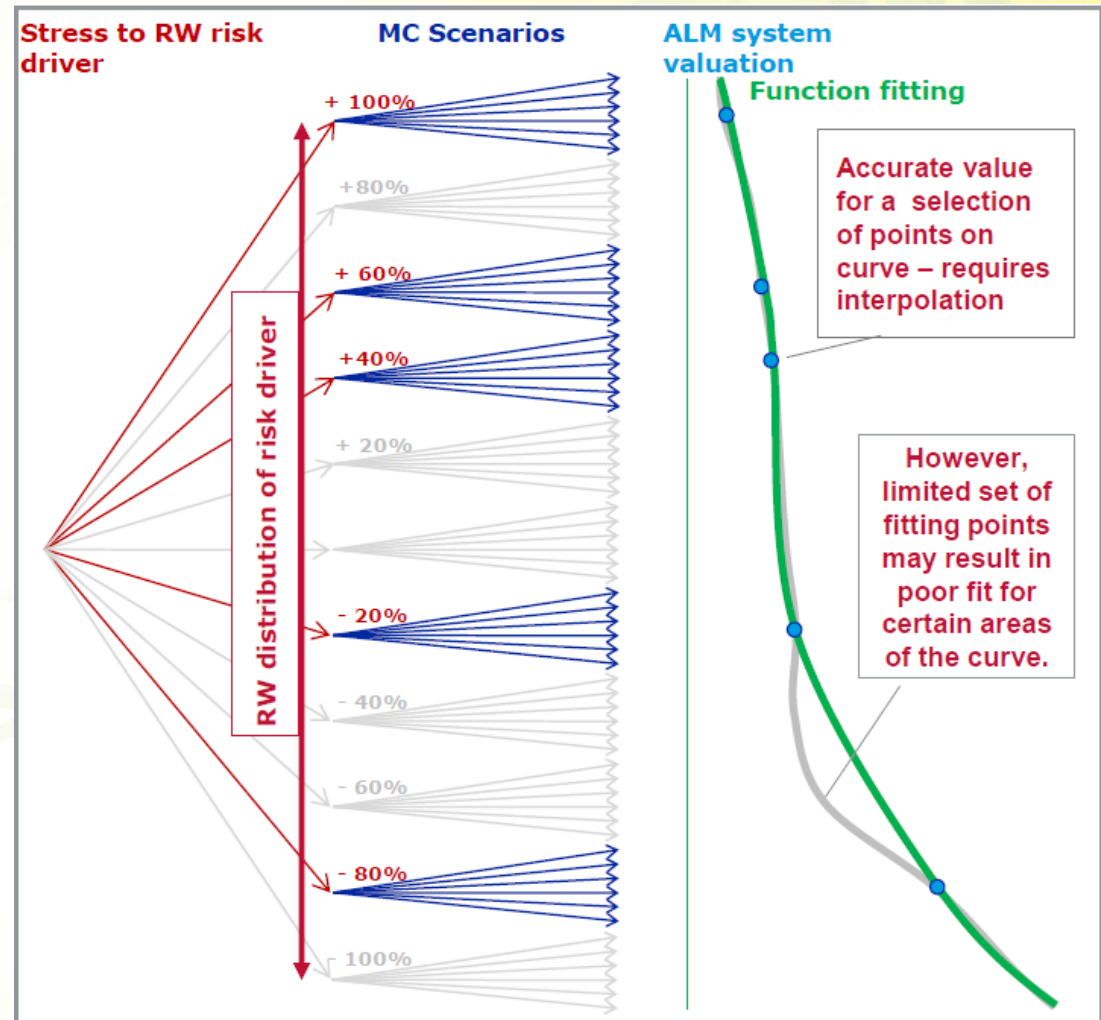


Curve Fitting

Fits a polynomial function through a set of chosen points with accurate valuations

Still a constraint to ALM

Scenario Budget	
1 year VaR Scenarios	50
Market Consistent Scenarios	5,000
Total Scenarios	250,000

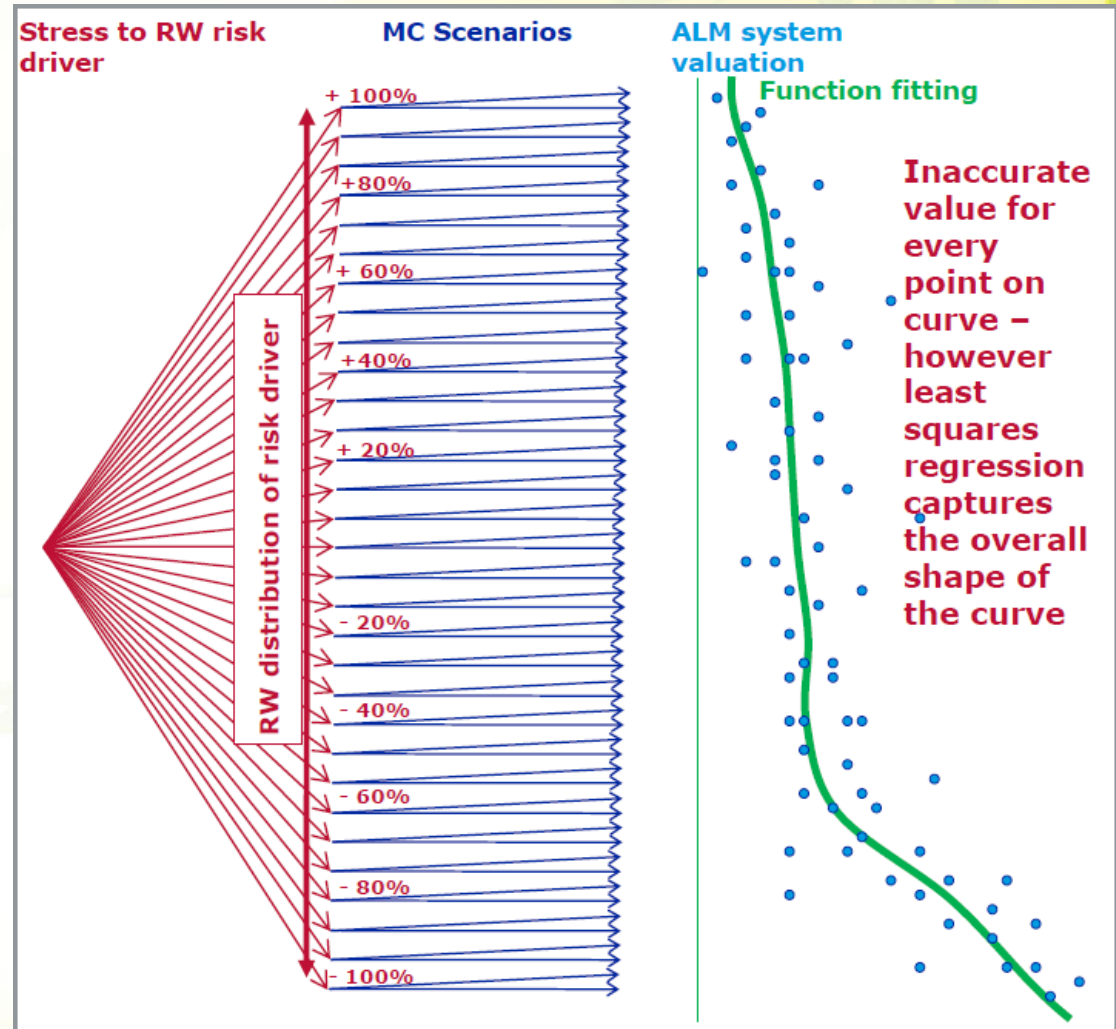


Least Squares Monte Carlo

More fitting points with reduced number of market consistent scenarios

Better fit in capturing the overall shape

Scenario Budget	
1 year VaR Scenarios	50,000
Market Consistent Scenarios	2
Total Scenarios	100,000



Economic Capital Methods

Key criteria for a good method:

Accuracy

- Tail estimate, joint risk factor dynamics, non-linearity...

Measurability of errors

- How good is the fit (and how to validate)?

Fitting efficiency

- Number of simulations needed?

Ease of implementation

- Fast, automated, easy to communicate, need subjective judgments?

Use as a practical management tool

- Provide full probability distribution, extendable to multi-year projections?

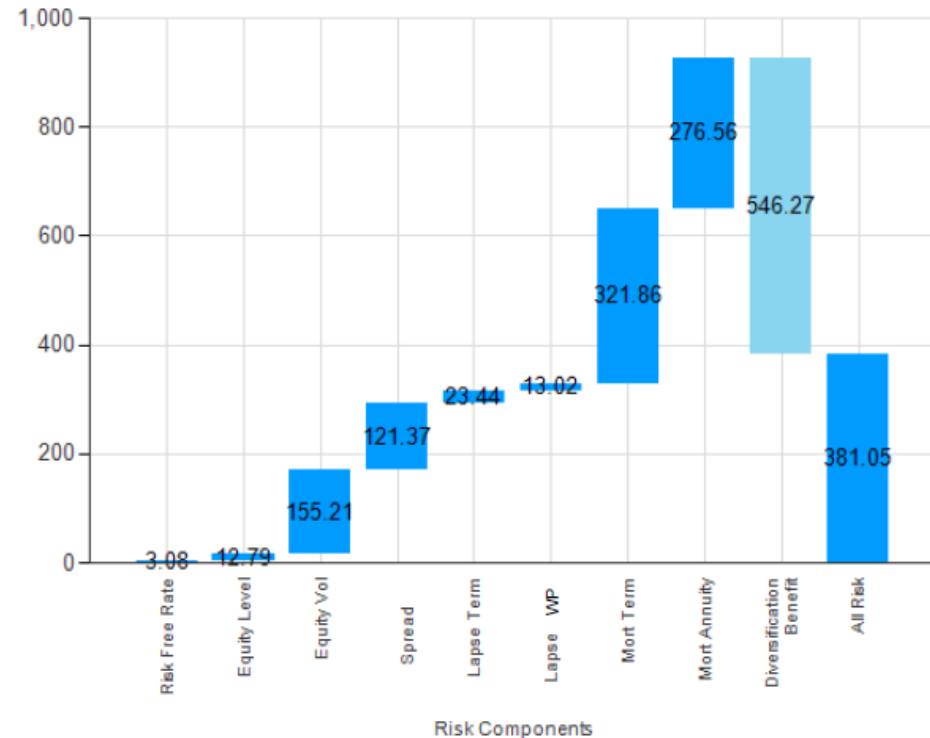
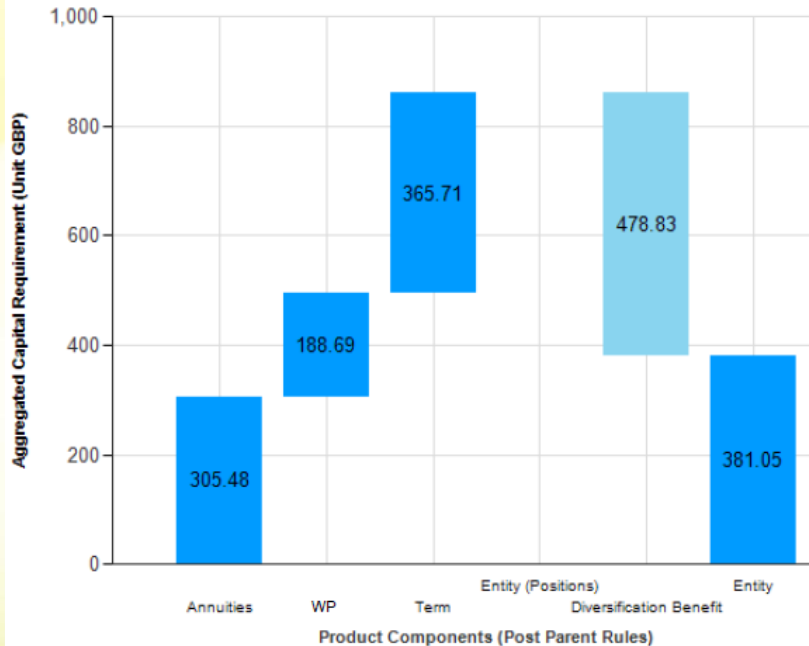
A comparison

	Stress-and-Correlate	Curve Fitting	LSMC
Accuracy			
Measurability of errors			
Fitting efficiency			
Ease of Implementation			
Use as a practical management tool			

Capital attribution

Insurers are often interested on quantifying how the overall capital can be attributed to:

1. Sub-portfolios (e.g. Business units, geographical locations, product types)
2. Risk factors



Validation of the EC model

Back-testing

- Comparison against actual realized outcomes; P&L attribution

Sensitivity Testing

- Impact of the variations in assumptions on the modelling conclusions

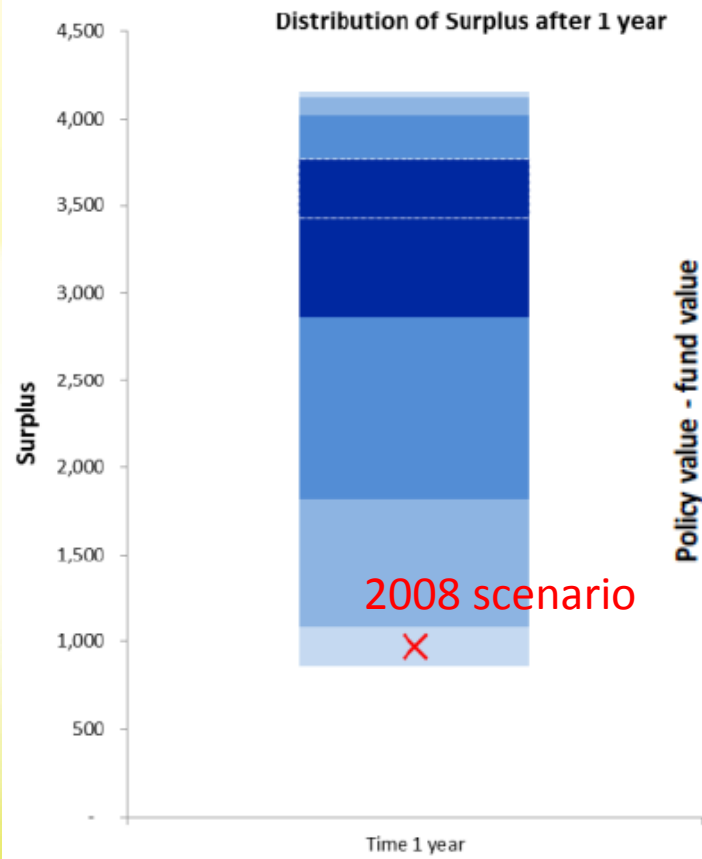
Stress and Scenario Testing

- Comparison against specific historical events or forward-looking downside risk.

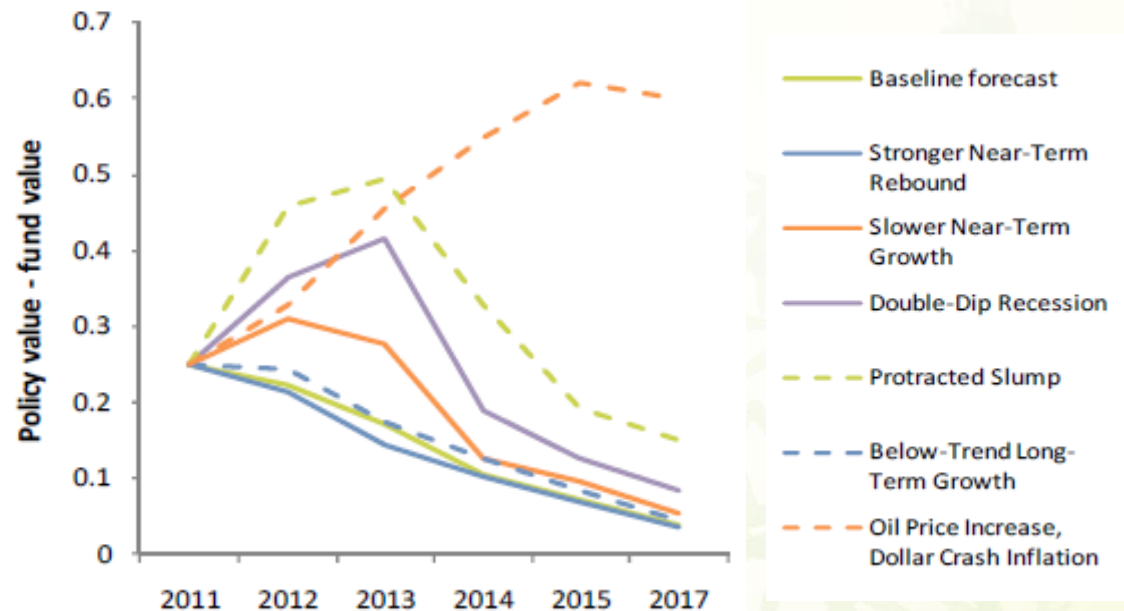
Scenario Testing examples

An intuitive and pragmatic way of probing the performance of the model

Historical Stress Event



Forward-looking Scenarios



Implementation Challenges

- **Planning**

Timeline, resources, budget, and also the technical roadmap

- **Knowledge development**

Continuous knowledge transfer and up-to-date documentation

- **Timeliness of calculation**

Timely calculation engine and workflow automation

- **Data management and Reporting tools**

End-to-end process to ensure good data quality and robust reporting

Thank you!

© 2014 Moody's Analytics, Inc. and/or its licensors and affiliates (collectively, "MOODY'S"). All rights reserved.

ALL INFORMATION CONTAINED HEREIN IS PROTECTED BY LAW, INCLUDING BUT NOT LIMITED TO, COPYRIGHT LAW, AND NONE OF SUCH INFORMATION MAY BE COPIED OR OTHERWISE REPRODUCED, REPACKAGED, FURTHER TRANSMITTED, TRANSFERRED, DISSEMINATED, REDISTRIBUTED OR RESOLD, OR STORED FOR SUBSEQUENT USE FOR ANY SUCH PURPOSE, IN WHOLE OR IN PART, IN ANY FORM OR MANNER OR BY ANY MEANS WHATSOEVER, BY ANY PERSON WITHOUT MOODY'S PRIOR WRITTEN CONSENT.

All information contained herein is obtained by MOODY'S from sources believed by it to be accurate and reliable. Because of the possibility of human or mechanical error as well as other factors, however, all information contained herein is provided "AS IS" without warranty of any kind. Under no circumstances shall MOODY'S have any liability to any person or entity for (a) any loss or damage in whole or in part caused by, resulting from, or relating to, any error (negligent or otherwise) or other circumstance or contingency within or outside the control of MOODY'S or any of its directors, officers, employees or agents in connection with the procurement, collection, compilation, analysis, interpretation, communication, publication or delivery of any such information, or (b) any direct, indirect, special, consequential, compensatory or incidental damages whatsoever (including without limitation, lost profits), even if MOODY'S is advised in advance of the possibility of such damages, resulting from the use of or inability to use, any such information. The ratings, financial reporting analysis, projections, and other observations, if any, constituting part of the information contained herein are, and must be construed solely as, statements of opinion and not statements of fact or recommendations to purchase, sell or hold any securities.

NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE ACCURACY, TIMELINESS, COMPLETENESS, MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OF ANY SUCH RATING OR OTHER OPINION OR INFORMATION IS GIVEN OR MADE BY MOODY'S IN ANY FORM OR MANNER WHATSOEVER.

Each rating or other opinion must be weighed solely as one factor in any investment decision made by or on behalf of any user of the information contained herein, and each such user must accordingly make its own study and evaluation of each security and of each issuer and guarantor of, and each provider of credit support for, each security that it may consider purchasing, holding, or selling.

Any publication into Australia of this document is pursuant to the Australian Financial Services License of Moody's Analytics Australia Pty Ltd ABN 94 105 136 972 AFSL 383569. This document is intended to be provided only to "wholesale clients" within the meaning of section 761G of the Corporations Act 2001. By continuing to access this document from within Australia, you represent to MOODY'S that you are, or are accessing the document as a representative of, a "wholesale client" and that neither you nor the entity you represent will directly or indirectly disseminate this document or its contents to "retail clients" within the meaning of section 761G of the Corporations Act 2001.

Moody's
ANALYTICS