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Quantitative tools for risk management – *stress testing and beyond*

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MOODY'S
ANALYTICS




Agenda

1. ERM objectives
2. Standard stress testing and limitation
3. Case studies
 - » Discrete versus full distribution
 - » Balance sheet projection
 - » Alternative scenario testing
4. Integrated risk management analytics







ERM objectives




- » Increasing requirement from management and regulators on ERM and proper risk management
- » Pressure on actuarial and risk resources
- » How can we integrate these works using some common languages?

- » Best estimate and potential deviation
- » Impact of changing market conditions
- » Assessment of future plausible scenarios
- » Xth percentile 1-year VaR

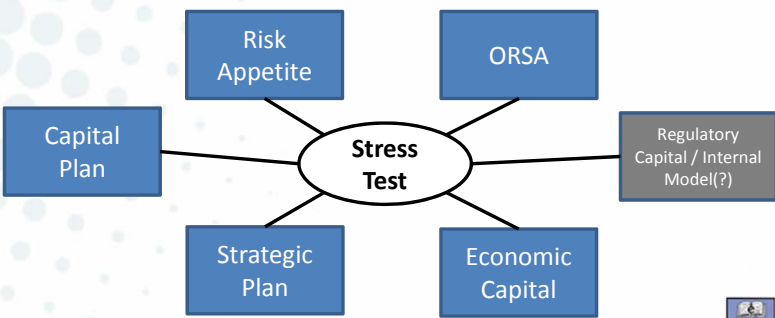





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Standard stress testing

- » Stresses are deterministic and sometimes on arbitrary scale:
 - Yield curve 100 bps up and down
 - Mortality 10% up
 - Etc...



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Standard stress testing

Some drawbacks

- » What is the probability of the stress?
- » How do we determine the magnitude of the stress? Do we linearly scale the shock impact?
- » Impact of non parallel yield curve shifts - given complicated mix of asset and liabilities rates sensitivities?
- » How to cater for simultaneous multiple stresses?



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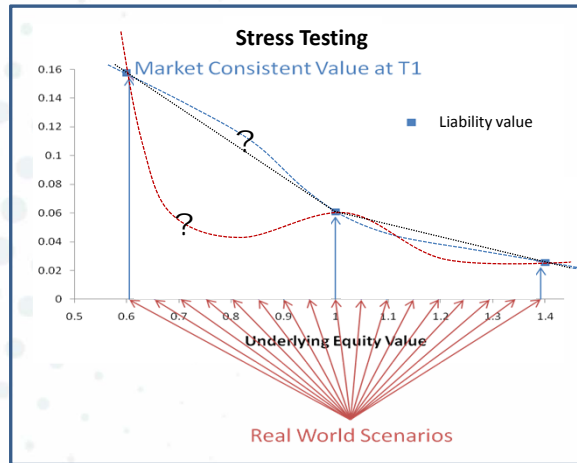


Discrete point vs Full distribution



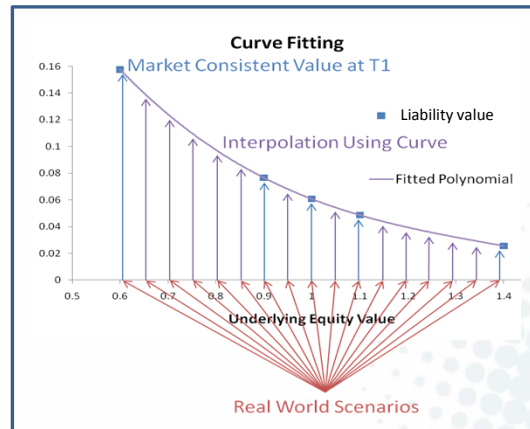
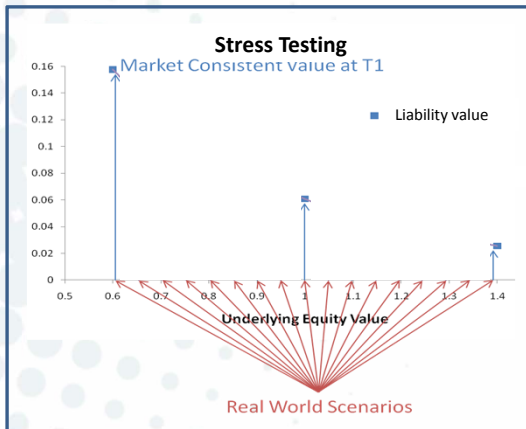
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Discrete point stress testing



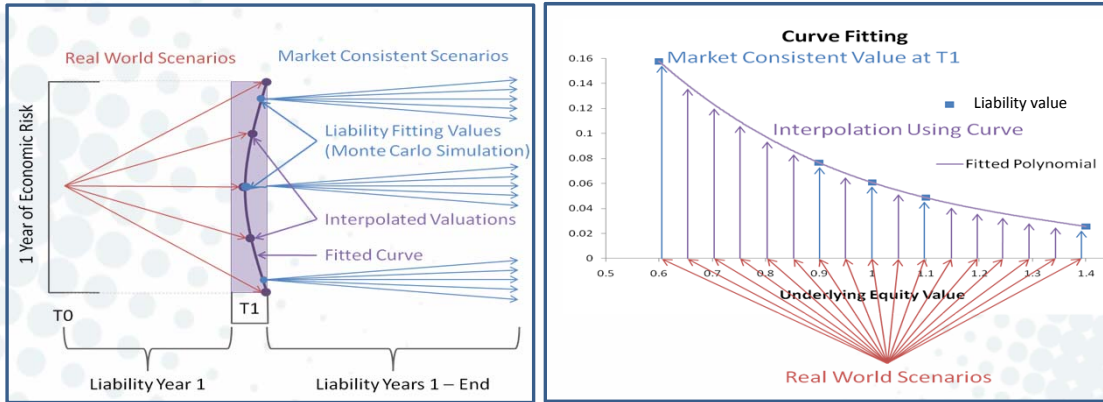
Stress testing

» Run more stresses and “join the dots”



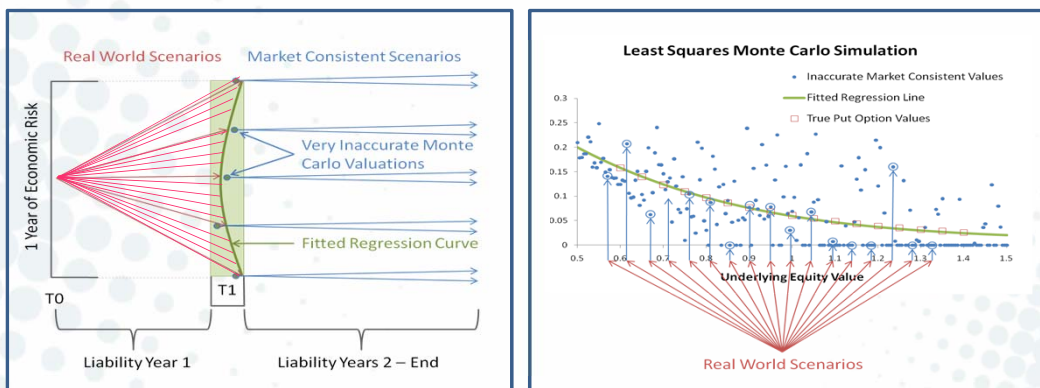
Curve fitting

- » Curve fitting defines a limited set of real world fitting scenarios and then calculates the associated “true” liability values to fit against.



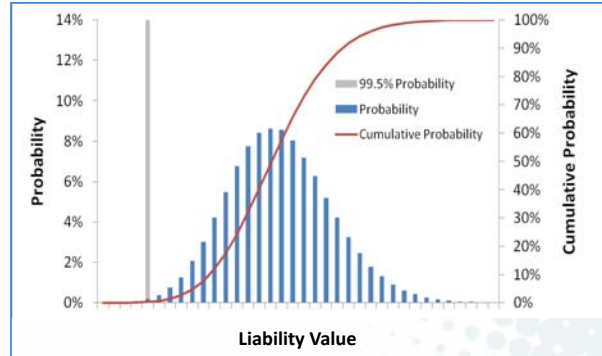
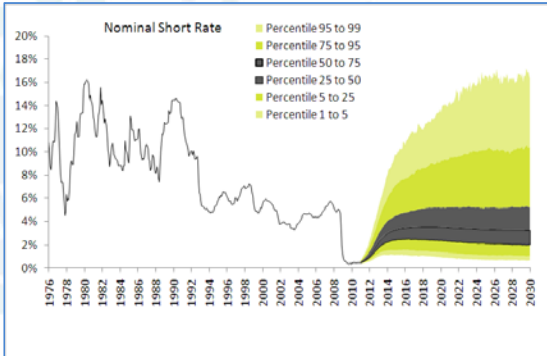
LSMC

- » Least Square Monte Carlo (LSMC) defines a large set of real world fitting scenarios and then calculates the “individual market consistent simulation” liability values to fit against



Full distribution

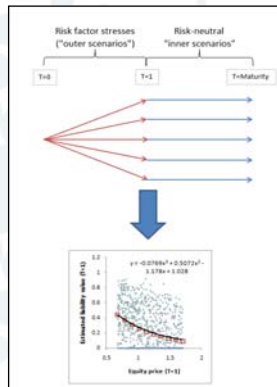
» With the help of real world distribution scenarios:



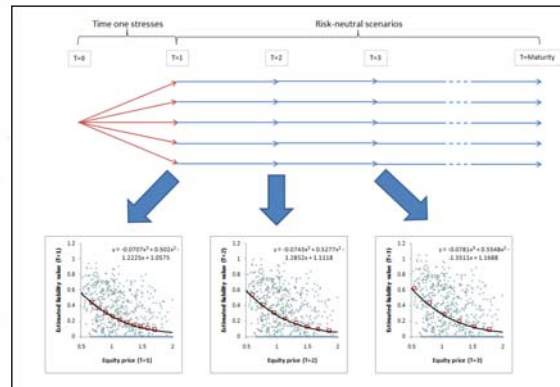
Balance sheet projection

Multi-year proxy function

1-year projection



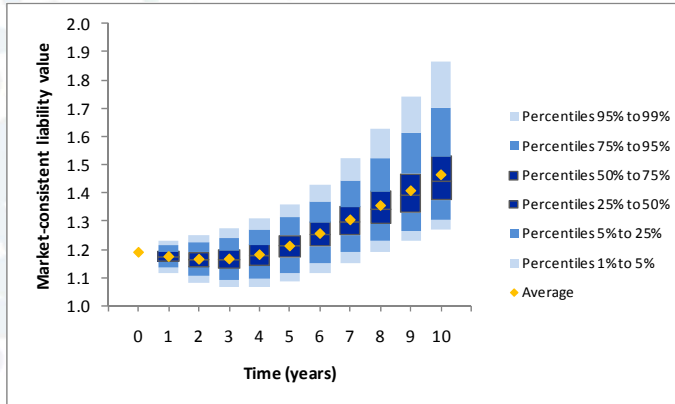
Multi-year projection



Product case study

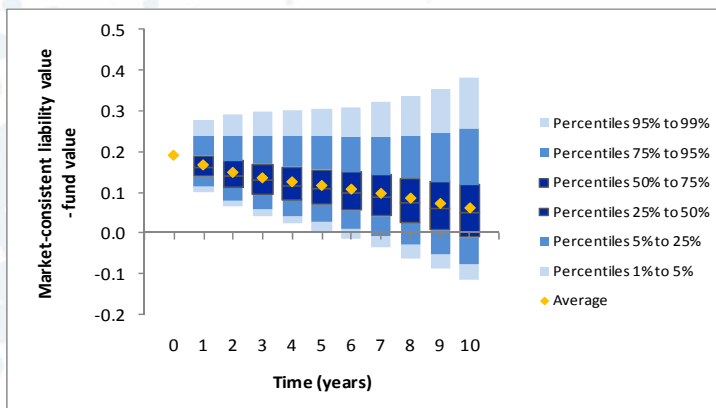
- » Universal Life product (10-year) where annual credited return is:
 - Max (Fund Return – 1.5%, 2%)
- » Fund is invested in diversified portfolio of US corporate bonds
 - 70% A-rated; 30% BBB-rated
 - Term of 8 years
 - Credit rating and term re-balanced annually
- » No allowance for tax, expenses or policyholder decrements

MC liability projection



- » 10,000 10-year real-world simulations
- » Time-0 valuation produced by set of market-consistent scenarios
- » Time-10 valuation is simply the product pay-out in the real-world scenario
- » Proxy function used to estimate market-consistent values in years 1-9

Balance sheet projection



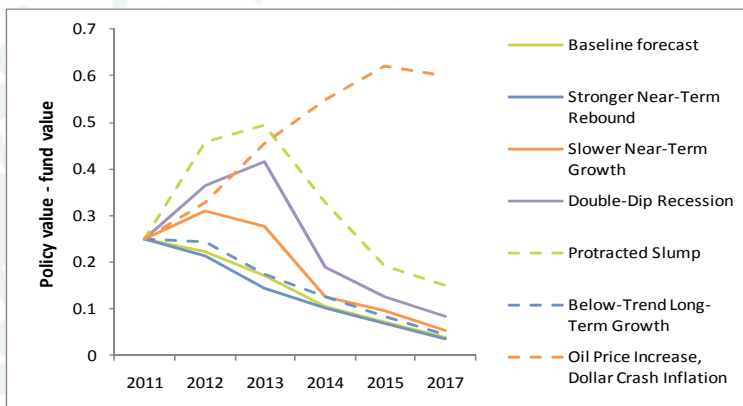
- » M-C deficit is expected to reduce over time due to risk premium in asset fund
- » About 30% probability of product pay-out being less than final asset portfolio value



Alternative scenario testing



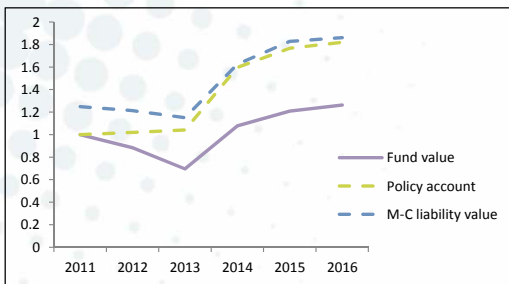
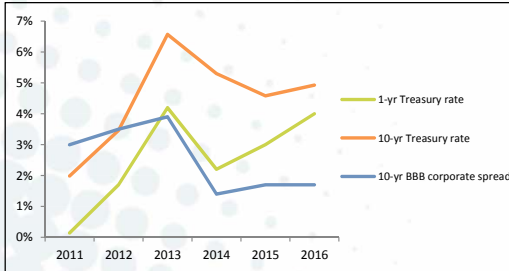
Macro-economic stress tests



- » Following previous universal life product sample...
- » 7 macro-economic, multi-year stress tests, based on economic forecast
- » Proxy function used to project liability valuations through these scenarios
- » What is happening in the oil price scenario?!

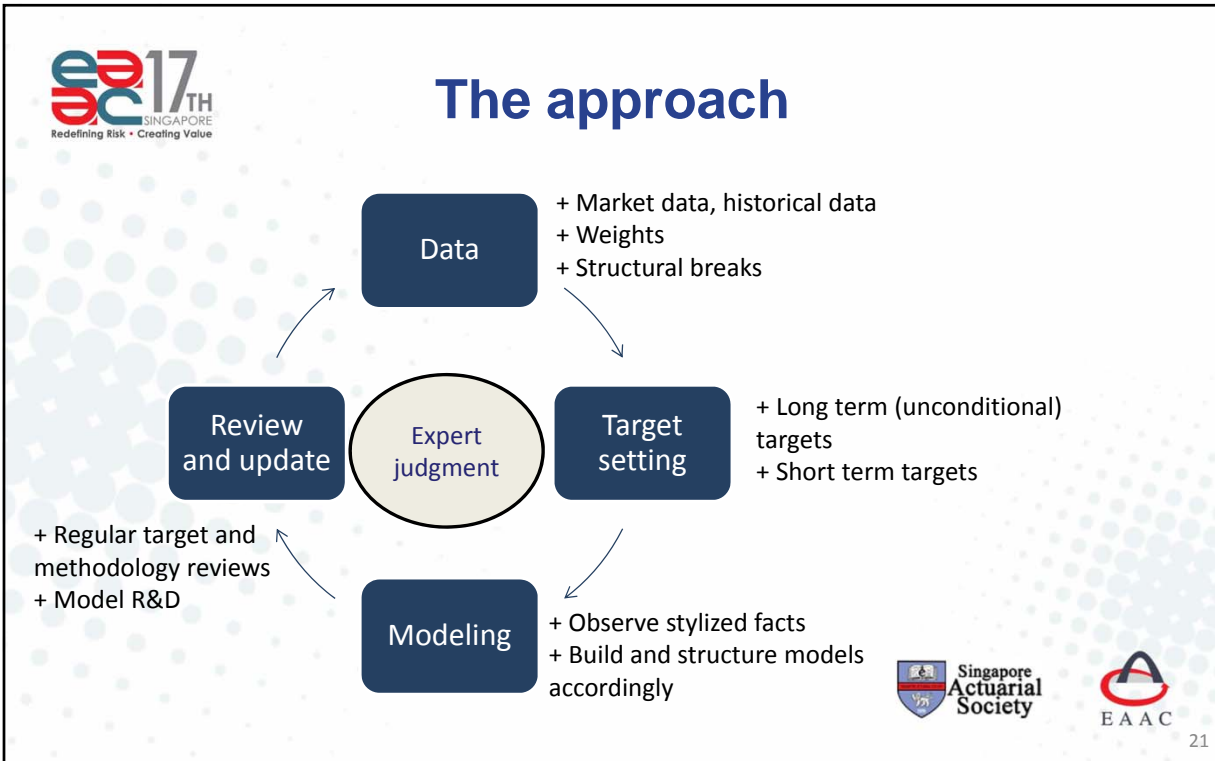


Oil shock scenario



- » 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

Integrated risk management analytics



Modeling

» Goal is to produce realistic and justifiable projections of financial and macroeconomic variables.

- Economic research
- Utilise historical market data
- Validate assumptions and model

USD Real GDP Growth

Long-term correlation targets for real GDP growth rate

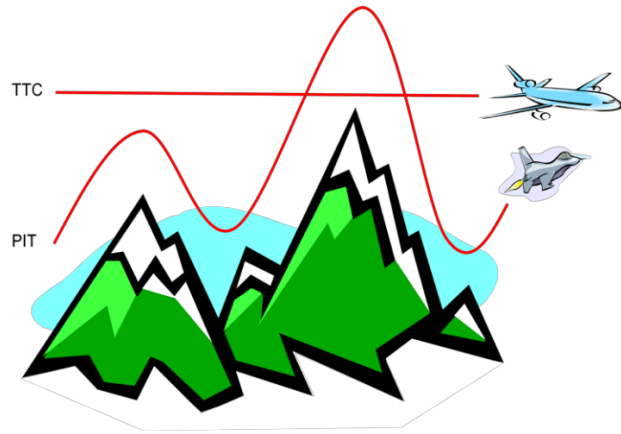
Variable	Key Correlation Targets		
	Expected relationship	Observed correlation	Target
Real short rate	Positive	0.39	0.4
Real Long Rate	Positive	0.22	0.2
Nominal short rate	Unclear	0.02	0.0
Nominal long rate	Unclear	-0.01	0.0
Foreign real GDP	Positive	0.47	0.5
Equity XS returns	Positive/unclear	0.28	0.3
CPI inflation	Negative	-0.25	-0.3

Singapore Actuarial Society
E A A C

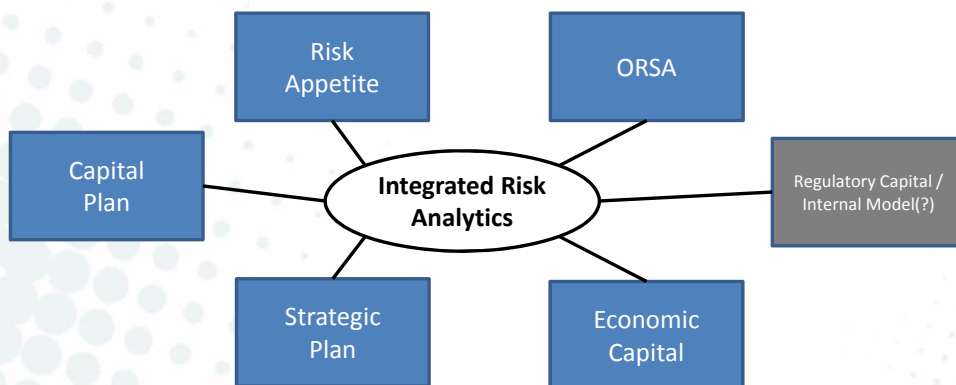
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Calibrations

- » Multiyear / through the cycle long term view.
- » 1 year VaR / conditional calibration to capture current market environment
 - Targeting the distribution at the 1 year horizon
- » Preference will depend on application and horizon of interest



ERM objectives



- » Single time point statistical distribution
- » Multi-year projected statistical distribution
- » Mapping macro-economic scenario to market risk factors



Thank you!

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