The Actuarial Profession
making financial sense of the future

# Changing your ICA model to a Solvency II Internal Model

## How hard can it be!?

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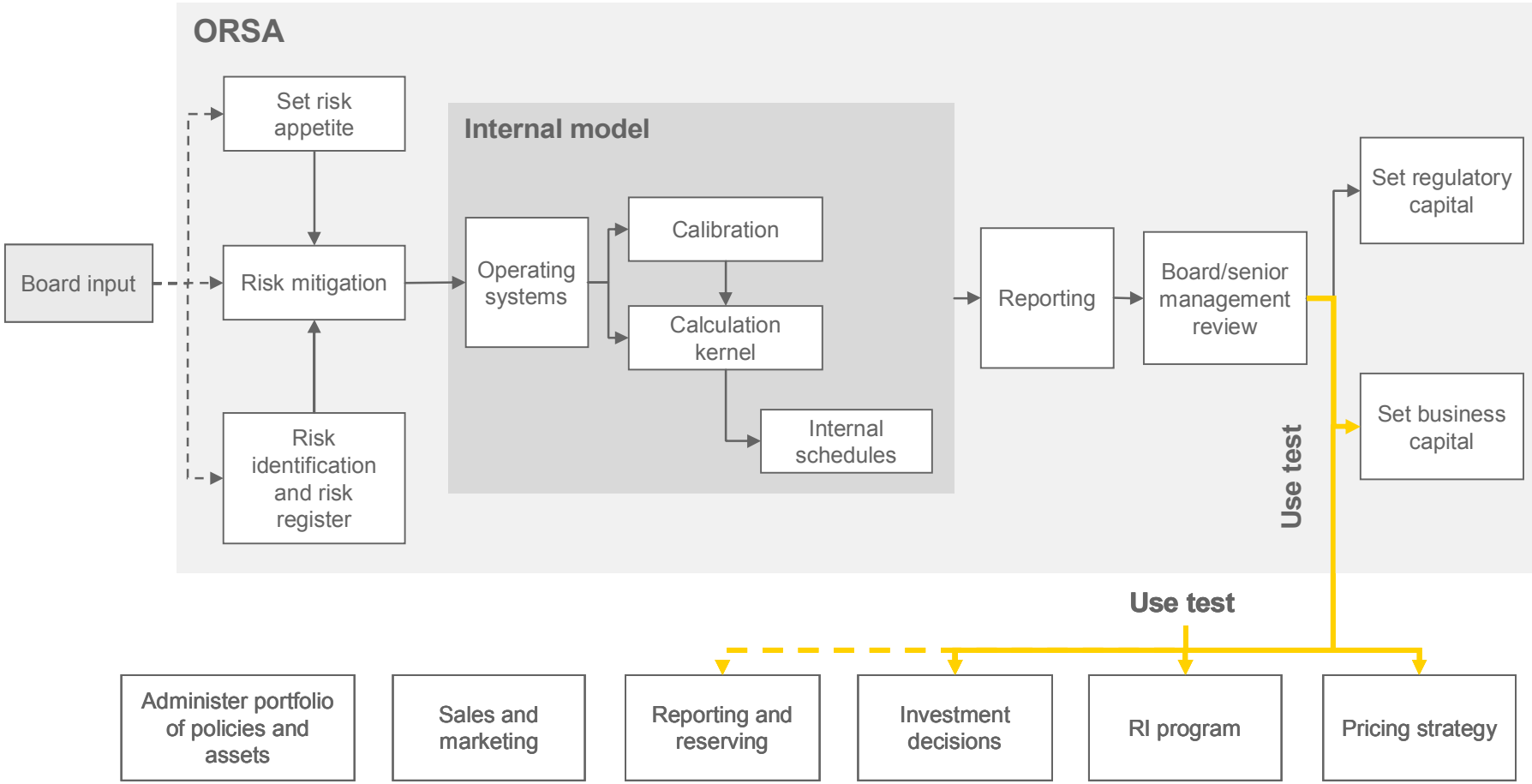
# IMAP - Summary of requirements

| Requirement | Summary of FSA DP08/4 | CP 56 |
|---|---|---|
| Use Test | Lists possible uses including reinsurance, capital allocation, IM, MI, Strategy, Finance | Fundamental requirement, use of the model should result in pressure to improve it. 9 principles describing the use test |
| Statistical Quality Standards | Need to select, fit and combine distributions, allowing for dependencies, mitigations and management actions. Use accurate and complete data at the appropriate resolution | Actuarial methods should be applicable, relevant, appropriate, up to date, transparent, detailed, parsimonious, robust and sensitive.<br>Identify all assumptions and justify them<br>Demonstrate data quality standards and implement policy |
| Calibration standards | Choice of time period and risk measure should be appropriate but also produce SCR.<br>Benchmark portfolios or assumptions may need to be run | Choice of time period and risk measure should be appropriate but also produce SCR.<br>Benchmark portfolios or assumptions may need to be run |
| Profit and Loss attribution | Model should be capable of predicting possible sources of P+L, and there should be a control cycle and back testing to ensure new experience is incorporated into the model | Model should be able to explain a large proportion of annual profit/loss. |
| Validation | There should be a regular cycle of objective challenge by an independent function that has the necessary skills to perform such a review. | Validation encompasses all qualitative and quantitative aspects of the model, including expert judgment and documentation, and is laid out in a policy. Includes back-testing, sensitivity testing and comparison to extreme scenarios. |
| Documentation | Needs to be detailed and complete so that a third party can understand the model, and should include any areas where model is weak. Should be updated regularly. | Documentation should include evidence that all levels of management understand the relevant aspects of the model. |
| External models | Need to comply with internal model requirements | Use of external models shall be appropriate to the nature of the risks. Each model should be justified as well as documenting alternatives considered and why it was chosen. Policy for validating and reviewing model |

DP08/4 is the FSA discussion paper titled “Insurance Risk Management: The path to Solvency II

CP56 is CEIOPS consultation paper number 56 regarding IMAP

# Internal Model – Context and Details



# Where are we now?


| Criteria | 1. Innocent | 2. Aware | 3. Developing | 4. Advanced | 5. Market leading |
|---|---|---|---|---|---|
| **Valuation methodology** | ▪ Statutory minimum reserving only, using case estimates or mainframe systems<br>▪ Limited analysis of experience | ▪ Basic Non-life statistical tools<br>▪ Reserves monitored on key metrics | ▪ Non-life cashflow models<br>▪ Full range of standard actuarial techniques | ▪ Blend of stochastic reserving and standard actuarial techniques<br>▪ Estimates contain explicit risk margin with explanation | ▪ Full economic balance sheet, reported in controlled general ledger system (IFRS Phase II)<br>▪ Direct link with risk modelling |
| **Statistical Quality Standards** | ▪ Not aware of key risks<br>▪ Regulatory minimum solvency tests performed only | ▪ Awareness of key risks<br>▪ Using a external model to measure risk, such as S&P, BCAR or Solvency II standard model | ▪ Awareness of key risks<br>▪ Analysis of own risk distributions and volatility<br>▪ Partial internal model used for selected risks<br>▪ Additional scenario tests | ▪ Full internal model for all key risk exposures<br>▪ Detailed scenario testing<br>▪ Sensitivity analysis of key assumptions<br>▪ Links between risk models | ▪ Consistent modeling of extra- and intra-group instruments<br>▪ Sophisticated aggregation techniques (e.g. copulas, driver modeling) |
| **Control and validation** | ▪ None | ▪ Documentation of roles and responsibilities | ▪ Research environment, manual controls<br>▪ Some formal sign off<br>▪ Limited senior management review | ▪ Internal (independent) model validation departments. Use of checklist and work programs | ▪ SOX-like controls around internal model<br>▪ Independent model validation |
| **Documentation** | ▪ Regulatory reporting only | ▪ Regulatory report<br>▪ Some ad-hoc documentation | ▪ Covers most technical aspects of model<br>▪ Includes most updates, changes and testing | ▪ All technical aspects<br>▪ All testing, validation<br>▪ Sign off assumptions throughout company | ▪ All model aspects<br>▪ Context of model, eg, risk appetite, risk register etc.<br>▪ ORSA |
| **Use test** | ▪ Used for regulatory reporting only | ▪ Used for regulatory reporting and some cost benefit analysis eg,RI spend | ▪ Used in capital management, capital allocation | ▪ Used in pricing and performance measurement | ▪ Key element of regular board-level MI, used to drive a wide range of strategic decisions |

# Comparing models to requirements

| Model | Use Test | SQS General | SQS Time horizon | SQS Risk Margin | Calibration | P+L | Validation | Docum entation | External Models |
|---|---|---|---|---|---|---|---|---|---|
| Pure Stress and Scenario | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ? | ✗ | ✗ |
| Only Insurance Risk Stochastic | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ? | ✗ | ✗ |
| Stochastic Insurance, Market and Credit risk | ? | ✓ | ✗ | ✗ | ? | ? | ? | ✗ | ✗ |
| Full stochastic with annual projections | ? | ✓ | ? | ✗ | ? | ? | ? | ✗ | ✗ |

✗ Probably not ? Possibly ✓ Probably

SQS refers to Statistical Quality Standards

# Converting an ICA model - Options

To move from an ICA model to the calculation kernel there are three possible options:-

- Rebuild from scratch
- Modify and improve existing kernel
- Kernel unchanged - estimate and extract different results

The choice depends upon the current structure.

Additionally there will be a significant amount of work around the kernel to satisfy the other requirements.

# Conversion - Possible steps

- Reporting - decide on uses and outputs of model
- Determine structure of model
- Practicalities (Data, Resources, Timelines etc)
- Cross reference to current model and capabilities
- Create/Update technical aspects of model
  - Calendar Year Volatilities
  - Risk Margin
- Validate and document model (plus plan future cycles)
- and then use it!.....

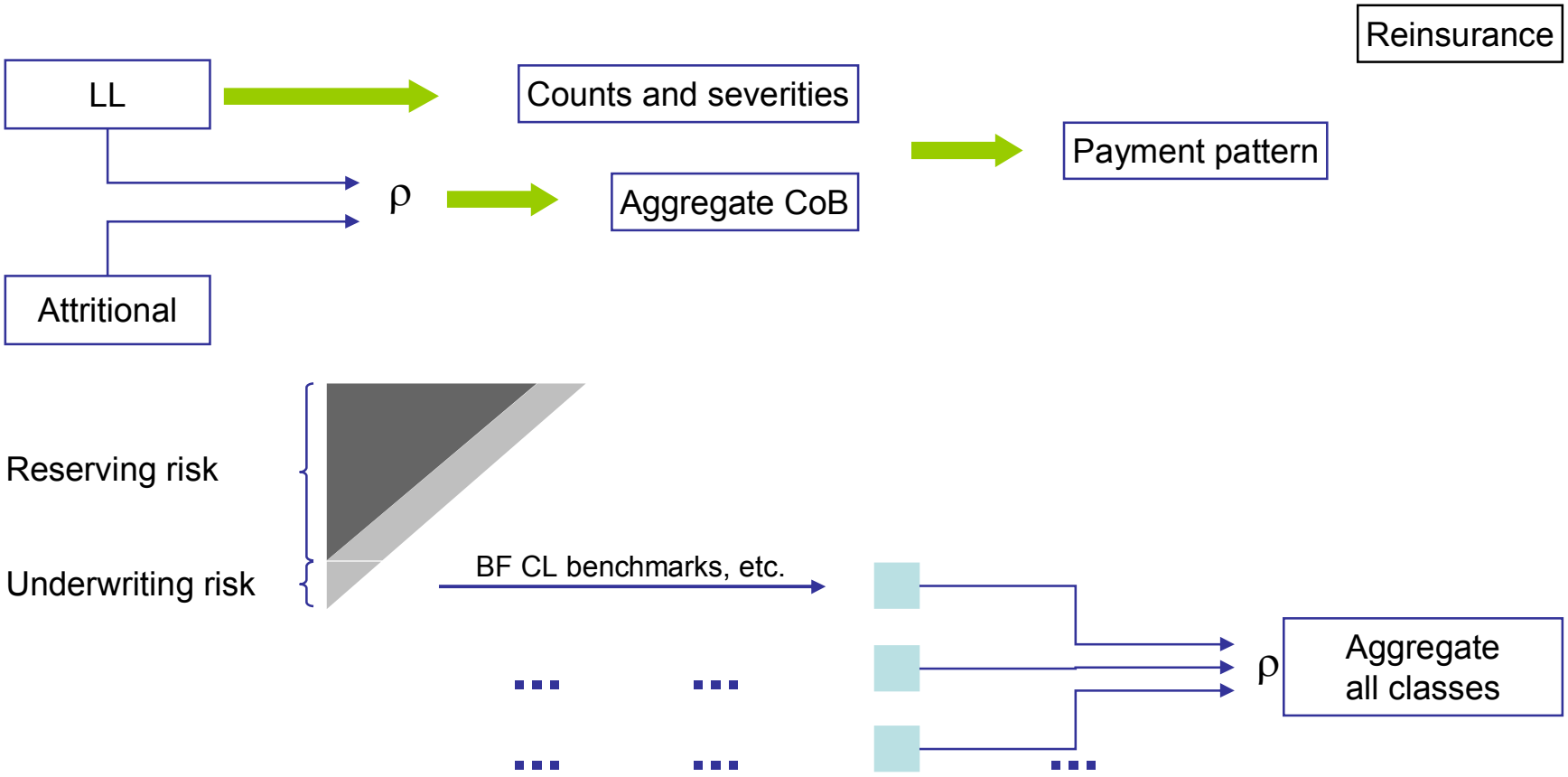
# Conversion - Technical Issues

- Calendar year volatilities and correlations
- Risk margin
- Reporting
- Comparison to ICA and Standard Formula

# One Year Volatilities

- Obviously different from “ultimate” versions
  - Drivers of risk/volatility
  - Data and modelling requirements
  - Relationships between risks (correlations)
- Need to model the movements within the year as well as the closing balance sheet.
- Eg, from an UW risk perspective:-
  - Paid claims within the year
  - OS claims within the year
  - IBNER reserve required at year end
  - Pure IBNR reserve required at year end

# Calendar Year Volatilities - UW Risk



# Calendar Year Volatilities - Reserve Risk

Reserve risk can be estimated using one of two main approaches:

1. Formulaic calculation of the Variance coupled with a distribution assumption
2. Monte-Carlo simulation using bootstrapping techniques

# Reserve Risk - Analytical approach

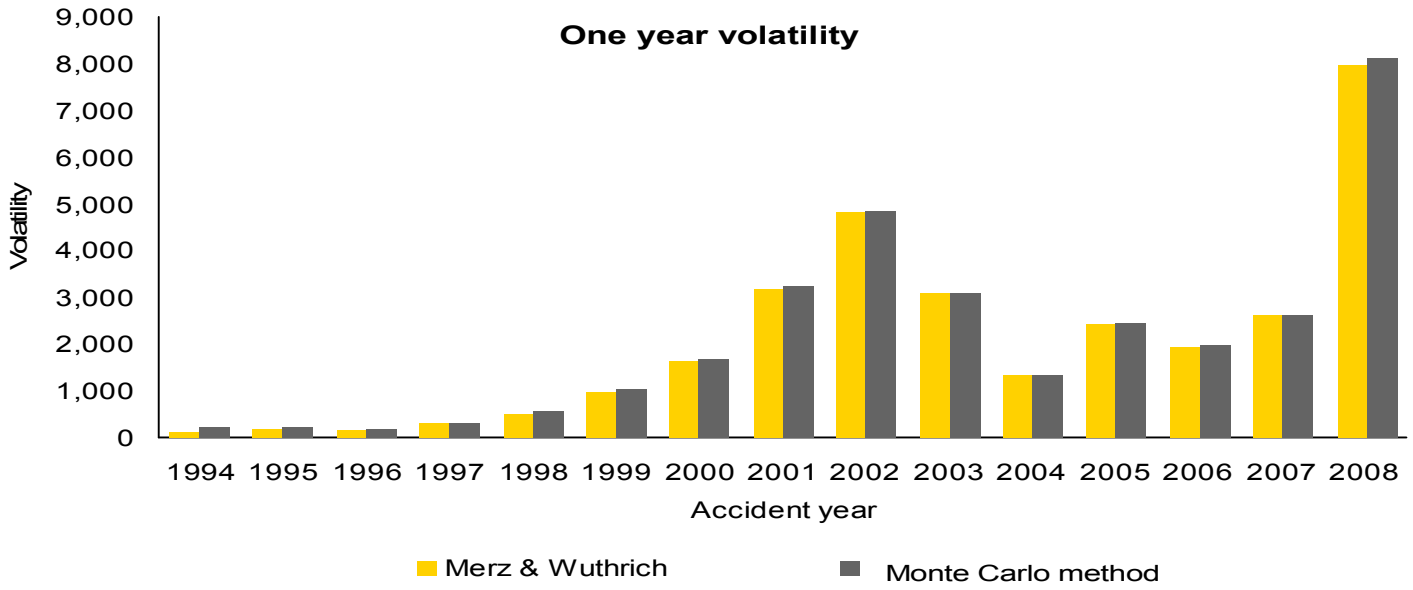
- Estimate the variance of the reserve
- Assume a distribution for the reserve eg, LogNormal
- Estimate the reserve risk as the 99.5$^{th}$ percentile deterioration

# Analytical approach - Merz-Wuthrich formula as an example

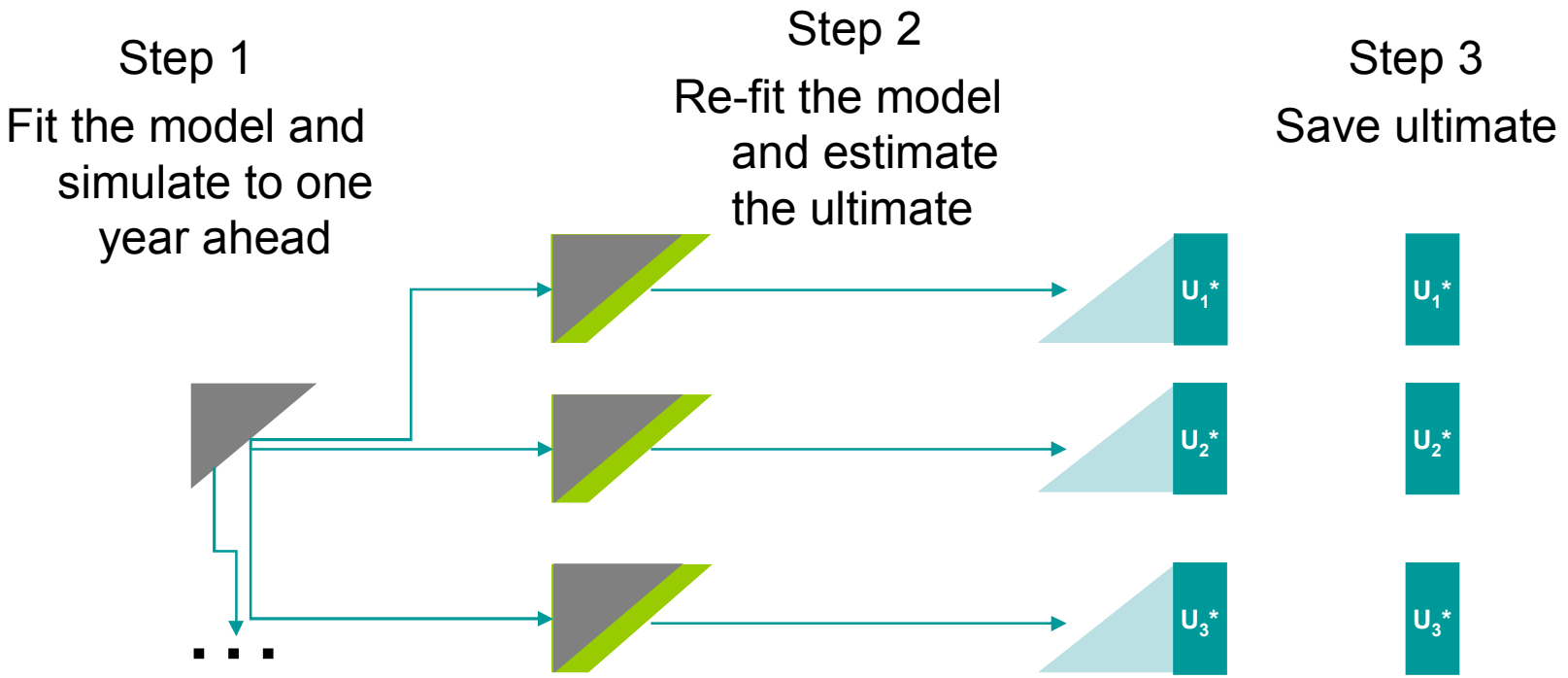
- Assuming a Mack-Murphy claim model the variance was devised by Merz & Wuthrich, at ASTIN.
- Results are based on Murphy's model which assumes residuals are independent however this is not exactly the nonparametric Mack's model.
- However:-
  - The model assumes path dependent claims amounts, ie, the residual movement depends upon the current value.
  - The chain ladder is the optimal estimate, like in Mack's model
- The one year volatility formula for the non-parametric Mack model has not yet been found yet.

# Analytical Approach - Example

- Determined the formula based on the ODP model as a test case, it does not assume path dependant claim amounts



# Reserve Risk - Monte Carlo approach

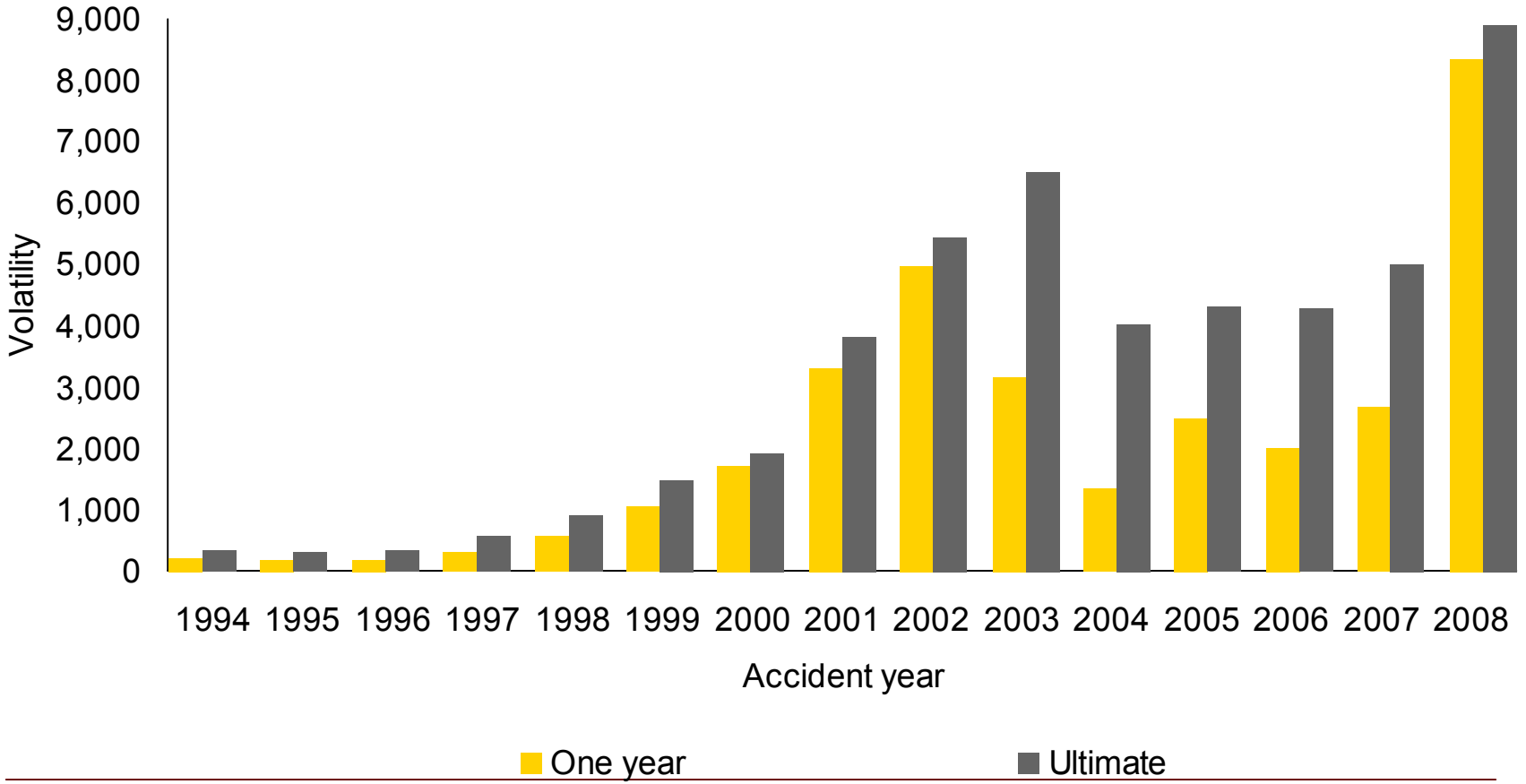



- If U* is the random variable generated by the above simulation. The one year volatility refers to the distribution of the difference between U* and the currently estimated ultimate.

- The 99.5%le of that distribution is the required SCR (ignoring MVM)

# Monte Carlo Example

**Simulated results**



# Further Technical Issues with One Year Modelling

- Correlations
- Reinsurance
- Timings
- Other

# Calendar Year Modelling - Correlations

- Correlations will need to change as the relationships between risks have changed:-
- Reserve risk
  - Key drivers are now reserve bias, management actions and mis-estimation, suggests these may be similar across all classes rather than depending on type of business
- UW risk
  - Depends on length of tail, but pressure to meet plan may result in negative correlation!?
- Between Reserve and UW risk
  - This strongly depends on the length of tail and size of shock
- Still little data to use in any parameterisation

# Calendar Year Modelling - Other Issues

- Reinsurance
  - Reserve risk - approach depends upon materiality
  - UW risk - calendar year gross losses have been estimated and can be put through RI programmes
- Credit risk - includes reinsurers, brokers and others
- Catastrophes - External models tend to produce calendar year results. These are currently “grossed up” to allow for a full future underwriting year.

# Conversion - Technical Issues - Risk Margin

- Capital defined as the 99.5% potential deterioration in economic balance sheet in one year time
- MVM is the expected cost of all such future capital amounts

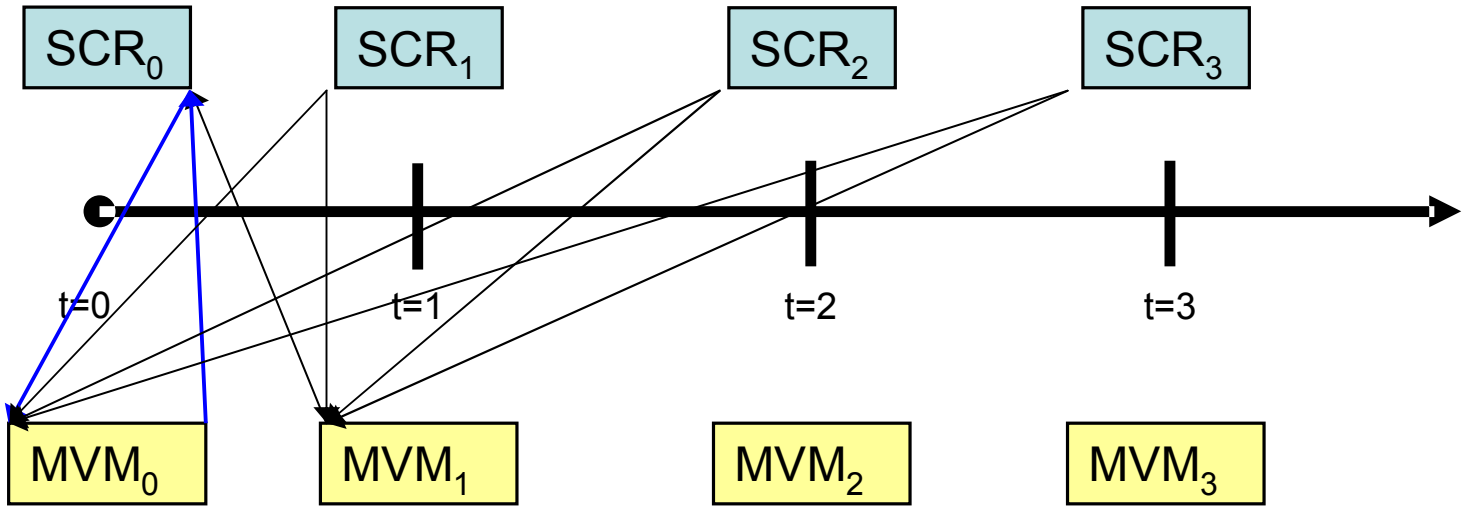
$$MVM_T = CoC \times \sum_{t=T}^{N-1} SCR_t$$

$$SCR_t = 99.5\%\left[MVM_{t+1} + E\left(C_N \middle| C_{t+1}\right) - MVM_t - E\left(C_N \middle| C_t\right)\right]$$

- Here Ct is the cumulative loss at time t, T is current year, N is the final claim year and p%[X] indicates the p% percentile of the probability distribution of X

# Risk Margin - Circularity

- $SCR_0$ depends on the movement in MVM and so depends on $MVM_0$, $MVM_0$ depends upon $SCR_0$



# Risk Margin - QIS 4 Proxy

- Circularity can be an issue, the CRO forum paper and QIS 4 proxy assume the effect of the MVM on future SCR amounts is negligible
- The QIS4-suggested proxy is

$$MVM_T = CoC \times SCR_T \times \left[1 + \sum_{t=T}^{N-1} \frac{R_{t+1}}{R_T}\right]$$

- Where Rt are the time-t reserves as expected at current time T

$$R_t = E\left[C_N - C_t \middle| C_T\right]$$

- This is equivalent to approximate:
- $SCR_{T+1}$ □ SCRT $(R_{T+1}/R_T)$
- $SCR_{T+2}$ □ SCRT $(R_{T+2}/R_T)$
- …
- $SCR_{N-1}$ □ SCRT $(R_N/R_T)$
- The implicit assumption is that the capital requirement decreases proportionally to the reserve

# Risk Margin - Testing QIS 4 Proxy

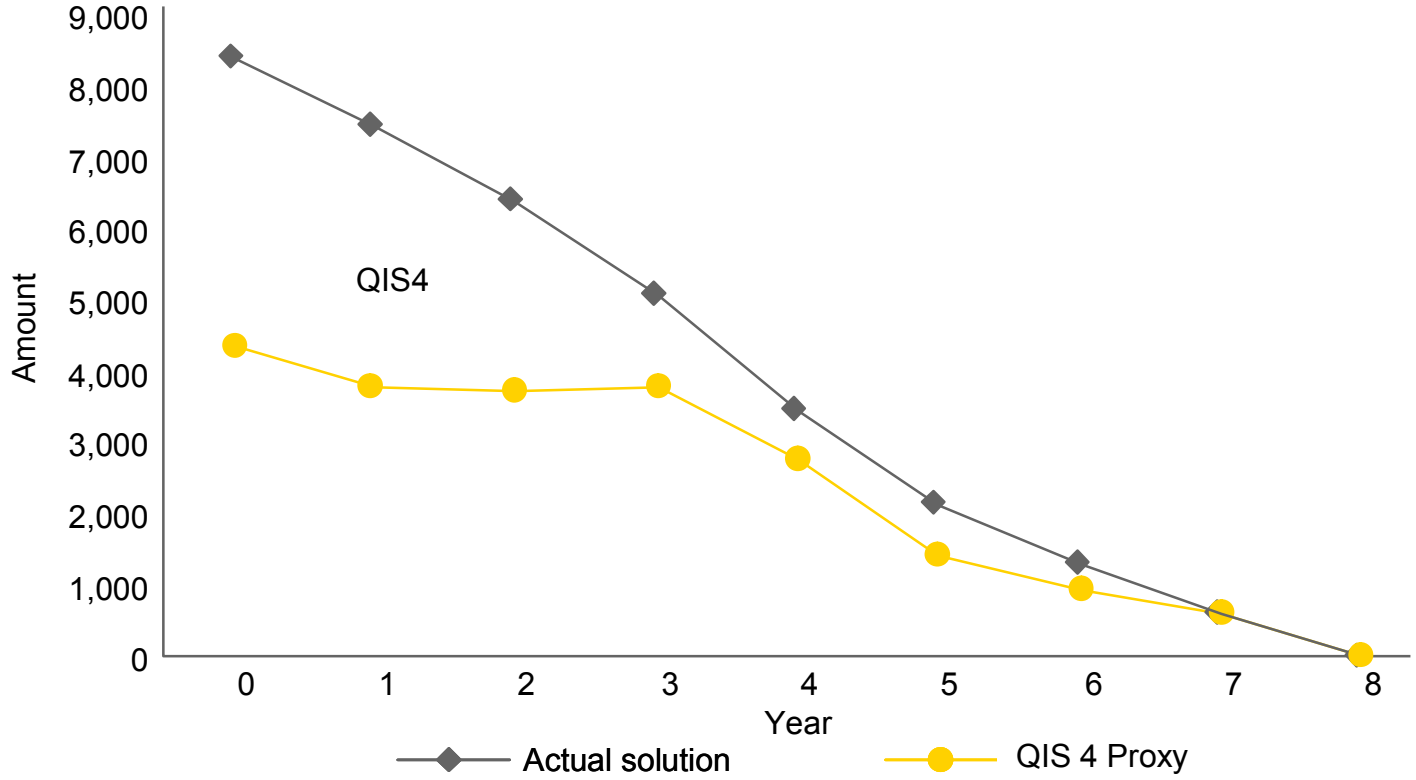
- Let us now check the QIS4 proxy using a toy LogNormal model

$$C_t = C_{t-1} LnN\left(\mu_t, \sigma_t^{\,2}\right)$$

- This model has the property that the mean and volatility are path dependent
- The capital requirement formulas are analytically tractable under this model
- We can fit this to the cashflows from a simulation of reserving risk to obtain the MVM trajectory over time and compare with QIS4 proxy

# Risk Margin - Testing QIS 4 Proxy

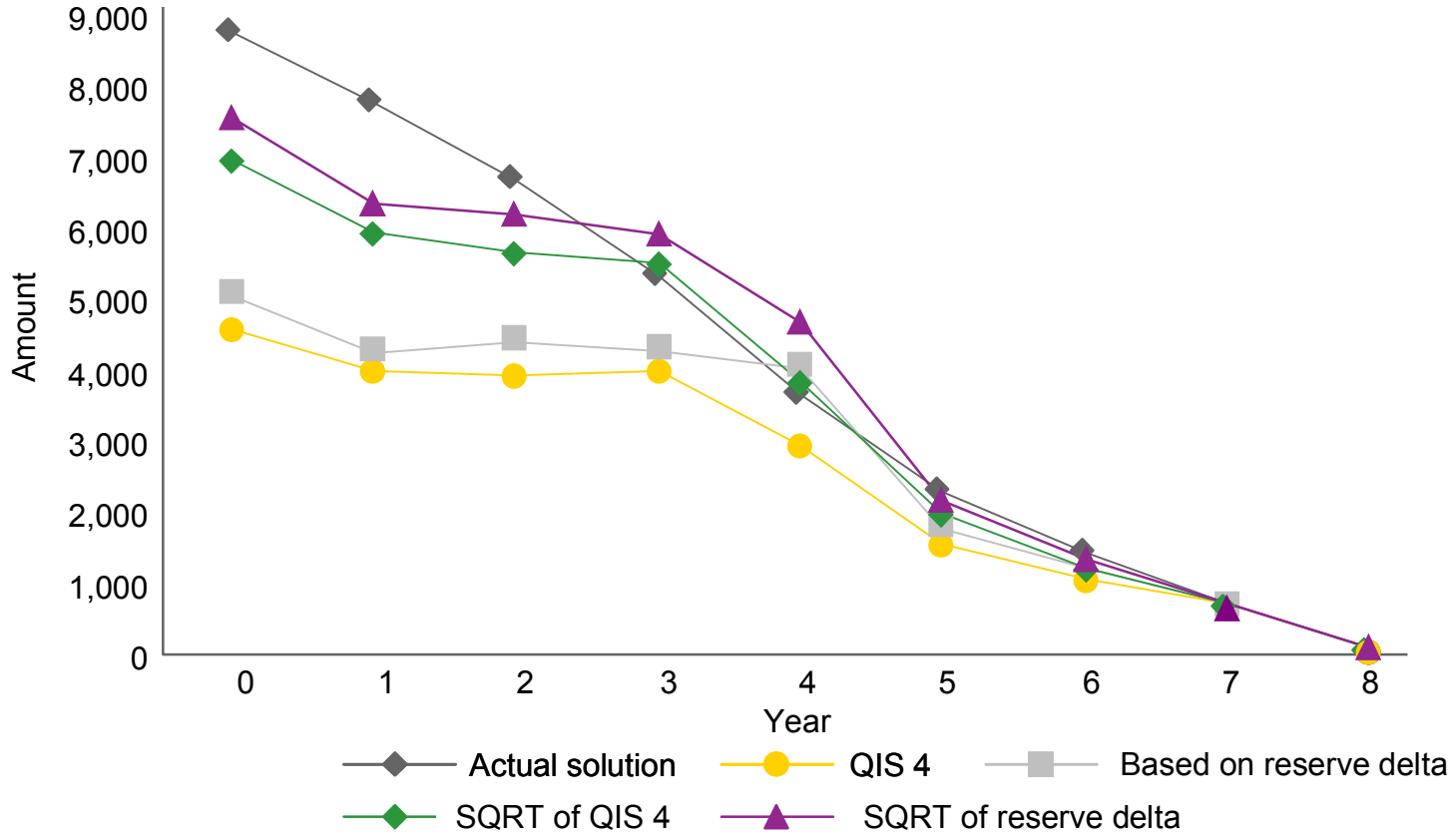
**MVM: Path over time**




**QIS4 underestimates significantly!**

# Risk Margin - Testing other proxies

**MVM path over time**



# Risk Margin - CP 42

- Proxy work has been discussed with CEIOPS and the FSA, before the CP was released.
- The CP gives more details on the nature of the reference entity.
- This essentially defines which risks should be included within the future SCR amounts.
- Future SCR's can be calculated by the internal model.
- If the model uses a proxy method then it will need to be justified and validated.

# Conversion - Technical Issues - Reporting

- Reporting from the model is critical:-
  - Satisfying Use Test
  - Comparison to other metrics (ICA, std. Formula)
  - Validation processes
- Fundamentally governs structure and methodology of model

# Conversion - Other Issues

- Documentation Documentation Documentation!
- ORSA
- Links to risk management
- External models
- Validation
- Education/understanding within firm

# Any Questions?

# Important Information

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