Changing your ICA model to a Solvency II Internal Model

How hard can it be!?

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Ernst and Young LLP
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- Comparison of models to the requirements
- Converting an ICA model - possible options
- Conversion - Technical Issues
  - Calendar year volatilities and correlations
  - Risk Margin
  - Reporting and comparison to existing measures
- Conversion - Non-Technical Issues
## IMAP - Summary of requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Summary of FSA DP08/4</th>
<th>CP 56</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use Test</strong></td>
<td>Lists possible uses including reinsurance, capital allocation, IM, MI, Strategy, Finance</td>
<td>Fundamental requirement, use of the model should result in pressure to improve it. 9 principles describing the use test</td>
</tr>
<tr>
<td><strong>Statistical Quality Standards</strong></td>
<td>Need to select, fit and combine distributions, allowing for dependencies, mitigations and management actions. Use accurate and complete data at the appropriate resolution</td>
<td>Actuarial methods should be applicable, relevant, appropriate, up to date, transparent, detailed, parsimonious, robust and sensitive. Identify all assumptions and justify them Demonstrate data quality standards and implement policy</td>
</tr>
<tr>
<td><strong>Calibration standards</strong></td>
<td>Choice of time period and risk measure should be appropriate but also produce SCR. Benchmark portfolios or assumptions may need to be run</td>
<td>Choice of time period and risk measure should be appropriate but also produce SCR. Benchmark portfolios or assumptions may need to be run</td>
</tr>
<tr>
<td><strong>Profit and Loss attribution</strong></td>
<td>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</td>
<td>Model should be able to explain a large proportion of annual profit/loss.</td>
</tr>
<tr>
<td><strong>Validation</strong></td>
<td>There should be a regular cycle of objective challenge by an independent function that has the necessary skills to perform such a review.</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Documentation</strong></td>
<td>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.</td>
<td>Documentation should include evidence that all levels of management understand the relevant aspects of the model.</td>
</tr>
<tr>
<td><strong>External models</strong></td>
<td>Need to comply with internal model requirements</td>
<td>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</td>
</tr>
</tbody>
</table>

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

ORSA

Board input

Set risk appetite

Risk mitigation

Calibration

Calculation kernel

Internal schedules

Reporting

Board/senior management review

Set regulatory capital

Set business capital

Use test

Administer portfolio of policies and assets

Sales and marketing

Reporting and reserving

Investment decisions

RI program

Pricing strategy

Use test

Risk identification and risk register

Operating systems

Set business capital

Use test
### Where are we now?  

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

#### The Actuarial Profession

Making financial sense of the future
### Comparing models to requirements

<table>
<thead>
<tr>
<th>Model</th>
<th>Use Test</th>
<th>SQS General</th>
<th>SQS Time horizon</th>
<th>SQS Risk Margin</th>
<th>Calibration</th>
<th>P+L</th>
<th>Validation</th>
<th>Documentation</th>
<th>External Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Stress and Scenario</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Only Insurance Risk Stochastic</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

- ✗: 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

- Attritional
- Reserving risk
- Underwriting risk

Counts and severities → Aggregate CoB → Payment pattern

BF CL benchmarks, etc. → Reinsurance

Aggregate all classes
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\textsuperscript{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

Step 1
Fit the model and simulate to one year ahead

Step 2
Re-fit the model and estimate the ultimate

Step 3
Save ultimate

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%ile of that distribution is the required SCR (ignoring MVM)
Monte Carlo Example

Simulated results

Accident year

Volatility

One year
Ultimate

The Actuarial Profession
making financial sense of the future
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

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

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

- Here \( C_t \) 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

- $\text{SCR}_0$ depends on the movement in MVM and so depends on $\text{MVM}_0$, $\text{MVM}_0$ depends upon $\text{SCR}_0$.
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 \(R_t\) are the time-\(t\) reserves as expected at current time \(T\)

\[
R_t = E[C_N - C_t | C_T]
\]

- This is equivalent to approximate:
- \(SCR_{T+1} \approx SCRT \left(\frac{R_{T+1}}{R_T}\right)\)
- \(SCR_{T+2} \approx SCRT \left(\frac{R_{T+2}}{R_T}\right)\)
- …
- \(SCR_{N-1} \approx SCRT \left(\frac{R_N}{R_T}\right)\)
- 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

\[ C_t = C_{t-1} \ln N(\mu_t, \sigma_t^2) \]

- 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

- Actual solution
- QIS 4
- Based on reserve delta
- SQRT of QIS 4
- SQRT of reserve delta

Based on reserve delta

SQRT of QIS 4
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
- ORSA
- Links to risk management
- External models
- Validation
- Education/understanding within firm
Any Questions?
Important Information

- The information in this workshop is intended to provide only a general outline of the subjects covered. It should not be regarded as comprehensive or sufficient for making decisions, nor should it be used in place of professional advice.
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- If you require any further information or explanations, or specific advice, please contact us and we will be happy to discuss matters further.