GIRO Convention 2009
Workshop D5
Solvency II Non-Life Modelling Issues
Calculating Economic Capital under Solvency II

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Andrew Gray
Agenda

- Definition of 1-year risk
- Modelling approaches
- Real-world issues
- Conclusions
- Appendix
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- Definition of 1-year risk
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- Real world issues
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- Appendix
Definition of 1-Year Risk

- “…the Solvency Capital Requirement should be determined as the economic capital to be held by insurance and reinsurance undertakings in order to ensure that ruin occurs no more often than once in every 200 cases or, alternatively, that those undertakings will still be in a position, with a probability of at least 99.5%, to meet their obligations to policyholders and beneficiaries over the forthcoming 12 months.”¹

- “The Solvency Capital Requirement is calculated using Value-at-Risk techniques, either in accordance with the standard formula, or using an internal model: all potential losses, including adverse revaluation of assets and liabilities, over the next 12 months are to be assessed.”²

¹ P6_TC1-COD(2007)0143, (37)
² p.13: “General provisions for the Solvency Capital Requirement, using the standard formula or an internal model”
Agenda

- Definition of 1-year risk
- **Modelling approaches**
- Real world issues
- Conclusions
- Appendix
(1) Literal 1-year Approach

- Literal interpretation:
  - 99.5% VaR of:
    
    “Change in the ‘market value’ of the liabilities over a 1-year time horizon”

- Approach to assess SCR bases its computation on:

  \[
  \text{VaR}_{99.5\%} \left[ \{ \text{MVL}(t + 1) - \text{MVL}(t) \} \mid \text{Information}_t \right]
  \]

- \( \text{MVL} = \text{BEL} + \text{COCM} \)
## Original Incurred Claims Triangle ($t = 0$)

<table>
<thead>
<tr>
<th>Underwriting Year</th>
<th>Development Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1994</td>
<td>677</td>
</tr>
<tr>
<td>1996</td>
<td>1,656</td>
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<td>3,830</td>
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<td>2002</td>
<td>2,653</td>
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<td>2004</td>
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<td>2005</td>
<td>818</td>
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<tr>
<td>2006</td>
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<td>2007</td>
<td>1,427</td>
</tr>
<tr>
<td>2008</td>
<td>1,648</td>
</tr>
</tbody>
</table>

### VW All
- $7.724$  2.148  1.540  1.256  1.142  1.085  1.038  1.016  1.003  0.997  0.999  0.994  0.999  0.995  1.000

### VW Last 3
- $7.424$  2.232  1.704  1.295  1.163  1.088  1.050  1.022  1.005  0.994  1.003  0.994  0.999  0.995  1.000

### Simple Average All
- $7.906$  2.160  1.556  1.243  1.142  1.082  1.028  1.011  1.002  0.997  0.999  0.994  0.999  0.995  1.000

### Simple Average Last 3
- $7.536$  2.317  1.715  1.309  1.186  1.089  1.050  1.021  1.008  0.994  1.003  0.994  0.999  0.995  1.000

### Selected Factors
- $7.700$  2.300  1.600  1.275  1.150  1.085  1.040  1.017  1.003  1.000  0.999  0.996  0.999  1.000  1.000

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### Stressed Incurred Claims Triangle \((t = 1)\)

<table>
<thead>
<tr>
<th>Underwriting Year</th>
<th>Development Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1994</td>
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<td>2005</td>
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<td>1,032</td>
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<tr>
<td>2007</td>
<td>1,427</td>
</tr>
<tr>
<td>2008</td>
<td>1,648</td>
</tr>
</tbody>
</table>

**VW All**
- 8.788 2.189 1.552 1.257 1.142 1.081 1.044 1.016 1.002 0.998 0.999 0.995 0.995 0.999 0.998 1.000 1.000

**VW last 3**
- 13.861 2.461 1.764 1.324 1.211 1.087 1.059 1.020 1.002 0.995 0.999 0.999 0.998 0.998 1.000 1.000

**Simple Average All**
- 8.917 2.216 1.572 1.246 1.143 1.078 1.033 1.012 1.002 0.998 0.999 0.995 0.995 0.999 0.995 1.000 1.000

**Simple Average Last 3**
- 13.019 2.522 1.763 1.317 1.203 1.081 1.061 1.021 1.004 0.992 0.999 0.999 0.999 0.999 1.000 1.000

**Selected Factors (BEST)**
- 9.000 2.400 1.650 1.300 1.180 1.085 1.050 1.017 1.003 1.001 1.000 0.996 0.999 0.999 1.000 1.000

**Selected Factors (HIGH)**
- 10.000 2.600 1.750 1.350 1.210 1.090 1.060 1.020 1.005 1.002 1.001 1.000 1.000 1.000 1.000 1.000

**Selected Factors (LOW)**
- 8.500 2.200 1.550 1.250 1.140 1.070 1.035 1.010 1.002 1.000 0.998 0.994 0.996 0.998 1.000 1.000

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## Results

### Base Case \((t = 0)\)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>(1)</td>
<td>BEL Ultimate</td>
<td>996,155</td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>Paid to date</td>
<td>(695,218)</td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>BEL Reserve</td>
<td>300,936</td>
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</tbody>
</table>

### METHOD 1

**Re-reserving After 1-in-200 Stress \((t = 1)\)**

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Best</th>
<th>High</th>
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</thead>
<tbody>
<tr>
<td>(4)</td>
<td>BEL &quot;Ultimate&quot;</td>
<td>1,015,312</td>
<td>1,047,017</td>
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<tr>
<td>(5)</td>
<td>Paid to date</td>
<td>(695,218)</td>
<td>(695,218)</td>
</tr>
<tr>
<td>(6)</td>
<td>BEL Reserve</td>
<td>320,093</td>
<td>351,799</td>
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</table>

### METHOD 2

99.5% Bootstrap to "Ultimate" (from \(t = 0\))

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Best</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7)</td>
<td>Capital calculation* (= (6) - (3))</td>
<td>19,157</td>
<td>50,862</td>
</tr>
<tr>
<td>(8)</td>
<td>Capital as % reserve</td>
<td>6%</td>
<td>17%</td>
</tr>
<tr>
<td>(9)</td>
<td>Capital comparison: 1-year re-reserve relative to Bootstrap</td>
<td>13%</td>
<td>33%</td>
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</tbody>
</table>

*Risk Margin excluded for simplicity. The impact of its inclusion would be small.*
Literal Approach is a weak standard

- 1-year capital calculation significantly lower than deterioration to ultimate under ICA
- 13–53% of ICA capital standard for long-tail line
- Long-tail lines capital requirements typically in the range 30–50% of ICA
- Effect less significant for short-tail lines
(2) ICA Approach

- “1 in 200” estimate of ultimate liabilities incorporating one year of projected business in excess of initial best estimate
- Commonly referred to as an “ultimate” projection
- No explicit allowance for changes of state
(3) Modified ICA Approach

- Explicitly model effect on capital of additional 1-year of experience
- Could require nested stochastic approach
- Approximations needed to reduce run-time
One-year capital requirement is the change in the current assessment of ultimate claims.

Estimation of ultimate claims changes over one year due to:
- **Stochastic risk** e.g. an earthquake occurs
- **Parameter risk** An event occurs that invalidates time 0 models e.g. Asbestos, Katrina/Rita/Wilma, WTC, Enron

Risk quantification

Best estimate liabilities at $T=0$

Change in market pricing level

New risks are written

Claims emerge or settle

Catastrophes occur

Revaluation of liabilities due to new information

Liabilities at $T=1$

Probability density of the change in ultimate claims

Probability $< 0.5\%$

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The Economic Capital on a one-year time horizon for a satellite launch risk is zero

- Assume the satellite launch is insured, taking place at time $t=2$.

Information only arises during the second year

The launch happens, and there is no additional uncertainty beyond this point

Assumes that no additional information will emerge until the launch takes place
Except for the fact that new information arises

Assumes that no additional information will emerge until the launch takes place

Recognises that additional information will emerge before the launch takes place

Parameter risk  Stochastic risk
Model effect of additional experience

Scenario 1

Market Value Assets
EC
RM
BEL₁

0.5% probability
0.03% probability

T = 0
T = 1

Probability of outcome

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Methodology that meets technical requirements

Random Number Generator

Dependency

Property Book

Liability Book

Nat Cat

Inflation

Parametric distributions
Cat model output
Empirical distributions

Σ = Natural Catastrophe
Σ = Inflation
Σ = Insurance Losses
Σ = Total

Reinsurance
Tax
Fungibility

Stochastic model output

Stress test fitting

Required capital

Risk factor

Probability

Loss

Risk factor

Probability

Loss

Risk factor

Probability

Loss
Typical reserving maps naturally into this methodology

- One-year development on a real-world stochastic basis
- For each scenario, development to ultimate on a risk-neutral (deterministic) basis
- Discount (for each scenario)
  - The development of the triangle over one-year contributes to the risk factor
  - Additional information and alternative scenarios will contribute to the tails of the distribution
  - The development of ultimate values maps to losses

<table>
<thead>
<tr>
<th>Accident year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
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<tbody>
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<td>250</td>
<td>250</td>
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<td>233</td>
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<td>2001</td>
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<td>1</td>
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<td>55</td>
<td>55</td>
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<tr>
<td>2002</td>
<td>331</td>
<td>331</td>
<td>450</td>
<td>500</td>
<td>590</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

Making financial sense of the future.
Graphical Illustration

1-year Reserving Risk

- $C_1$ = Literal approach
- $C_2$ = ICA approach
- $C_3$ = Modified ICA approach

Ultimate Liabilities ($t=0$) vs. Ultimate Liabilities ($t=1$, post-shock) for different approaches.
Agenda

- Definition of 1-year risk
- Modelling approaches
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Specific Multi-Year Risk Issues

- Short-term volatility can be much less than settlement volatility for non-life insurance
- Capital calculation significantly influenced by judgemental selections, as illustrated in the case study
- Policies are priced and business is managed by reference to expected ultimate amounts
- Literal one-year test compromises the use test
“Market Value” Issues

- Solvency II based on principle that an insurer can transfer its portfolio to a third party insurer with 99.5% confidence
- Ready market prices do not exist for insurance liabilities
- Transfer value in practice may use conservative assumptions or explicit margins greater than COC
  - Allow for “trend”
  - COC assumption could be much higher than QIS4 standard
    - Market-wide stresses could result in significant capital shortage
    - Recent financial crisis: high level of illiquidity with COC as high as 15%
  - 3rd party would load for profit
- Commercial decision whether liabilities are transferred or run-off

In stress situation, transfer value likely to exceed BEL + COCM
Problems with Current Stochastic Approaches

- Uncertainty in estimating ultimate liabilities increases significantly in the tail.
- Stochastic reserving approaches to estimate the 99.5\textsuperscript{th} percentile are likely to be inadequate
  - Range produced based largely on historical experience
  - Limited scope for actuarial judgement
  - No explicit allowance for trends / future changes of state

“Ultimate” stochastic methods understate ultimate volatility because changes in state are not explicitly considered.
Relative Significance of Underwriting Risk

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Non-Life</th>
<th>Life</th>
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</thead>
<tbody>
<tr>
<td>Underwriting Risk</td>
<td>85%</td>
<td>23%</td>
</tr>
<tr>
<td>Operational Risk</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>Default Risk</td>
<td>7%</td>
<td>17%</td>
</tr>
<tr>
<td>Market Risk</td>
<td>20%</td>
<td>75%</td>
</tr>
<tr>
<td>TOTAL*</td>
<td>118%</td>
<td>120%</td>
</tr>
</tbody>
</table>

*Undiversified

QIS4 Capital Requirements by Risk Category

- **Underwriting Risk**: 85% for Non-Life, 23% for Life
- **Operational Risk**: 6% for Non-Life, 5% for Life
- **Default Risk**: 7% for Non-Life, 17% for Life
- **Market Risk**: 20% for Non-Life, 75% for Life

*Undiversified

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- Definition of 1-year risk
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Conclusion

- Robust definition of 1-year risk horizon for underwriting risk is required
- Stressed market price of liabilities is likely to exceed SII technical provision (BEL + COCM)
- Modelling approach significantly affects underwriting risk capital
Agenda

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Solvency II Directive – Some Definitions (1)

- **Underwriting risk (non-life)** – “...the risk of loss, or of adverse change in the value of insurance liabilities, due to inadequate pricing and provisioning assumptions.”

- **The value of technical provisions** “...shall correspond to the current amount insurance and reinsurance undertakings would have to pay if they were to transfer their insurance and reinsurance obligations immediately to another insurance or reinsurance undertaking.”
  - “The value of technical provisions shall be equal to the sum of a best estimate and a risk margin as set out in paragraphs 2 and 3.”

- **Risk Margin** “...shall be such as to ensure that the value of the technical provisions is equivalent to the amount insurance and reinsurance undertakings would be expected to require in order to take over and meet the insurance and reinsurance obligations.”

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1. Article 105, 2.(b)
2. Article 75, 2.
3. Article 76, 1.
4. Article 76, 4.
Solvency II Directive – Some Definitions (2)

- **Calculation of SCR**
  - “…the Solvency Capital Requirement should be determined as the economic capital to be held by insurance and reinsurance undertakings in order to ensure that ruin occurs no more often than once in every 200 cases or, alternatively, that those undertakings will still be in a position, with a probability of at least 99.5%, to meet their obligations to policyholders and beneficiaries over the forthcoming 12 months.”

  
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5 P6_TC1-COD(2007)0143, (37)
6 p.13: “General provisions for the Solvency Capital Requirement, using the standard formula or an internal model"
Interpretations of 1-year Reserving Risk

- “The parameters and assumptions used for the calculation of the SCR are intended to reflect a VaR risk measure (calibrated to a confidence level of 99.5%) and a time horizon of one year.”\(^1\)

- “Reserving risk on a one-year time horizon is reflected in the volatility of the claim development (or runoff) result — the actuarial revaluation of claim reserves given that one additional year of information is available.”\(^2\)

\(^1\) QIS4 TS.VIII.A.5
\(^2\) CRO Forum: “Calibration Principles for the Solvency II Standard Formula