Aggregation of capital requirements in Solvency II standard formula
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• Retail bank
  – Four home markets (Sweden, Estonia, Latvia, Lithuania)
  – 7.2 million private customers, 0.6 million corporate customers
  – 13 900 employees
  – Also has asset management and insurance companies as subsidiaries

• Swedbank’s insurance business
  – Swedbank Försäkring AB, Life insurance, Sweden, AUM 170bn SEK
  – Swedbank Life Insurance SE, Baltics, AUM 5bn SEK
  – Swedbank P&C Insurance SA, Non-Life Insurance, Baltics
Solvency Capital Requirement (SCR)
Solvency II: The three pillars

**Pillar I**  – Solvency Capital Requirements (SCR)

**Pillar 2**  – Governance

**Pillar 3**  – Reporting

**Pillar I**
- **Solvency Capital Requirements**
  - Minimal Capital Requirements (MCR)
  - Solvency Capital Requirements (SCR)
  - Standard model or Internal model
  - Capital structure
  - Mark to market/model

**Pillar II**
- **Governance and Risk Management**
  - System for:
    - Governance
    - Risk Management
    - Internal Control
  - Own Risk and Solvency Assessment

**Pillar III**
- **External and Internal Reporting**
  - IT-system support
  - Data Quality
  - Reporting structure and procedures
Identify risk exposures (example from life insurance)

Identifying risk exposure to future profits

- Future cash flows are exposed to a number of risks that, if crystallized, may have an adverse affect on Own Funds.

SII risk taxonomy

- The main exposures applicable to SFAB business is highlighted above.
Shocking Market Valued Balance Sheet (MVBS)
- VAR approach calibrated to a 99.5% confidence level

Assets

- Market Value of Assets
- Best estimate
- Own Funds

Liabilities

- Net Asset Value
- Risk Margin
- TVOG
- Net Asset Value
- Risk Margin
- TVOG

MVBS post a 99.5% event

TVOG

Net Asset Value

SCR

Own Funds

Own Funds
Solvency Capital Requirements
Aggregation
Two risk factors

• In all examples we will look at two risk types $X$ and $Y$, e.g. Equity and Lapse

• In principle, the correct capital requirement is the 99.5% quantile of the value distribution, when we simulate both $X$ and $Y$ simultaneously → difficult
The standard formula is a simplification (1)

In the Standard Formula, we stress one risk factor at the time, by a prescribed stress.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Value ( f(X,Y) )</th>
<th>Capital requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>( q_X = -0.5 )</td>
<td>0</td>
<td>-75</td>
<td>( C_X = 75 )</td>
</tr>
<tr>
<td>0</td>
<td>( q_Y = -0.3 )</td>
<td>-300</td>
<td>( C_Y = 300 )</td>
</tr>
</tbody>
</table>

• \( C_X = -f(q_X, 0), C_Y = -f(0, q_Y) \), where \( q_X \) and \( q_Y \) are quantiles of \( X \) and \( Y \), and \( f \) is the “value function”.
• The value function \( f \) describes how the value of our portfolio varies with \( X \) and \( Y \), and is obviously very important for the outcome.
The standard formula is a simplification (2)

In the Standard Formula, we then aggregate the individual capital requirements $C_X$ and $C_Y$ using a prescribed “correlation” $\alpha$.

- $SCR = SCR(\alpha) = \sqrt{C_X^2 + 2\alpha C_X C_Y + C_Y^2}$
Example: Two risks, each with a capital requirement of 100

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>Capital requirement (SCR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>200</td>
</tr>
<tr>
<td>0.75</td>
<td>187</td>
</tr>
<tr>
<td>0.5</td>
<td>173</td>
</tr>
<tr>
<td>0.25</td>
<td>158</td>
</tr>
<tr>
<td>0</td>
<td>141</td>
</tr>
<tr>
<td>-0.25</td>
<td>122</td>
</tr>
</tbody>
</table>

- What is the correct $\alpha$?
  - That depends on $f$, but also on the underlying joint distribution of $X$ and $Y$.
- What is a prudent $\alpha$?
  - For Life Risks and Market Risks, Solvency II has $\alpha=0.25$. 
Everything is normal…

- Solvency II does not assume any specific joint distribution for the risk factors.
- We will assume bivariate normal distribution of $X$ and $Y$, with mean 0, variance 1 and correlation $\rho$.
- The theme of my work is:

  Given $\rho$, if we want $\text{SCR}(\alpha)$ to equal the correct capital requirement (from the joint distribution), how shall we choose $\alpha$?

- Naive conclusion: $\alpha = \rho$
Special case: The “volume dependent” situation in a life portfolio
Volume dependent case in life insurance

• A portfolio of unit-linked contracts. The company receives fees that are proportional to the Assets Under Management (AUM).
• After expenses, this gives rise to a number of cash flows that are discounted to today with a (hopefully) positive net sum = Own Funds (OF). Statically, the Own Funds are approximately proportional to AUM.
• Losing AUM “over-night”, due to e.g. mass lapse or equity crash, means losing OF overnight in a proportional way.

Surprisingly, if the stresses are not too small, the correct $\alpha$ is negative, even for highly positive $\rho$. “A lapsed portfolio can’t crash.”
Plot of how $\alpha$ depends on the stress and on $\rho$

1. Small stress and high correlation gives positive $\alpha$.
2. Large stress gives negative $\alpha$.
3. Zero or negative correlation gives negative $\alpha$, regardless of stress.
Case study: Three portfolios in a life insurance company
Three portfolios of a life insurance company

• P1, unit-linked
• P2 and P3, guarantees
• Equity stress: Full stress of EQ Type 1 as -39% (no stress of Type 2 or Fixed Income instruments). Half stress -19.5%.
• Lapse: Full stress: Mass lapse, 40%. Half stress 20%.
Risk matrices (a small number of simultaneous stresses for each portfolio)

<table>
<thead>
<tr>
<th></th>
<th>P1</th>
<th>0</th>
<th>½</th>
<th>1</th>
<th></th>
<th>P3</th>
<th>0</th>
<th>½</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>946</td>
<td>1893</td>
<td></td>
<td></td>
<td>0</td>
<td>66</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td>½</td>
<td>823</td>
<td>1593</td>
<td>2364</td>
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<td></td>
<td>½</td>
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<tr>
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<td>2835</td>
<td></td>
<td></td>
<td>1</td>
<td>185</td>
<td>228</td>
<td>285</td>
</tr>
</tbody>
</table>

Rows = Lapse  
Columns = EQ  
(Each cell requires a large stochastic simulation)
Simulation approach ("internal model")

• Distribution assumptions:
  – EQ: Student-t distributed
  – Lapse: another heavy-tailed distribution
  – Independence between EQ and Lapse

• Draw a large number of scenarios (EQ,Lapse) from the assumed distribution.

• Use the risk matrices to calculate the value (OF) of the portfolio given each scenario ("value response function")

• Find the correct quantile of the OF value changes, and compare with $SCR(\alpha)$; the latter is found analytically.

• Back out $\alpha$. 
Results and conclusion

The found $\alpha$ are -0.19, -0.19, -0.12, for the three portfolios, respectively. Here $\rho = 0$. However, some analysis shows that we are in the area where $\alpha$ is negative for all $\rho$.

The prescribed $\alpha=0.25$ is too large!
Thank you!
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