Risk management in life insurance
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Allocating Diversification Benefits and Fungibility

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Agenda

1. Aggregation and diversification
2. Allocation: Theory and practice
3. Assessing capital fungibility: Two means to the same end (?)
4. Summary
1. AGGREGATION AND DIVERSIFICATION

What is aggregation?

**Concept**
- An *aggregation method* is a method for determining the overall capital requirements on the basis of the stand-alone capital requirements of the underlying risk categories.
- The chosen aggregation method is the basis for the assessment of *diversification benefits*.
- Aggregation does not change the undertaking’s exposure to the individual risk categories.
- Usually aggregation proceeds by specifying a *dependency structure* between the underlying risk categories. However, additional elements may be present as well (e.g. assumption on type of overall distribution).

**Illustration**

Choice of aggregation method is of pivotal importance.
Data availability and reliability concerning dependencies ...

... within risk categories (illustration)

- Market risk
- Credit risk
- Basic loss risk
- Natural Cat risk
- Man-made Cat risk
- Life biometric risk

Data availability and reliability

... between risk categories

- Hardly any data available for most pairs
- Intuition suggests qualitative ranking (illustrative):

<table>
<thead>
<tr>
<th></th>
<th>Market</th>
<th>Credit</th>
<th>Nonlife</th>
<th>Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Credit</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonlife</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Any data-based analysis concerning dependencies must be complemented by certain assumptions, decisions and expert judgement.

Two common ways of aggregation

<table>
<thead>
<tr>
<th></th>
<th>Aggregation of capital requirements</th>
<th>Aggregation of distributions</th>
</tr>
</thead>
</table>
| Process                     | • Determination of capital requirements for risk categories  
                              | • Aggregation of stand alone capital requirements figures to arrive at overall capital requirement  
                              | • Determination of result distributions representing the different risk categories  
                              | • Aggregation of distributions to arrive at overall result distribution |
| Prevalence                  | • Pure factor models like rating agency models (Solvency II, SST)  
                              | • Standard regulatory models  
                              | • Internal models  
                              | • Academic toy models |
| Advantages                  | • Conceptually easy  
                              | • Computationally simple and fast  
                              | • Multiple dependency structures possible (copulas)  
                              | • Better alignment with (risk) management / ALM, e.g. by allowing to assess the aggregate result at different return periods |
| Disadvantages               | • Calibration challenging  
                              | • Focus on one specific return period (usually "rare events")  
                              | • Range of dependencies restricted – mostly simple correlation matrix  
                              | • May give doubtful incentives for (risk) management, e.g. for ALM  
                              | • Calibration challenging  
                              | • Conceptually more complex than correlation matrices  
                              | • Possibly computationally time-consuming |

Aggregation of distributions allows a larger range of options.
Choosing a dependency structure

Calibrating dependencies between risk categories

- SCR and ERC represent tail scenarios.
- Thus, dependencies between risk categories should reflect tail events.
- At Munich Re we use specifically developed scenarios which incorporate cross-balance sheet events (e.g. a severe pandemic).
- With an assumption about dependencies in “normal circumstances” solve the following equation:

«Scenario + normal dependency = Tail dependency»
Aggregation: Upcoming challenges

Regulatory scepticism about diversification*:

• P. 4: “[T]he financial crisis that began in 2007 highlighted at least some degree of failure of risk aggregation methods.”
• P. 6: “Supervisors surveyed for this report understand that opportunities for diversification exist, but were skeptical that financial firms are able to measure diversification benefits reliably.”

High validation, documentation and communication efforts to be expected under Solvency II for internal model users.

*) Basel Committee on Banking Supervision – Joint Forum, Developments in Modelling Risk Aggregation, October 2010

2. ALLOCATION: THEORY AND PRACTICE
Evolution of business steering

Allocation principles investigated: Formulas

- Risk measure-proportional
  \[ RBC_i := \frac{\text{Risk measure}[X_i]}{\sum_i \text{Risk measure}[X_i]} \]

- Covariance
  \[ RBC_i := \frac{\text{Cov}[X_i, X]}{\text{Var}[X]} \]

- Tail-VaR-Co-Measure
  \[ RBC_i := \frac{\mathbb{E}[X_i | X > Q_i(X)]}{\mathbb{E}[X | X > Q_i(X)]} \]

- For \( n \) segments 1, ..., \( n \) let \( S \subseteq N = \{1, ..., n\} \), \( s := |S| \), \( c(S) := \text{RBC}(S) \) and
  \[ C_i := \{ S \in \mathcal{P}(N) : i \in S \} \].
  The Shapley-value for segment \( i \) is defined as
  \[ \sum_{S \in C_i} \binom{n-1}{s-1} \binom{n-1}{s-1} / n! \times \left[ c(S) - c(S \setminus \{i\}) \right] \]

**Remarks on Shapley**

1. \( c(S) - c(S \setminus \{i\}) = \) increment in RBC caused by segment \( i \) in coalition \( S \)
2. \( (s-1)! (n-s)! / n! = 1/n^* (s-1)! (n-1-(s-1))! / (n-1)! = 1/(n^* \#\{ S \subseteq N : |S| = s & i \in S \}) \]
Aggregation and Allocation Principles

Theory

• Mathematical discussion on eligible properties based on Denault (2001) et seq.
  ➢ Completeness: $\sum RC_i = RC = R(\sum X_i)$
  ➢ “No undercut”: $\sum_{i \in M} RC_i \leq R(\sum_{i \in M} X_i)$
  ➢ Symmetry:
    $R(\sum_{i \in M} X_i + X_m) = R(\sum_{i \in M} X_i + X_m)$
    $\Rightarrow RC_m = RC_n$
  ➢ Riskless allocation: $RC(c) = c$ (or 0!)

• Interplay of allocation and risk measure
  ➢ “No undercut” follows sub-additivity
  ➢ Proportional methods on risk measure
  ➢ Shapley allocation on various risk measures

Choice of allocation mechanism depends on mathematical and non-mathematical factors.

Practise

Diversification level

Granularity

Allocation mechanism

Business objectives & strategy

Portfolio specifics

Consistency with aggregation

Coherent allocation from a practical perspective

Properties of “coherent allocation” ...

• Completeness

• No undercut

• Symmetry

• Riskless allocation

... and their practical relevance

• Completeness is a crucial property. However, completeness should not be taken to imply
  ➢ a uniform return target (e.g. Life vs Nonlife)
  or
  ➢ a requirement of “value addition” by any business activity (e.g. growth usually has to be “financed” in the first years).

• No relevance due to consideration of unexpected loss only.
  • Moreover, ERC is not suited to cover losses which are sure.

Theoretical requirements may not meet the “litmus tests” of reality!
Tentative requirements concerning allocation from a steering perspective

**Completeness**
- The total amount of ERC has to be allocated.
- Value creating or destroying activities – deliberated or not – should be made explicit.

**Stability**
- *Ceteris paribus* local changes should be dominating changes from year to year.

**Concentration**
- Concentration risks should receive a “penalty” for exposing the undertaking.
- *Ceteris paribus* the higher the concentration the higher the ERC allocation.

**Business adequacy**
- The allocation principle should respect specifics of the business and the implied steering impulses.

Practical requirements concerning allocation cannot be reduced to pure mathematical properties.

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3. ASSESSING CAPITAL FUNGIBILITY: TWO MEANS TO THE SAME END (?)
Fungibility and Transferability within a Group

Fungibility

- Fungibility at group level means that an element of own funds can fully absorb any kind of losses within the group, regardless of the undertaking within which those own funds are held or where the commitments arise (in compliance with the local prudential and legal rules).
- Fungible capital in this sense is not dedicated to a certain purpose.

Group Own Funds

- The usability of local excess for the purpose of group solvency depends on restrictions within the corresponding unit.
- Those restrictions may be legal/regulatory or internal (e.g. Rating).

Transferability

- Transferability refers to the ability to transfer own funds from one undertaking to another within the group.
- Transferability leads to increase/decrease of own funds in a solo entity without increasing/decreasing the group own funds, except the likely cost of the transfer.

The determination of group solvency based on a consolidated balance sheet must incorporate fungibility and transferability restrictions.

Non-available own funds and their impact of group OF

- Step 1: Accounting consolidation (OF = OF1 + OF2)
- Step 2: Regulatory OF in accounting consolidated OF = Transferrable
- Step 3: Calculation of OF
- Step 4: Group OF available = Regulatory OF - Non-Available OF2 in excess of contribution

- Step 5: Group OF available under two subcategories

16
17
Details of step 4 - current status (QIS5)

**G.66.** In addition to capital funds and any subordinated but not ‘pushed down’ capital, other capital funds could also be considered if not effectively available to cover the SCR of the participating investment undertaking for which the group solvency is calculated. Such non-accountable capital funds may serve the SCR of the relevant undertaking.

**G.67.** The group should pay particular attention to capital funds which are intended as subordination G.2 if higher than necessary by group level.

**G.68.** For each relevant undertaking, the global amount of subordinated capital funds should be considered available for covering the group SCR up to the contribution of the SCR to group SCR.

**G.69.** In order to ensure the contribution of subordinated capital funds from entity j (where included in the calculation of SCR) to the entities for which diversification is recognised, the following proxy should be used:

\[ \text{Credit} = \frac{\text{SCR}^j_{	ext{SCR, group SCR}}}{\sum \text{SCR}^i_{	ext{SCR, entity i}}} \]

where:

- the index (covers all entities of the group included in the calculation of the SCR);
- SCR is the SCR of entity i;
- SCR is the SCR of undertaking j;
- the ratio can be considered as a proportional adjustment due to diversification effects.

**G.70.** For methodologies using an internal model the attribution of diversification can be carried out using the internal model. Groups should explain the method used for allowing diversification effects when using an internal model.

Diversification and Capital Fungibility Constraints

A joint distribution of to legal entities X and Y (positive values = losses)

<table>
<thead>
<tr>
<th></th>
<th>Positive (%)</th>
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<tbody>
<tr>
<td>2</td>
<td>4% 9% 21%</td>
</tr>
<tr>
<td>-1</td>
<td>11% 14% 9%</td>
</tr>
<tr>
<td>-4</td>
<td>19% 11% 4%</td>
</tr>
</tbody>
</table>

If capital is fully transferable between two legal entities X and Y then Y can transfer 1 to X in this case in order to avoid X’s shortfall without running into problems itself. The compensation of losses of one risk X by profits from another risk Y is called diversification benefit.

In reality, there sometimes exist capital fungibility constraints (e.g. from regulatory requirements).

In the above example, the scenario X = 1 and Y = -4 might represent a shortfall of the ‘group’ consisting of X and Y as Y might not be allowed to transfer capital to X.

More economic risk capital is needed under capital fungibility constraints.
**Representation of capital fungibility within the MRCM**

**Fungibility in the MRCM**
- A simplified model of Munich Re's group structure is built and correlated results per entity are simulated.
- The fungible excess for each simulated result is transferred to the parent.
- In turn the parent balances losses up to the point of insolvency for each entity.
- As a result it is possible to derive the distribution of Munich Re taking restricted capital fungibility into account.

**Illustration**

![Diagram of capital fungibility](image)

The modelling of capital fungibility at Munich Re leads to an increase of ERC.

**Two means to the same end?**

**Adjusting Own Funds**
- Avoids stochastic calculations
- Easier than ERC / SCR adjustment
- May lead to artefacts: Consider a group with 2 companies, each at 200% solvency ratio and 100% non-fungible capital ⇒ group solvency ratio of 100%

**Adjusting ERC / SCR**
- Uses Own Fund adjustment as a starting point
- Conceptually more convincing
- Computationally more involved
4. SUMMARY

Summary for actuaries

• Aggregation especially across risk categories has to be based on science and expert judgement. Regulators are sceptical about diversification and hence aggregation techniques used within internal models will be put under scrutiny during the supervisory review.

• Allocation of risk capital has to be aligned with various practical considerations which are specific to each company.

• Assessing capital fungibility is so far largely untested but may have an impact on future corporate structure.

A “one-size-fits-all” approach does not work!
Summary for poets

It is the pervading law of all things organic and inorganic,
of all things physical and metaphysical,
of all things human and all things super-human,
of all true manifestations of the head,
of the heart, of the soul,
that the life is recognizable in its expression,
that form ever follows function. This is the law.

Louis Sullivan, The tall office building artistically considered