GIRO Convention
23-26 September 2008
Hilton Sorrento Palace
Risk Aggregation in a Multi-Line, Multi-Entity Group
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Dr. Nigel Hooker - DFA Capital Management Inc.

Talanx Group: a Multi-Line, Multi-Entity Group Domiciled in Hanover, Germany

Talanx Group: History and Evolution

- 1903: founding of Hafpflichtverband der deutschen Eisen- und Stahlindustrie
- 1936: drop “Eisen- und Stahl” to become simply HDI
- 1953: offer insurance to non-members
- 1970: merge with Feuerschadenverband rheinisch-westfälischer Zeche, owner of Hannover Re (est. 1966)
- 1991: start to offer life insurance
- 1994: partial spin-off of Hannover Re through IPO
- 1996: group restructured under HDI Beteiligung AG, a non-listed stock company, wholly owned by HDI V.a.G.
- 1998: renaming of holding company as Talanx AG
- 2006: acquired Gerling life and property-casualty companies (est. 1904)
- 2007: €19 billion gross written premiums, number 3 insurance group in Germany
Talanx Group: Risk Modelling Situation

- Talanx Group comprises numerous, diverse companies
  - Bancassurance, Life assurance, primary Property-Casualty insurance (industrial, commercial, private), Life and Health reinsurance, Property-Casualty reinsurance, asset management
- Traditionally these have been operated “federally”
  - Five divisions, several brands in each
- Impact on risk modelling
  - Companies have made different choices for modelling
  - Companies are at different levels of sophistication
  - Recently acquired companies (Gerling) contribute to the complexity

Talanx Group: Risk Modelling Challenge

- Develop a risk aggregation process meeting the Group’s need for
  - economically sound financial and risk management
  - an internal model for Solvency II, certifiable by the regulators
  - cost effectiveness
  - …and that
  - Preserves the federal culture of the group
  - Achieves maximum buy-in from local management
  - Leverages the value of the modelling work already carried out
  - Maintains strong connection between modelling and managing
  - Provides a step by step progression route for smaller companies with more limited resources

How to Handle Risk Aggregation?
Different Ways to Solve the Problem

1. Single risk modelling system
   - One big model for the whole group
   - Links together sub-models for each operating company using the same modelling system
2. Aggregate risk bottom-up using correlation matrix
   - Each operating company’s model feeds into correlation matrix
3. Simulation-based bottom-up aggregation
   - Companies’ existing models feed scenario results
   - Aggregates scenario-by-scenario
How to Handle Risk Aggregation?
1. Single Risk Modelling System

- How it works
  - Companies convert existing models to the selected system
  - Companies’ sub-models use consistent assumptions
  - Companies provide their sub-models to the centre
  - Sub-models linked together in large Group model run centrally

- Features and requirements
  - Potentially costly and time consuming
  - Training effort and learning curve for everyone
  - Possible disconnection from existing models and applications
  - Possible duplication of effort (if continue existing models in parallel)
  - Confusion and ambiguity about which one is the real model

- Conclusions
  - Highly complex solution but highly consistent for detailed Group management information

How to Handle Risk Aggregation?
2. Bottom-up Correlation Matrix Approach

- How it works
  - Model sources of risk separately
  - Superimpose correlation / dependence structure using correlation assumptions
  - Calibrate to individual companies’ own models where possible

- Features and requirements
  - Large disconnect from existing models and applications (connection not transparent enough)
  - Significant calibration issues (correlations pulled out of thin air)
  - Suspect quality of information for group management (inadequate information, single number, lack of intermediate results, lack of explanation of what is driving the results)

- Conclusions
  - Simple and quick but provides only limited (and sometimes wrong) management information

How to Handle Risk Aggregation?
Correlation Matrix Approach: S.II QIS4*

QIS4 builds SCR bottom-up
QIS4 formula for Market Risk SCR
QIS4 for BSCR

...and so on through a cascade process

How to Handle Risk Aggregation?

3. Simulation-based Bottom-up Approach

- How it works
  - Companies continue with existing solutions (based on stochastic simulations)
  - Standardize the theoretical risk measures (definition of economic capital)
  - Apply consistent risk parameters
  - Aggregation tool combines individual model results
- Features and requirements
  - Analyze dependencies into environmental, causal (functional) and statistical
  - Standardize the environmental (economic and nat cat) scenarios used
  - Require minimum degree of granularity of individual models
  - Needs new aggregation tool to be built
  - Provide simple (balance sheet based) tool for less sophisticated companies
- Conclusions
  - Leverages existing models
  - Leverages group management information (more granular information)
  - Captures the key dependencies applying the 80/20 rule
  - Continues the existing federal approach

How to Handle Risk Aggregation?
Summary: Talanx Solution

<table>
<thead>
<tr>
<th>Solution</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Consistent Model for all Lines and Entities</td>
<td>High Consistency for maximal Management Information</td>
<td>High Complexity, may demand one Software Solution for everyone</td>
</tr>
<tr>
<td>Factor Model with Aggregation by a Correlation Matrix</td>
<td>Quick and simple Solution</td>
<td>Limited (possibly even wrong) Management Information</td>
</tr>
<tr>
<td>Federal Approach with consistent Risk Collector Aggregation</td>
<td>Feasible Solution with sufficient consistency for Management Information</td>
<td>Compromise - does not achieve maximal Management Information</td>
</tr>
</tbody>
</table>

Talanx Group: Risk Aggregation
Key Components of Chosen Solution

- Consistent management metric – net worth to shareholders
  - Economic Capital (P&C)
  - Embedded Value (Life)
  - Standardized environmental scenarios
  - Economic scenarios
  - Catastrophe scenarios
- Aggregation tool – “Risk Collector”
  - Stochastic
  - Modular
  - Standard data interface
- Base model + standard parametrization
  - For operating companies lacking (as yet) a full internal model
Risk Collector Concept: Architecture

General Approach

- Tool that establishes a stochastic economic group balance sheet
- Flexible definition of balance sheet entries
- Consistent treatment of capital market and Nat Cat scenario information
- The properties of a balance sheet entry are defined by:
  - Information in a given interface not by special formulas in the program
  - The program merely has to resample individual entities' results based on the input distributions defined from the individual systems
  - Balance sheet entries may be original or "linked" stochastic variables
  - The stochastic distribution and/or the linkage are defined in the interface
- This enables the aggregation of the balance sheets of individual entities to a group balance sheet in a consistent way
- The interface supports a "RC base model"
  - Entities without an individual model can also be included in the risk aggregation

Challenges:
- Feeding external scenarios into existing systems,
- Replacing existing approaches

Benefits:
- Standardization,
- Comparability

Risk Collector Concept: Architecture

Stochastic Dependencies

The implementation of capital market and Nat Cat scenarios enables a consistent treatment of stochastic dependency through the external environment.

A stochastic variable can be defined as a function of other stochastic variables. Pre-defined (system) and user-defined functions and transformations (e.g., linear splines) are permitted.

Two original stochastic variables can be linked by (rank) correlation with copulas in the usual way.
The complexity of the data interface is determined by the Risk Collector base model, where the RC can treat original as well as derived stochastic variables.

The calculation scheme covers original as well as derived stochastic variables. It is trivial for internal models.
Risk Collector Concept: Data Interface

<table>
<thead>
<tr>
<th>Balance Sheet Category</th>
<th>Business</th>
<th>Business</th>
<th>Liability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Assigned</td>
<td>Analogous to asset positions, usually with positive sign.</td>
<td>Analogous to Liability positions, usually with positive sign.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Analogous to asset positions, usually with positive sign.</td>
<td>Analogous to Liability positions, usually with positive sign.</td>
<td></td>
</tr>
<tr>
<td>Netted Surplus</td>
<td>Analogous to asset positions, usually with positive sign.</td>
<td>Analogous to Liability positions, usually with positive sign.</td>
<td></td>
</tr>
</tbody>
</table>

Netted Surplus = \( \sum \text{Assets} + \sum \text{Netted} - \sum \text{Liabilities} \). Internal variable calculated by the RC.

Risk Collector Concept: Group Issues

Necessary Supplements

- Severe losses in a subsidiary requires a capital transfer
- Operational losses (modelled at group level) affect several companies simultaneously
- Life company’s operational losses may be partially absorbed by policyholders

Risk Collector architecture allows Management Rules like these to be included. Work in progress: multi-period functionality.

Risk Collector Implementation

Standard Outputs – 1

Economic Balance Sheet in Mio. €
Entity: SV2_AG, evaluation period: 2007, paths selected (125) All
Risk Collector Implementation
Standard Outputs – 2

Crucial Paths - Economic Capital in Mio. €
Entity: SY2_AG, evaluation period: 2007, quantile: 9, selected paths: 21, total paths: 128

<table>
<thead>
<tr>
<th>Number</th>
<th>Path</th>
<th>EK (Mio)</th>
<th>SFV (Mio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>7.03</td>
<td>5.09</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>8.04</td>
<td>6.02</td>
</tr>
<tr>
<td>3</td>
<td>42</td>
<td>9.05</td>
<td>7.01</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Risk Collector Implementation
Standard Outputs – 3

Economic Capital Distribution in Mio. €
Entity: SY2_AG, evaluation period: 2007, discount factor: 1.0000

<table>
<thead>
<tr>
<th>Value</th>
<th>SFV (Mio)</th>
<th>TRSF (Mio)</th>
<th>TRSF (Mio)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Risk Collector Implementation
Standard Outputs – 4

Risk Capital Allocation in Mio. €
Entity: SRV1_AG, evaluation period: 2007, percentile: 1.2%, separate non-tax effect: Yes

<table>
<thead>
<tr>
<th>Value</th>
<th>SFV (Mio)</th>
<th>TRSF (Mio)</th>
<th>TRSF (Mio)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
Risk Collector: Processing
General Process for Internal Models

Risk Collector: Processing
Special Process for Life Models

Risk Collector: Processing
Individual vs. Standard Solution (Non-Life)
Risk Collector: Processing
DMT Principle for the Standard Solution

**Input Module:**
- Excel® + VBA
- Standard IFRS Import
- Standard Model Import
- Manual Inputs

**Parametrization Module:**
- Excel® + VBA
- Standard Input Import
- Standard Parametrization of the RC Base Model
- Standard RC Interface
- Model Control

**Risk Collector:**
- ADVISE™ and GEMS™
- Path Identity
- RC Base Model
- Query Functionalities
- Standard Output

Fulfillment of Solvency II Requirements only by sufficient Transparency in any Aspect

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Risk Collector: Processing
Output of the Standard Solution

<table>
<thead>
<tr>
<th>Balance Sheet Category</th>
<th>Economic Capital = Total Surplus + Non Linear Tax Effects</th>
<th>1) Additional to the Linear Latent Tax Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old Re-Evaluation of IFRS Assets (BY)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old Re-Evaluation of IFRS Liabilities (BY)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Net Premiums (BY + 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in Value (BY + 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surplus = ∑ Assets - ∑ Liabilities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inclusive Latent Tax Effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>inclusive Latent Tax Effects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Risk Collector: Processing
Roles and Responsibilities

- Process is managed by a central quantitative risk management group (KQR) responsible for
  - Setting technical requirements
  - Obtaining approval of economic and nat cat scenarios
  - Approving economic and nat cat base models
  - Ensuring requirements are met

- Project management
  - Defined and developed back up plans
  - Ensures requirements are met
  - Provides results to Group management
  - Quality assurance, review and challenge individual company models and documentation
  - Form and deliver conclusions and recommendations

- Individual companies’ responsibilities
  - Build models complying with Group requirements
  - Documentation (including test models, tests, test procedures)
  - Deliver results on time to KQR
  - Assist with audit and review processes
  - Test models and ensure appropriate documentation and economics can test
  - Feed back experiences, V&SR for continual improvement of the process
Question & Answer Session