Internal model validation: a Solvency II perspective

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Overview: Solvency II regulatory framework

Pillar 1
Valuation principles
Solvency capital requirement (ORSA)
Internal model governance & use test
Model validation
Internal model approval

Pillar 2
Own Risk & Solvency Assessment (ORSA)
Overall governance arrangements
Supervisory review process (SRP)
Disclosure — solvency & financial condition report
Market discipline

Pillar 3

Solvency II requirements for validation

Solvency II Directive Article 124:
Insurance and Reinsurance undertakings shall have a regular cycle of model validation to demonstrate to their supervisory authorities that the resulting capital requirements are appropriate. This includes, but is not limited to:
► Monitoring the performance of the internal model
► Reviewing the ongoing appropriateness of its specification
► Testing the forecasted distributions using various quantitative and qualitative methods

Impact:
► Validation is a critical part of demonstrating that the internal model is suitable for setting capital for regulatory purposes, i.e., to get internal model approval for regulatory capital setting purposes.
► Validation is a critical element of the Use test—i.e. risk adjusted decisions are more credible based on a validated model.
► The validation process is ultimately owned by the board.
Elements of internal capital model validation

► Validation policy
► Data Policy
► Validation methodology/principles/tools
► Validation report
► Findings and Conclusions

Examples of internal model validation gaps compared to the Solvency II requirement

► Validation policy:
  ► Lack of governance, no escalation procedures, roles and responsibilities unclear
  ► Lack of governance between legal entities and group (i.e., Who runs the model? Who validates what?)
  ► Frequency of validation unspecified
  ► Lack of consistency between model methodology and validation across legal entities
  ► No principles of "materiality" established to identify "material items" or "non-material items"
  ► No principles of "proportionality" established

► Validation methodology/principles/tools:
  ► No methodology or principles or tools for validating the model results
  ► No methodology or principles for model calibration and parameterization
  ► Level of granularity of validation is unclear

► Independence:
  ► No independent review or appropriate governance for independent review in place
  ► "Independent" review is carried out occasionally if requested by regulators or by senior management but not on a regular basis

► Validation documentation/reports:
  ► No documentation or documentation standards for validation results

Validation policy – sample of key items

<table>
<thead>
<tr>
<th>Scope of validation — What?</th>
<th>Validation items</th>
</tr>
</thead>
<tbody>
<tr>
<td>- What is included - exclusion criteria?</td>
<td>- Validation of assumptions</td>
</tr>
<tr>
<td>- What is excluded - inclusion criteria?</td>
<td>- Validation of parameterization</td>
</tr>
<tr>
<td>- What is excluded - data quality</td>
<td>- Validation of risk management process</td>
</tr>
</tbody>
</table>

Principles of materiality and proportionality

► How do you establish principles of materiality (i.e., objective, subjective, combination)?

Granularity of validation — How deep?

► How far and how detailed should the validation be for a given risk type X item?

Limitations and future developments

► What are the limitations of your validation process?

Frequency of validation process — How often?

► How often will the validation process be carried out (i.e., are more material items checked more frequently)?

Thresholds

► What are the minimum acceptable thresholds for each item of your model?

- How do you evaluate qualitative validation?
### Validation methodology: quantitative and qualitative validation tools

<table>
<thead>
<tr>
<th>Quantitative aspects of the validation</th>
<th>Qualitative aspects of the validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Validation of methodology</td>
<td>• Validation of data, data feeds and IT systems</td>
</tr>
<tr>
<td>• Validation of assumptions</td>
<td>• Validation of documentation</td>
</tr>
<tr>
<td>• Validation of parameter methodology</td>
<td>• Validation of market governance</td>
</tr>
<tr>
<td></td>
<td>• Validation of regulatory requirements</td>
</tr>
</tbody>
</table>

**Quantitative tools:**
- Back-testing (against experience)
- Sensitivity testing
- Stability testing
- Stress and scenario testing
- P&L attribution
- Change Analysis
- Reversion stress testing
- Comparison to standard formula
- Comparison to other capital models

**Qualitative tools:**
- Industry benchmarking
- Third-party review
- Written justification of methods chosen
- Written justification of strengths vs. weaknesses in model
- Explanation of alternative methods considered

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### Sample roadmap for a validation process

<table>
<thead>
<tr>
<th>Step</th>
<th>Tasks</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initial planning</td>
<td>Identify the scope of validation.</td>
</tr>
<tr>
<td>2</td>
<td>Data collection</td>
<td>Gather necessary data.</td>
</tr>
<tr>
<td>3</td>
<td>Data validation</td>
<td>Assess the accuracy and completeness of data.</td>
</tr>
<tr>
<td>4</td>
<td>Methodology validation</td>
<td>Validate the model logic.</td>
</tr>
<tr>
<td>5</td>
<td>Stress testing</td>
<td>Evaluate the robustness of the model.</td>
</tr>
<tr>
<td>6</td>
<td>Sensitivity testing</td>
<td>Assess the impact of varying assumptions.</td>
</tr>
<tr>
<td>7</td>
<td>Stability testing</td>
<td>Validate the model over time.</td>
</tr>
<tr>
<td>8</td>
<td>Comparison to other capital models</td>
<td>Validate against other methods.</td>
</tr>
<tr>
<td>9</td>
<td>Comparison to standard formula</td>
<td>Validate against regulatory requirements.</td>
</tr>
<tr>
<td>10</td>
<td>Comparison to other models</td>
<td>Validate against industry benchmarks.</td>
</tr>
<tr>
<td>11</td>
<td>Written justifications of methods chosen</td>
<td>Justify the selection of methods.</td>
</tr>
<tr>
<td>12</td>
<td>Written justifications of strengths vs. weaknesses</td>
<td>Highlight model strengths.</td>
</tr>
<tr>
<td>13</td>
<td>Written justification of alternative methods considered</td>
<td>Identify alternative approaches.</td>
</tr>
</tbody>
</table>

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### Quantitative validation tools

1. **Back-testing**
   - Use historical databases
   - Run more than one capital model (e.g., “EC light”)
   - Run more than one capital model on a consistent basis
   - Run more than one capital model on a diverse portfolio of risks

2. **Stress testing**
   - Target test of acceptable power and accuracy
   - Identify most significant key drivers, assumptions and parameters of the model
   - Analyze sensitivity of the results to changes in key parameters and assumptions

3. **Sensitivity testing**
   - Use statistical testing such as Goodness of Fit, Parameter Estimation, etc.
   - Compare actual vs. expected/modeled
   - Use actual vs. expected

4. **Change analysis**
   - Implement model change in own funds by creating “mini” P&L statements
   - Analyze changes of capital model results over time
   - Assess the impact of a single event – stress testing

5. **P&L attribution**
   - Compare modeled P&L to realized P&L
   - Identify modeled vs. unmodeled risks, double counting

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### Qualitative validation tools

- Industry benchmarking
- Third-party review
- Written justification of methods chosen
- Written justification of strengths vs. weaknesses in model
- Explanation of alternative methods considered

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### Validation Report

- Produce initial validation results and action plans
- Produce results, reports and action plans in a consistent manner
- Escalate breaches to the validation policy
- Make improvements in a non-stop improvement process
- Escalate breaches to validators and apply validation to any validation that is being applied to the model

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**Notes:**
- Dimension #1: risk type
  - Operational
  - Reinsurance
  - Investment
  - Market/ALM
  - Nat CAT
  - Premium
- Dimension #2: what to validate? (finalized)
  - Key activities
  - Critical values (see table)
- Dimension #3: how to validate?
  - Methodology components:
    - Documentation
    - Input data
    - Model logic
    - Parameterization
    - Calibration
  - Validation of assumptions
  - Validation of methodology
  - Validation of use test
  - Industry benchmarking
  - Reversion stress testing
  - Comparison to standard formula
  - Comparison to other capital models

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**Outcome:**
- Key activities
- Critical values (see table)

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**Assess the impact of a single event – stress testing**
- Target level of acceptable simulation error

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**Stability testing**
- Identify most significant key drivers, assumptions and parameters of the model
- Analyze sensitivity of the results to changes in key parameters and assumptions

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**Sensitivity testing**
- Use statistical testing such as Goodness of Fit, Parameter Estimation, etc.
- Compare actual vs. expected/modeled
- Use actual vs. expected

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**Back-testing**
- Implement model change in own funds by creating “mini” P&L statements
- Analyze changes of capital model results over time
- Assess the impact of a single event – stress testing

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**Comparison to other capital models**
- Compare internal model results to standard formulas: solvency capital requirements (SCR) and minimum capital requirements (MCR)
- Evaluate likelihood of such scenarios

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**Comparison to standard formula**
- Compare internal model results to standard formulas: solvency capital requirements (SCR) and minimum capital requirements (MCR)
- Evaluate likelihood of such scenarios

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**Comparison to other models**
- Compare internal model results to other comparable methodologies
- Evaluate likelihood of such scenarios

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**Validation of methodology**
- Identify breaches to the validation policy
- Make improvements in a non-stop improvement process
- Escalate breaches to validators and apply validation to any validation that is being applied to the model
Sample roadmap: putting it all together

What?
Risk types: 1, 2, ..., N-1

How?
Risk type N:
Aggregation
Gaussian Copula
Free capital
Insurance risk (premium & Solvency)

 валдидов 99.5%, one year of basic own funds

Validation is a process

- Continuous improvement: each subsequent validation cycle should be more comprehensive and granular than the prior cycle
- Use test: the validation process is critical to foster strategic decision-making, e.g., risk-adjusted returns, capital allocation and so forth

Internal model validation: a Solvency II perspective

Conclusion

- Internal model validation is an essential part of good risk management
- The validation process is just as useful as the validation result
- Minimizes operational risks
- Internal model validation enhances the use test — risk-adjusted performance decisions can be made using a more transparent and credible model.
- Internal model validation is a critical element for internal model approval for regulatory capital-setting purposes (outside of the US).
- Internal model validation is likely to become a key part of NAIC ORSA.
- Internal model validation is central to rating agency evaluations of internal models.
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