Model Risk Working Party (1)

Background

• A model risk research project was established by the IFoA ERM Research and Thought Leadership Committee in October 2013

• The model risk project was initiated by a member-led research working party (the “model risk working party”)

• The remit of the working party was to consider:

  – can a quantitative risk model itself be a source of risk?

  – how should decision-making reflect the potential of the decision tool (model) itself introducing more risk?
So, can a quantitative risk model itself be a source of risk?

So there's a problem with my model... What's the worst that could happen?! It's hardly going to bring my multi-million dollar super business down... Is it?

Real world & industry miscalculations

Mars Climate Orbiter  ONS 2011  Reinhart & Rogoff
Mars Climate Orbiter  ONS 2011  Reinhart & Rogoff
Millennium Bridge  Herding  Trains – Laidlaw/SCNF
Millennium Bridge  Herding  Trains – Laidlaw/SCNF
Model Risk Working Party (2)

Objectives

• Raise industry awareness and understanding of model risk
• Develop a framework for measuring and managing model risk
• Foster good practice around governance and control of models

Progress to date

• We’ve established a set of questions to explore
• We don’t have all the answers yet!
• This presentation summarises our progress so far

We welcome your views on whether we’re answering the right set of questions

Agenda

• A simple, clear definition of model risk
• How the risk culture of an organisation or model user can affect attitude to model risk
• How existing risk management frameworks could be used to manage model risk
• Criteria for assessing materiality of model risk
• Practical case studies to illustrate the theory
• Good practice around governance and control of financial models
But what is a Model?

Definition of a Model

• “A representation of some aspect of the world which is based on simplifying assumptions. A model is defined by a specification that describes the matters that should be represented and the inputs and the relationships between them, implemented through a set of mathematical formulae and algorithms, and realised by using an implementation to produce a set of outputs from inputs in the form of data and parameters.” – BAS Technical Actuarial Standard Modelling, 2010

• “A quantitative method, system, or approach that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates” – OCC / Fed Guidance on Model Risk Management, 2011
Definition of Model Risk

- Model risk is the risk of adverse consequences from actions or decisions based on incorrect or misused model outputs and reports
- Model risk can lead to financial loss, poor business and strategic decision making, or damage to reputation
- Model risk occurs primarily for three reasons:

![Diagram of Model Risk]

Risk culture: The 4 quadrants of model users (1)

<table>
<thead>
<tr>
<th>User</th>
<th>Beliefs and characteristics</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cynical</td>
<td>Management intuition and expertise will trump that of modellers</td>
<td>Unknown-knowns</td>
</tr>
<tr>
<td>Naive</td>
<td>Direct link of model results to decisions, expert judgement downplayed</td>
<td>Known-knowns</td>
</tr>
<tr>
<td>Pragmatic</td>
<td>Model results treated as advisory, one of several pieces of evidence used for decision making</td>
<td>Known-unknowns</td>
</tr>
<tr>
<td>Pessimistic</td>
<td>Models irrelevant in decision making; models bound to be wrong</td>
<td>Unknown-unknowns</td>
</tr>
</tbody>
</table>

Different model users generate different model (or non-model) risks
Model users with different styles have different opinions of each other
Risk culture: The 4 quadrants of model users (2)

Cynical
Risks they are broadly aware of, but would rather not consider when making decisions

Naive
Risks that can be quantified and modelled

Pessimistic
Risks whose existence they are not even aware of

Pragmatic
Uncertainties that they identify through their modelling of risks

Risk culture: The 4 quadrants of model users (3)

Cynical
Unknown-knowns

Naive
Known-knowns

Pessimistic
Unknown-unknowns

Pragmatic
Known-unknowns
Risk culture: The 4 quadrants of model users (4)

- No one quadrant in isolation can be successful without the challenge / control from the other quadrants

Conclusions

| Good governance will include representation of each group |
| Governance needs to address the needs of different users to get a good outcome |
| Validation needs to address the possible challenges from each quadrant |

Risk management framework for model risk

<table>
<thead>
<tr>
<th>Area of framework</th>
<th>Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership</td>
<td>The risk team is responsible for the model risk management framework, the chief executive is responsible for managing model risk</td>
</tr>
<tr>
<td>Model inventory</td>
<td>To be maintained by the framework owner but populated and updated by model owners</td>
</tr>
<tr>
<td>Risk appetite</td>
<td>Setting appetite and tolerance limits for model risk</td>
</tr>
<tr>
<td>Materiality assessment</td>
<td>To be carried out in order to put a sensible limit on the number of models the framework applies to</td>
</tr>
<tr>
<td>Oversight categories</td>
<td>Governance, data quality, changes, use, assumptions / expert judgements, methodology, performance, validation, documentation, external models and data</td>
</tr>
<tr>
<td>Governance standards</td>
<td>Required for each of the oversight categories (‘watered down’ version of regulatory standards where appropriate)</td>
</tr>
<tr>
<td>Risk reporting</td>
<td>All model owners will need to assess how well they are managing the risks / operating the controls on a periodic basis, e.g, quarterly via risk self assessment process (owned by risk team)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>03 June 2014</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>03 June 2014</td>
<td>14</td>
</tr>
</tbody>
</table>
Assessing materiality of Model Risk (1)

Where does model risk arise?

- Model risk arises from a decision using information derived from model outputs, when:
  - this information is “wrong” (i.e. the information is not what is intended)
  - the purpose for which the information is being applied is not an appropriate use of the model

Scope

- Include all models being used within business and support processes and also any models produced for third party use (customers and regulators)

Definition of materiality

- The risk is material if the information from the model could influence the decision-making or judgement of the intended users of that information
  - it equally applies to outcomes for a third party (customer, regulator, public)

Assessing materiality of Model Risk (2)

- **Identify** ALL the models being used
- **Log** all models being used → record where they are being used and what they are being used for
- If the model risk is **immaterial** → could it become material in the future?
- If the model risk is **material** → does it need to be controlled?
- **Ongoing** requirement to **maintain** the accuracy of the assessment

**Could the information from the model drive a different decision?**

03 June 2014
Assessing materiality of Model Risk (3)

Assessment of whether the model could drive a different decision

Assume a model will be controlled unless:

- Its contribution to the model application is sufficiently small (not only of point in time but also over the foreseeable future)
- No concentrations of risk
- Model is stable and not likely to give very different results
- Low interconnectedness with other models

Assessing materiality of Model Risk (4)

Model application and metric for assessment

<table>
<thead>
<tr>
<th>Process</th>
<th>Metric</th>
<th>Process</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reserving</td>
<td>Total reserves</td>
<td>Transactions</td>
<td>£M of price</td>
</tr>
<tr>
<td>Regulatory capital</td>
<td>Capital requirement</td>
<td>Forecasting</td>
<td>Total PBT</td>
</tr>
<tr>
<td>EEV / MCEV</td>
<td>Total EEV / MCEV</td>
<td>Benefit illustration</td>
<td>Sales volumes</td>
</tr>
<tr>
<td>Product pricing</td>
<td>Total NB PBT</td>
<td>Experience analysis</td>
<td>Total BEL</td>
</tr>
<tr>
<td>ALM</td>
<td>Percentage of BEL</td>
<td>Reinsurance</td>
<td>Reinsurance premiums</td>
</tr>
</tbody>
</table>
Working Party case studies (1)

Proxy models

- We are an insurer and we want to revalue assets and liabilities quickly under many stress scenarios
- Running full valuations in the “heavy model” takes a long time
- So we perform a moderate number of “fitting” scenarios in the heavy model and then fit a smooth formula (the “proxy model”), usually a polynomial, through those scenarios
- To check the proxy model is working, we also generate “out of sample” scenarios, separate from those used in the fitting, for which we run both the proxy model and the heavy model and compare the results

Working Party case studies (1) continued

Proxy models key questions the working party aim to address

- How many out-of-sample tests are needed to assess how accurate the proxy model is?
- How best to construct the out-of-sample tests and the fitting tests?
- How can we use the out-of-sample test errors to construct confidence bounds for proxy model errors where we haven’t done heavy model runs?
Working Party case studies (2)

Longevity models

Working Party case studies (3)

Investment advice models
Governance and control of financial models

Applying the standard risk management cycle

<table>
<thead>
<tr>
<th>Identify</th>
<th>Measure/assess</th>
<th>Control</th>
<th>Monitor/manage</th>
<th>Report</th>
<th>Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop model inventory&lt;br&gt;2. Develop model change inventory&lt;br&gt;3. Assess materiality of models and model changes&lt;br&gt;4. Refresh on a regular basis</td>
<td>Carry out risk assessments of all material models and model developments: &lt;br&gt;1. Model risk governance standards&lt;br&gt;2. Self assessments&lt;br&gt;3. Address key gaps&lt;br&gt;4. Independent model validation team&lt;br&gt;5. Independent model risk assessments</td>
<td>1. Develop model risk appetite with model risk limits and tolerance levels</td>
<td>1. Implement model risk appetite monitoring into governance&lt;br&gt;2. Monitor model risk profile against risk appetite&lt;br&gt;3. Apply appropriate mitigating actions where model risk profile outside appetite</td>
<td>1. Set up model governance committee&lt;br&gt;2. Develop model risk MI templates&lt;br&gt;3. Implement model risk reporting into model governance committee and escalate issues to risk management committee</td>
<td>Fully integrate into company wide decision making</td>
</tr>
</tbody>
</table>
## Model Risk management: Different to standard?

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should model risk be managed in the same way as other risks?</td>
</tr>
<tr>
<td>Do you already capture model risk in your operational risk frameworks?</td>
</tr>
<tr>
<td>Do you build in prudence to calibrations?</td>
</tr>
<tr>
<td>Who should own model risk?</td>
</tr>
<tr>
<td>How do you assess materiality?</td>
</tr>
</tbody>
</table>

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## Model Risk: Still work to do.....

- Education, Education, Education!
Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.