ICA Modelling Seminar

Parameter Uncertainty

Peter Tavner, Gavin Hill, Trevor Maynard
Agenda

- Introduction
- Catastrophe Modelling
- Specific areas of uncertainty
Introduction
Uncertainty: the problem

- We have been asked to calculate remote scenarios
- We have:
  - limited data
  - some theory
  - some tools
  - our actuarial judgement
  - ..and lots of ‘expert opinion’
- In the context of a 99.5% CI, we can never say with certainty that the ICA number is ‘correct’
- …but how far out are we?
The response so far?

Burying my head in the sand over climate change is much easier, now that half the world’s turned to desert!
The response so far?

- Many ICAs do not fully acknowledge the issue of uncertainty. Why not?
  - Insufficient awareness of tools and methods
  - Insufficient data in first place => guesstimates
  - Difficult to sell internally
  - Other priorities
  - Likely to increase the number!

- Are actuaries in danger of over-promising?
Drivers of Uncertainty

- Parameter Uncertainty
  - Specific to our data sample
  - Beyond the data
- Model error
- Convergence error, process error
Parameter uncertainty

- Parameter estimate is based on population sample
- It will always be an estimate, hence uncertain
- Different estimation methods will give different answers e.g.
  - Maximum likelihood
  - Method of moments
- But you do need some data in first place! 😊
Identifying Parameter Uncertainty

- Keeping it simple: back test the results
- Conventional statistical methods
  - Confidence intervals
  - Goodness of fit tests
  - Asymptotic distribution of ML estimator
- Bayesian approach

Note: explicitly incorporating parameter uncertainty can materially impact distributions
Beyond the data: is the past a reliable guide to the future?
- Regulatory/legal changes e.g. Ogden
- Latent claims

Very difficult to capture explicitly
- Sensitivity test the results
Other sources

- **Model Error**
  - The best fit may not be the true underlying
  - Over-parameterisation can be an issue

- **Convergence**
  - 10,000 sims may be insufficient
  - Problem worse with risk measures that look further into tail
  - Technical solutions available: stratified/importance sampling
What the guidance says

- **FSA sector briefing (Nov 2005):**
  
  “important that firms recognise the issue”
  
  “that uncertainty is adequately communicated”
  
  “not appropriate to ignore this risk”

- **Lloyd’s:**
  
  “Adopt prudent assumptions to compensate for known shortcomings including parameter uncertainty”
The bigger picture

- ICAS is not just about the number, it is also the framework
  - Remember the ICA process is intended as a tool to inform management
  - Use statistical methods (and judgement) to *identify* risk areas and weaknesses
  - Communication important: better to flag areas of uncertainty than do nothing
  - Keep the ICA strictly ‘best estimate’? Discuss
Catastrophe modelling

- Parameter Uncertainty
Types of uncertainty

- Aleatory
  - inherent randomness
  - cannot be reduced by collation of additional data

- Epistemic
  - lack of information/understanding
  - can be reduced

- Useful concepts
Epistemic sources

- Hazard data is scarce!
  - a few hundred years at most
  - of very low probability events

- Limited scientific knowledge

- Cross disciplinary nature
  - Actuaries
  - Structural Engineers
  - Climate Scientists/ Seismologists
(more) epistemic sources

- Exposure data
  - often poor – lack of GIS data
  - but important
    - E.g soil type can vary within small area but
    - crucial for earthquake damage
  - Insured values often uncertain

- Damage functions
  - Based on laboratory models
  - Models within models!

**GIS** = Geographic Information Systems = geographically referenced data
General Comments

- Knowledge wave; modelling wave (lag) –
  - Find out what’s known
  - Ask your modelling company their view

- Modelling Co’s are “silent” on this

- Some of the parameter uncertainty is built in
  - secondary uncertainty
  - damageability factors

- Understand the choices they have made on your behalf
  - E.g. RMS near term view/ AIR long baseline
### FCHLPM scenarios

<table>
<thead>
<tr>
<th>Event ID</th>
<th>SSI</th>
<th>Central Pressure (mb)</th>
<th>Radius of Max Winds (mi.)</th>
<th>Forward Speed (mph)</th>
<th>Landfall Latitude</th>
<th>Landfall Longitude</th>
<th>Landfall Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>913.5</td>
<td>8</td>
<td>15</td>
<td>30.3</td>
<td>-81.4</td>
<td>Jacksonville</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>930.7</td>
<td>10</td>
<td>15</td>
<td>30.3</td>
<td>-81.4</td>
<td>Jacksonville</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>956.4</td>
<td>12</td>
<td>15</td>
<td>30.3</td>
<td>-81.4</td>
<td>Jacksonville</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>973.5</td>
<td>15</td>
<td>15</td>
<td>30.3</td>
<td>-81.4</td>
<td>Jacksonville</td>
</tr>
<tr>
<td>....</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>982.1</td>
<td>15</td>
<td>15</td>
<td>30.1</td>
<td>-85.8</td>
<td>Panama City</td>
</tr>
</tbody>
</table>

- For certification
- 4 model companies complete returns
- Public results

---

Florida Commission on Hurricane Loss Projection Methodology

[The Actuarial Profession](https://www.actuary.org)  
making financial sense of the future
FCHLPM scenarios - results

<table>
<thead>
<tr>
<th>AIR</th>
<th>ARA</th>
<th>Eqecat</th>
<th>RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,387,021</td>
<td>13,579,563</td>
<td>14,619,000</td>
<td>11,244,471</td>
</tr>
<tr>
<td>3,369,452</td>
<td>8,774,355</td>
<td>8,397,000</td>
<td>5,964,194</td>
</tr>
<tr>
<td>736,047</td>
<td>1,742,091</td>
<td>2,433,000</td>
<td>1,652,508</td>
</tr>
<tr>
<td>208,825</td>
<td>379,178</td>
<td>629,000</td>
<td>498,050</td>
</tr>
<tr>
<td>.......</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32,330</td>
<td>57,075</td>
<td>209,000</td>
<td>115,176</td>
</tr>
</tbody>
</table>
FCHLPM scenarios - results

- Average range 62% to 150% of mean
- Is your ICA result that uncertain?
- Different models give very different results
- The science is not exact!!!
Parameter risk can be huge.

- Ground up losses
- 3 models + Wharton School
- 99.5%ile
  - $0bn, or
  - $3bn!!
- Why?
  - No data

Figure 4.5. Composite exceedance probability curves for Charleston region.

Source: Grossi and Kunreuther. Catastrophe Modelling, Springer 0-387-23082-3
“A little knowledge is a dangerous thing; drink deep, or taste not the Pierian Spring: there shallow draughts intoxicate the brain, and drinking deeply sobers us again”

Alexander Pope – an essay on Criticism 1709
Catastrophe modelling

- Climate change
“Climate change poses risks to a large number of general insurers….it became apparent that some firms may rely too much on the output of their catastrophe models without proper consideration of the inputs….it is imperative that firms address this issue Urgently”

FSA Financial Risk Outlook 2006

“...it is **not acceptable to wait** until the effects of the trend are well understood before commenting on the possible implications... consider scientific evidence on climate change with regards to parameter setting”

Lloyds ICA guidance 2006
Why wait?

There is no justifiable reason any more:

- Climate change is happening
- Even the (sane) sceptics agree
- There is sufficient information to do something
The AMO

Source: Atlantic Ocean Forcing of North American and European Summer Climate
Rowan T. Sutton* and Daniel L. R. Hodson

or is it? .......
The AMO
Means

- cycle 2.46
- high mode 3.18
- low mode 1.91
Simple model

- Hurricane formation rate $3.18/2.46 - 1 = 29\%$ above average (could say $4/2.46$)
- Assume constant landfall proportion (25%)
  - From NHC data
  - debatable
  - probably higher in hot phase
- Assume poisson landfall process, $X_t$
- Assume capital proportionate to 95\%ile of $X_t$

$\Rightarrow$ Required Capital increases by 20\%
Intense Hurricane Risk

“we don’t know the right answer….”

- Correct
- But zero is definitely the wrong answer
- Uncertainty = risk…
  - Volatility has increased
  - Price (& capital requirement) goes up
The data is out there

climatechange.pbwiki.com/DataSources
Specific areas of uncertainty
Areas we will cover

- Sensitivity testing
- Data considerations
- Insurance risk
- Credit risk
- Operational risk
- Market risk
- Stress and scenario tests
Sensitivity testing

How does parameter uncertainty apply here?

- Identification of key parameters
- What is the impact of changing key parameters
- Correlation levels
- Communication – separating theory and practical implementation
Data considerations

Are there different / new data considerations in the ICA environment, compared to reserving?

- Data outliers
- What is the impact of one year of extra data?
Insurance risk

Observations

- Best practice splits underwriting risk, reserve risk and reinsurance risk
- Underwriting risk can be further split between claims risks and pricing risks
- Claims risks can be further split between attritional losses, large losses and catastrophic losses
Insurance risk

Reserve risk

- Allowing ultimate reserve uncertainty to emerge
  - Need to allow for relevant reinsurance?
- When is bootstrapping paid claims a reasonable approach to estimating reserve risk?
Insurance risk

Underwriting risk

- Separating underlying attritional loss ratio volatility from pricing volatility
- What is a ‘1 in 200’ level of catastrophe?
- What is the uncertainty surrounding this?
- What is a ‘1 in 200’ level of large loss?
  - What is a ‘1 in 200’ motor large loss?
Insurance risk

Long tailed lines of business / liability business

- What is the appropriate amount of uncertainty to allow for when considering long tailed liability account reserves, eg Asbestos
- What allowance should be made for future latent claims?
Credit risk

Which things need consideration?
- Investment credit risk
- Counterparty credit risk
  - Where does materiality let us stop?
  - Allowance for reinsurance credit risk ‘to ultimate’
  - Ripple effects - Increased risk following major insurance event (increase in probability and exposure)
- How to treat ‘binary’ events
Operational risk

- ‘Most operational risks eventually manifest themselves within historic (claims) data – our parameterisation includes Op risk implicitly’
  - Is this a reasonable claim?
- Use of risk registers to populate stress test models of Op risk
- Defined benefit pension scheme ICA requirement
- Is a simple percentage loading for Op risk reasonable?
- Avoiding double counting / excessive prudence
Market risk

- Valuation basis
- Allowance for discounting
- Parameter uncertainty
- Market consistency
- Use of an ESG versus self derived models
- Investment policy – designed for which basis?
- Materiality
Stress and scenario tests

- Typical use – stress tests to derive capital requirement, scenario tests for testing
- Ensuring consistency between probabilities for different stress tests
- Evaluation of expected and maximum costs for stress tested events
- What is a reasonable objective when using stress tests
- Use of model output to inform stress/scenario tests
- Aggregation of stress test results