Principles of actuarial modelling

CHRIS SUTTON
Topic outline

1. Why and how actuaries use models
2. Advantages and disadvantages of using models
3. Deterministic versus Stochastic models
4. Discreet and continuous states and time
5. How to assess the suitability of a model
6. Timeframe, analysis and sensitivity tests
7. Communicating model results
What is a “model”? 

A model is an imitation of a real world system or process.
Why do we use models?

Often trying something out in the real world is not possible:
- Too risky
- Too slow
- Too expensive
- Sampling issues
- Conflicting objectives
What do we need to build a model?

maths

parameters

data
An example of a modelling process

Define objectives
Define parameters
Collect data
Conceptual model
Engage experts
Computer programme
Random number generator
Test initial output
Small change in parameters
Analyse output
Check TAS
Present results
Advantages and disadvantages

Biggest advantage to actuaries is the ability to study multi-year processes in a short period of time. Also:

• Life assurance companies are complex organisations and simulation is a helpful management tool
• Ability to compare different possible courses of action
• Control of the model allows us to reduce variance from certain parameters

However, there are a number of disadvantages:

• Models are generally better for comparing the effect of varying inputs (relative results) rather than delivering precise outputs (absolute results)
• Risk that the model leads people to over-confidence
• Data quality issues
• Some types of future events are very difficult to model
Deterministic and Stochastic models

**Stochastic:**
- Includes random nature of inputs
- So model results are also random
- Useful for investigating multiple scenarios
- Need several independent runs of the model to allow use of statistical theory on the results
- Can use Monte Carlo simulation to investigate the model [see 2\textsuperscript{nd} year notes]

**Deterministic:**
- No random inputs, they are fixed
- So model results are determined once these inputs are known
- Used to investigate a single scenario
- Really a special case of a stochastic model
Discreet and continuous states and time

<table>
<thead>
<tr>
<th>Discreet states</th>
<th>Continuous states</th>
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<td><img src="image" alt="Discreet states" /></td>
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<table>
<thead>
<tr>
<th>Discreet time</th>
<th>Continuous time</th>
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<td>2018 2019 2020 2021</td>
<td><img src="image" alt="Continuous time" /></td>
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How to assess the suitability of a model

- Does it meet the objectives?
- Is the type of model valid?
- What is the quality of the data?
- Are the assumptions valid?
- What errors are possible in model design or parameters?
- What would be the impact of correlation between “random” variables?
- Are the results credible?
- Could there be spurious accuracy?
- Any regulatory considerations?
- How easy is it to communicate the model and its results?
Short term and Long term properties

As actuaries we need to remember that we are generally interested in long term outcomes or relationships but mathematical models are generally more stable in the short term.

◦ This is because small changes in the relationship between parameters become magnified in the longer term.
Analysis of model output

Sampling techniques from Statistics are needed to analyse model outputs

However care is needed as multiple observations from one model will be correlated

- Hence IID assumptions cannot usually be made

“Turing Test”

- Engage experts with anonymised data sets to see whether they can tell the difference between model outputs and real world data
Sensitivity testing

Important discipline

Test model by repeating simulations with small changes in:

◦ Parameter input values
◦ Their statistical distributions
Communicating results

Important final step for actuaries

Need to take account of the level of technical knowledge of the target audience

Need to include comments on the limits of the model and its uses