Making the most of a longevity internal model

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Making the most of a longevity internal model

1. How to design a robust longevity model

2. The PRA’s quantitative indicators

3. How a good model can add value, and a bad model destroy value
1) How to design a robust longevity model

Key risks, modelling decisions and interactions
Seven steps to success

1) Context
2) Review existing
3) Taxonomy
4) Modelling approach
5) Modelling
6) Aggregation
7) Submission
Context

“The methods used to calculate the probability distribution forecast shall be based on adequate, applicable and relevant actuarial and statistical techniques and shall be consistent with the methods used to calculate technical provisions.”

Paragraph 2, Article 121 of SII Directive (our emphasis)
What risk drivers are in scope?

Longevity
- Volatility
- Base table mis-estimation
- Longevity trends

Demographic
- Proportion married
- Age difference
- Optionality
- Selection

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Being proportionate

Optionality
Proportion married
Age difference
Selection
Base table mis-estimation
Longevity trends

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Taxonomy

Key areas where the risk manifests

Consolidation level for modelling

What can change your best estimate?
An illustrative taxonomy: Trend risk

- Data risk
  - New experience data
  - Data error risk
- Model risk
  - Parameter mis-estimation risk
  - Model assumptions risk
- Event risk
  - Interpretation risk
  - New information risk
- Basis risk
  - Basis risk
  - Anti-selection risk
How a taxonomy can add value

- Longevity trends
- Base table mis-estimation
- New information risk
- ...
Modelling approach: Competing approaches

- Extrapolative
- Explanatory

- Regression
- Structural stochastic
- Stochastic CMI
- Cause of Death
- Cause of Cause of Death
- Scenario based

Judgement:
- High
- Low

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An illustrative modelling approach: **Trend risk**

Longevity trends

- **Data risk**: Structural stochastic
  - New experience data
  - Data error risk
- **Model risk**: Structural stochastic
  - Parameter mis-estimation risk
  - Model assumptions risk
- **Event risk**: Expert judgement
  - Interpretation risk
  - New information risk
- **Basis risk**: Scenario based
  - Basis risk
  - Anti-selection risk
Submission: Mind the shape

Chart illustrative of shapes of stresses. Stresses not to scale relative to each other.

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Submission: Different firms, different capital

Undiversified longevity trend stress seen within market

1. Varies with age profile of book

2. 4%+ spread

50 60 70 80 90
% of BEL

Average age of annuitants

Firms at higher end of range
Mid-range
Firms at lower end of range

Different firms, different capital

Varies with age profile of book

4%+ spread

Firms at higher end of range
Mid-range
Firms at lower end of range

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2) The PRA’s Quantitative Indicators
Data risk…

**Basic approach:**
- Simulate and identify median outcome under run-off
- Simulate one year of extra data, refit model and simulate run-off. Identify change in median. Repeat many times.

**PRA QIs:**
- Do above for commonly used structural stochastic models
  *(P-spline, Lee-Carter, Cairns-Blake-Dowd and Age-Period-Cohort; analysis shown here based on first three)*
- The spread of refitted medians is very different for each model, ranging from 1% to 4%
- The arithmetic average across the three models is c.2.5% of BEL

‘Best estimate’ liabilities under alternative models for future improvement

- P-spline (age-cohort)
- Lee-Carter
- Cairns-Blake-Dowd

For ease of illustration only 3 models included above. Jaggedness in distributions arises from modest number of simulations used (5,001).

Analysis shown for a ‘typical’ annuity business with a mix of IA and BPA and primarily annuities in payment. Actual QI will depend on age profile and mix of your back book.

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Event risk…

- Compare the median outcomes under the run-off from the different models.
- Potential change in best-estimate owing to event risk taken from the range of views given by the four models.
- The chart illustrates different ‘best estimate’ views under each model.
- Each model’s best estimate is relative to the mean of best estimate across the models.
- Event risk component of PRA’s QI is c.6% of BEL.

‘Best estimate’ liabilities under alternative models for future improvement

<table>
<thead>
<tr>
<th>P-spline (age-cohort)</th>
<th>Lee-Carter</th>
<th>Cairns-Blake-Dowd</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>100%</td>
<td>110%</td>
</tr>
</tbody>
</table>

Median liabilities relative to average across all three Models.

Analysis shown for a ‘typical’ annuity business with a mix of IA and BPA and primarily annuities in payment. Actual QI will depend on age profile and mix of your back book.

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Example QIs: The importance of correlation

- Independent risks
  - 0% correlation
  - c.6½% of BEL

- Additive risks
  - 100% correlation
  - c.8½% of BEL

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3) Adding and destroying value
A bad model can destroy value...

Risk capital as a % of BEL

Age

Internal model (all risks)
Expressed as baseline stress

Strategic decisions use this approach?
Market pricing uses this approach
And a good model can add value…

• A mono-line protection business is considering expanding into the life market
• Currently has no diversification benefits

Note: This example is purely for illustration – we appreciate it is unlikely that the mono-line would immediately seek a full internal model for longevity

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And a good model can add value…

Writing diversifying business is efficient

Writing negatively correlated business is better than free
And a good model can add value…

Reach an optimal mix for new business

Strategic re-shaping of business

Business as usual  Negatively correlated business  Higher negative correlation
To conclude...

Your longevity internal model is worth investing in...

…it can pay strategic dividends
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.