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The CMI Library of Mortality Projections

Gordon Sharp

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CMI mortality projections research

- Mortality Projections Working Party established to explore possible projection methodologies for use with the "00" Series tables
- Seminar with GAD in 2003 – speakers included demographers, statisticians and gerontologists
- Groundwork documented in Working Papers 3 (including rationale for not projecting by cause), 11 and 15
- Concluded that P-spline and Lee-Carter warranted further, more detailed, research

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CMI mortality projections research: P-splines

Working Paper 20
- Regression model fitted to past data
- P-splines impose a penalty on differences in adjacent co-efficients
- Choice of penalties determines balance between smoothness and closeness of fit
- Model fitted to a surface, either:
  - age and calendar year (Age-Period) or
  - age and year of birth (Age-Cohort)
- Fitting process provides:
  - Fitted $\log(\mu) \Rightarrow$ mean values
  - Standard deviations $\Rightarrow$ determine confidence intervals

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CMI mortality projections research: Lee-Carter

Working Paper 25

- Structured time-series model

$$\log \mu(x,t) = a(x) + b(x)k(t) + e(x,t)$$

- No allowance for parameter uncertainty, so CMI have introduced through bootstrapping
- Basic model does not capture cohort effects
  - $\Rightarrow$ Poor fit when back-testing from 1992
- Renshaw & Haberman Lee-Carter APC model

$$\log \mu(x,t,c) = a(x) + b_1(x)k(t) + b_2(x)I(c) + e(x,t,c)$$

- Introduces extra parameter to model cohort effects

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CMI mortality projections research: Conclusions

Objective	P-Spline age-cohort	P-Spline age-period	Lee-Carter	Lee-Carter APC
Ease of use	Y	Y	Y	Y
Parameter Interpretation	N	N	Y	Y
Structure & fit	Y	Y	N	?
Cohort effects	Y	N	N	Y
Best estimate	Y	Y	Y	Y
Confidence Intervals	Y	Y	Y	Y
Sample paths	N	N	Y	Y

Working Paper 25

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CMI mortality projections research: conclusions

- Issues with both P-spline & Lee-Carter
  - P-spline – vulnerable to edge effects
  - Lee-Carter – doesn't fit UK data (cohort effects)
- Both dependent on improvements within past data
- CMI could not recommend any specific method
- No projections in "00" Series tables

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Mortality Projections – making the CMI's work more accessible

- CMI recognised its research was inaccessible to many actuaries
- Task Force formed to:
  - Illustrate the CMI's recent research to make it more accessible
  - Propose terminology to facilitate disclosure of mortality projections
  - Develop sets of projections which can be used as benchmarks
  - Collaborate with ECPD Board on education needs
- Membership of Task Force included life and pensions actuaries

The draft "library" of Mortality Projections

Draft "library" of projections included:
- Existing projections:
  - "92" Series
  - Cohort Projections
  - ONS 2004-based population projections
- Variations on existing projections in current use:
  - Imposing a minimum improvement on a Cohort Projection
  - Using a percentage of a Cohort Projection
- Examples of P-spline and Lee-Carter projections
- **… but the "library" was NOT intended to offer guidance on choice of projection**

The structure of the draft "library"

- 42 "projections" in the draft library
- Each projection can be combined with any base table
- Each sheet contains data:
  - From age 20 to 120
  - From calendar year 1992 to 2100
- Each cell is the cumulative reduction factor:

$$RF(x,t) = q_{x,t} \, / \, q_{x,0}$$

- Improvements between 1992 and 2005 are a mixture of actual improvements and projections

Feedback to Working Paper 27: Key themes

- The need for the library
- Naming convention
- The projections in the library
- 'Mind the gap'
- Very old ages
- Illustrating uncertainty
- Suggested further reading

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Working Paper 30 & the library

- Version 1.0 of the library published in multiple spreadsheets in November 2007
- Accompanied by
  - CMI Working Paper 30 – reviews feedback received and Task Force's responses
  - User guide – details contents of version 1.0 of the library

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Additional projections from the draft library

- ONS 2004-based projections for males in Scotland included
- ONS 2006-based projections included:
  - Males (EWNI), males (Scotland) and females (all)
  - Principal, HLE and LLE
  - Key difference – continued cohort effect
- Additional variation on the Interim Cohort Projections - a percentage of a cohort projection with a minimum of 2.5% p.a.
- … *making 55 projections in total*

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Changes from the draft library

- Projections extended to 2130
- Smoothed actual improvements for 1992-2004 removed from ONS 2004-based projections; now commence from values of 100% in 2004
- P-spline projections extended to allow calculation of other percentiles than 50th
- Minor amendments have been made to some of the names of the projections, e.g. region of the UK clarified in the names of the ONS projections and the projections generated by the CMI based on ONS data
- P-spline and Lee-Carter projections using CMI data previously incorrect due to inconsistency in the exposure

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Future Updates

- No set times, updates for:
  - New data
  - Intuitive scenarios
  - New methodologies

- Indicative criteria in User Guide …new projections should be:
  - A worthwhile addition to the current library
  - Publicly available
  - Clearly described and documented
  - 'Road-tested' on different datasets and for different time-periods; and
  - Adequately exposed to the Actuarial Profession for discussion

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Library - what happens next?

- Task Force has completed its work and disbanded …
- … but library is envisaged to be a living document
- CMI is setting up a new "Library Management Group":
  - Envisage a small nucleus of members
  - Representation from Life Office and SAPS Mortality Committees
  - May supplement for specific exercises, e.g. reviewing a new methodology
- Possible developments in 2008:
  - P-spline and Lee-Carter projections using 2006 data?
  - Cairns-Blake-Dowd models?
  - Lee-Carter Age-Period-Cohort?

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Mortality projections – the bigger picture

- Regulators are keen for more guidance to be given
- TPR is consulting on a trigger of Long Cohort with a minimum
- BAS issued its consultation on mortality assumptions in March
- CMI keen to work constructively with interested parties
- Projections will continue to be a Hot Topic !

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