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Components of longevity risk

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27 June 2013

Agenda

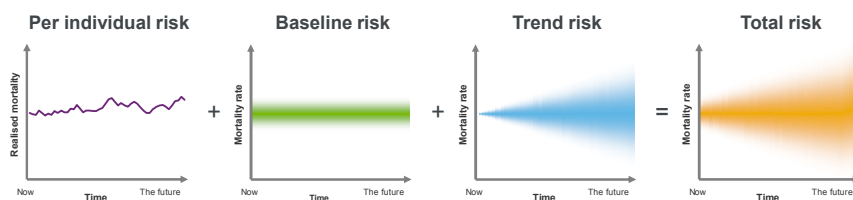
- Context is final salary pensions – low anti-selection risk
- Longevity risk by component
 - Per individual
 - Baseline
 - Trend
- Value at risk
- Conclusions



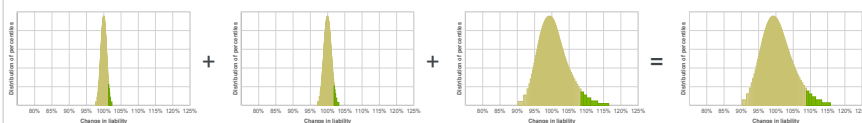
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2

Components of longevity risk



Illustrative impact on pensioner liability for a 'medium sized' final salary pension scheme



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3

Per individual risk

Per individual risk

- Sometimes called 'idiosyncratic' (but there's more than one idiosyncratic v systematic breakdown in longevity)
- In principle, this is easy to calculate
 - Run lots of simulations at a per individual level
 - Replace q with 1 with probability q and 0 with probability $1-q$
 - But this approach scales (very) badly for larger schemes
- Typical shortcuts
 - Simulate time of death and calculate annuity certain
 - Calculate separately from other simulations
 - Group the data (correctly!)



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4

Baseline risk

- Baseline gets lots of attention
 - Not the largest risk, but the most amenable to analysis
 - Trend risk assessment often generic
- Baseline mortality is constructed from
 - Scheme's own experience
 - Postcode model, i.e. lots of other schemes' experience
 - Actuarial judgement
- Deal with risk impact of each these in turn



Scheme's own mortality experience

- Simple approach
 - Assume a flat scaling model, i.e. scale μ by A/E
 - Select S1P table with A/E 'close to' 100%
 - $1/20 \Delta$ scaling risk is

$$-1.645 \sqrt{\frac{\text{Expected deaths weighted by (pension)}^2}{\text{Expected deaths weighted by pension}}}$$

- Complex approach
 - Fit a model and use associated stats to assess uncertainty
 - To measure *liability* risk, *must* weight or stratify



Baseline risk

Extra-model scheme experience risk

- Standard experience analysis items
 - Seasonality – use whole number of years
 - Annual variation – use at least 5 years
 - IBNR deaths – remove data close to extract date
- Experience v liability populations
 - May be different
 - Insufficient disaggregation (frailty)
 - Rating factor inconsistency or drift
- The data itself may be wrong – QA gets you only so far, e.g.
 - Pension inconsistent lives v deaths, e.g. GMP, top-ups, PIE
 - Change in administrator or recording practices



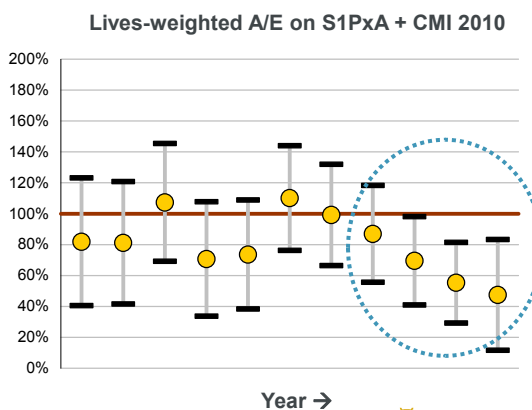
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7

Baseline risk

Data errors are commonplace – example

- Actual longevity transaction
- Deaths fall off in later years
- Administrator had omitted deaths from a member category

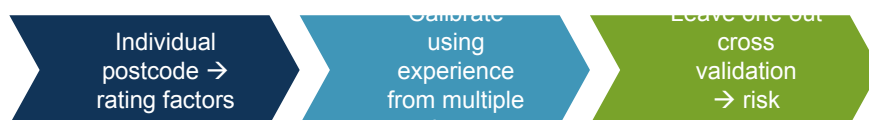


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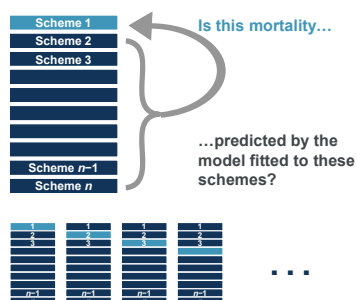
8

Baseline risk

Base mortality models using postcode



Leave-one-out cross-validation (LOOCV)



- Postcode model risk can be derived from leave one out cross validation (LOOCV)
- Model quality depends on database used



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9

Baseline risk

Extra-model postcode model risk

- LOOCV includes (some) data error implicitly
- But some extra-model risk remains
 - Poor + biased postcode coverage
 - Non-residential addresses
 - Insufficient disaggregation (frailty)
 - Small population risk, i.e. usually untested on small populations
 - Holes inside model
 - Rating factor drift
 - Pension is common culprit, but also anything postcode-based
 - Actives/deferreds require additional assumptions



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10

Baseline risk

Combined baseline risk

- Baseline risk
 - Not the largest component of longevity risk
 - *But often critical for pricing*
- Postcode + experience is powerful combination
 - 2 data points
 - Combination (e.g. using credibility) means less risk
 - Postcode model helps apply experience to liabilities
- Baseline risk in an occupational pensions context should in any case be limited by actuarial judgement

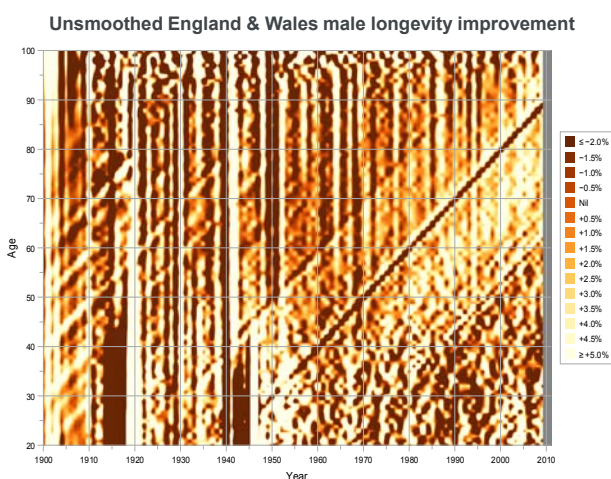


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11

Trend risk

Data for calibrating trend risk models



- Time inhomogenous
- Complex cohort and age-based long term features
- Annual noise
- Overdispersion

Based on deaths and population data from the Human Mortality Database (www.mortality.org)



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12

Trend risk

Data for calibrating trend models

- It's the 'wrong' data
 - Future mortality improvement will depend on
 - Different drivers
 - Unforeseeable economic, social and technological developments
 - National data is the wrong data for pension schemes
 - Have to have been in employment to be in a final salary scheme
 - Liabilities are pension-weighted
 - More wrong for higher socio-economic groups – basis risk
 - Schemes' own data
 - Insufficiently stable over sufficient term (v national data?)
 - Rating factor drift looks like longevity improvement



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13

Trend risk

Trend model catches

- Mismatch between deterministic and stochastic best estimates
- No allowance for annual noise – can overstate risk
- No parameter risk (less likely these days) – understates risk
- No model risk – understates risk (NB lots of models \neq model risk)
- Driver complexity more important than model choice? E.g. random walk mortality model may understate risk for longer term liabilities
- No allowance for population basis risk – understates risk
- No allowance for data being wrong – understates risk
- Cause of death – insufficient data to calibrate, not falsifiable, opinion not statistics so expect to understate risk?
- Expert opinion – past suggests this understates risk?



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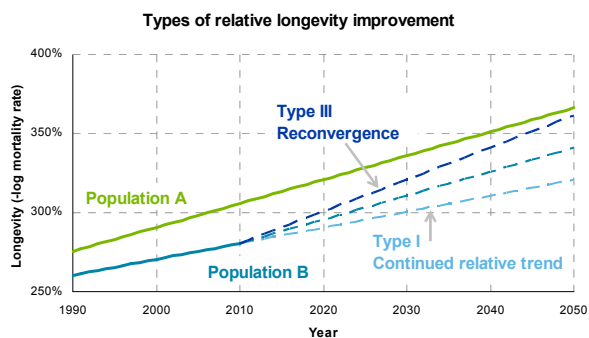
14

Trend risk

Basis risk

- How do you project past inter-population differences?

- Type I.
Difference in mortality *trend* continues
- Type II.
Difference in mortality *level* continues
- Type III.
Reconvergence,
i.e. difference in absolute mortality rates
returns to historical value



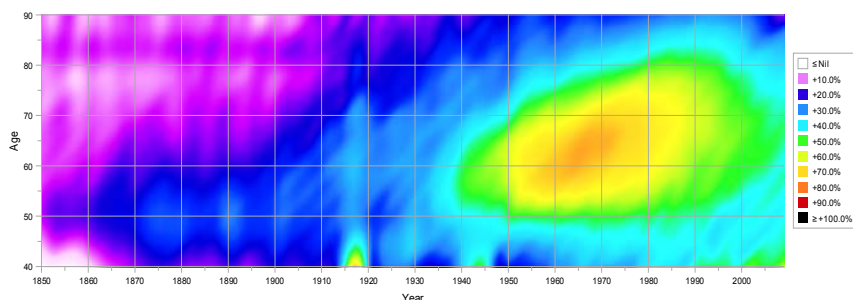
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15

Trend risk

Reconvergence example: males/females

Male v female log mortality in England & Wales



Notes

1. Heatmap plots $\log(\mu_{\text{Male}}/\mu_{\text{Female}})$ with some smoothing.
2. Data is from the Human Mortality Database.

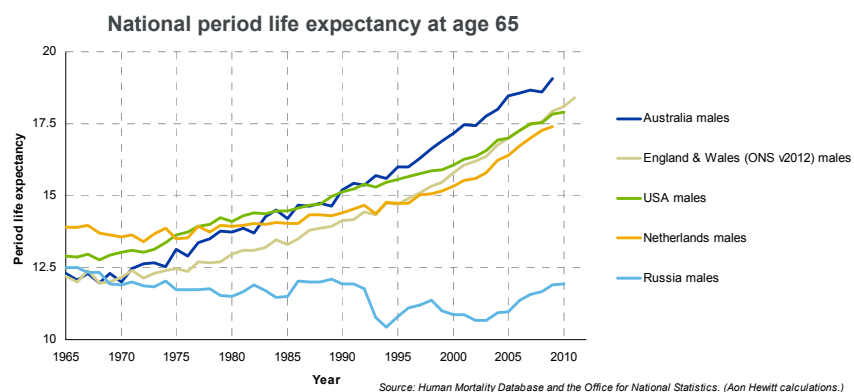


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16

Trend risk

Is UK independent of other locales?



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17

Value at risk (VaR)

- Required for Solvency II and comparison with asset risks
- Asset VaR is based on market *price*, and so
 - Includes market expectations about the future
 - Includes investor attitudes to risk
 - Includes competition between asset classes
 - Can be measured objectively using price history/implied volatility
- Longevity *model* VaR
 - Not comparable with asset VaR – illiquid market/opaque pricing
 - Fat-tailed – e.g. what if CMI changes projections model?
 - Is correlated with bond risk

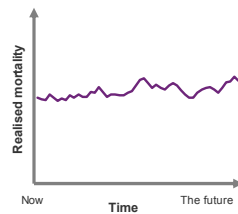


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18

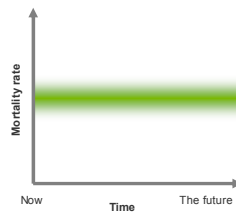
Conclusions

Per individual risk



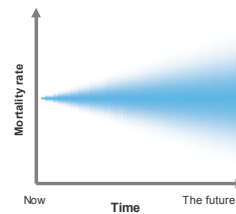
- Straightforward
- Matters for small schemes
- Approximate method fine for large schemes

Baseline risk



- Risk limited by scheme experience + postcode model + actuarial judgment
- Extra-model risk is important
- Often most critical assumption for pricing

Trend risk



- Key risk for medium and large schemes
- Common stochastic model implementations light on risk?
- Basis risk!



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