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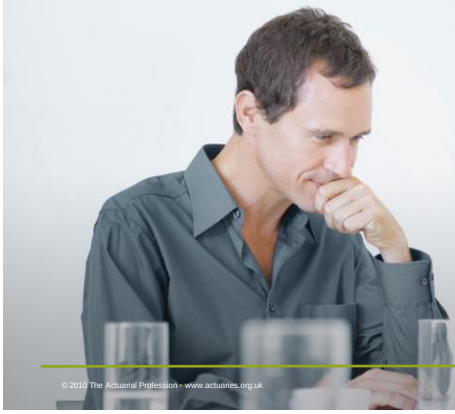
Mortality and Longevity Seminar
Neil Robjohns, Barnett Waddingham LLP



# Understanding and managing uncertainty in mortality-related cashflows

22 March 2011

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## Uncertainty in mortality-related cashflows
## Agenda

- Components of mortality risk
  - Process risk
  - Level risk
  - Trend risk
- Context-driven expressions of mortality uncertainty
  - Survival curve
  - Pension scheme example
  - Whole-of-life cover example
- Summary

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## Mortality Process Risk

- Uncertainty in random incidence of the underlying mortality rate
- Degree of uncertainty (when measuring by lives)
  - Is a function of number of expected deaths, N
  - % standard error, $\sigma$, approximately $\sqrt{(1/N)}$
  - So is a function of portfolio size and mortality rate
- Degree of uncertainty (when measuring by amounts)
  - Additional variation arises if lives have different benefits
  - Depends on range and skewness of distribution
  - Perhaps increases lives $\sigma$ by 25% to 100%

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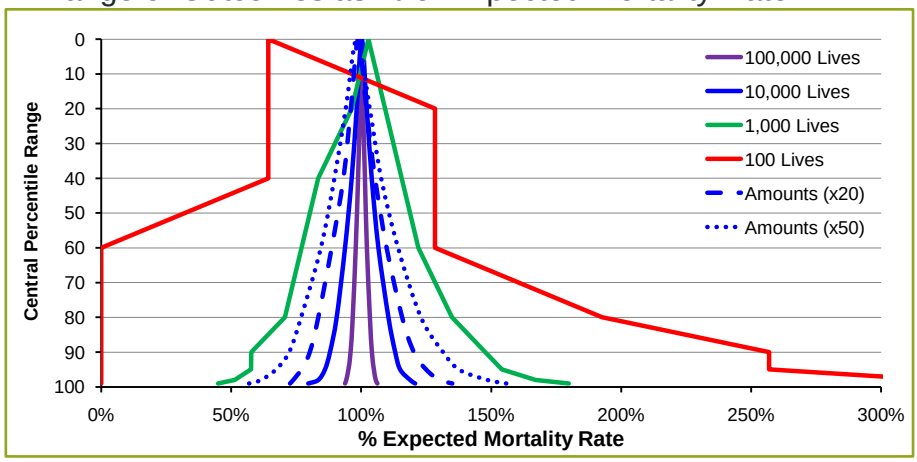
## Mortality Process Risk
## Sample distributions of outcomes by portfolio size

- Range of Outcomes as % of Expected Mortality Rate

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## Mortality Level Risk

- Uncertainty over the current estimated level of mortality
- Degree of uncertainty
  - Depends on information used to make estimate
- Experience analysis 'sampling error'
  - Another expression of process risk
  - So a function of number of deaths and distribution of amounts
- Independent estimates
  - For example using socio-economic profile
  - Improve estimates and provide upper bound for uncertainty

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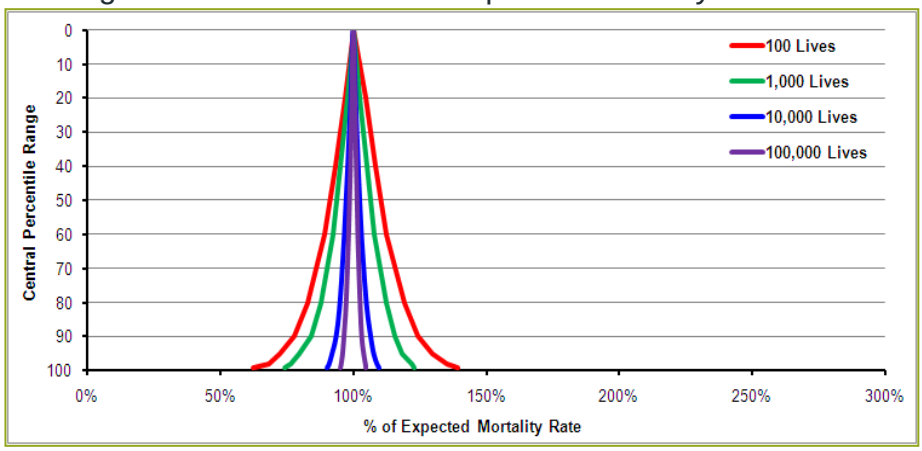
## Mortality Level Risk
## Sample distributions of outcomes by portfolio size

- Range of Outcomes as % of Expected Mortality Rate

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## Mortality Trend Risk

- Uncertainty in the future path mortality improvements
- Degree of uncertainty
  - Difficult to establish!
  - Use projection models, by cause-analysis, expert opinion, ...
- Unlikely to be correlated with size of group
  - But possible variation by socio-economic profile of group
- Trend risk starts from effective date of mortality level estimate
- Simplistic model used for these example
  - In particular, ignore short term variations

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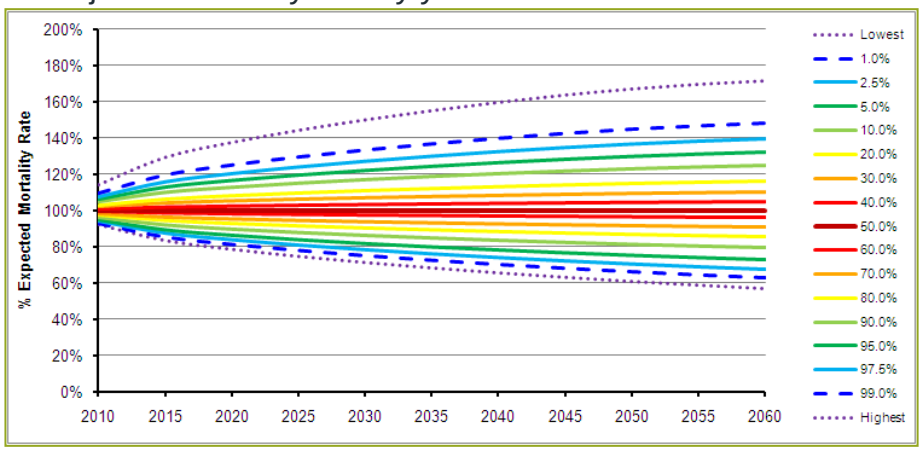
## Mortality Trend Risk
## Sample distribution of outcomes

- Projected mortality rate by year as % of best estimate rate

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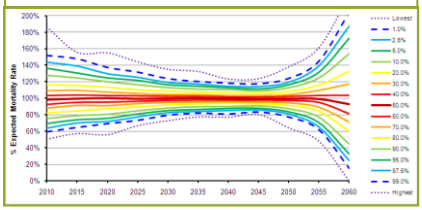
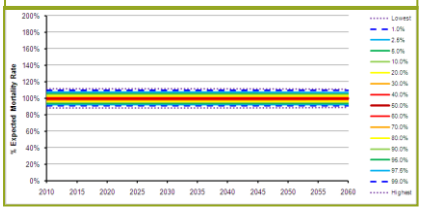
## Components of Mortality Risk
## Sample distributions of outcomes by component

- Projected mortality rate by year as % of best estimate rate
  - 10,000 lives; age 60 at outset; outcomes allow for distribution of benefit amounts

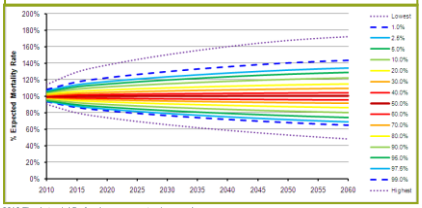
Process Risk



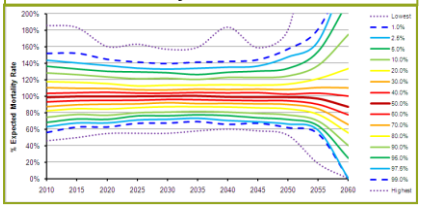
Level Risk



Trend Risk



All mortality risks combined



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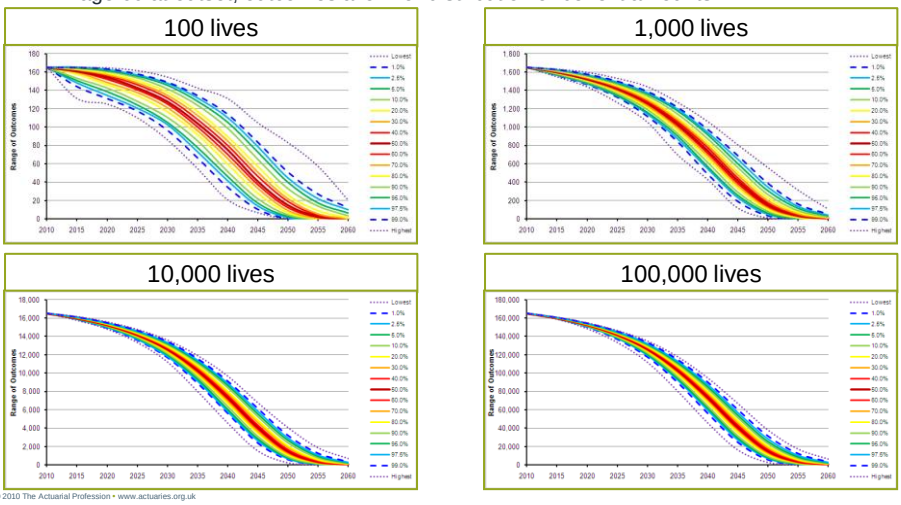
## Projected Survival Curve
## Sample distributions of outcomes by portfolio size

- Projected surviving benefit amount by year
  - age 60 at outset; outcomes allow for distribution of benefit amounts

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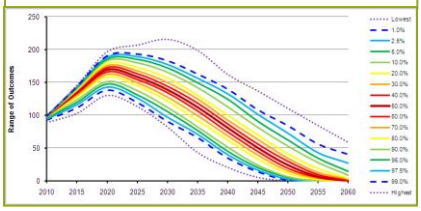
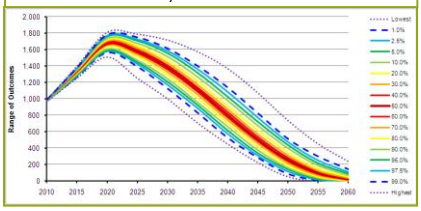
## Portfolio example 1: Pension Scheme
## Sample distributions of outcomes by portfolio size

- Projected net cashflow by year

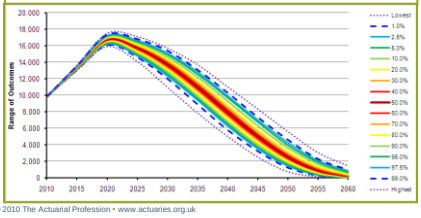
100 lives



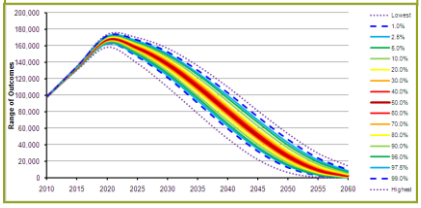

1,000 lives




10,000 lives




100,000 lives

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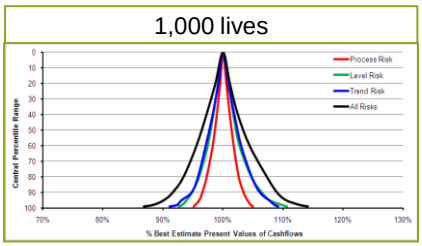
## Portfolio example 1: Pension Scheme
## Sample distributions of outcomes by portfolio size

- PV [projected cashflows] as % best estimate by risk component

100 lives


1,000 lives

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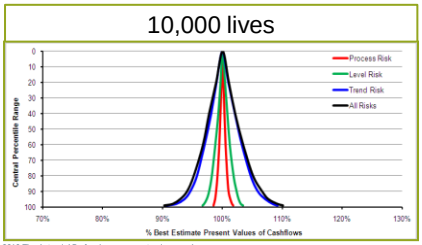
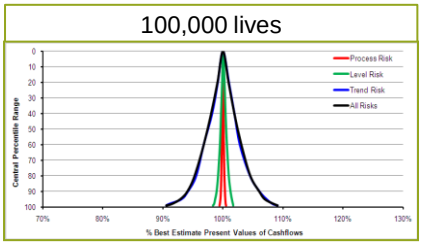



100,000 lives

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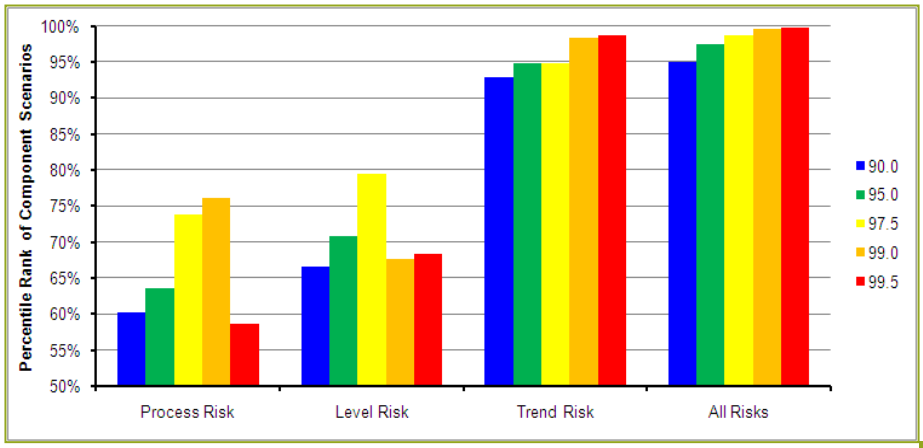
## Portfolio example 1: Pension Scheme
## Relative contributions by risk component

- Contribution to extreme scenarios by risk component
  - Average percentile rank by risk component for 'All Risks' scenarios above each threshold
  - 10,000 lives; using PV [cashflows]; series are 90th, 95th, 97.5th, 99th and 99.5th percentiles

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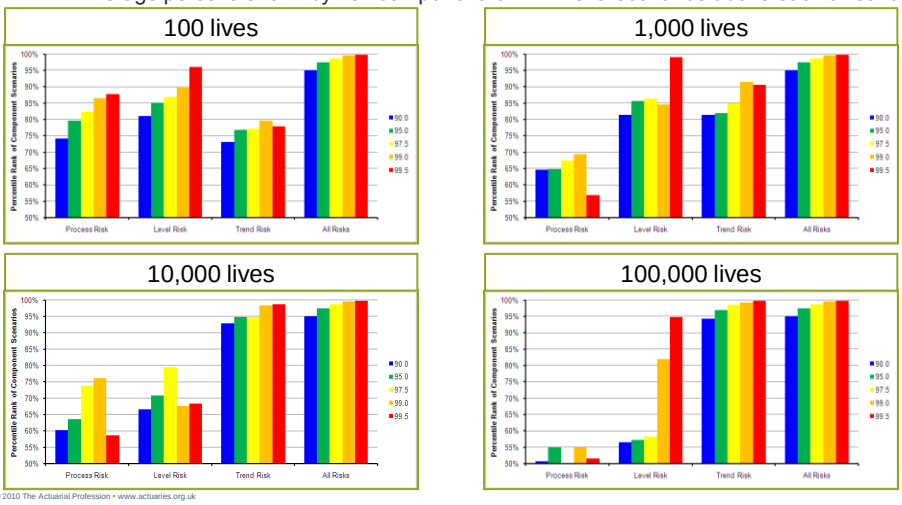


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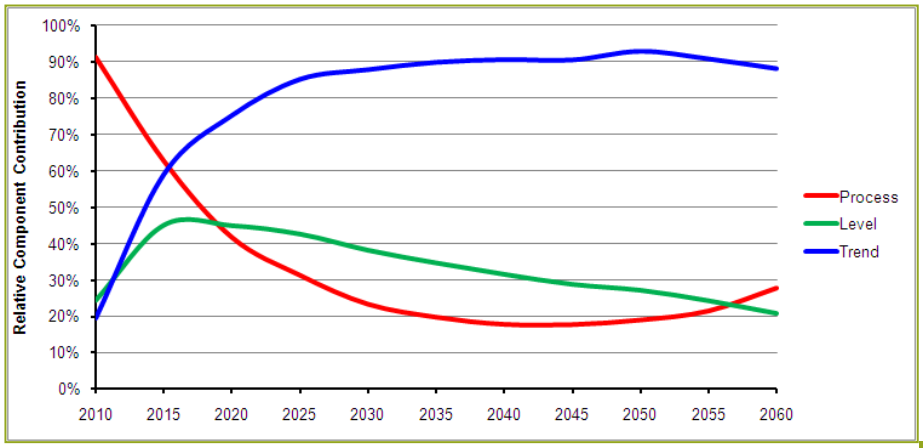
## Portfolio example 1: Pension Scheme
## Relative contributions by risk component

- Projected relative contribution by risk component by year
  - calculated as ratio of component to 'All Risks' using width of central 90th percentile ranges
  - 10,000 lives; using projected yearly cashflows

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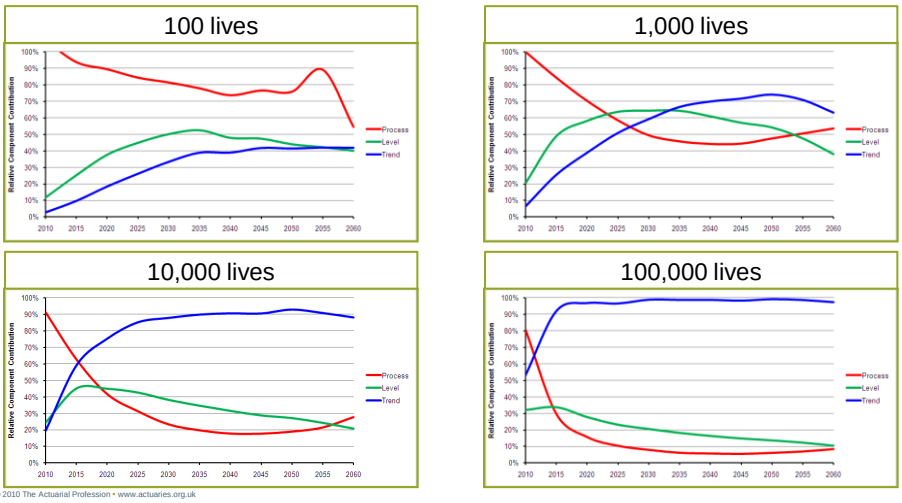


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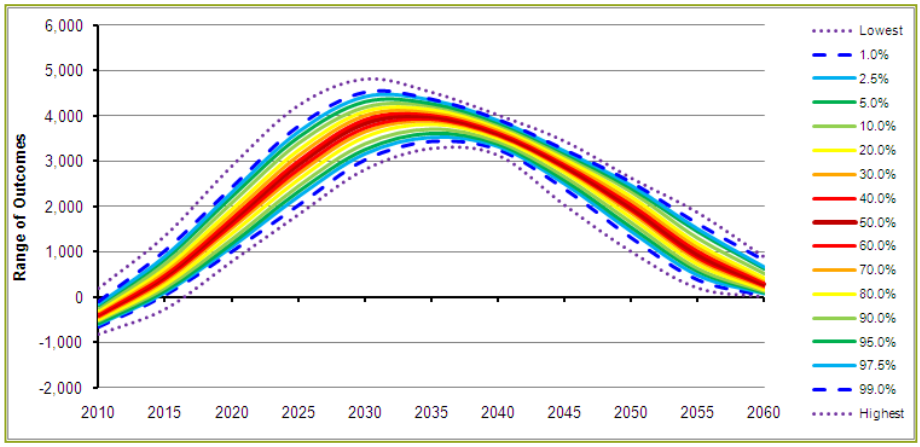
## Portfolio example 2: Whole-of-life
## Sample distributions of outcomes by portfolio size

- Projected net cashflow by year
  - 100,000 lives

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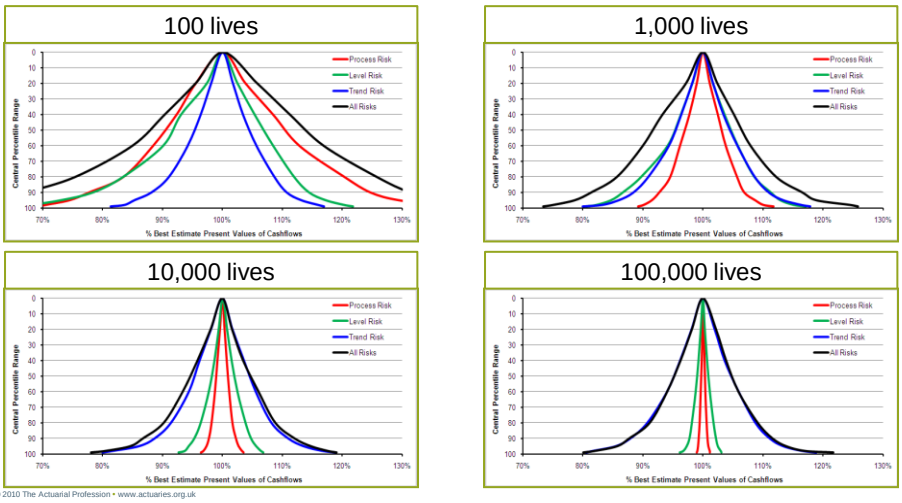
## Sample distributions of outcomes by portfolio size

- PV [cashflows] as % best estimate by risk component

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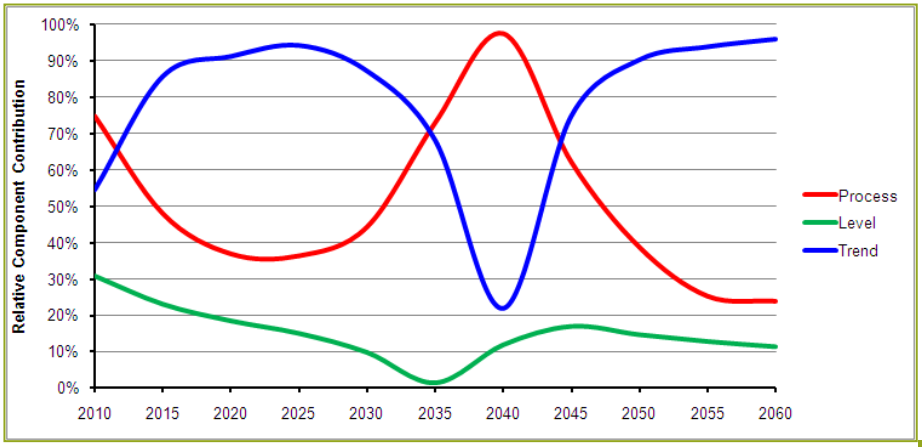


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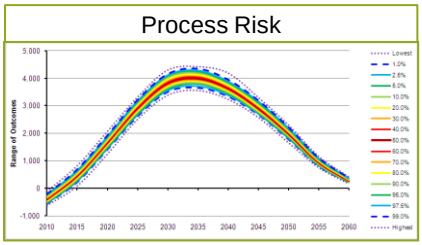



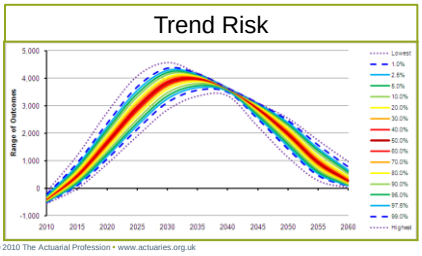


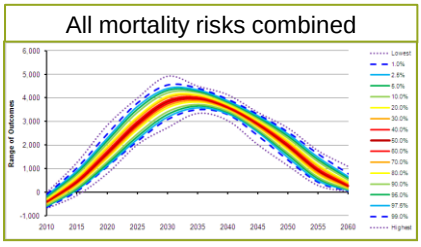


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## Uncertainty in mortality-related cashflows Summary

- Quantify mortality uncertainty in 3 main components
  - Process, Level and Trend (ignore catastrophe risk for now)
- The expression of mortality uncertainty is context sensitive
  - Depends on nature of mortality-related cashflows
- Interaction and relative contribution of components varies
  - over time; with size of group; and with risk threshold
- Manage mortality-related uncertainty by
  - Better information to improve estimates
  - Targeted transfer of risk, for example:
    - Life cover: Surplus, quota share and stop-loss reinsurance
    - Pensions: Selective buy-ins; full or partial swap or hedge

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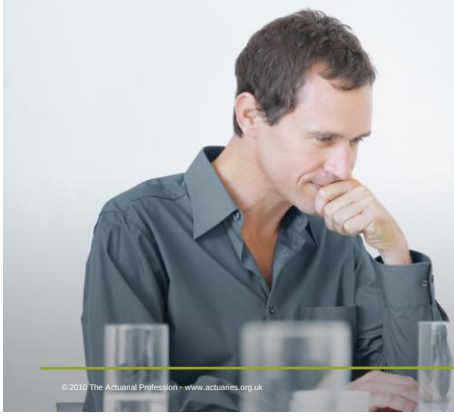

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