De Nederlandsche Bank, Amsterdam

A value-at-risk framework for longevity trend risk

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1. The problem with longevity trend risk

1. The problem with longevity trend risk

- Annuities and pensions are paid over many years.
- Trend risk in mortality unfolds over decades.

1. The problem with longevity trend risk

- However, regulations often demand a one-year view of risks:
  - — ICA (in UK)
  - — SST (in Switzerland)
  - — Solvency II
- How do you view a long-term trend risk through a one-year prism?

2. The need for stochastic projections

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"computation of the SCR for longevity risk via the VaR approach obviously requires stochastic modelling of mortality"

Boerger (2010)

2. The need for stochastic projections

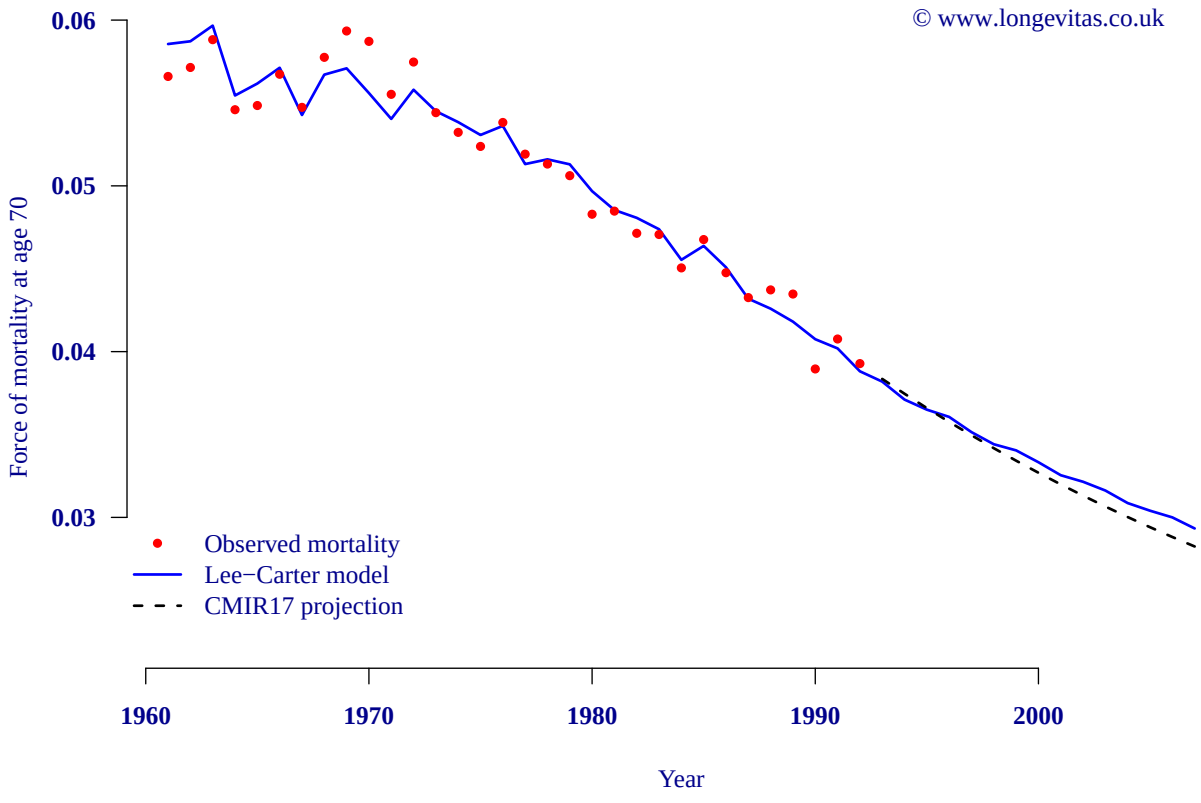
"naturally this requires stochastic mortality rates"

Plat (2011)

2. An illustration — back-testing

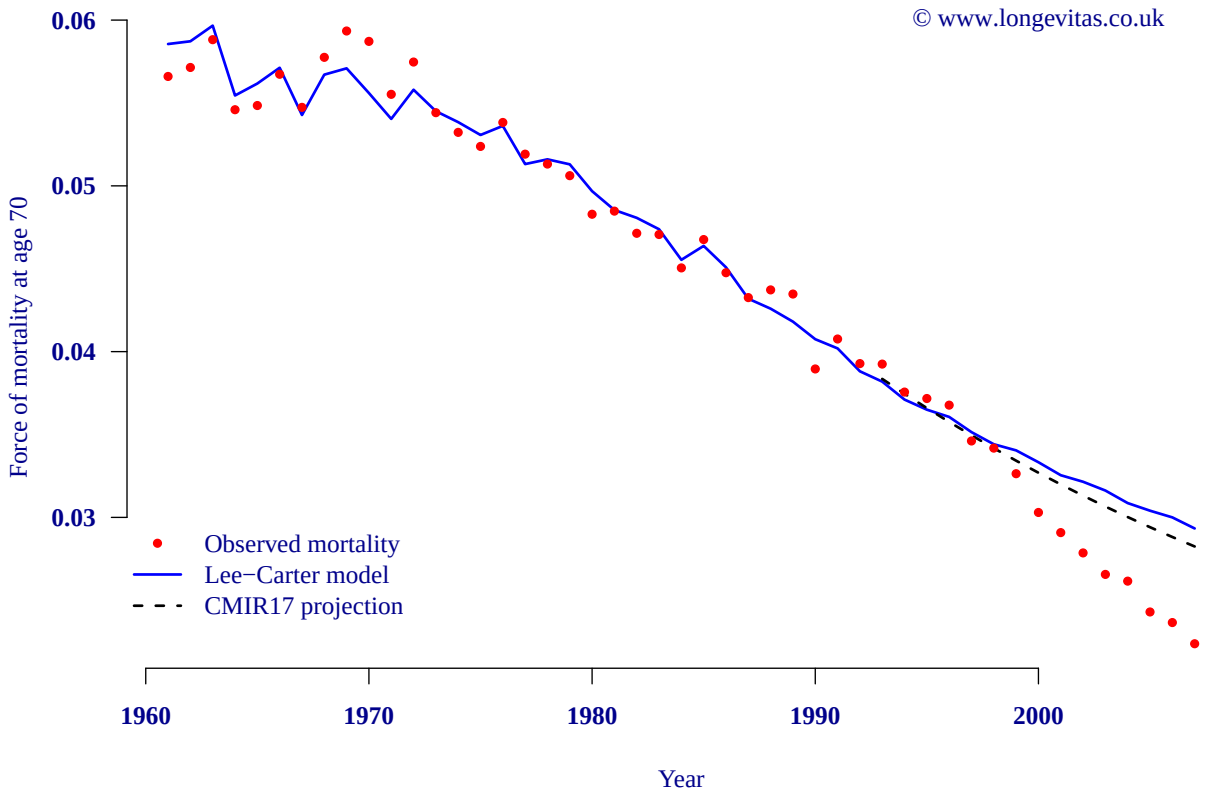
- Take a long data series.
- Discard latter years and fit projection model to first part only.
- Compare projected rates with what actually happened...

2. Back-testing: fit model to E&W data to 1992



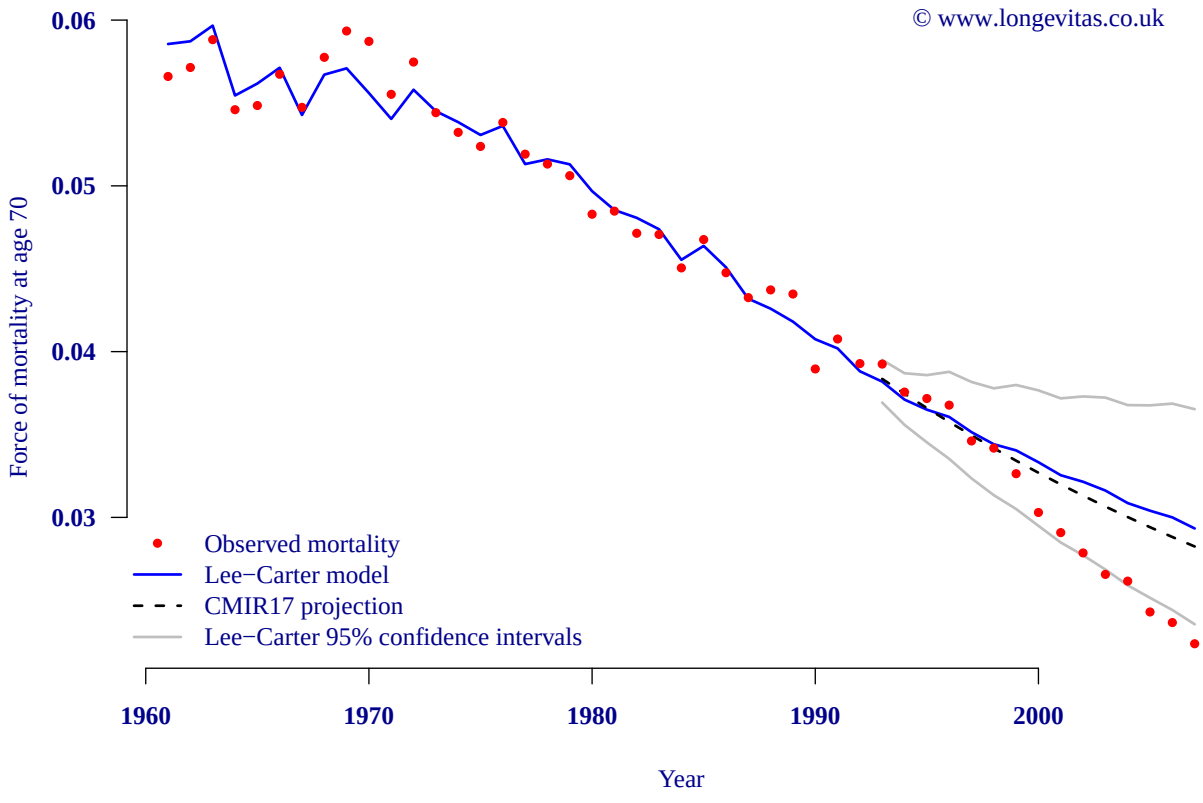
Source: Longevitas Ltd. ONS data for England & Wales, CMIR17 projections

2. Back-testing: compare projections to reality



Source: Longevitas Ltd. ONS data for England & Wales, CMIR17 projections

2. Back-testing: add confidence intervals



Source: Longevitas Ltd. ONS data for England & Wales, CMIR17 projections

3. The stressed-trend approach

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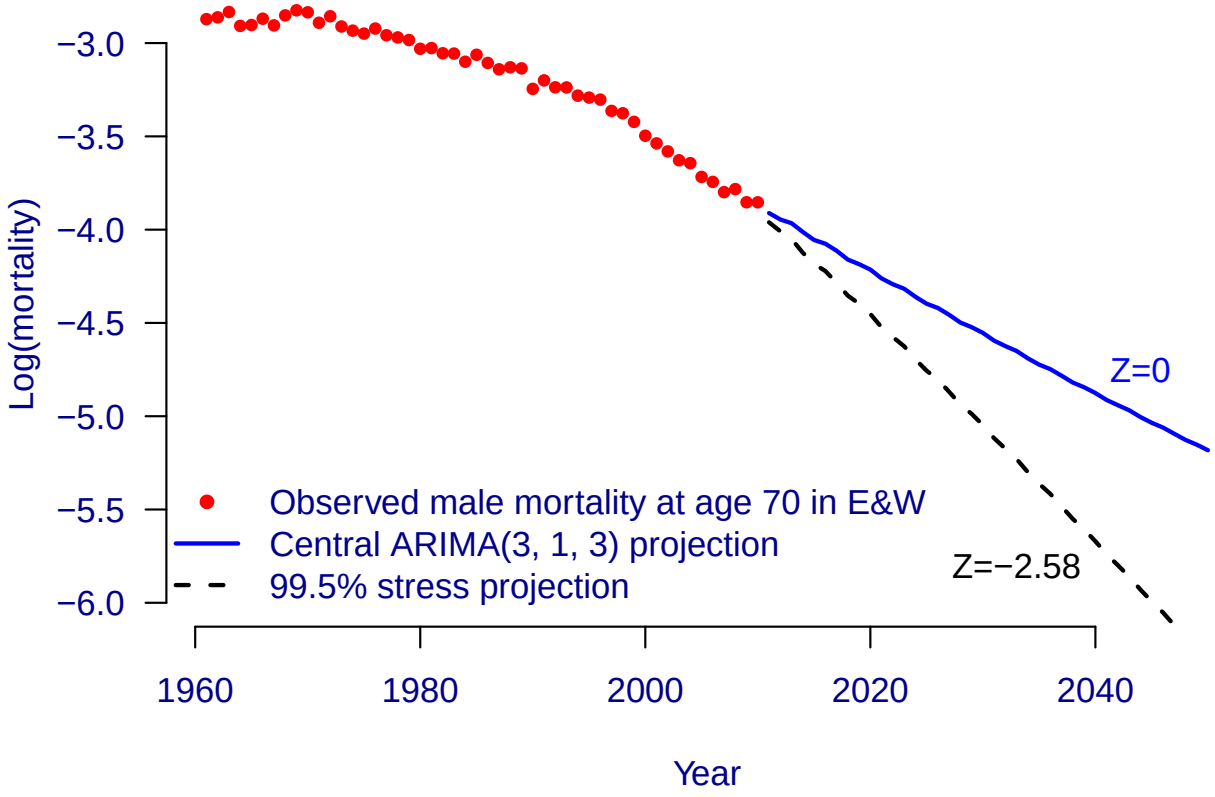
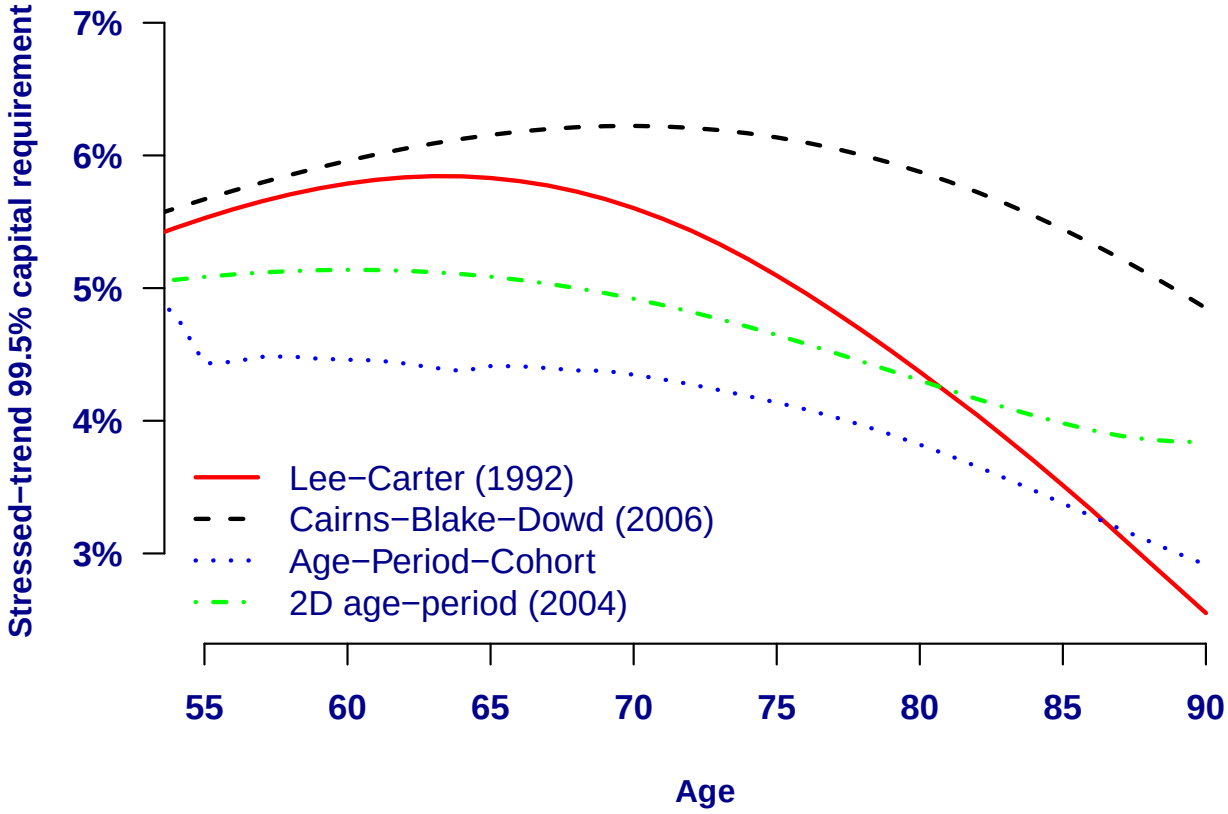


Source: Richards, Currie and Ritchie (2012), Figure 1.

3. The importance of model risk



Source: Richards, Currie and Ritchie (2012), Figure 2.

4. A value-at-risk (VaR) framework

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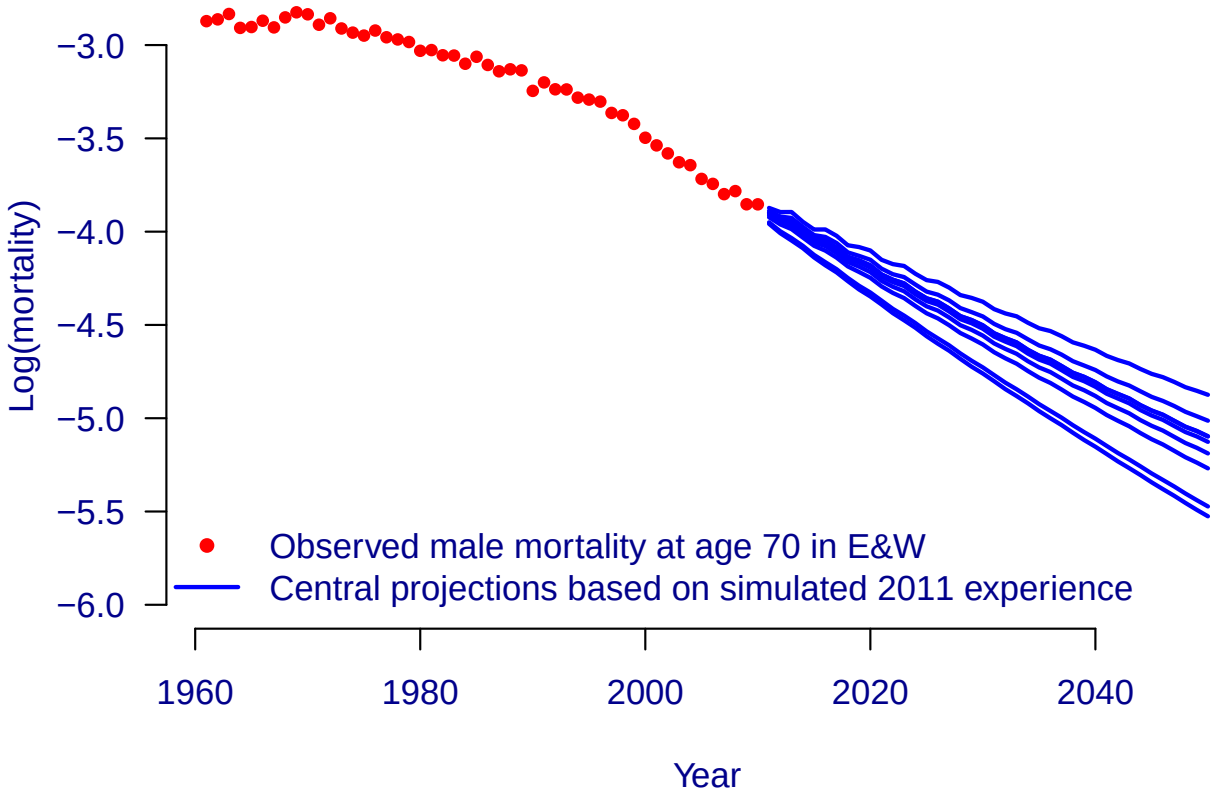
Q. By how much can a best-estimate liability change over one year?

A. Set reserve to cover 99.5% of scenarios over coming year.

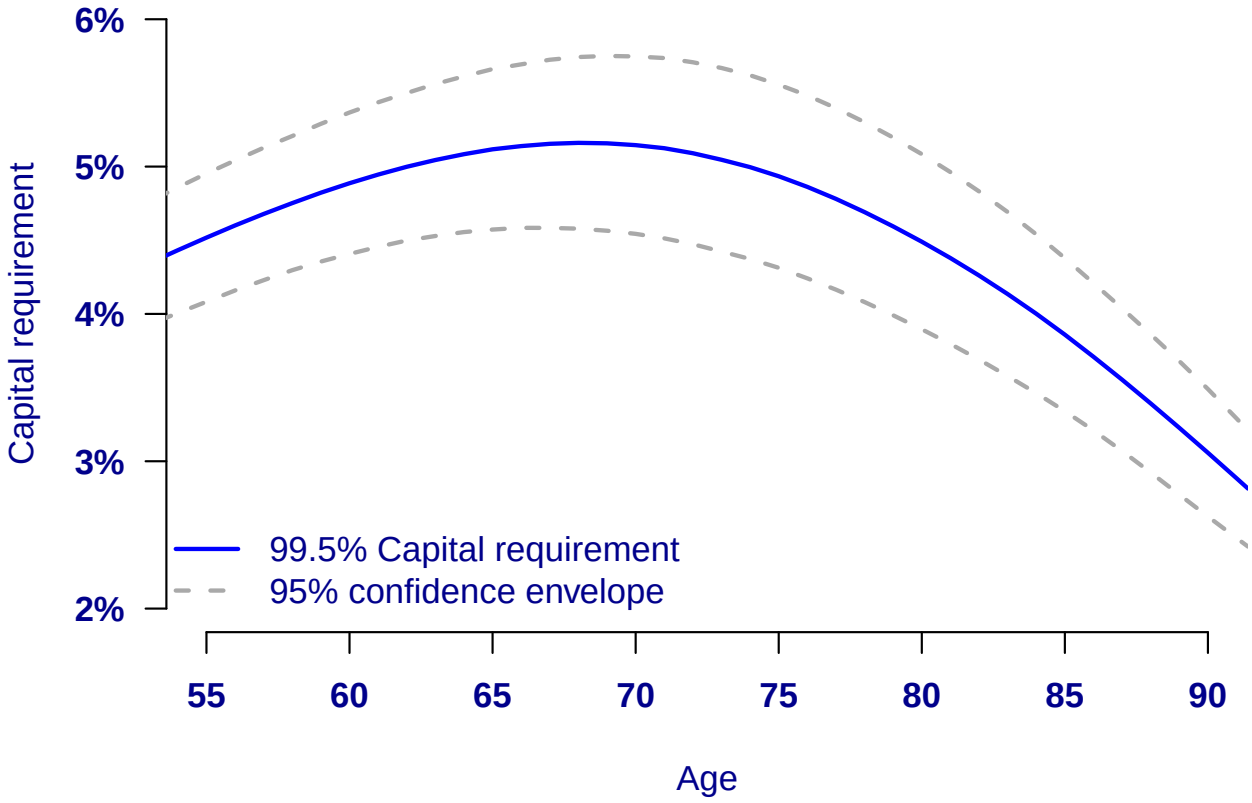
4. Lee-Carter VaR with 1,000 simulations



Source: Richards, Currie and Ritchie (2012), Figure 5.

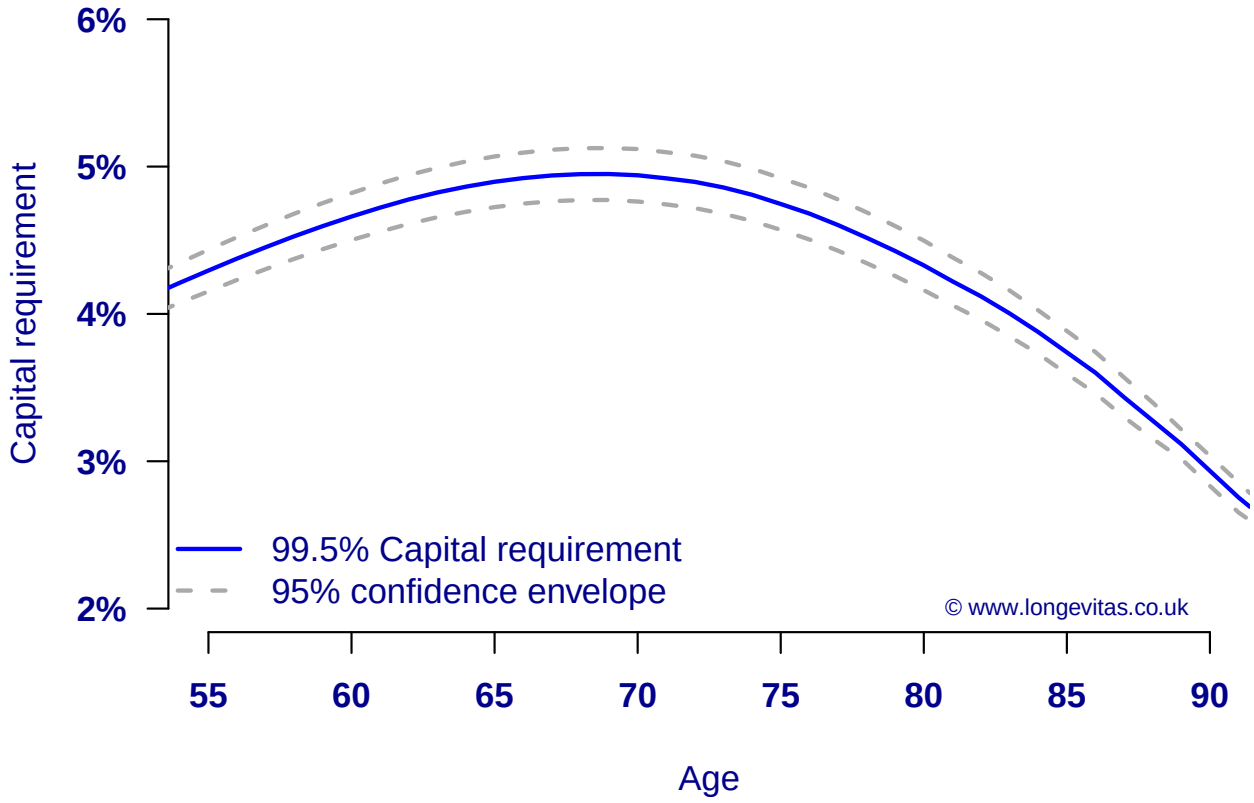
5. Number of simulations required

5. Lee-Carter VaR with 1,000 simulations



Source: Richards, Currie and Ritchie (2012), Figure 6.

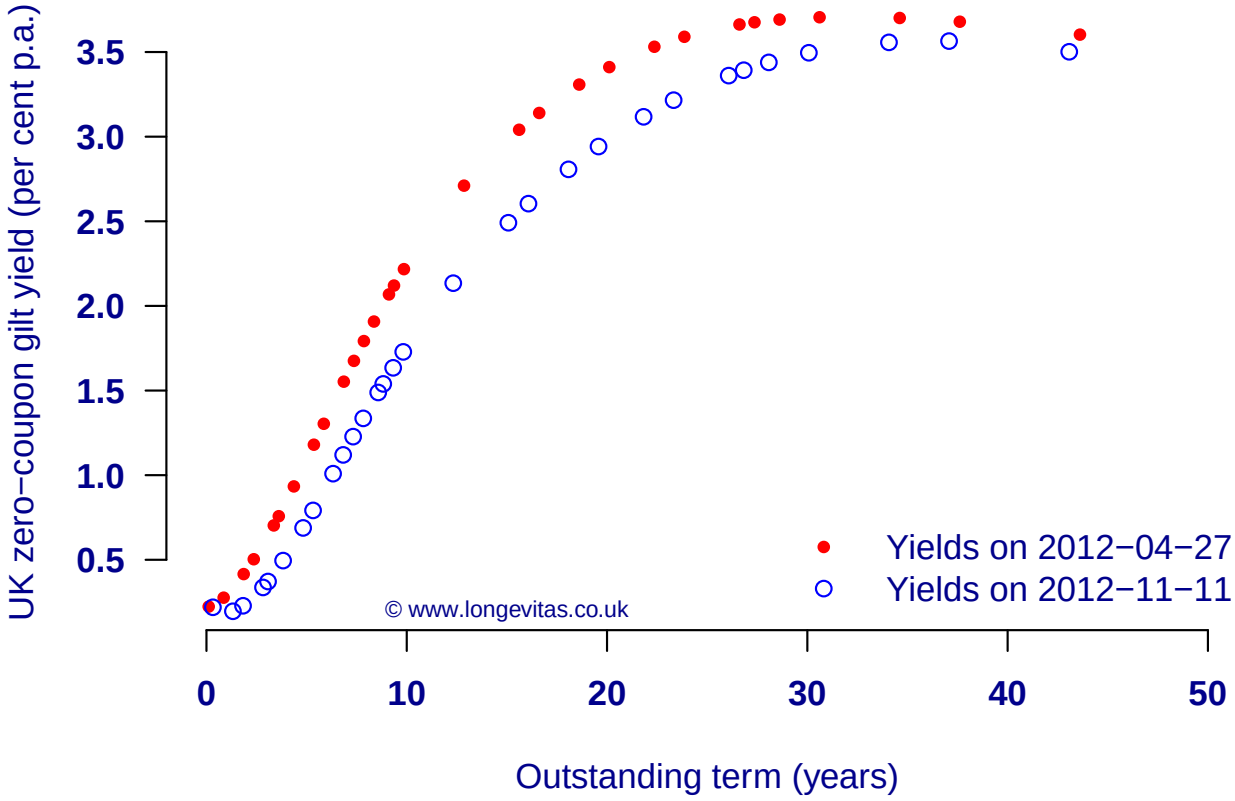
5. Lee-Carter VaR with 10,000 simulations



Source: Longevitas Ltd.

6. The need to regularly recalibrate VaR capital

6. UK zero-coupon gilt yield curve



Source: Data from Debt Management Office, http://www.dmo.gov.uk

7. Conclusions

- Deterministic scenarios can't answer a probabilistic question.

  → stochastic projections are needed!
- Stressed-trend approach too strong for one-year view.
- Model risk must be acknowledged and different models used.
- VaR capital needs to be regularly recalibrated if yield curve changes.

References

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Addendum 1: Parallel VaR — 4 processes

Model	Scalability factor
Lee-Carter Gompertz	4.0x
CBD5 P-spline	4.0x
2D Age-cohort	3.9x
CBD5 Gompertz	3.8x
Lee-Carter Original	3.8x
APC Original	3.7x
Lee-Carter Smooth	3.6x

Source: Longevitas Ltd. The scalability factor is the speed increase relative to serial processing.

Addendum 2: Parallel VaR — 7 processes

Model	Scalability factor
Lee-Carter Original	6.6x
Lee-Carter Smooth	6.6x
Lee-Carter Gompertz	6.6x
CBD5 P-spline	5.8x
2D Age-cohort	5.1x
APC Original	5.0x
CBD5 Gompertz	4.1x

Source: Longevitas Ltd. The scalability factor is the speed increase relative to serial processing.