Birmingham

Mortality projections and Solvency II

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Overview

1. Solvency II

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"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. The methods used to calculate the probability distribution forecast shall be based upon current and credible information and realistic assumptions."

Article 121 (2009)

1. Solvency II

"probability distribution forecast"

= stochastic projection?

1. Solvency II — some opinions

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1. Solvency II — some opinions

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"onus on firms to demonstrate why non-stochastic model is appropriate."

"I don't share your interpretation"

Source: Longevitas Ltd. Survey of life-office actuaries with responsibility for longevity risk.

www.longevitas.co.uk

2. Methods of projection

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- Historically actuaries relied on deterministic scenarios
- Often rates or improvements blending to a long-term value
- Such models are called *expectations*
- Cannot say how likely or unlikely such scenarios are

More detail on expectations can be found on our blog

2. Methods of projection — expectations

"The advantage of expert opinion is the incorporation of demographic, epidemiological and other relevant knowledge, at least in a qualitative way. The disadvantage is its subjectivity and potential for bias. The conservativeness of expert opinion with respect to mortality decline is widespread, in that experts have generally been unwilling to envisage the long-term continuation of trends, often based on beliefs about limits to life expectancy."

Booth and Tickle (2008)

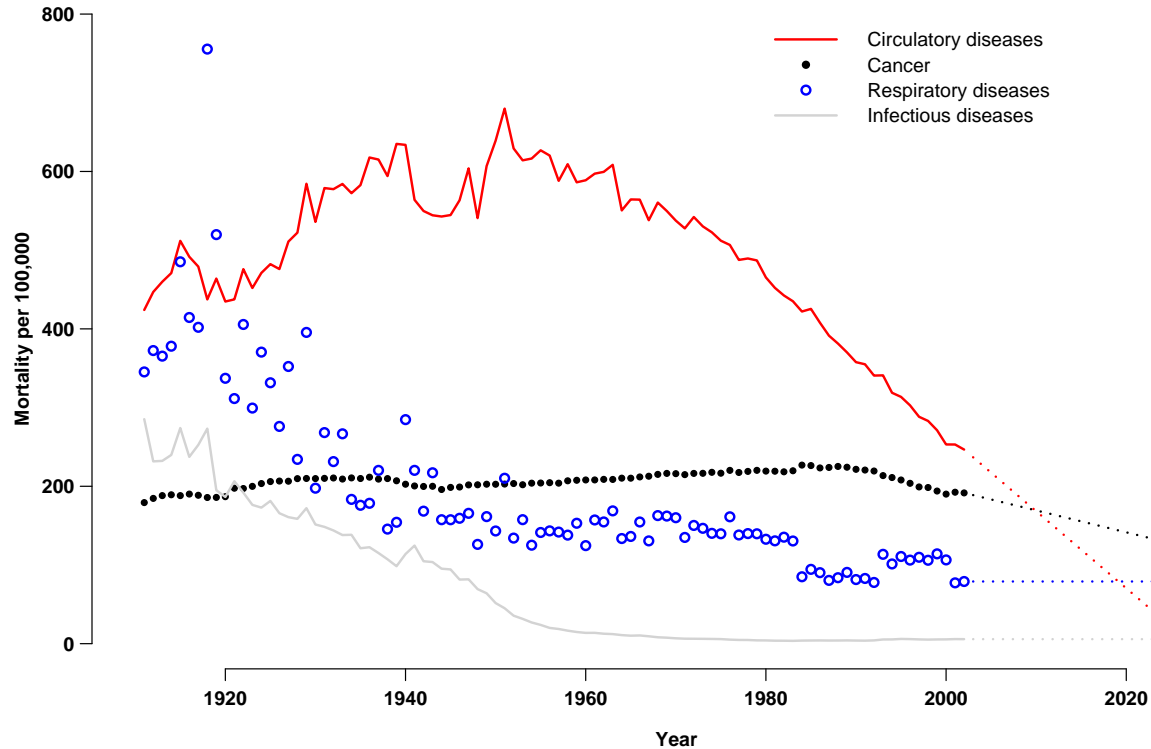# 2. Methods of projection — extrapolations

- Most other models extrapolate past trends

3. Projections by cause of death

3. Benefits of using cause-of-death data

- Insight into past patterns

3. Mortality rates by broad cause groups

Source: ONS data for England and Wales.

3. Some challenges in using cause-of-death data

- Subjective simplification of thousands of codes into a few broad groups
- Changing classification systems: ICD-1 to ICD-10 in past century
- Changing classification guidelines *within* a system

3. Changing causes

1979	2000	Description
23.7% (1)	13.1% (1)	Acute myocardial infarction
9.9% (2)	9.7% (2)	Malignant neoplasm of trachea, bronchus and lung, unspecified
5.7% (3)	4.1% (5)	Bronchopneumonia, organism unspecified
5.1% (4)	4.0% (6)	Acute but ill-defined cerebrovascular disease
3.8% (5)	8.3% (3)	Other forms of chronic ischaemic heart disease — unspecified
3.5% (6)	5.1% (4)	Other forms of chronic ischaemic heart disease — coronary athersclerosis

Source: Frequency of top six causes of death cited for males aged 70-74 in England and Wales, 20th Century Mortality

3. Changing causes

"Trend analysis spanning the years either side of 1984 and 1993, must take into account some important coding changes. There is a large increase in mortality from chronic diseases [...] between 1984 and 1993. This is an artefact due to changes in the way ICD-9 rules [...] were interpreted in England and Wales. [...] As a result, some deaths for which bronchopneumonia in Part I of the certificate would previously have been coded as the underlying cause of death were coded to a condition mentioned elsewhere in Part I or Part II."

Dr Paul Aylin, Office for National Statistics

3. Challenges with cause-of-death data — practical

- Projecting correlated time series is difficult
- As general mortality falls, one cause can increase
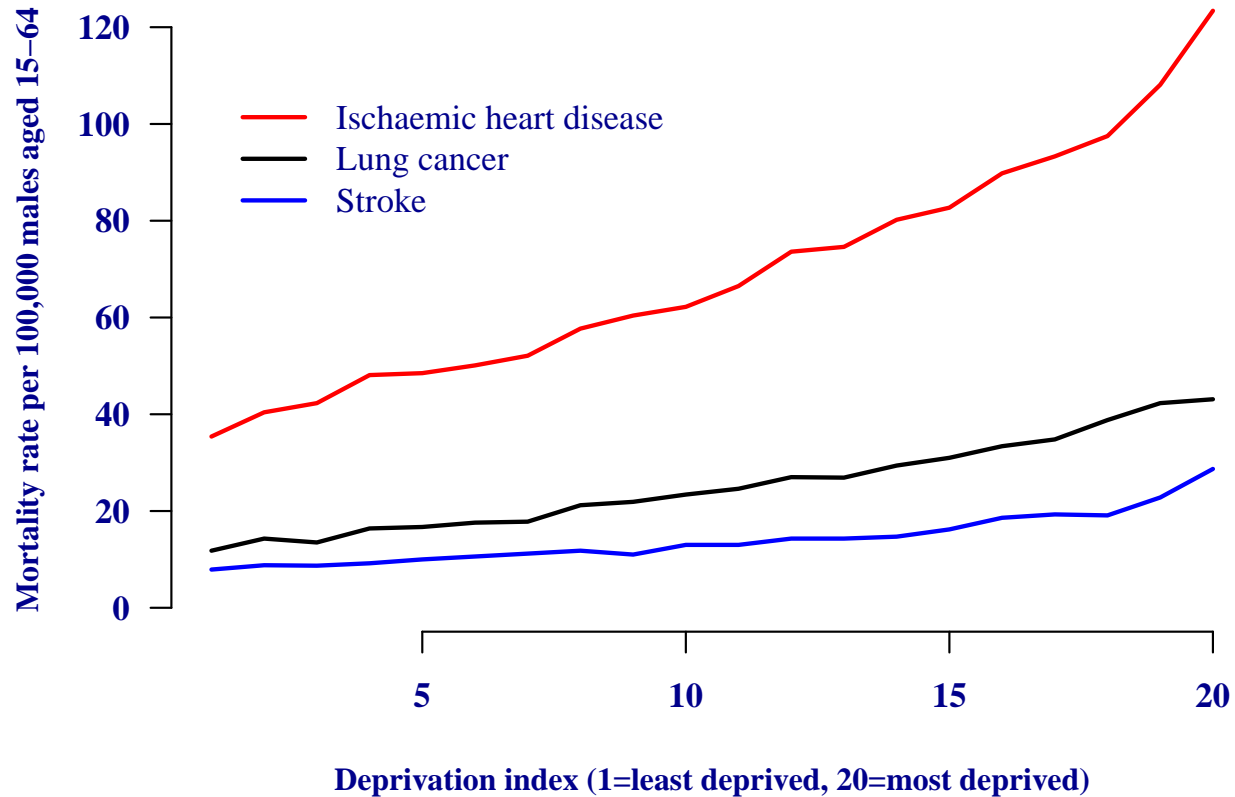
3. Mortality rates
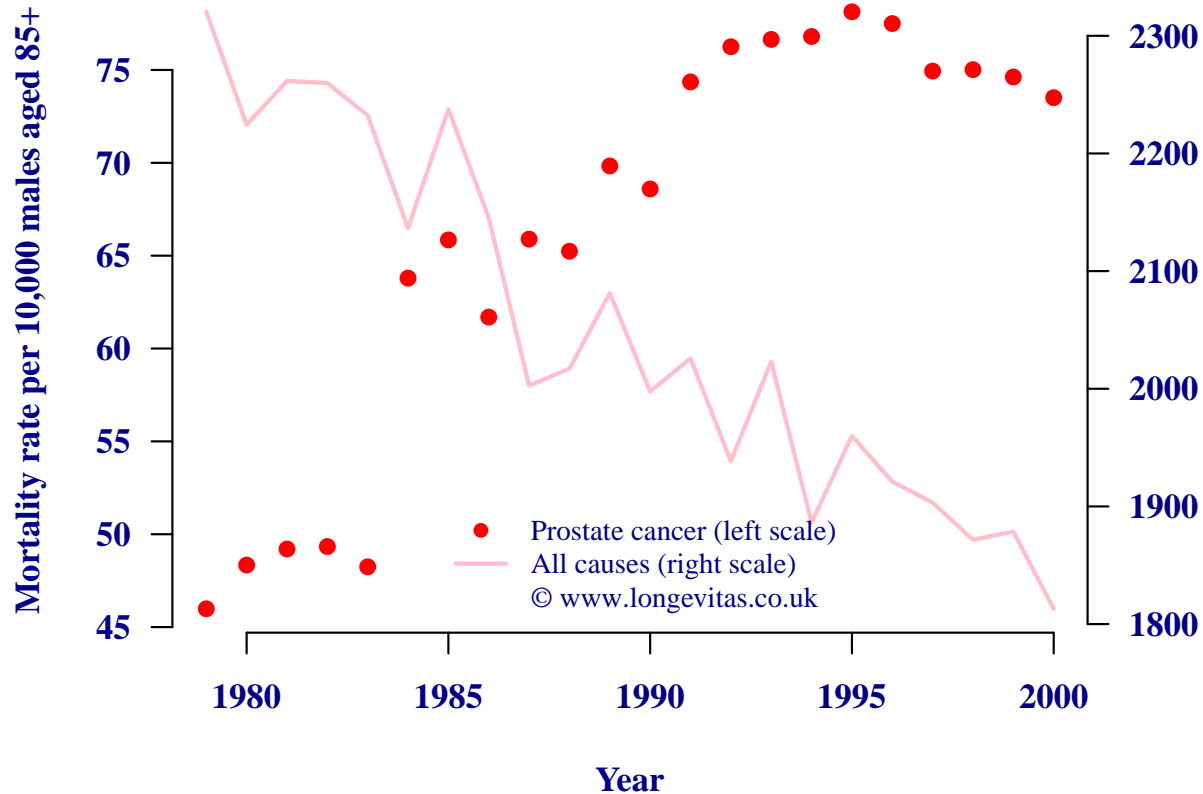
Source: Mortality rates per 10,000 males over age 85 in England and Wales, 20th Century Mortality

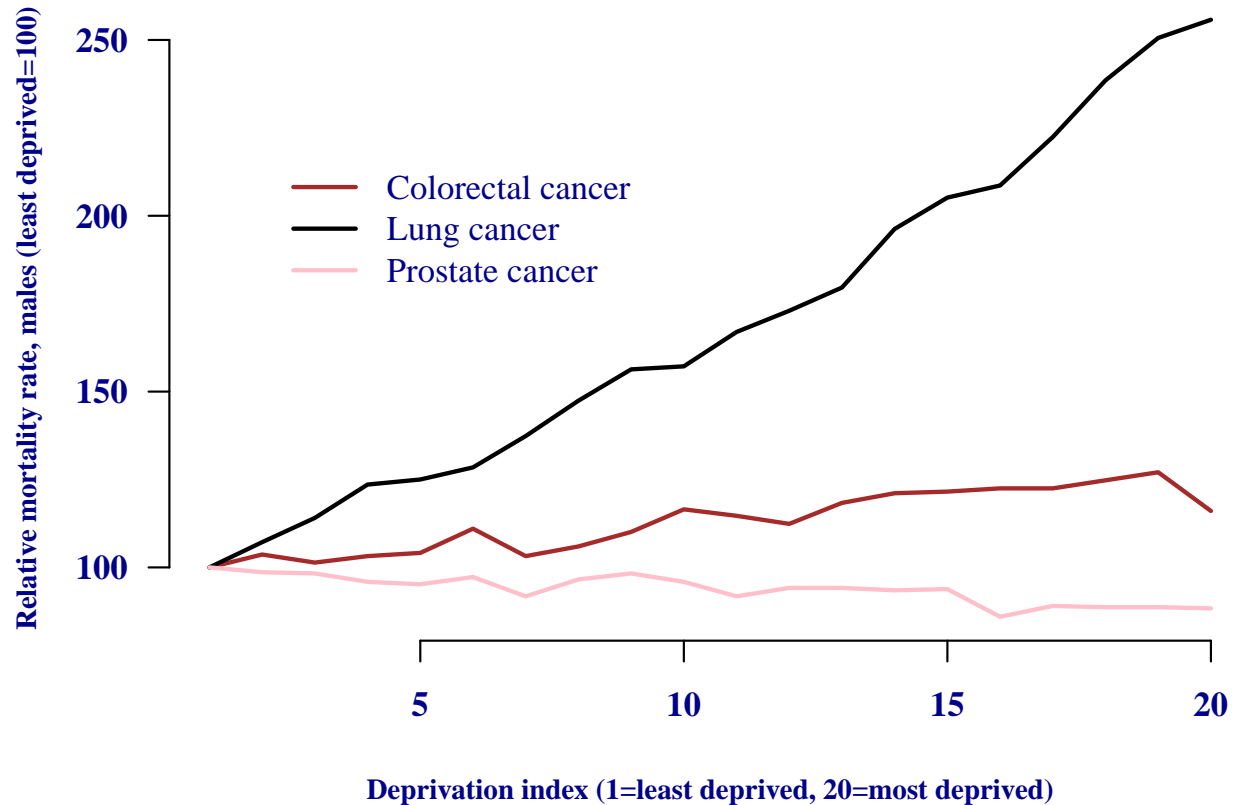# 3. Challenges with cause-of-death data — practical

- Projecting correlated time series is difficult
- As general mortality falls, one cause can increase
- Strong confounding link to socio-economic group. . .

3. Mortality by selected cause of death

Source: ONS data for males aged 15-64 in England and Wales.

3. Relative mortality by selected cause of death

Source: Relative mortality rates by selected cause of death for males of all ages in England and Wales (least deprived=100).

4. Stochastic projections
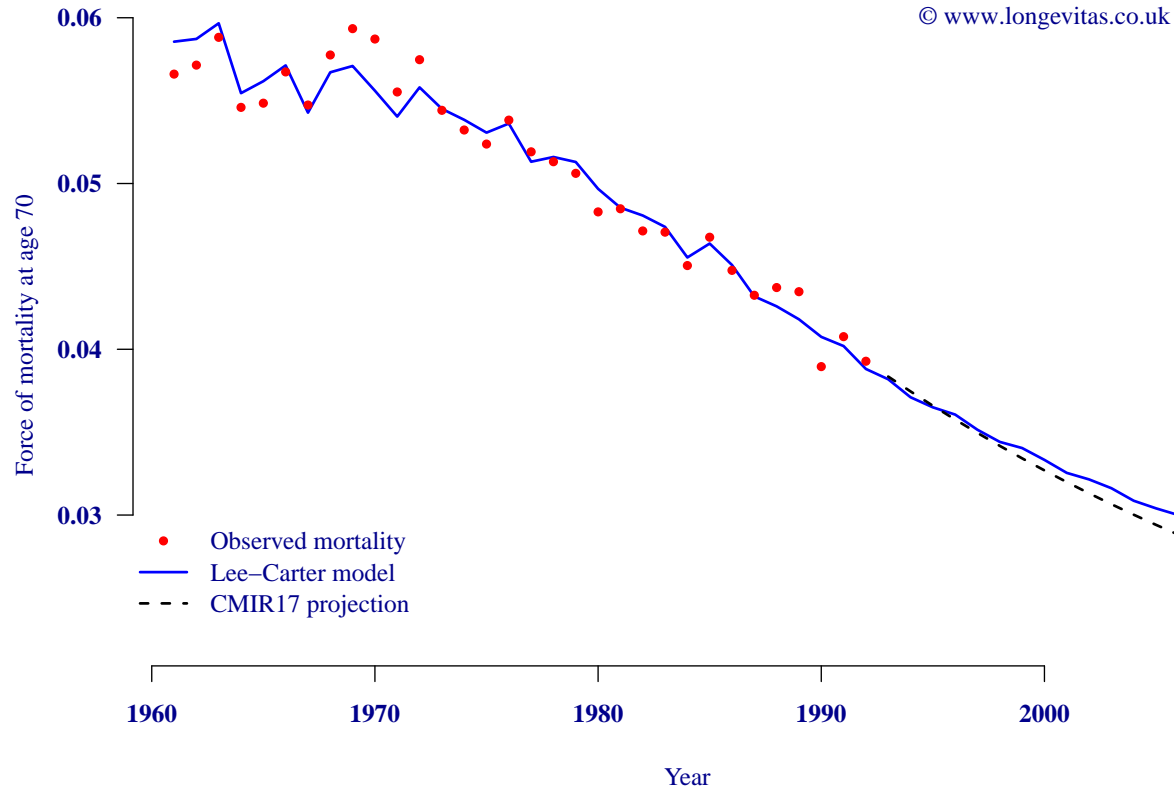
4. Stochastic projections

- Measuring uncertainty is a key part of Solvency II
- A stress test ideally has a probability attached to it
- Such tests and probabilities come from *stochastic projections*

4. An illustration — back-testing

- Take a long data series
- Discard latter years and fit projection model
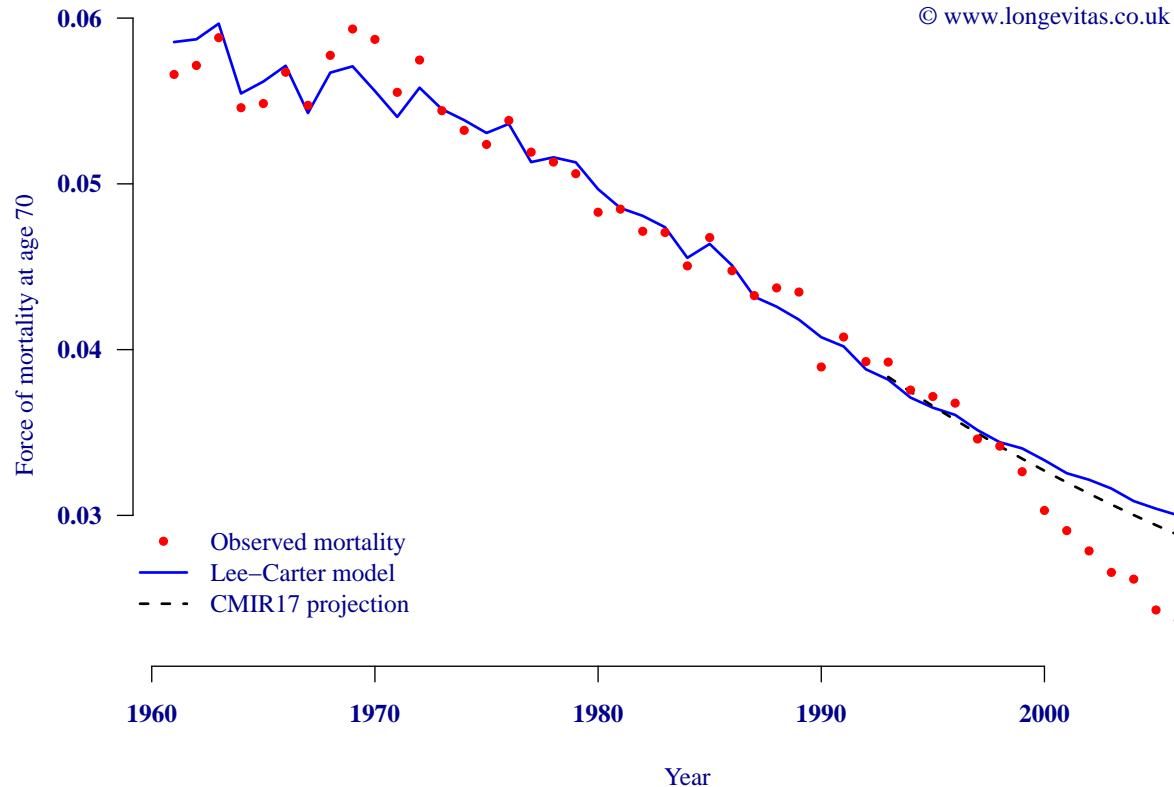- Compare projected rates with what actually happened
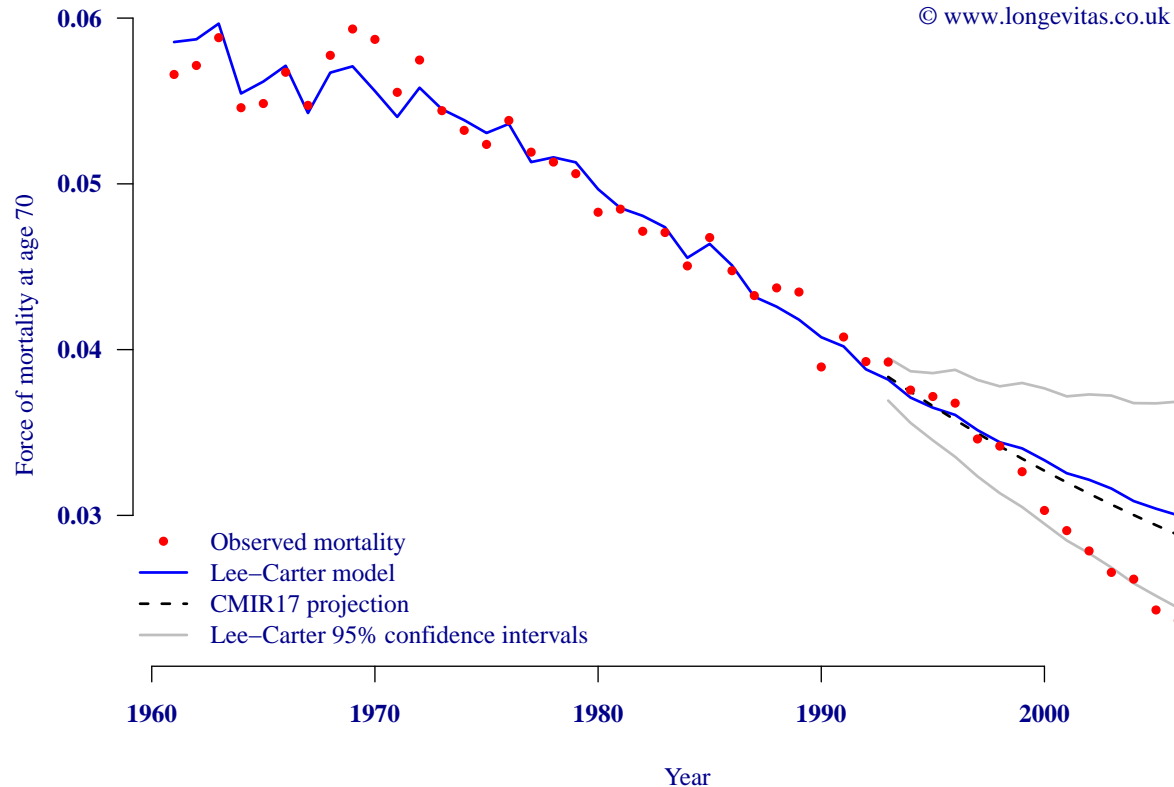
More on back-testing can be found on our blog

Source: Longevitas Ltd. ONS data, CMIR17

4. Compare projections with experience data

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Force of mortality at age 70

0.06
0.05
0.04
0.03

- Observed mortality
- Lee−Carter model
- CMIR17 projection

1960   1970   1980   1990   2000

Year

Source: Longevitas Ltd. ONS data, CMIR17

www.longevitas.co.uk

4. Compare with confidence intervals

Source: Longevitas Ltd. ONS data, CMIR17

5. Conclusions

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- Stochastic projections seem to fit the bill for Solvency II

- Cause-of-death methods face considerable challenges:

- — forecasts don't have attached probability needed for Solvency II

- — worries over continuity of classification

- — strong but complicated links with socio-economic group

- — data limitations: age bands instead of ages

References

Booth, H. and Tickle, L. **2008** *Mortality modelling and forecasting: a review of methods*, Annals of Actuarial Science, Vol. 3, Parts 1 and 2, page 8

Richards, S. J. **2010** *Selected Issues in Modelling Mortality by Cause and in Small Populations*, British Actuarial Journal (to appear)