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Longevity risk

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Overview

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1. About the speaker
2. Why longevity risk is different
3. Model risk
4. Conclusions

1 About the speaker

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- Independent consultant on longevity risk since 2005.
- Founded longevity-related software businesses in 2006:

- Joint development with Heriot-Watt University in 2009:

2 Why longevity risk is different

2 Why longevity risk is different

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- Opposing interests.
- Time frame over which risk operates.
- Limited information.

2.1 Opposing interests

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- Life insurance: neither side wants insured event to occur.
- Longevity insurance: pensioner wants *exact opposite* of what the insurer wants.

2.1 Opposing interests

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- Pensioners, their relatives, their doctors, medical science and government are all working to reduce the risk of death and increase longevity.
- Insurers hope their pricing assumptions are adequate.

2.2 Time frame

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"Whereas a catastrophe can occur in an instant, longevity risk takes decades to unfold"

The Economist [2012]

2.2 Time frame

- Mortality shocks are easy to spot.
- Longevity shocks much less so...

2.2 1918 influenza pandemic

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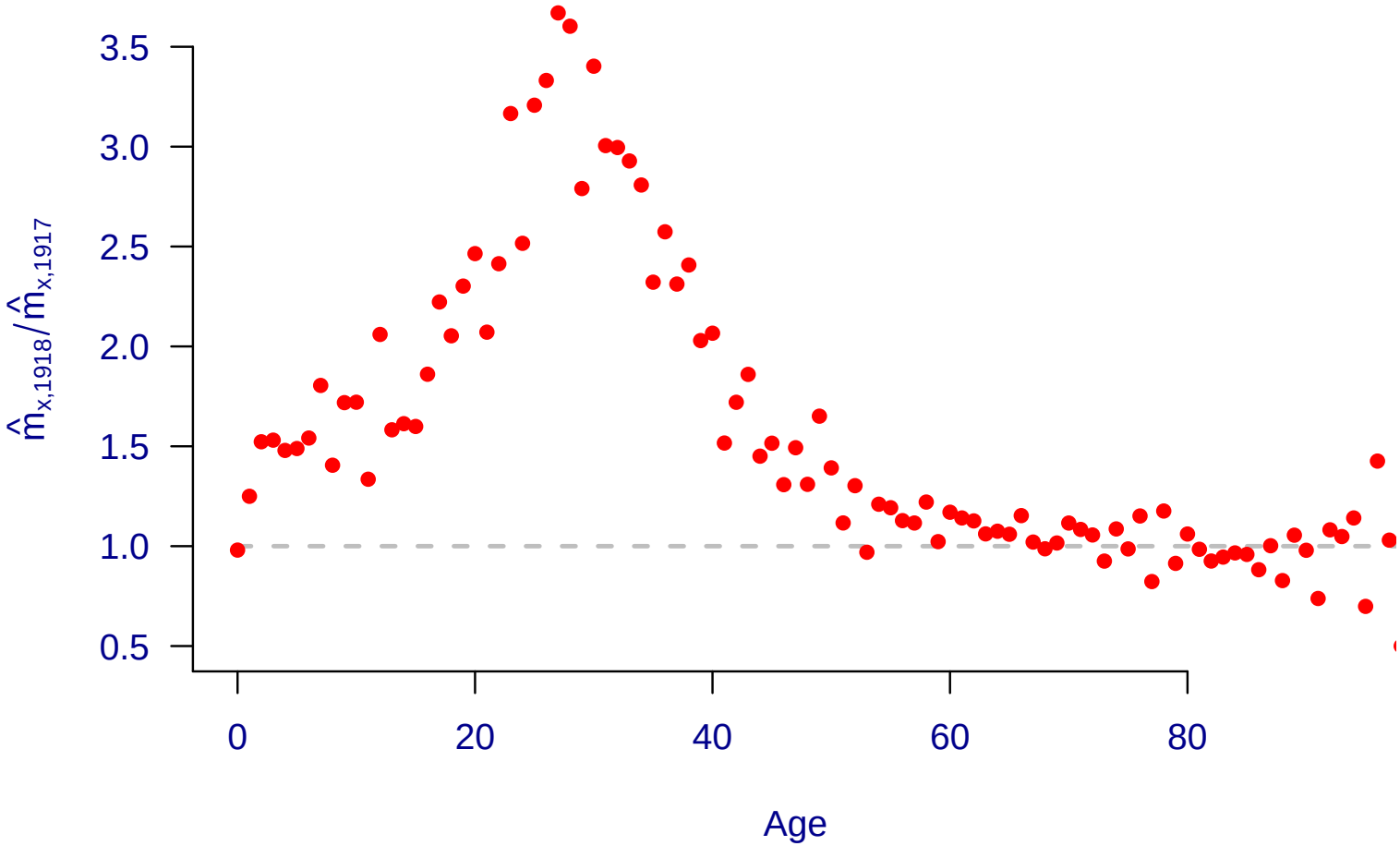
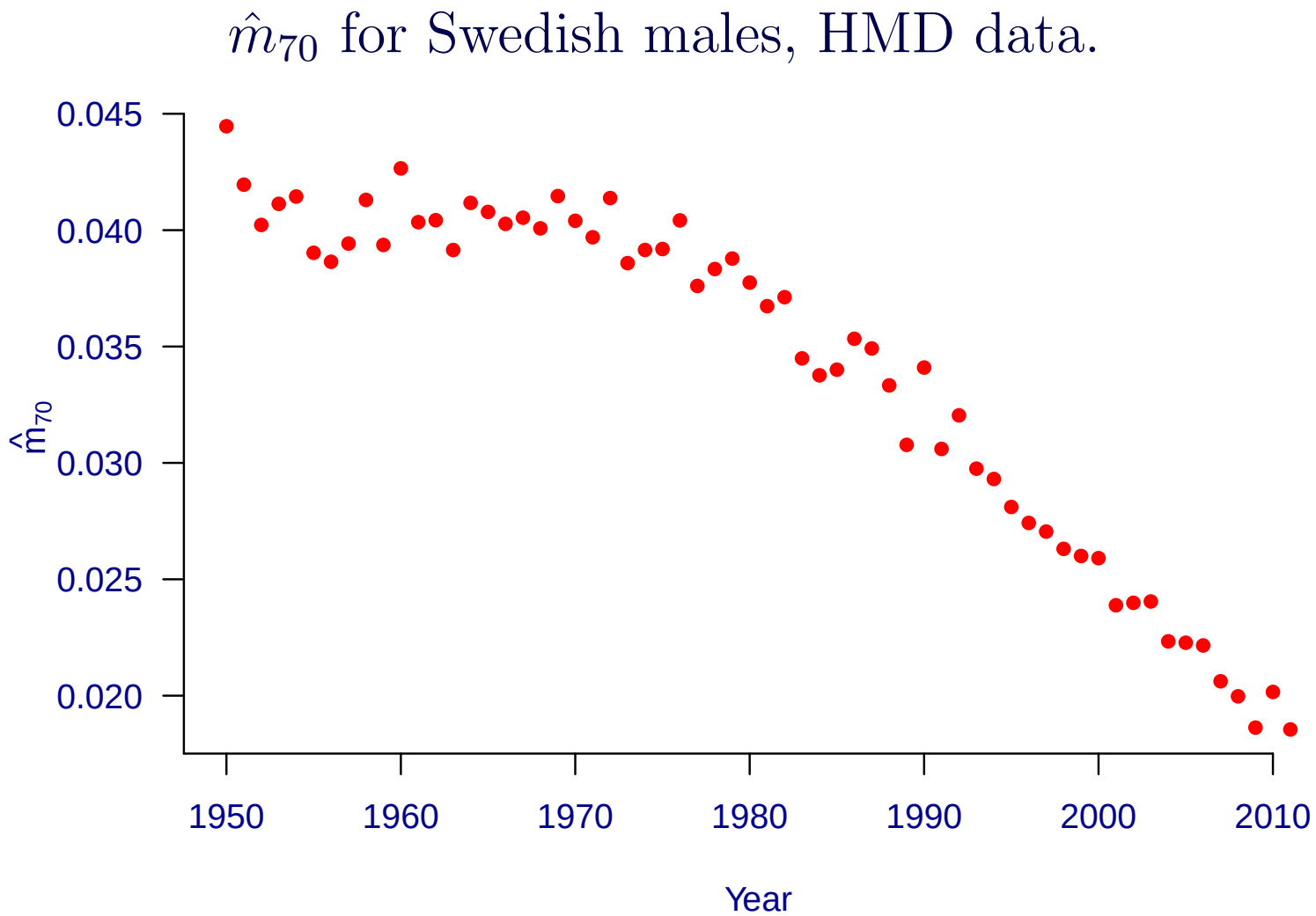
$\hat{m}_{x,1918}/\hat{m}_{x,1917}$ for Swedish males, HMD data[1].



[1] $\hat{m}_x$ is the estimated central death rate at age x last birthday.

2.2 When does a trend change?



2.2 Time frame

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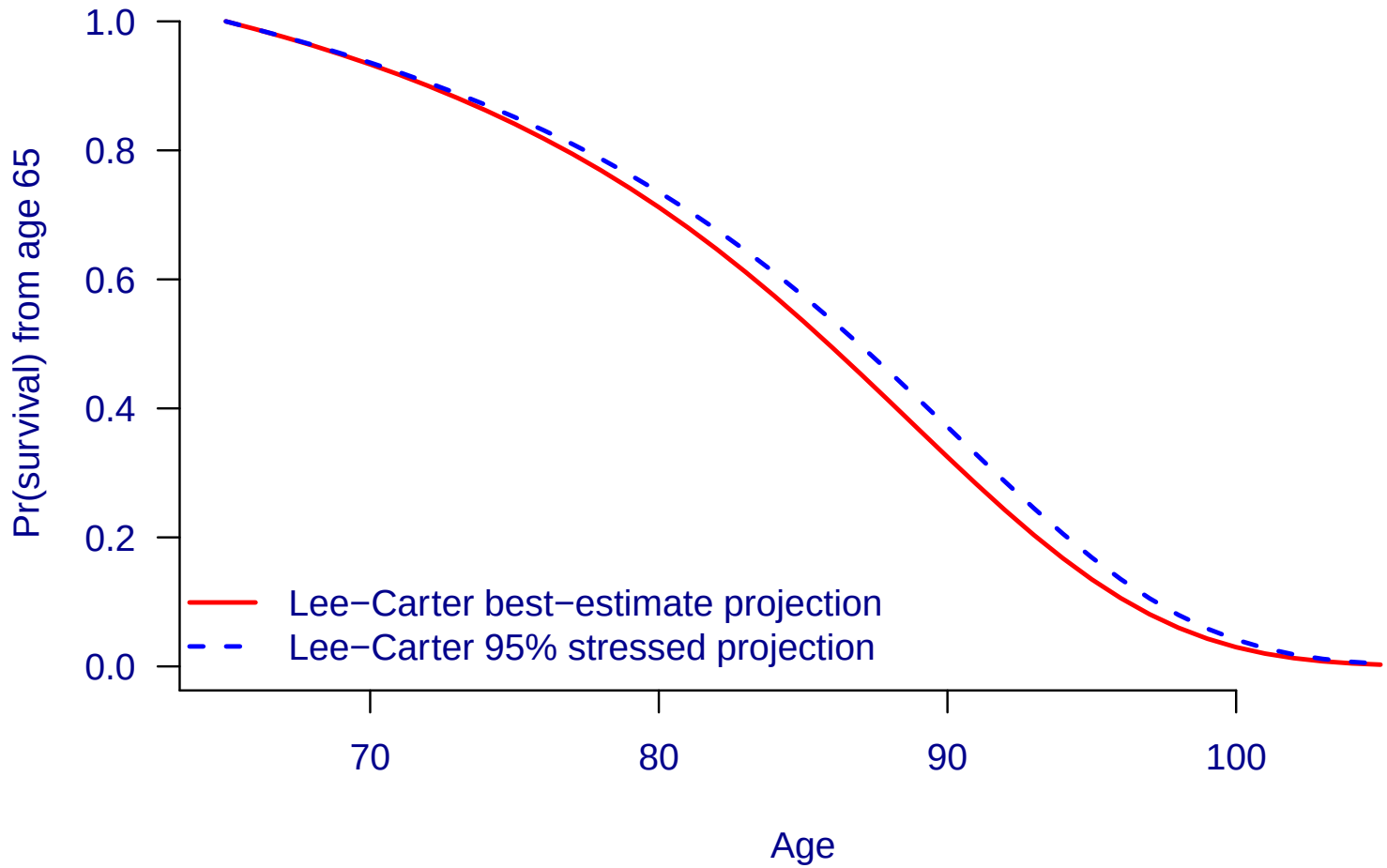
- Can only detect a trend change several years *after* it has already started...
- Longevity risk not a natural fit to "1:200 over one year" approach.
- Run-off is the appropriate way to view this risk...

2.2 Stressed survival curves

Projected survival curve for UK males aged 65 in 2013 (ONS data).



2.2 Run-off v. one-year VaR

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Q. How do you find a multi-year run-off scenario equivalent to a 1:200 event over one year?

- $99\frac{1}{2}\%$ run-off scenario is too prudent.
- Is 95% too low?
- Justifying a p-value below $99\frac{1}{2}\%$ is tricky...

  ...and vulnerable to manipulation.
- Suspicion that lower run-off p-value might be back-solved from a given level of capital.

2.2 Regulator's expectations

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"For the purposes of setting its QIs[2] the PRA has modelled longevity risk directly over a one year time horizon"

Bank of England Prudential Regulatory Authority [2015]

[2] QI=Quantitative Indicator, a benchmark the PRA uses to assess firms' submissions.

2.2 Regulator's expectations

A run-off approach can be acceptable...

> *"provided it can be demonstrated that the outputs (... provide) an equivalent level of policyholder protection"*
>
> **Bank of England Prudential Regulatory Authority [2015]**

→ Whatever methodology is used needs to be benchmarked against a one-year 1:200 approach.

2.2 Options for one-year view

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Several openly published methodologies for a one-year view of longevity trend risk:

- Börger [2010]
- Plat [2011]
- Richards et al. [2014]

2.3 Limited information

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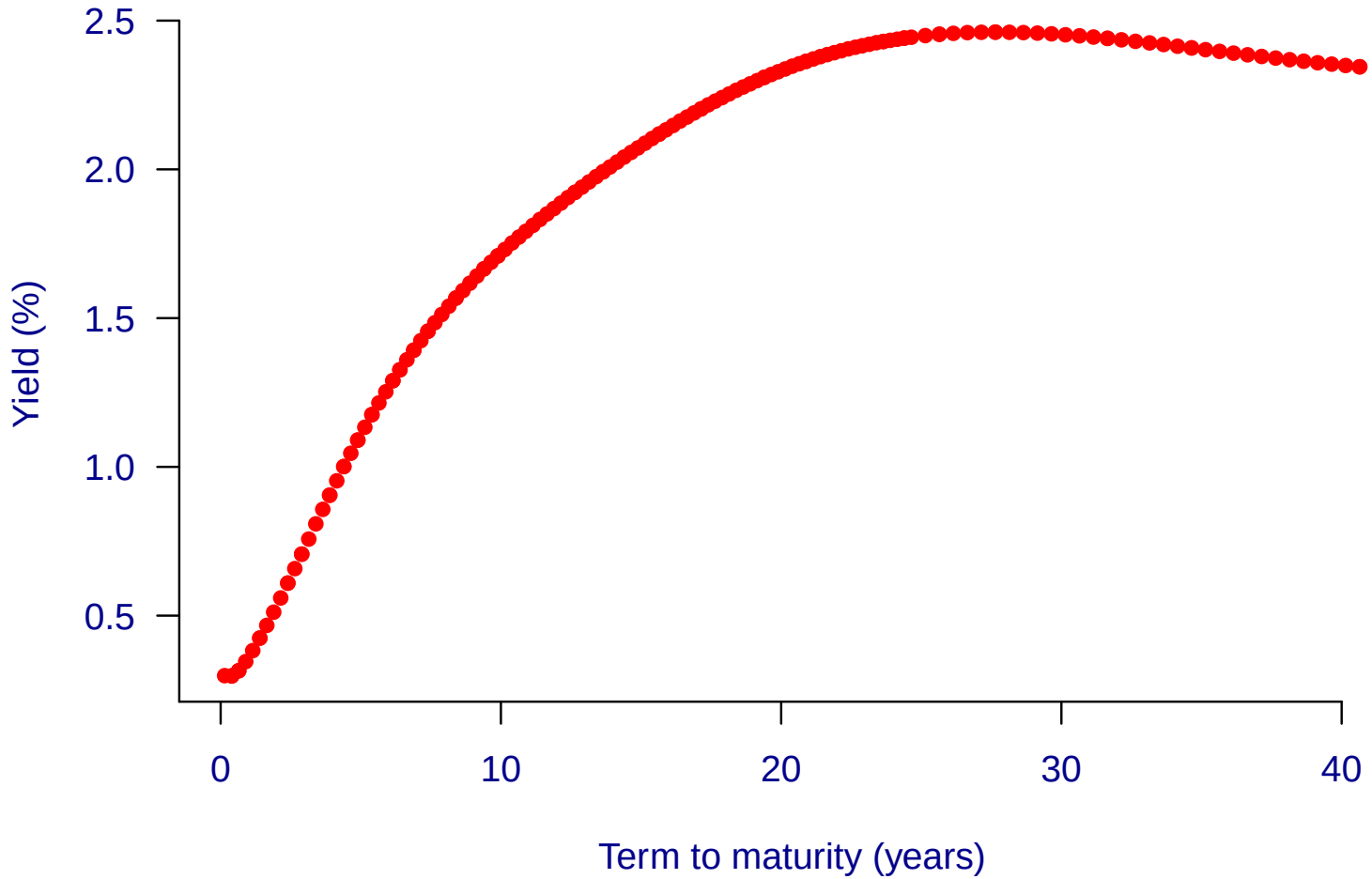
"As there is not currently a deep and liquid market for longevity risk, firms are required to derive their longevity assumptions from first principles"

Bank of England Prudential Regulatory Authority [2015]

2 Market forecast for interest

Yield curve for UK non-index-linked gilts without accrued interest (DMO data for 2015-04-16).



2 Market forecast for inflation

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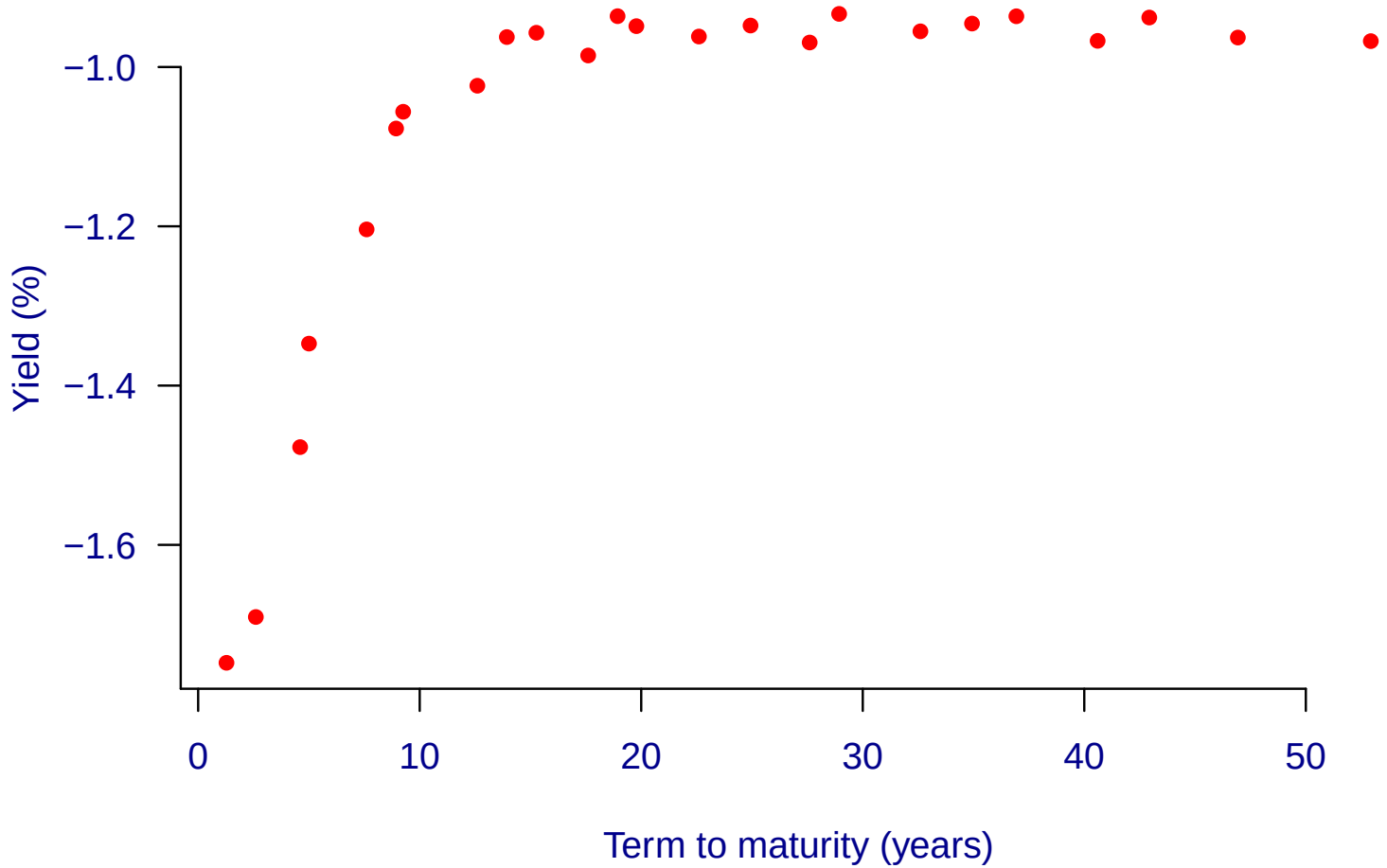
Yield curve for UK index-linked gilts (DMO data for 2015-04-16).



2.3 Limited information

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- Market forecasts exist for economic variables on a daily basis.
- There is no market forecast for mortality rates or longevity.
- Population mortality data published once a year.

2.3 Limited information

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- Without a "deep and liquid market" to provide market views, benchmarking projections is tricky.
- Longevity-related assumptions can be seen as a malleable item in reserving.
- Pressure to back-solve longevity assumptions from a given level of capital, rather than the other way around.
- Greatest risk of back-solving lies in models with lots of subjective assumptions.

3 Model risk

3 Model risk

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Many options available for mortality projections:

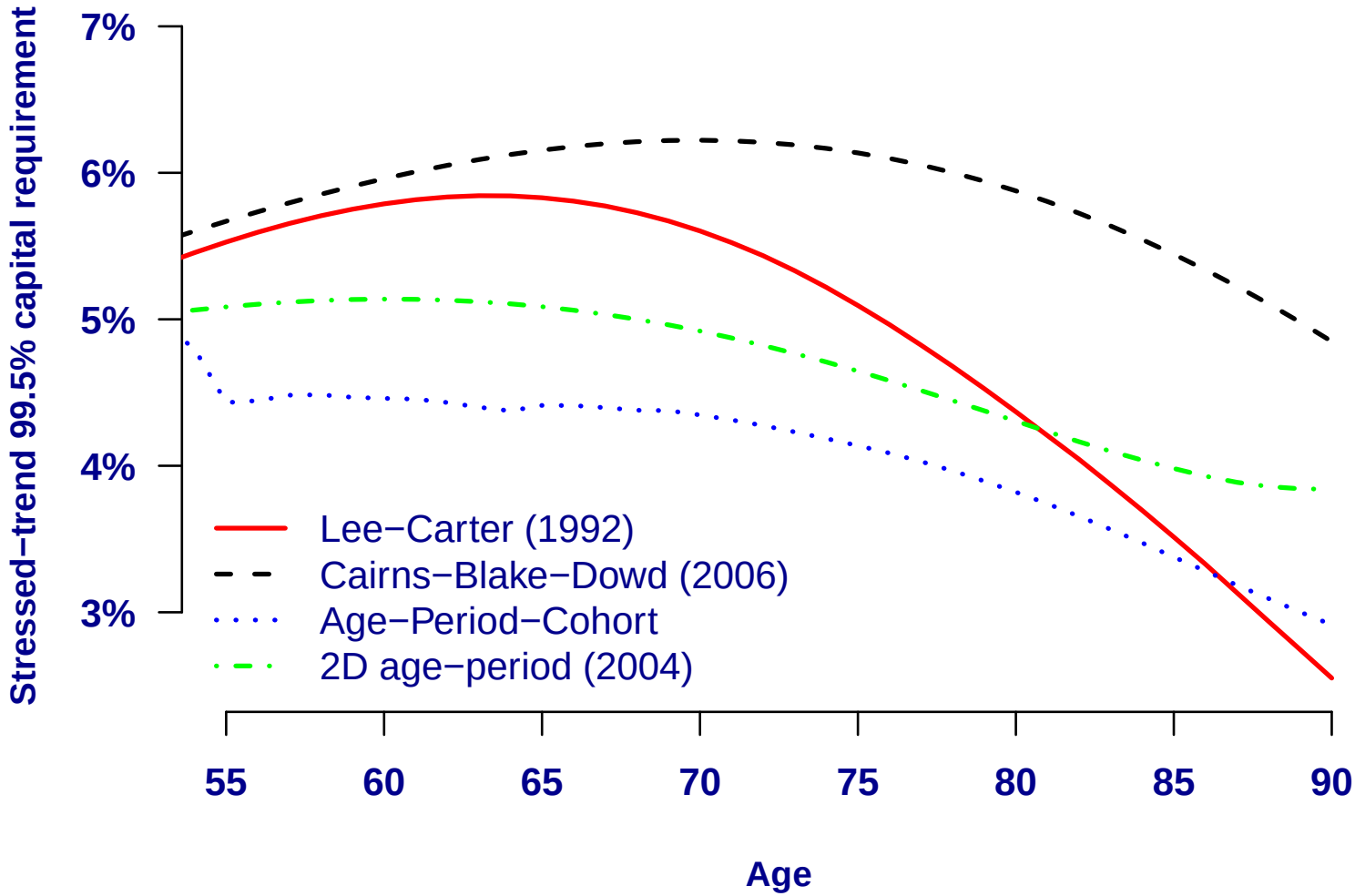
- Deterministic scenarios v. stochastic models.
- All-cause mortality v. cause-of-death.
- Targeting methods v. extrapolation.

3 Model risk

Different models produce different capital requirements. . .

3 Model risk

Run-off capital requirements by age for four stochastic models. Source: Richards et al. [2014].



3 Model risk

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- The best way to deal with model risk is to not rely on a single model.
- The PRA itself works with:

> *"four commonly used families of stochastic longevity risk models"*
>
> **Bank of England Prudential Regulatory Authority [2015]**

3 Expert judgement

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"The advantage of expert opinion is the incorporation of demographic, epidemiological and other relevant knowledge, at least in a qualitative way..."

Booth and Tickle [2008]

3 Expert judgement

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"...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]

3 Scope for abuse in . . .

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- CMI spreadsheet[3].
- Cause-of-death models.

[3] Continuous Mortality Investigation [2009] and subsequent annual updates.

3.1 CMI spreadsheet

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- Deterministic targeting method — no statement of uncertainty.
- Over 1,000 separately modifiable parameters[4].
- Difficult to understand customisations from a few sentences.
- Difficult to compare different customisations.

[4] See also ▸ www.longevitas.co.uk/site/informationmatrix/currencydevaluation.html

3.2 Cause-of-death models

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- Considerable technical challenges discussed by Continuous Mortality Investigation [2004].
- Drawbacks discussed by Richards [2010][5].

[5] More details at ▸ www.longevitas.co.uk/site/informationmatrix/?tag=cause+of+death

3.2 Cause-of-death models

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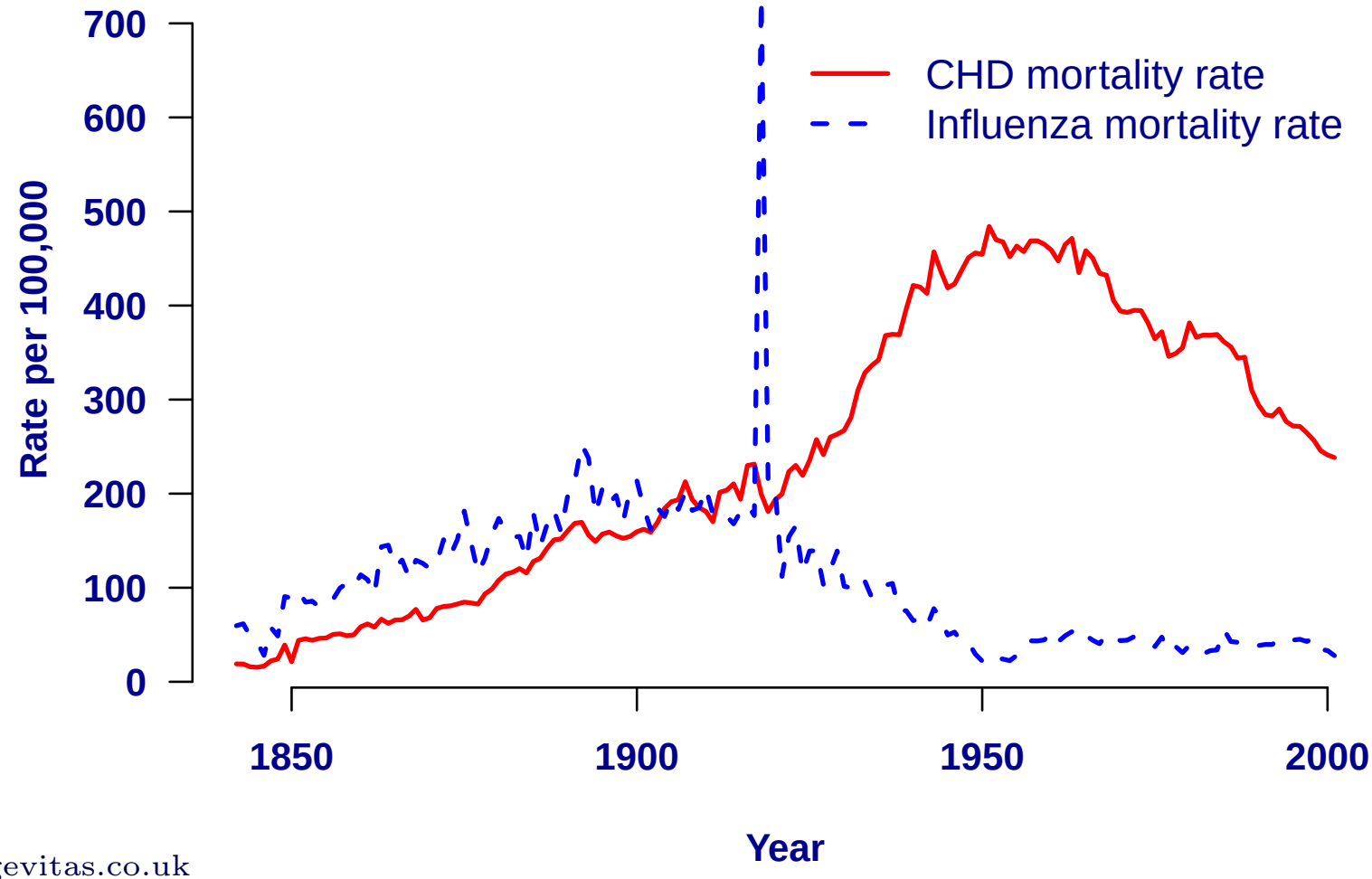
UK PRA did not use any cause-of-death models:

> *"due to their greater complexity, data requirements and the need for a greater level of expert judgement to be exercised. In particular we were concerned that the correlations between causes of death were not easily measured and would not be stable over time"*
>
> **Bank of England Prudential Regulatory Authority [2015]**

3.2 Correlated causes of death?

Mortality rates due to influenza and CHD. Source: Massachusetts Department of Public Health Registry of Vital Records and Statistics.



3.2 Cause-of-death models

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- Cause-of-death models often structured with a few broad "independent" categories.
- This is at best a simplifying assumption.
- At its worst, it ignores important correlations.

4 Conclusions

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- Longevity risk has unique features compared to other demographic risks.
- Longevity risk is not a natural fit to a one-year 1:200 view, but it can be done.
- Model risk handled by using multiple models.
- Beware models with lots of subjective parameters.
- Stick to openly published models in peer-reviewed journals.

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