

MORTALITY RISK FOR LIFE INSURERS AND PENSION FUNDS

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PLAN FOR TALK

- Background and the mortality problem
- Possible solutions
- Stochastic mortality models
- Basis risk
- Conclusions

The Problem

Nothing is certain in life except death and taxes.

(1789: Franklin)

2005: What we know as the facts:

- Death is still a certainty!
- Life expectancy is increasing.
- Future development of life expectancy is uncertain.

“Longevity risk”

The Problem: Insurance risk

- Traditional view:

Pooling of insurance risks \Rightarrow diversification

BUT

- Systematic risks: e.g.

- Florida hurricane risk

- Pandemic risk

- Long-term mortality improvements

The Problem – UK Defined-Benefit Pension Plans:

- Before 2000:
 - High equity returns masked impact of longevity improvements
- After 2000:
 - Poor equity returns, low interest rates
 - Decades of longevity improvements now a problem

The Problem – Life Insurers: annuity business

- Annuity providers:
 - Risk due to *unanticipated* improvements in mortality.
- Equitable Life (and others): GAO's
Guaranteed Annuity Option: becomes valuable if
 - interest rates fall
 - **mortality rates fall**

The Problem – Life Insurers: life business

- Short-term catastrophes
 - Pandemic
 - Terrorism
 - Earthquake etc.
- Long-term, *unanticipated* deterioration in mortality

Insurers: What to do with systematic mortality risk?

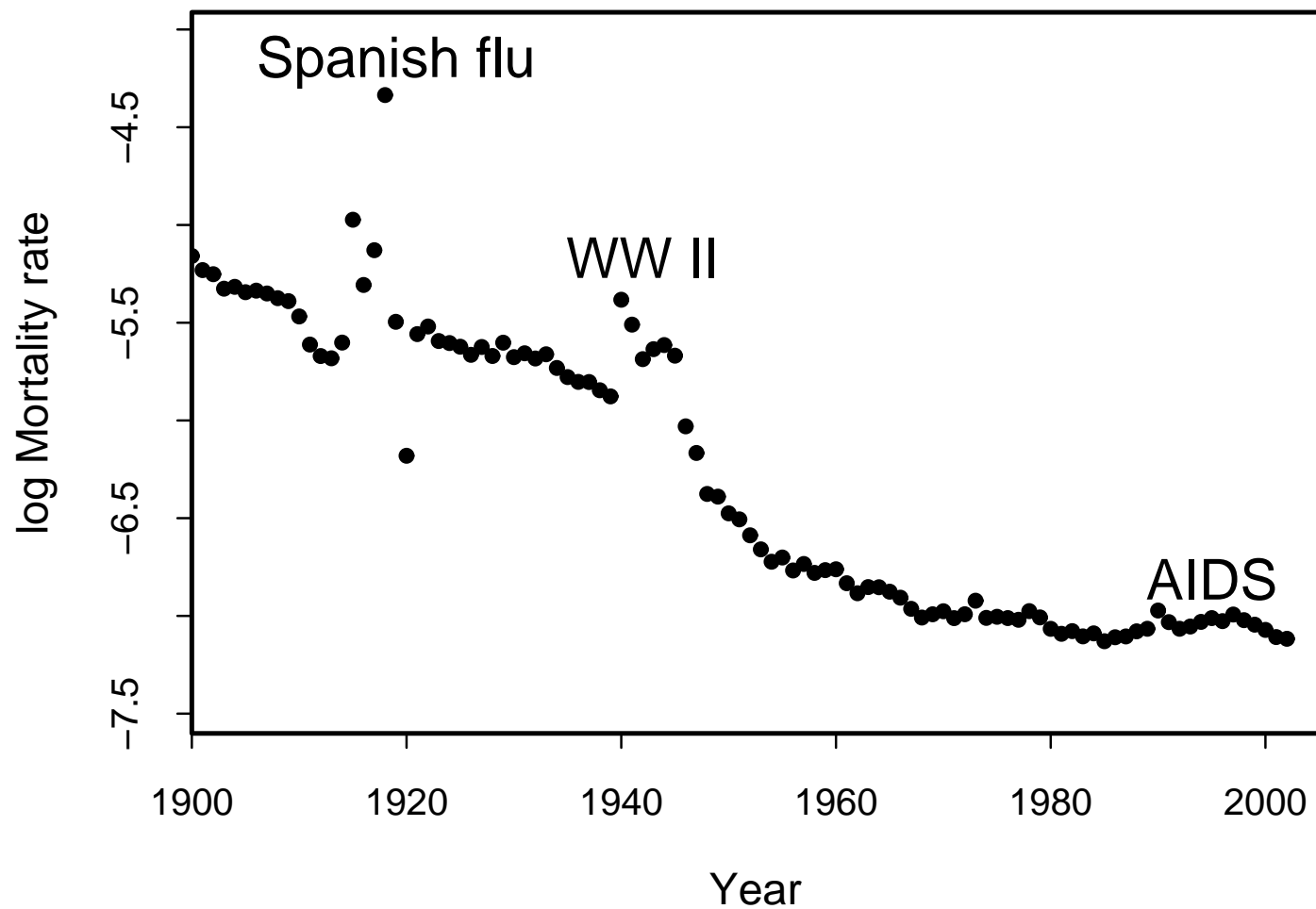
- Ignore – risk not significant;
- Accept as a legitimate business risk;
- Diversify insurance liabilities (annuities + life);
- Replace **fixed** annuities with **participating** contracts;
- Reinsurance (downside risk);
- Securitise a line of business;
- OTC mortality-linked contracts;
- Traded mortality-linked securities.

Pension plans: What to do with systematic mortality risk?

- Cannot/should not:
 - Ignore; Accept as business risk; Diversify.
- Purchase individual annuities from insurer;
- Bulk buyout;
- Actively manage risk using:
 - OTC mortality-linked contracts;
 - traded mortality-linked securities.

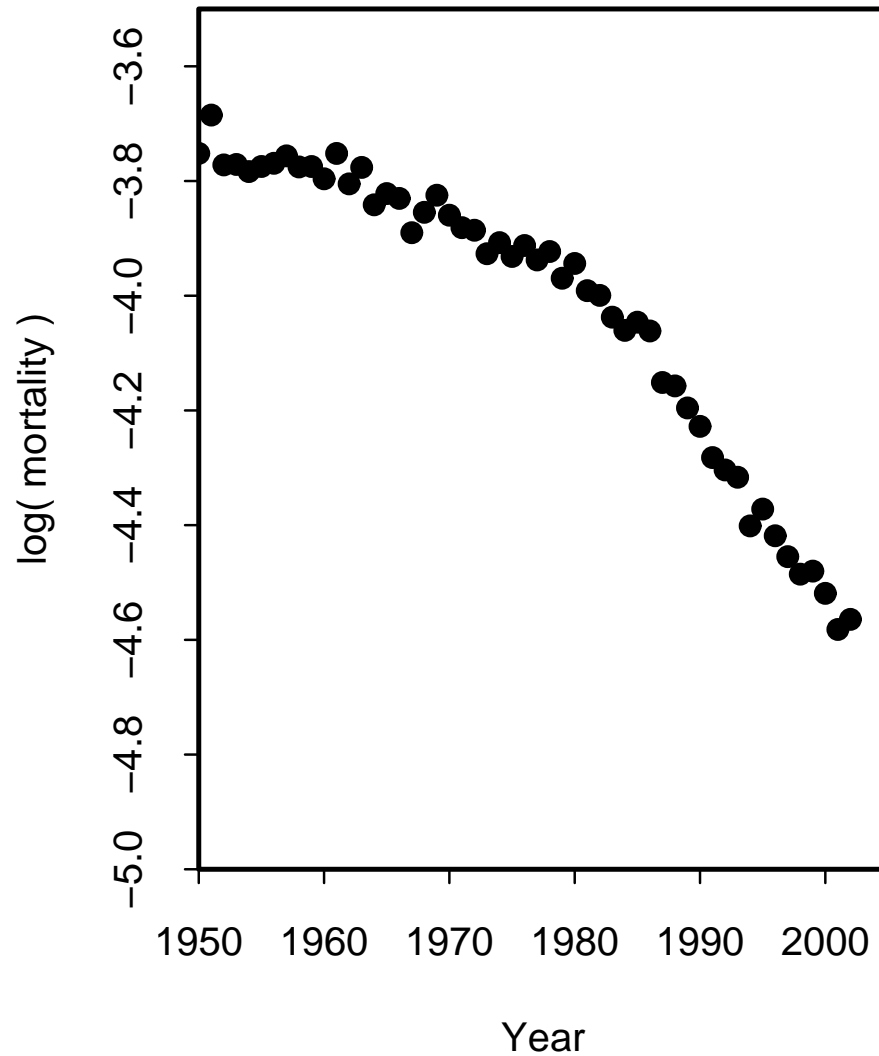
Life insurer's perspective

England and Wales: Males age 20–29 mortality

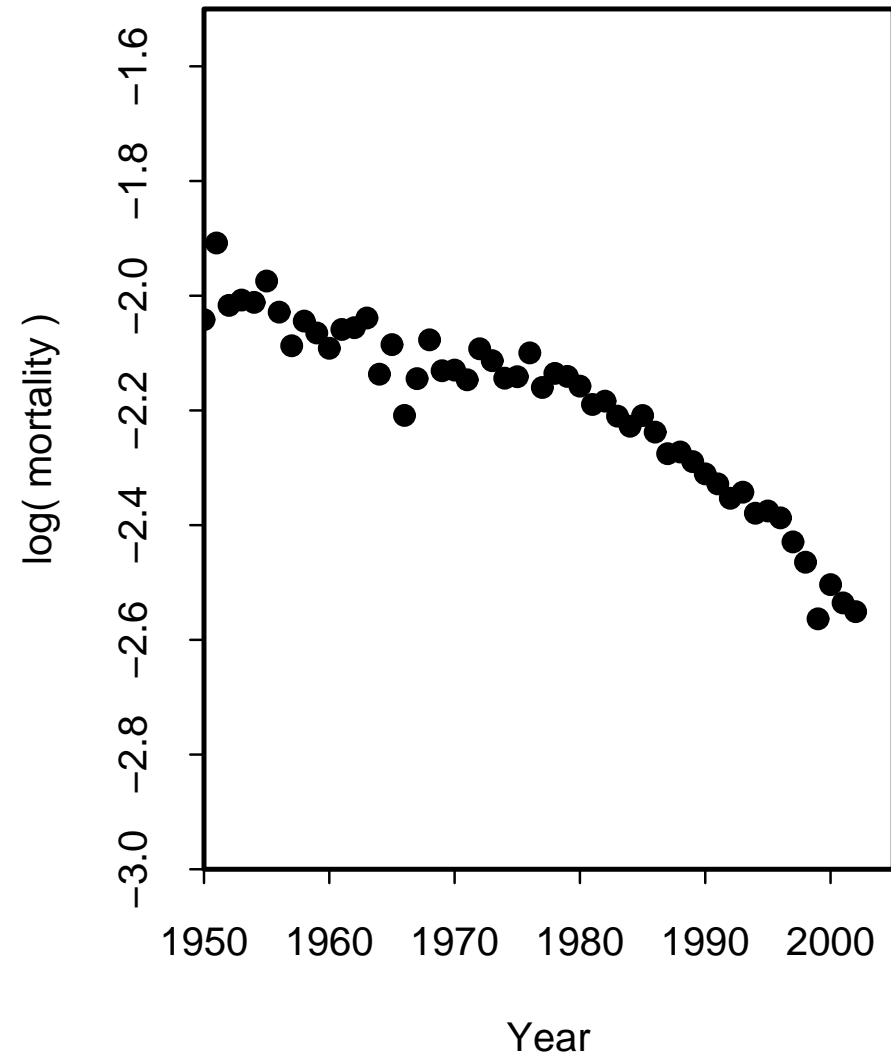


England and Wales log mortality rates 1950-2002

Age 60



Age 80



Why do we need stochastic mortality models?

Data \Rightarrow future mortality is **uncertain**

- Good risk management
- Setting risk reserves
- Life insurance contracts with embedded options
- Pricing and hedging mortality-linked securities

The wider picture

Life insurers and pension funds exposed to many risks

A: investment risk

B: interest-rate risk

C: mortality and longevity risk

A, B \rightarrow can hedge to reduce risk; C?

Stochastic mortality

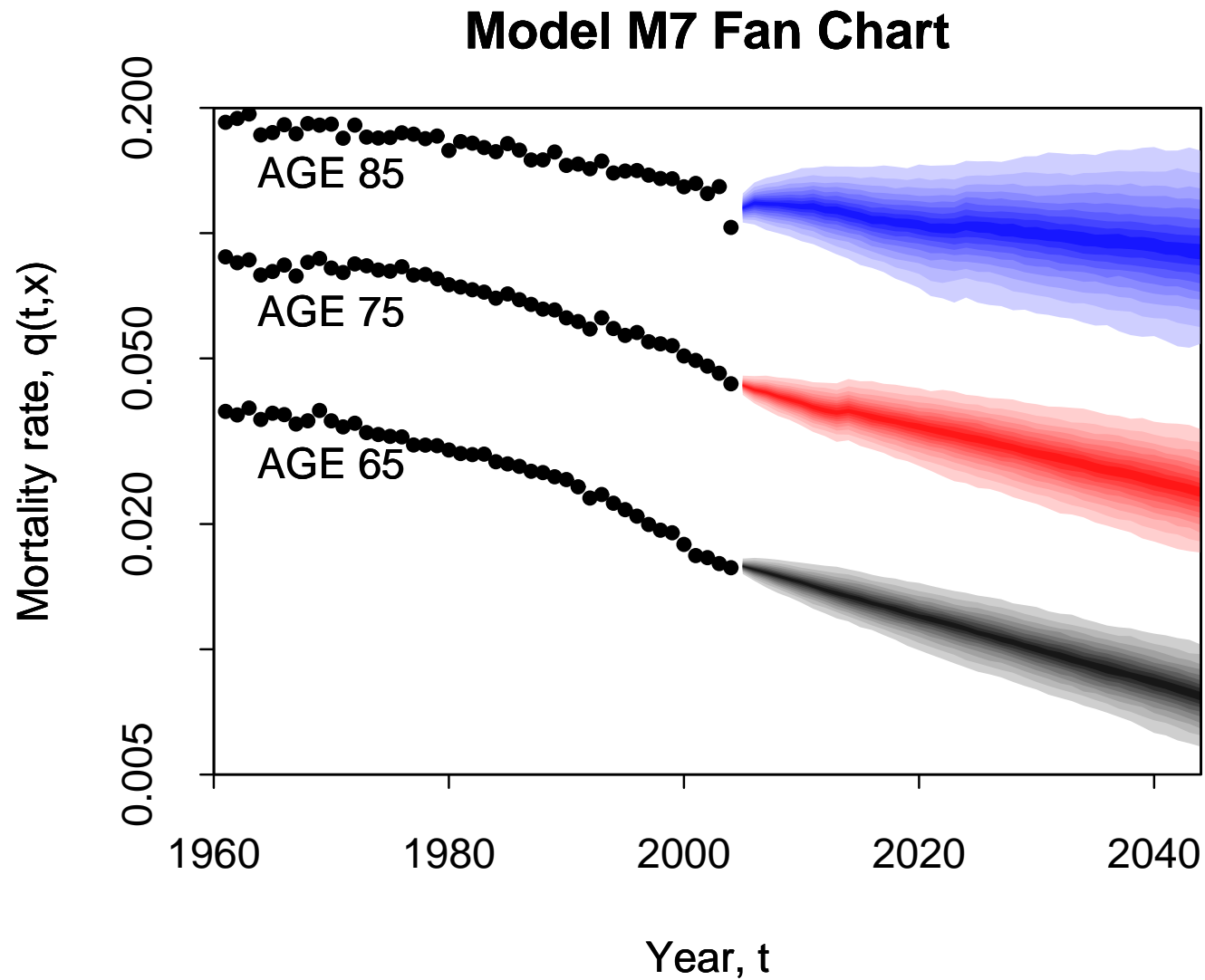
- Many models to choose from
- Annual mortality data
 - National data; subpopulations
- Limited data \Rightarrow model and parameter risk

How to compare stochastic models (*)

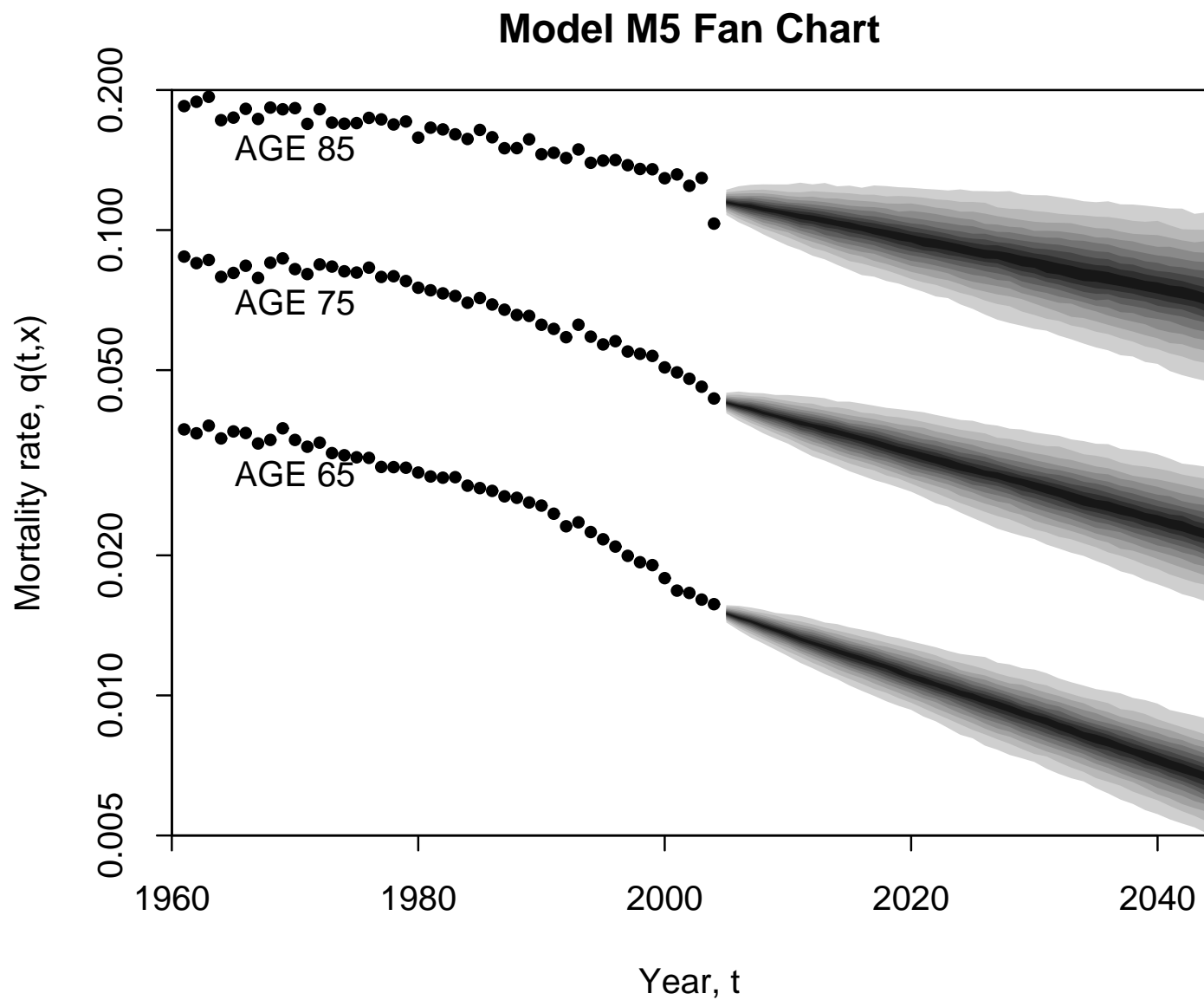
- Quantitative criteria
- Qualitative criteria
 - parsimony and transparency
 - robust relative to age and period range
 - biologically reasonable
 - forecasts are reasonable

(*) Cairns et al. (2007) A quantitative comparison of stochastic mortality models... Online: www.lifemetrics.com

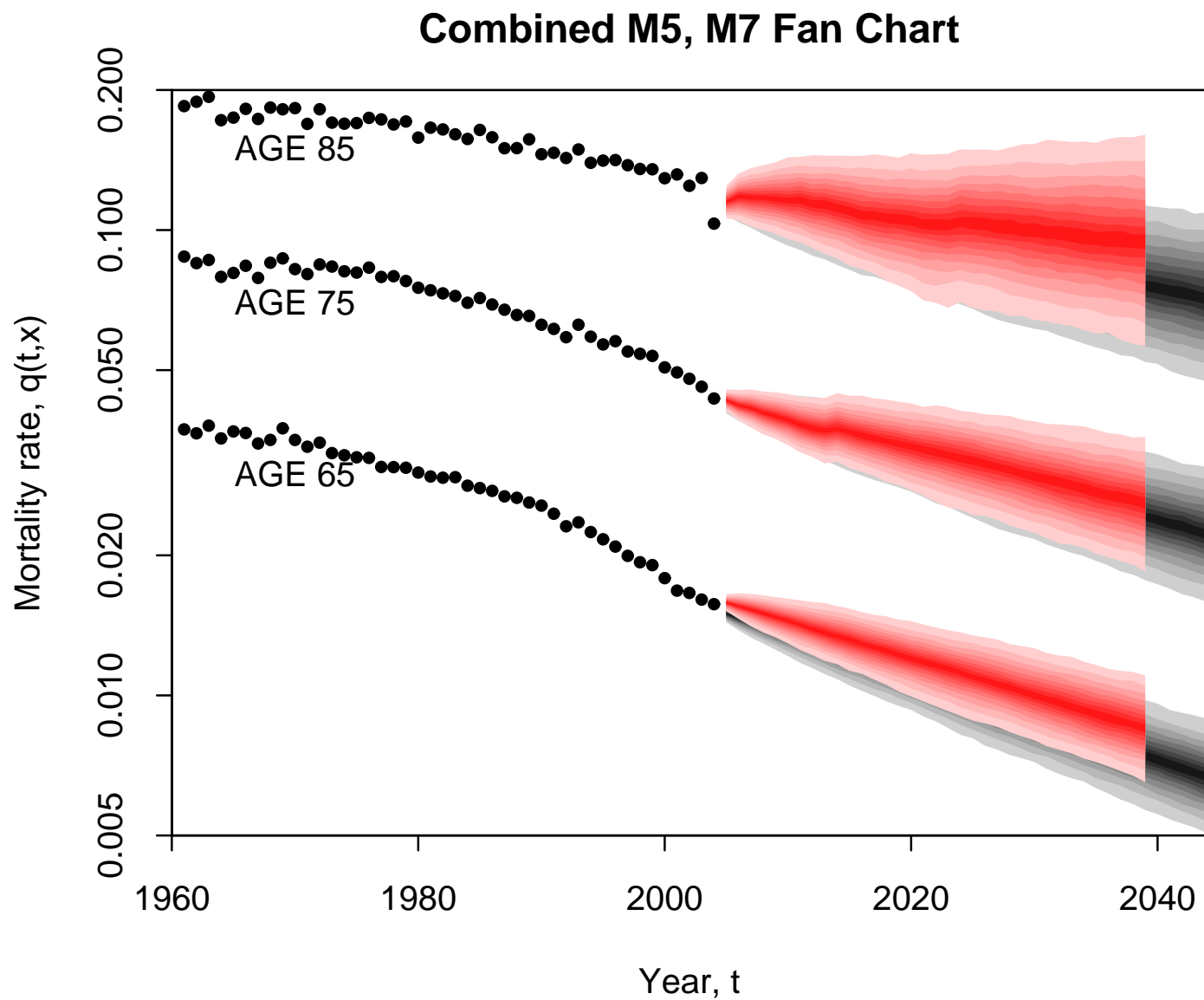
Fan charts + A plausible set of forecasts



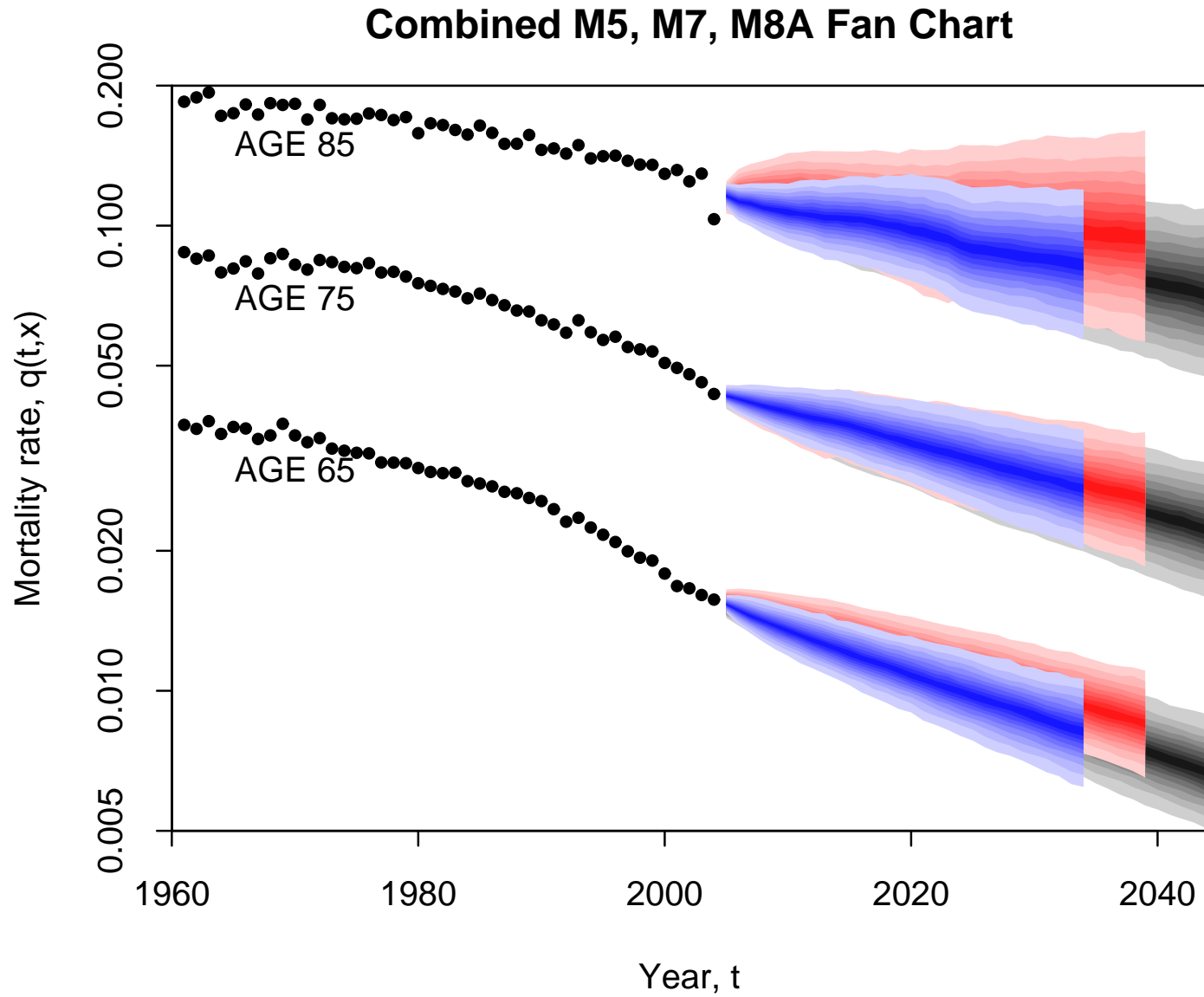
Model risk



Model risk

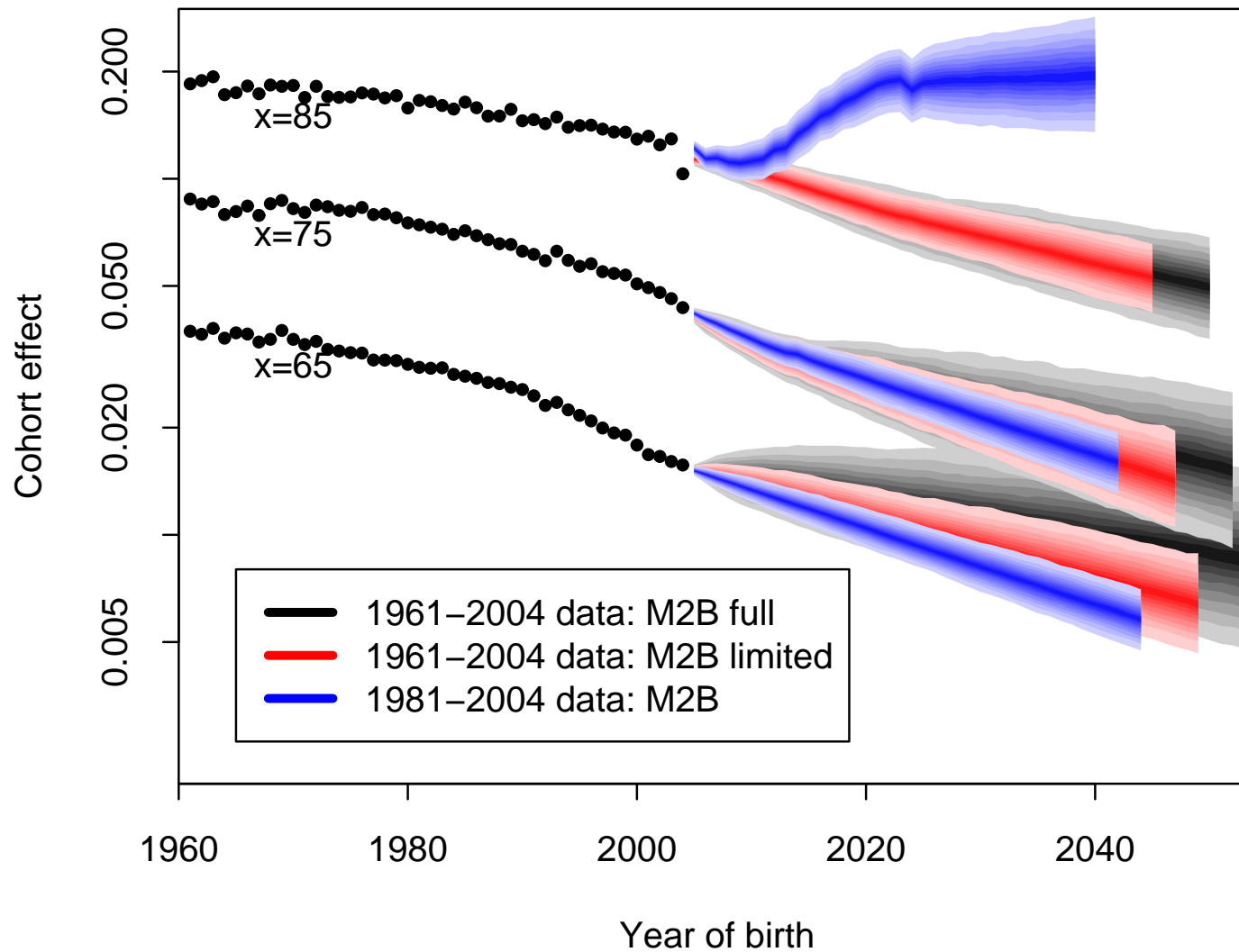


Model risk



Model M2 Forecast robustness problems

Model M2B (ARIMA(1,1,0)) projections



Modelling Conclusions

- Be aware of model and parameter risk
- Use a full range of quantitative and qualitative criteria

Uses include:

- Risk assessment and pricing of mortality-linked securities

MORTALITY-LINKED SECURITIES

- Short-term **catastrophe bonds** (Swiss Re, 2003, 2005)
- **Survivor swaps** (some OTC contracts)

swap fixed for floating mortality-linked cashflows

- Long-term **longevity bonds** (EIB/BNP, Nov. 2004)

cashflows linked to survivorship index

ultimately unsuccessful

What makes a proposed security successful?

- Attractive capital structure for hedgers
- Transparent and trustworthy underlying index
- Low basis risk for hedgers
- Good understanding of the risks being traded
⇒ need a good model
- Need *receivers* of longevity risk
⇒ natural hedgers; hedge funds etc.

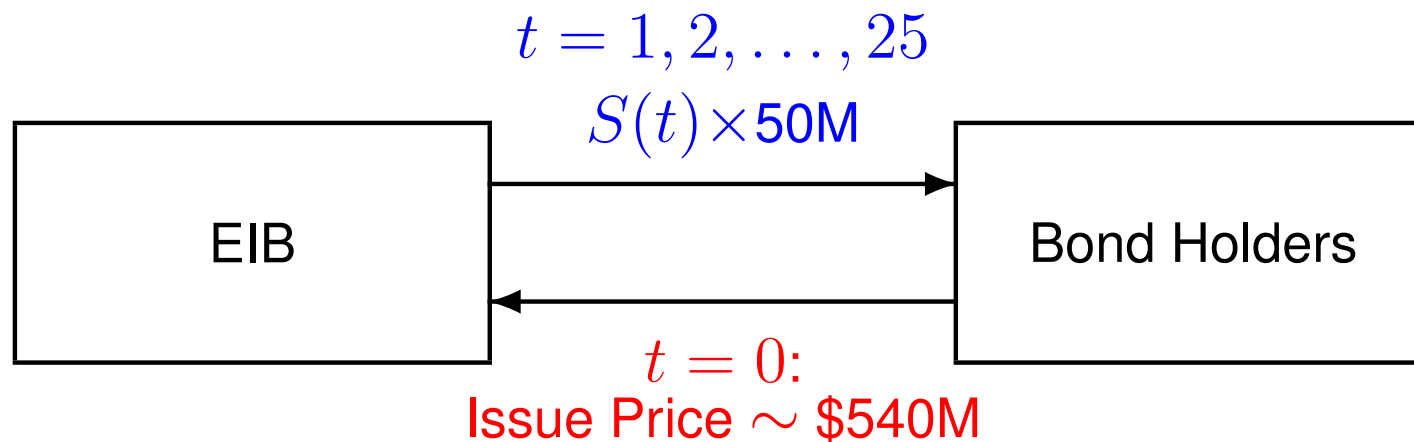
November 2004: EIB/BNP Paribas longevity bond

- Payments linked to survivor index $S(t)$
- $S(t)$ = proportion of cohort age 65 at time 0 surviving to time t .
- Bond pays $50M \times S(t)$ at time t
- Reference population: England and Wales, males
- Issuer=European Investment Bank
- Structurer and Manager=BNP Paribas

BNP Paribas / EIB Bond

European Investment Bank = Issuer

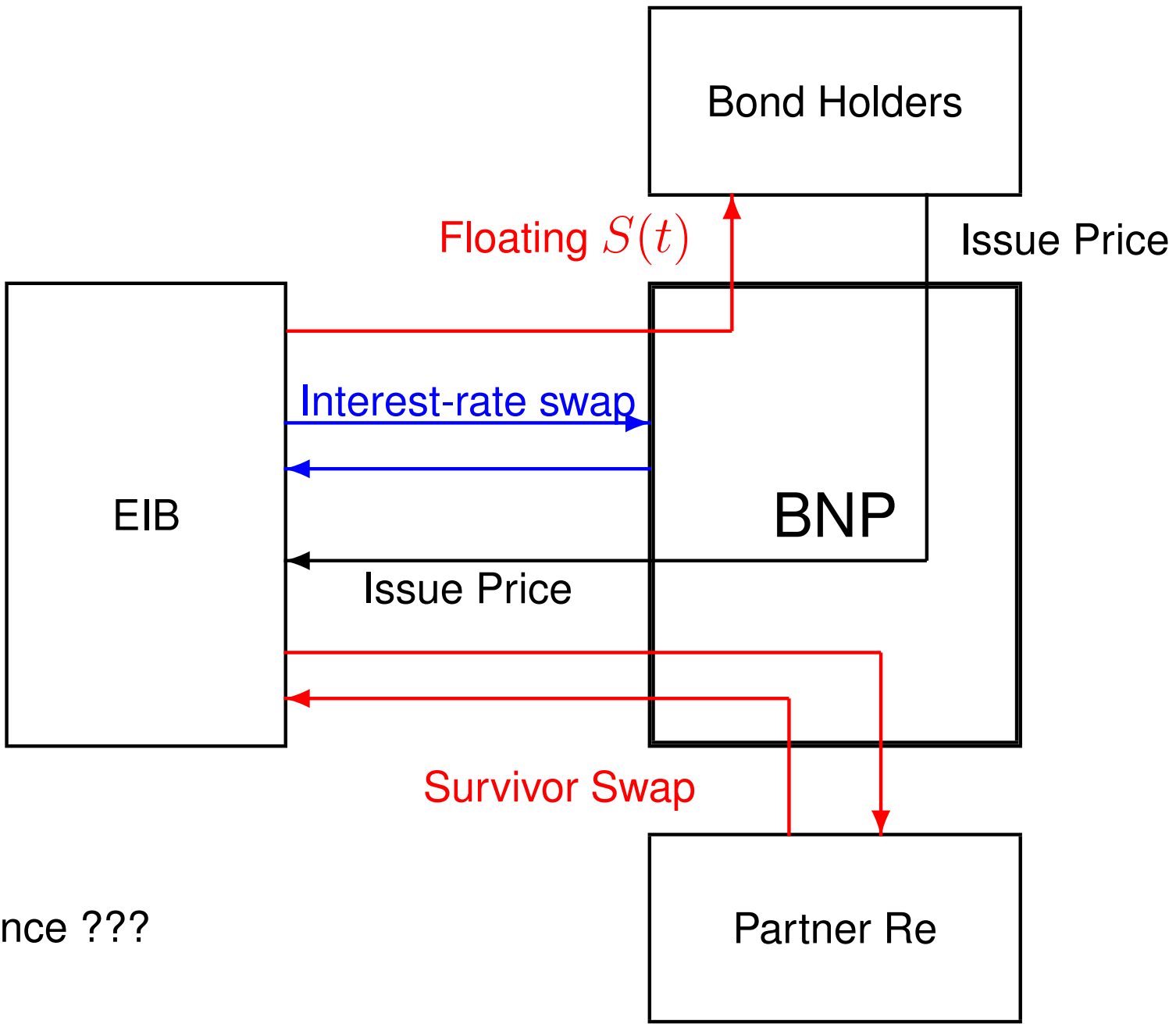
BNP Paribas = Manager and Structurer



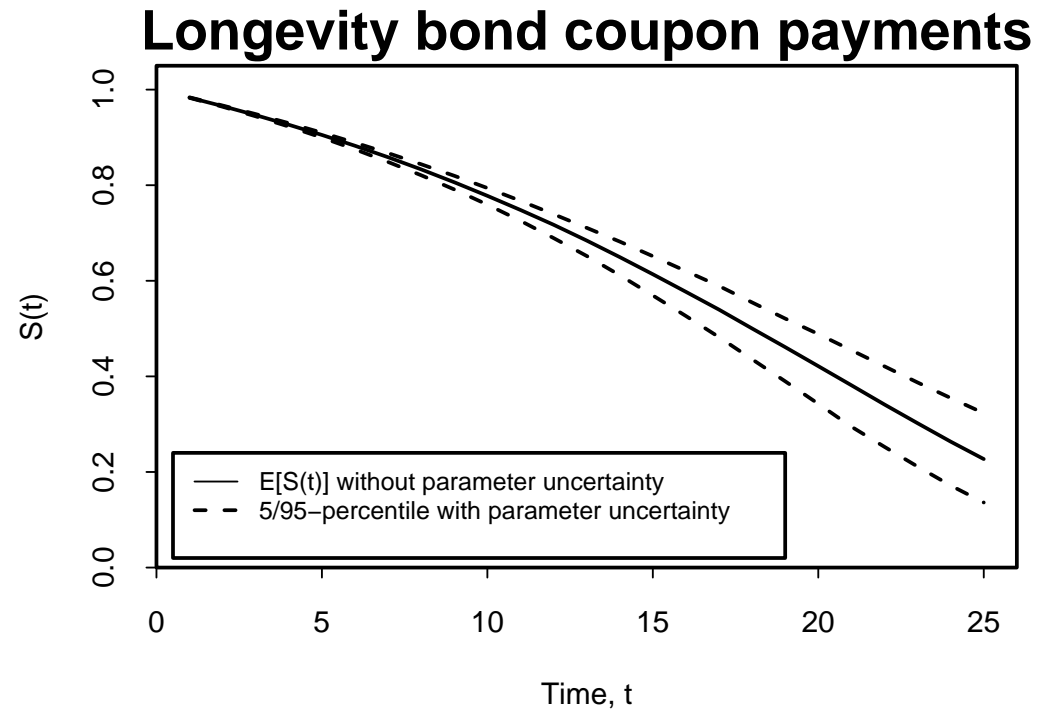
$S(t)$ = proportion still alive at t out of
males aged 65 in 2003

EIB's perspective

- Likes to issue floating-rate notes in Euros
- Does not like floating-mortality bonds in GBP



+ Credit Insurance ???



- Too much capital up front for limited risk transfer
- Perceived basis risk
- Price not obviously a problem

What still needs to be done?

Longevity-linked securities:

- Right capital structure
 - Survivor swaps (standardised?)
 - Survivor caps and caplets
 - Capital-at-risk bonds
- Need to understand basis risk

Traded securities: basis risk

Basis Risk \Rightarrow

mismatch between reference population and own risk

Examples:

- different population characteristics
- different age profile
- males/females

Traded securities: basis risk

Single, reliable reference population

⇒ high basis risk for many hedgers

⇒ security not worth holding

⇒ low demand

⇒ low liquidity

Traded securities: basis risk

Several reference populations

⇒ low basis risk for hedgers

BUT too many reference populations

⇒ poor transparency or reliability

⇒ low liquidity

Tradeoff required to get the right balance

Basis risk

- More work to be done
- Relatively little data
 - ⇒ need to work hard to extract stylised facts
- Role for biological reasonableness

Conclusions

- Life Insurance and Pensions liabilities are huge
(\$ Trillions)
- Life insurers and pension plans are exposed to significant systematic longevity risk
- Options:
 - bear the risk internally
 - transfer the risk to the financial markets

Conclusions

- Requirement for good risk management
⇒ Potential huge demand for mortality-linked securities
 - Challenges for the future:
 - *to improve statistical models;*
 - *to develop a substantial, liquid market in mortality-linked securities*
- ⇒ need to design products that are attractive for both buyers and sellers

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