Longevity Risk and How to Manage it in Pension Plans

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Agenda

- Longevity risk: What is it?
- Longevity risk: How to quantify it?
- Managing longevity risk using insurance solutions
- Managing longevity risk using capital market solutions
- Re-insurance sidecars: Introducing new investors
- A role for government: Issuing Longevity Bonds
- Longevity assets in a diversified portfolio
- Conclusion

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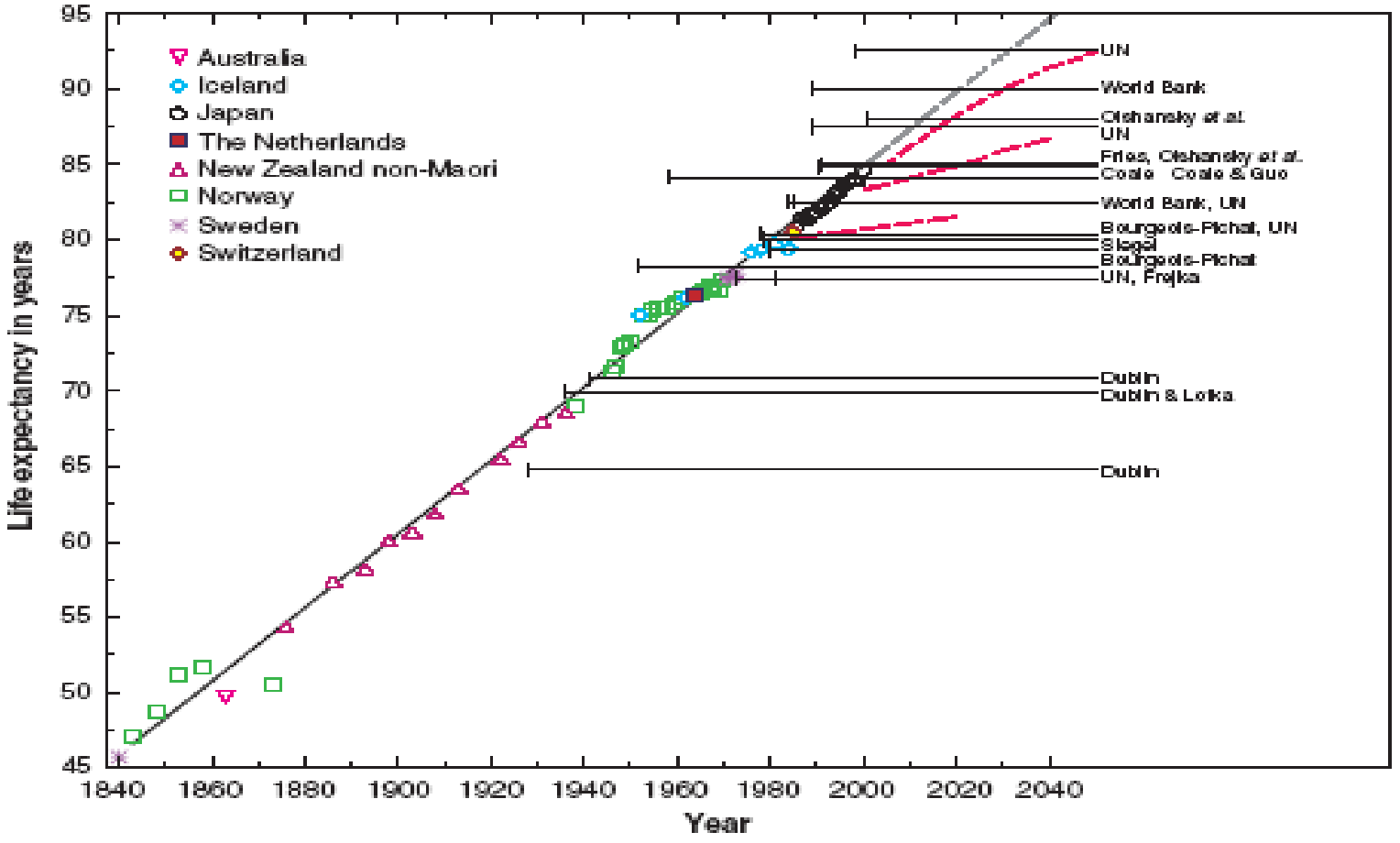
Longevity risk: What is it?

What is longevity risk?

- We systematically underestimate how long people are going to live:
  - Longevity is a slowly-developing trend risk
- Danger of:
  - Individuals outliving their savings:
    - As baby boomers retire, decumulation and longevity risk become key issues
  - Pension plans must provide retirement income security for however long people live:
    - Plan sponsors risk having to divert resources away from dividend and investment programmes
  - Annuity providers inadequately reserving

The past

(Broken limits to life expectancy – Oeppen & Vaupel)



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The future

- Will longevity continue to improve?
- Recent improvements have been underestimated
- Mortality now recognized as being a stochastic process

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Alternative expert views

- ‘Pessimists’ suggest that life expectancy might level off or decline (Olshansky et al)
  - Impact of obesity, poor diet, global warming etc.
- ‘Optimists’ suggest no natural limit to human life (Vaupel et al)
  - Supported by extrapolative methods
  - Future scientific advances?

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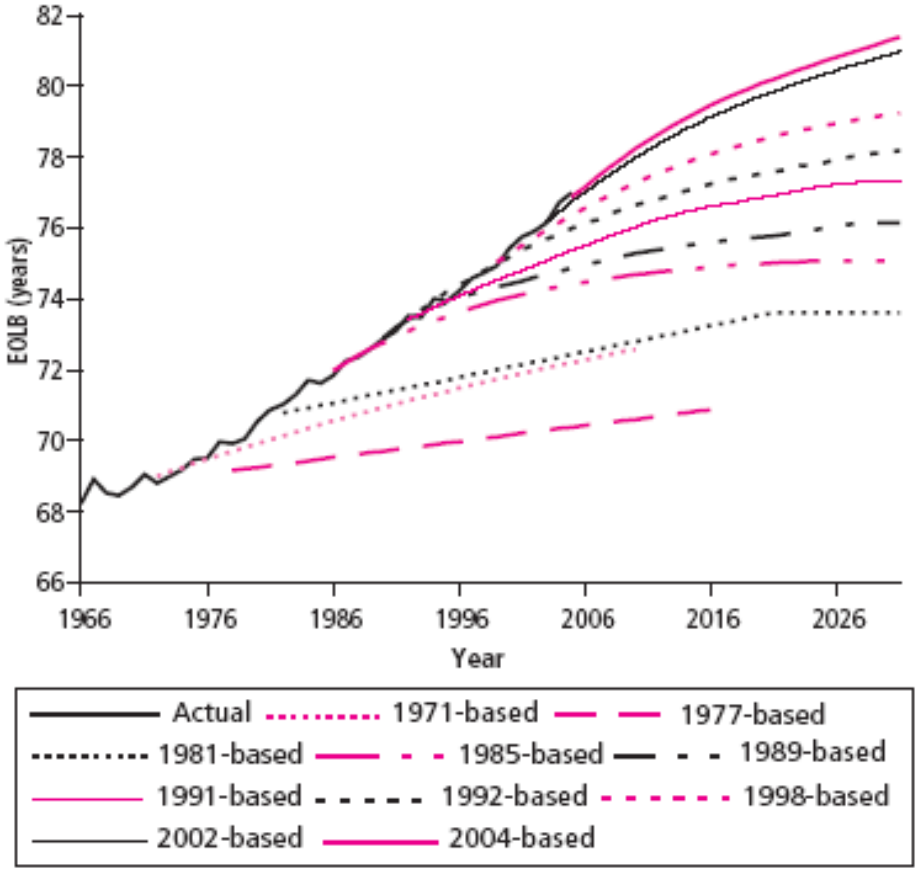
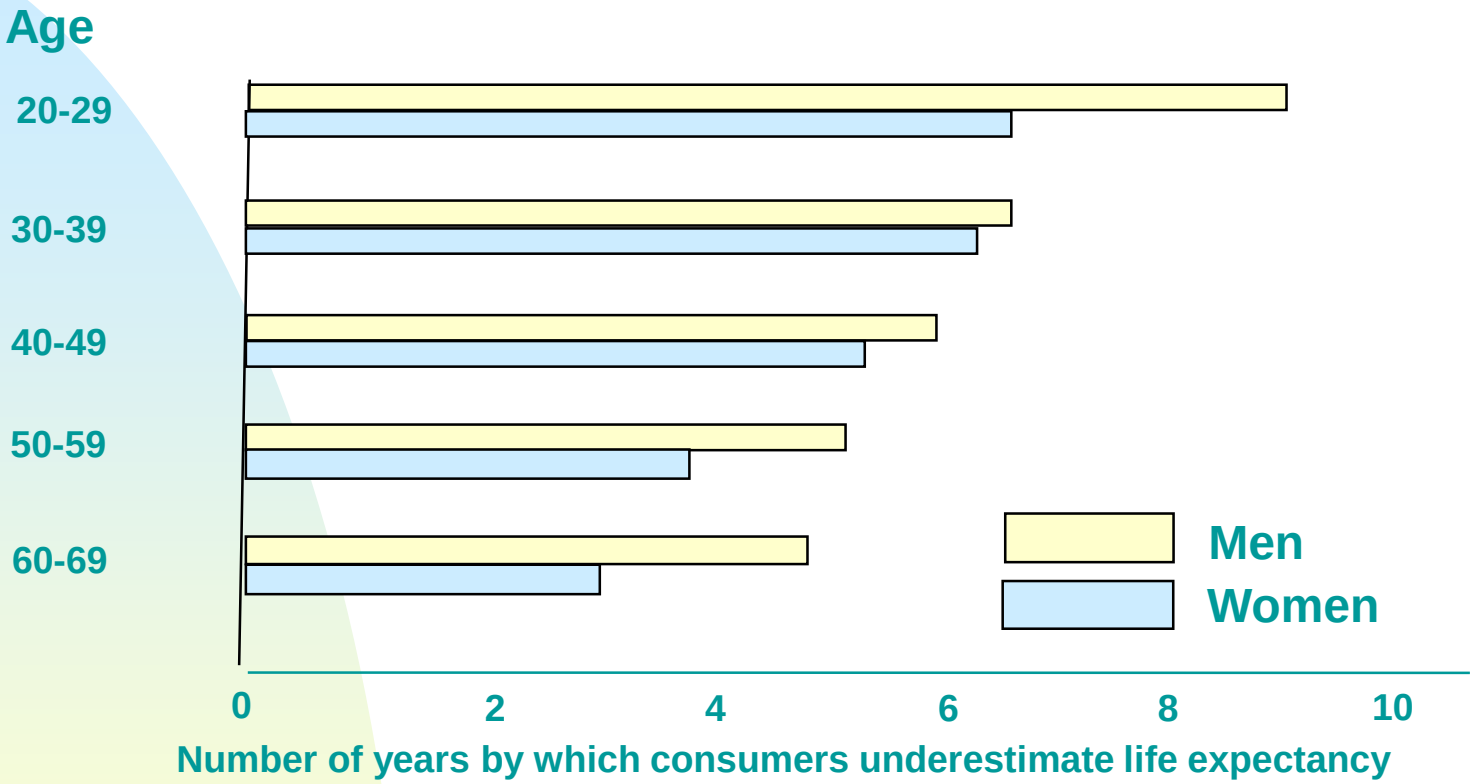
Accuracy of official mortality assumptions:
actual and projected period life expectancy at birth, UK males, 1966-2031



Shaw (2007, page 16)

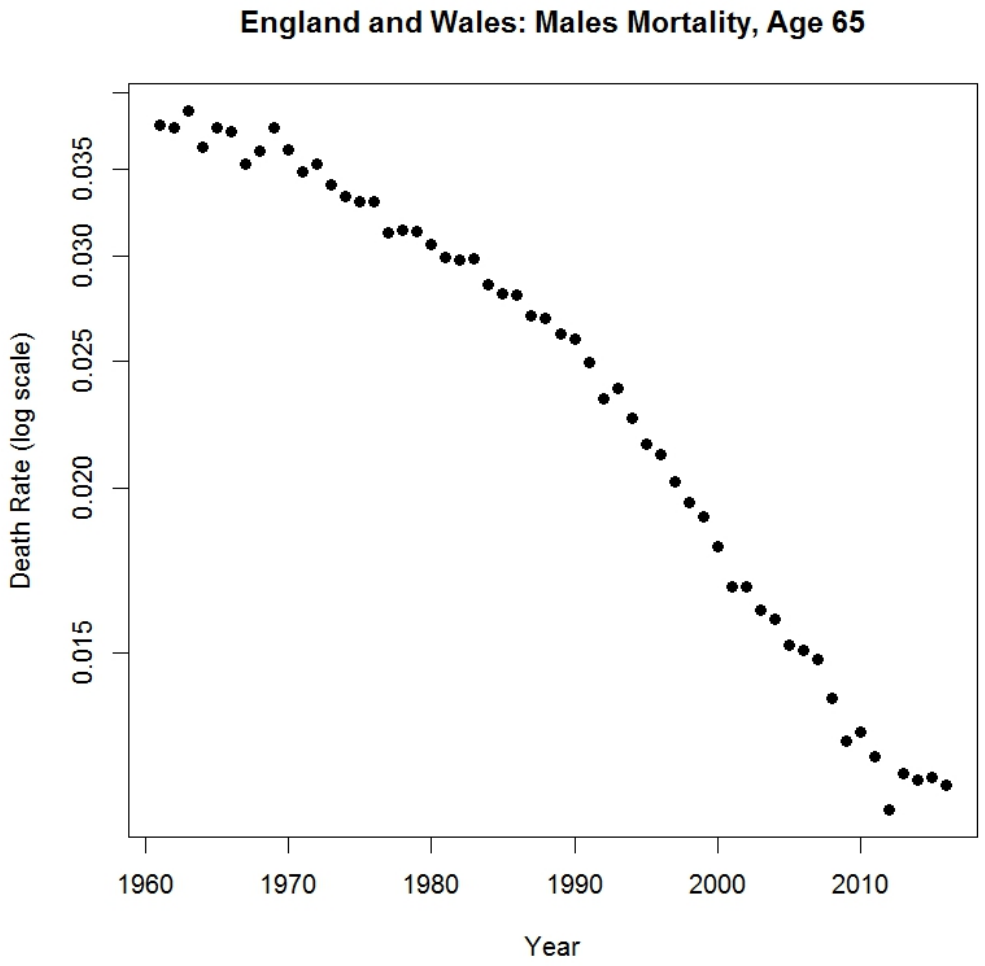
Individual underestimates of life expectancy by age



Source: O'Brian, Fenn, and Diacon, 2005, self-estimated life expectancy compared with GAD forecast life expectancy

Stochastic nature of mortality improvements

- Mortality clearly declining
- But declines are volatile



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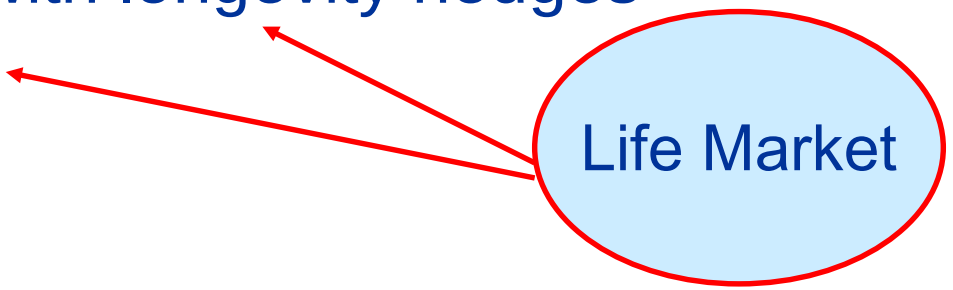
Range of responses

- Accept longevity risk as legitimate business risk
- Share longevity risk:
  - e.g., via participating annuities with survival credits
- Manage longevity risk using insurance solutions:
  - Buy-outs and buy-ins
- Manage longevity risk using capital market solutions:
  - Manage risk with longevity hedges
  - Securitization



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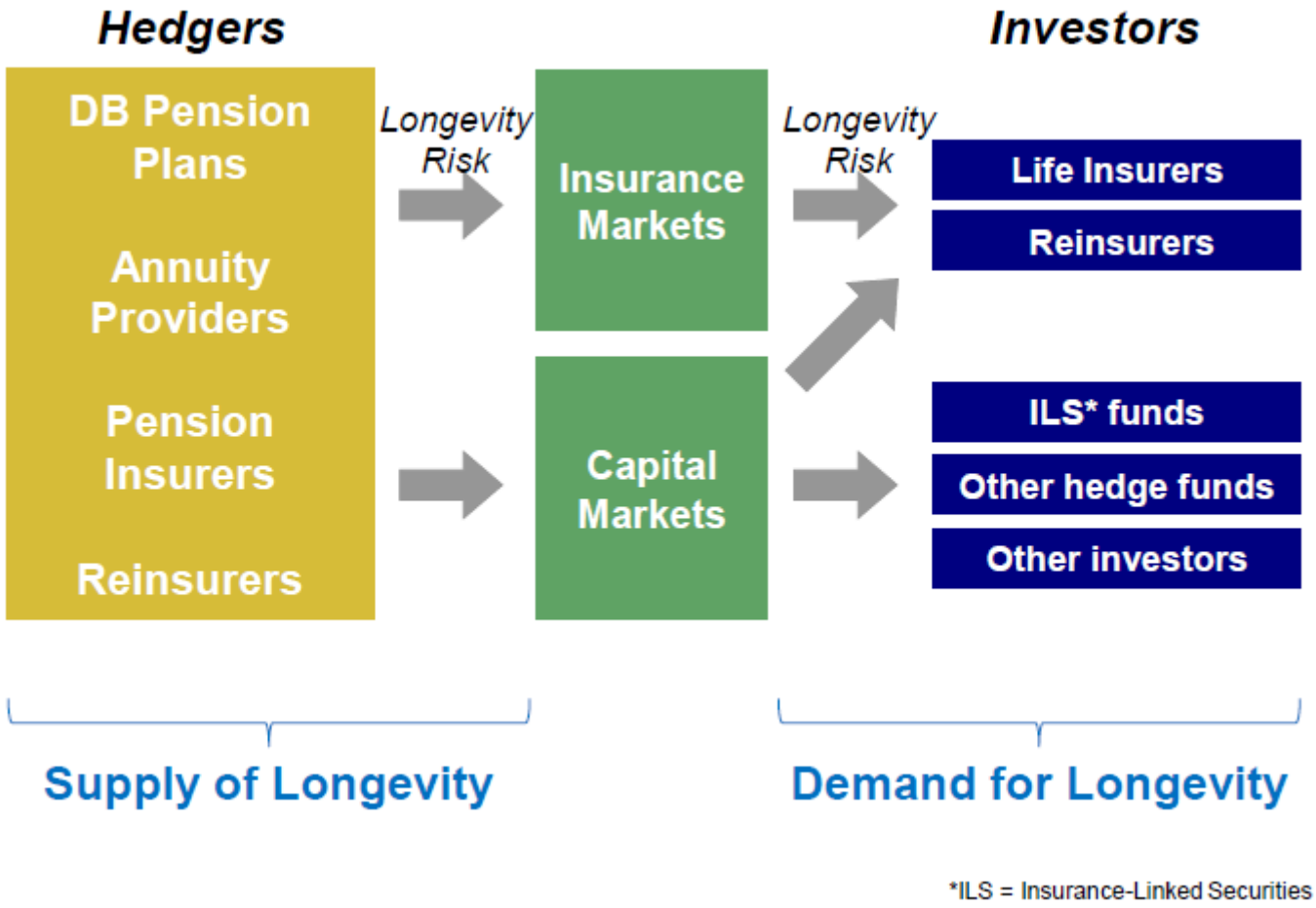
Supply and demand in the longevity market



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Longevity risk: How to quantify it?

Analysis of causal factors underlying longevity

Causal factors underlying longevity

- Gender
- Geographical location
- Social class
- Income/wealth
- Year of birth (cohort)

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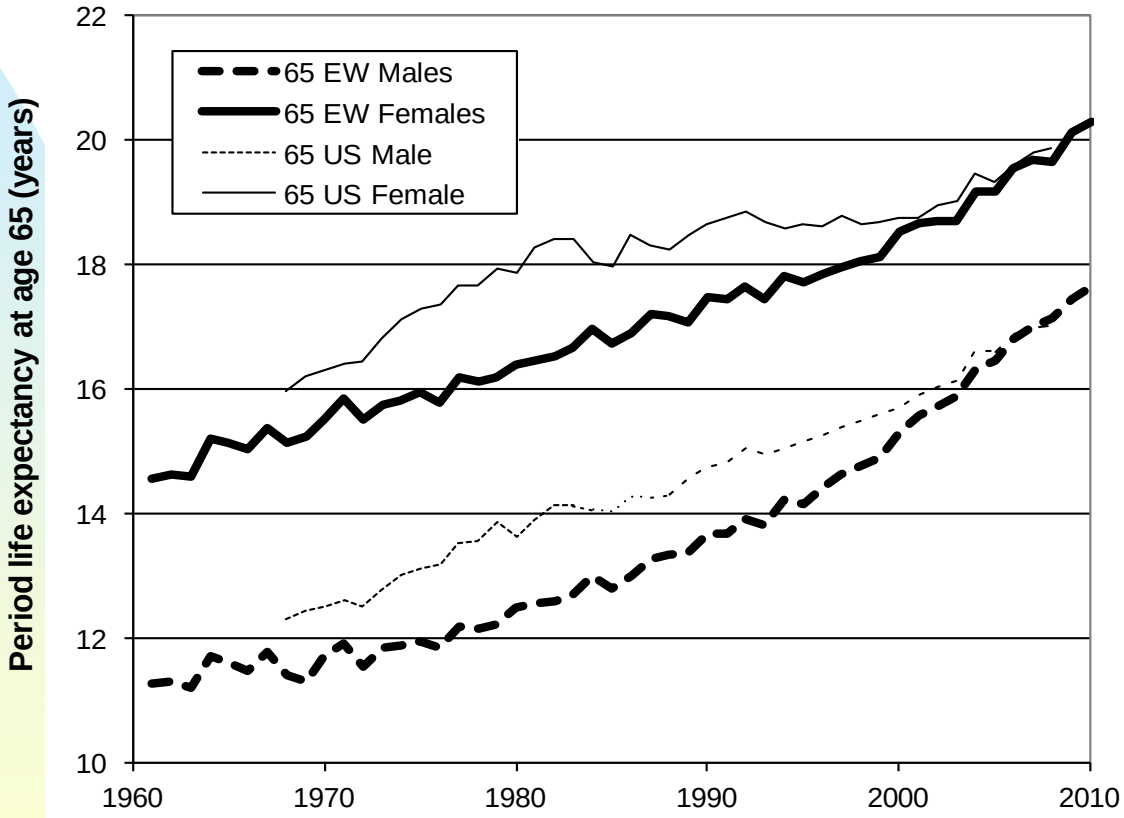
Life expectancy at age 65 in the UK/US



Source: J.P. Morgan LifeMetrics data

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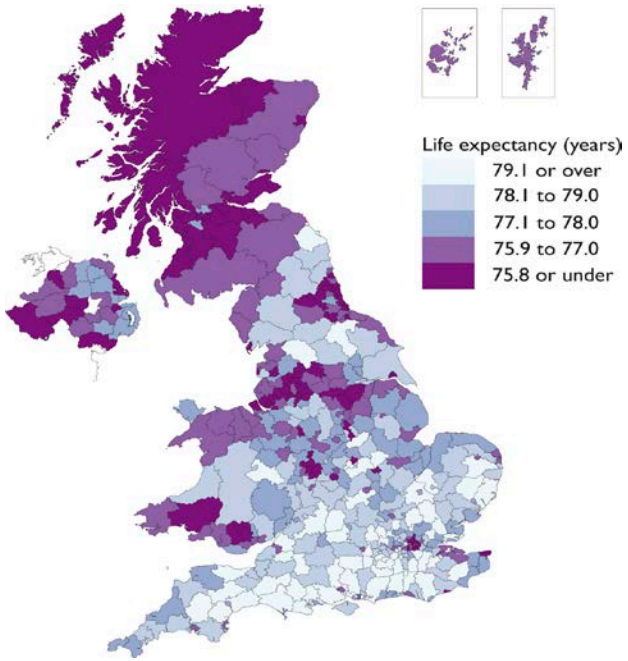
Male life expectancy at birth:
by local authority, 2004-6



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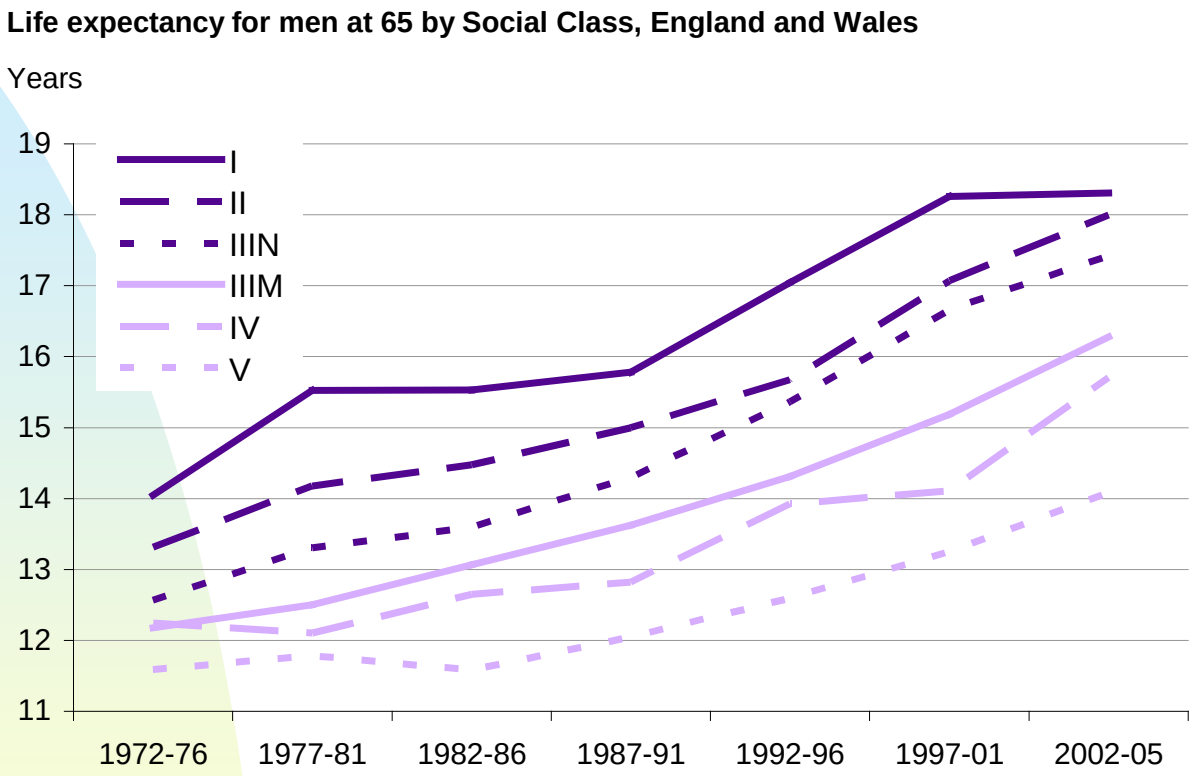
Social class



Source: Longitudinal Study, Office for National Statistics

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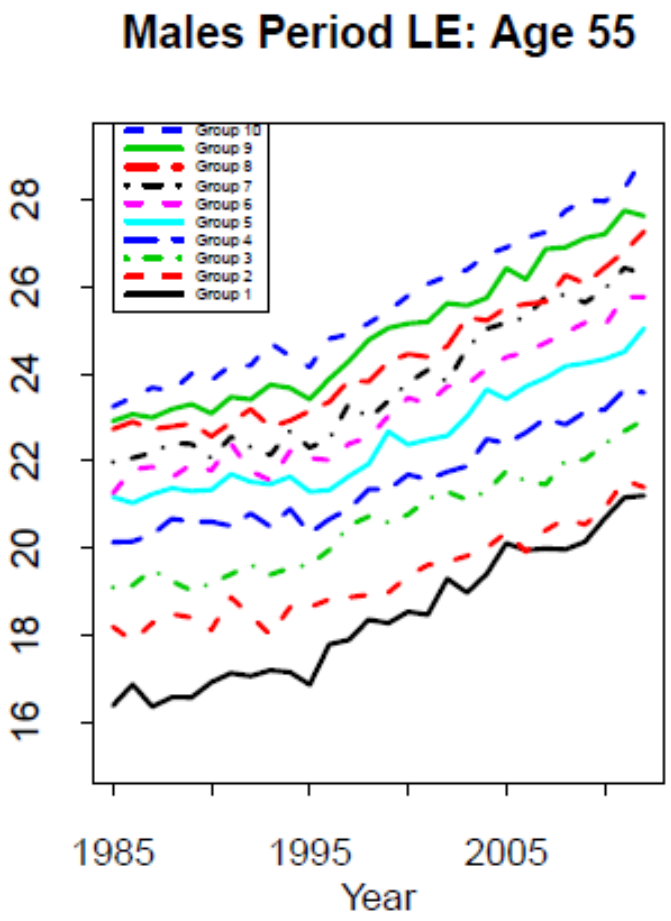
Income/wealth



Modelling Socio-Economic Differences in the Mortality of Danish Males Using a New Affluence Index - Andrew J.G. Cairns, Malene Kallestrup-Lamb, Carsten P.T. Rosenskjold, David Blake and Kevin Dowd

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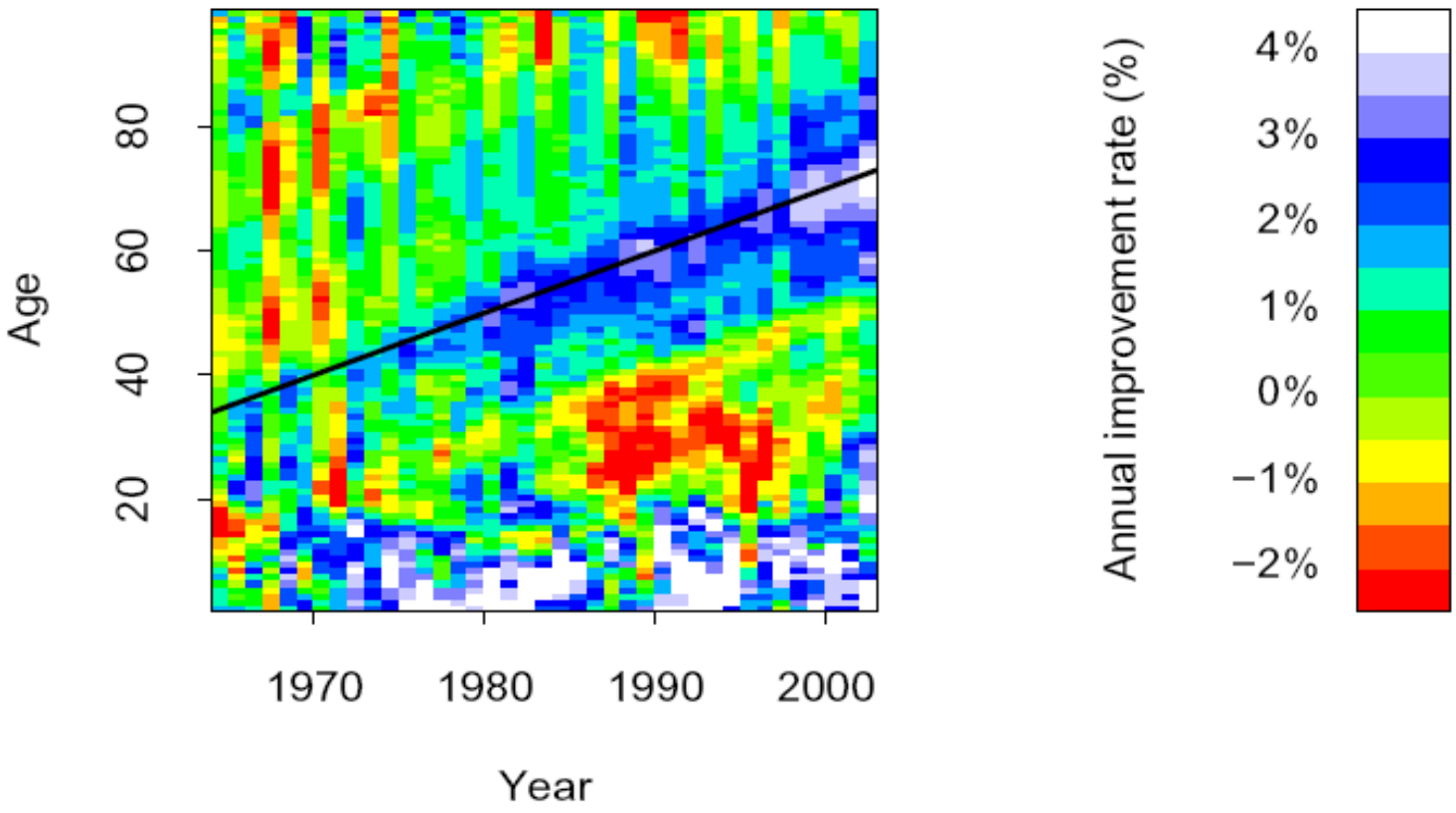
Cohort effect:
1930 cohort



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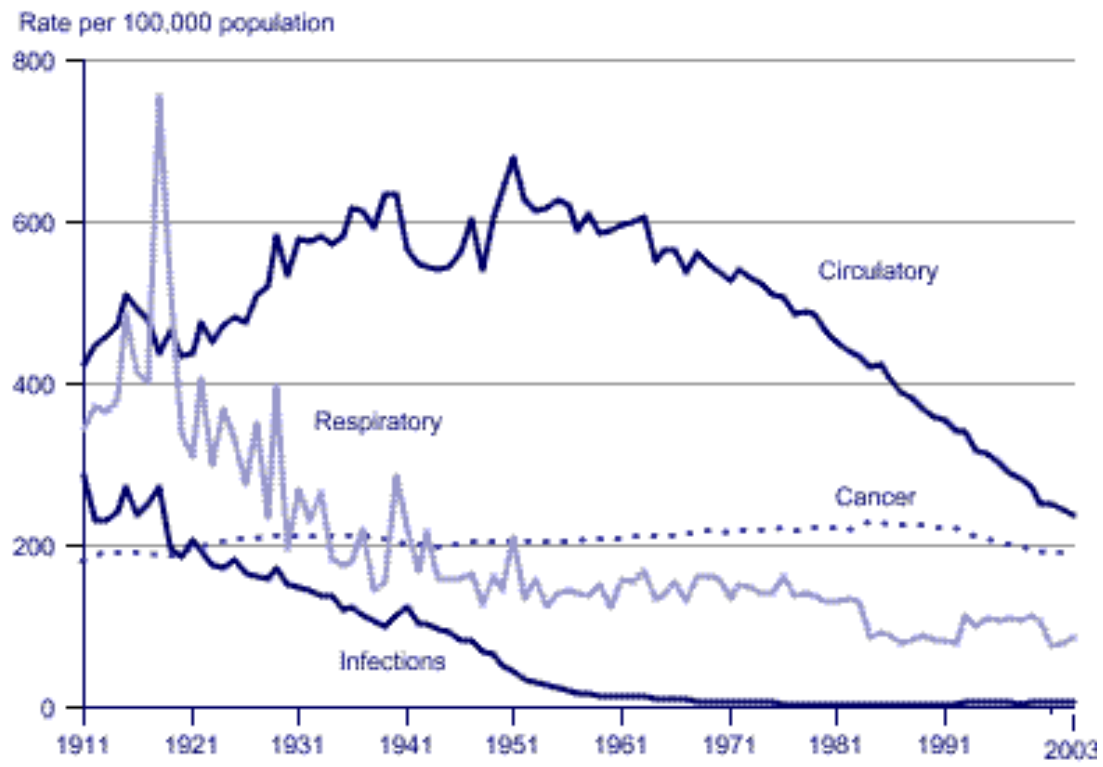
Mortality rates in England and Wales for key disease groups



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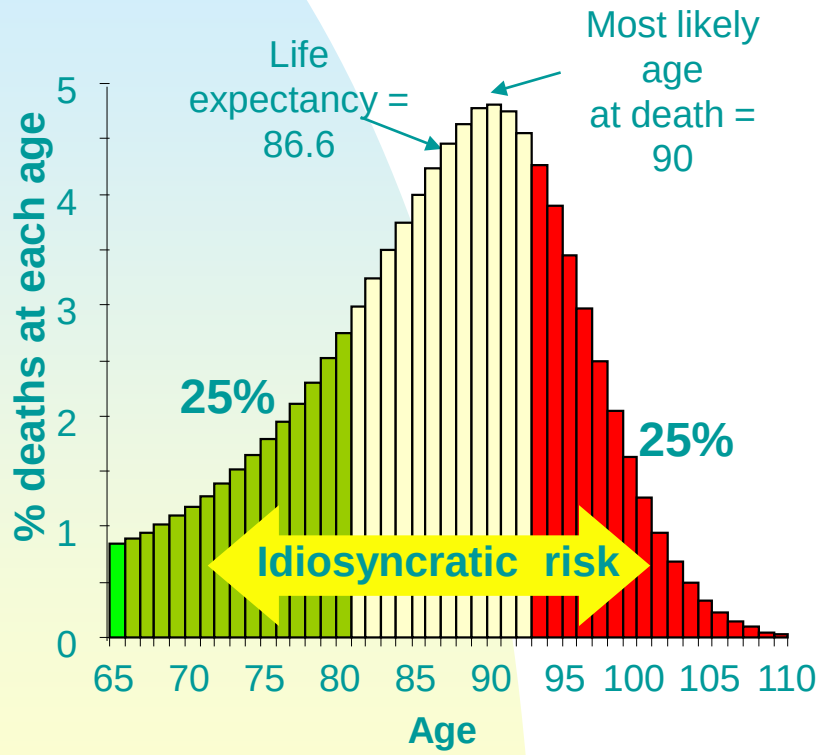
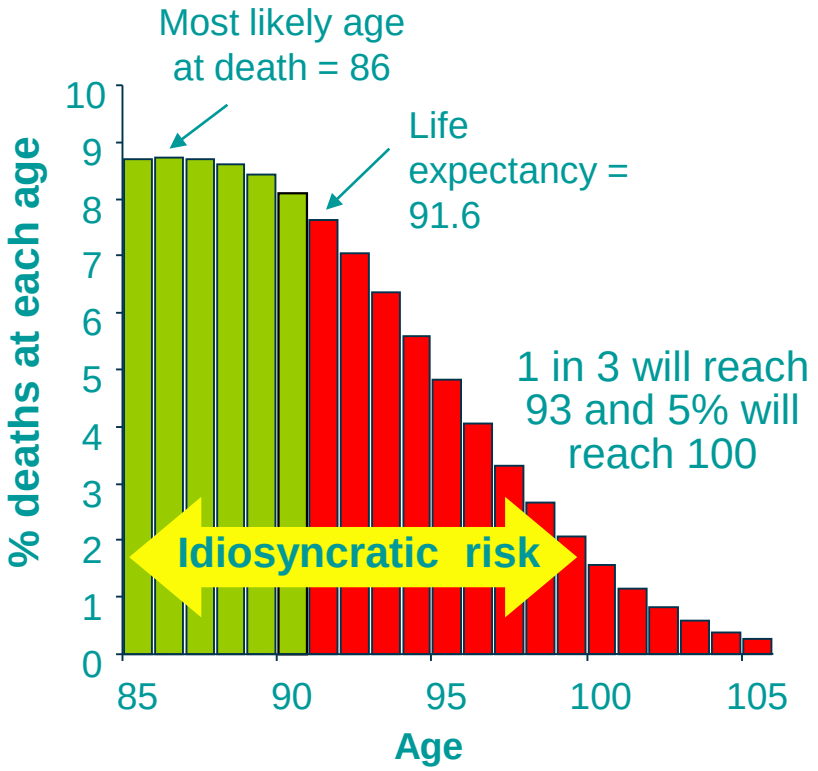
Quantifying longevity risk

Variability in life expectancy

Expected distribution of deaths: male 65



Expected distribution of deaths: male 85



Source: 100% PNMA00 medium cohort 2007

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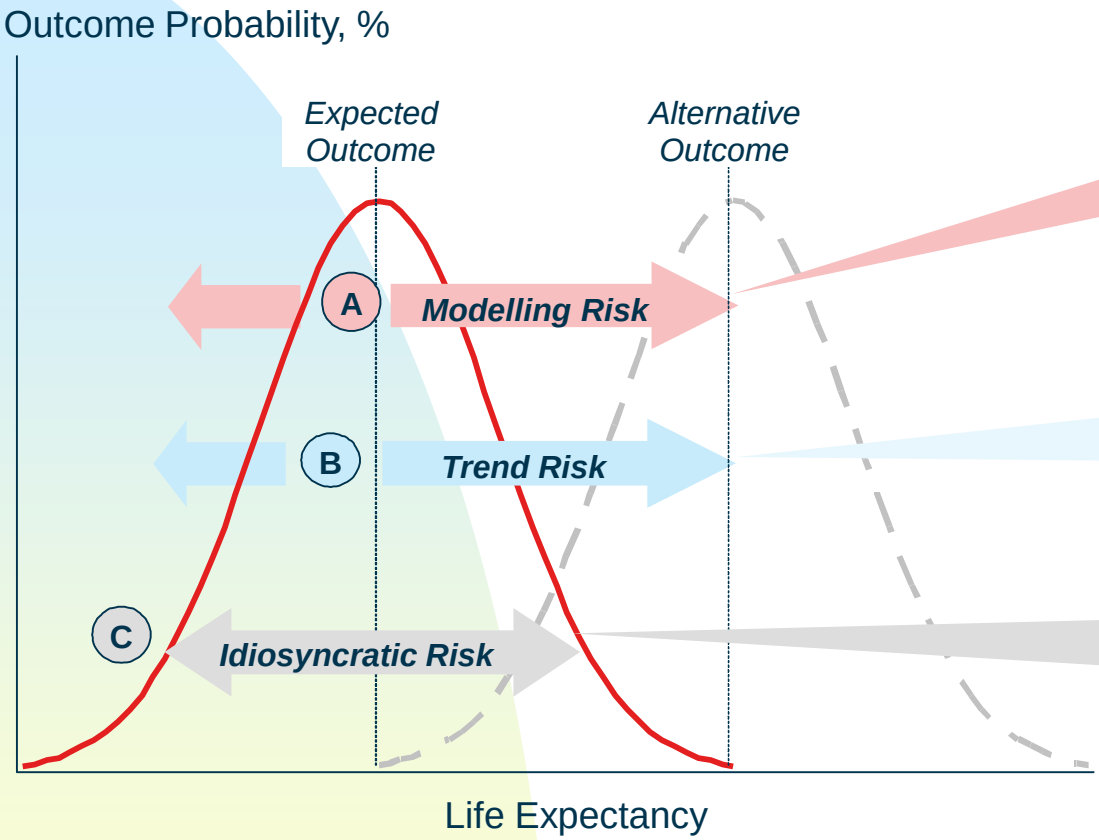
Longevity risk is driven by three underlying risks



A Modelling Risk: Risk that probability distribution is incorrectly modelled due to a limited data set.

B Trend Risk: Risk that large unanticipated changes in socio-economic environment or health care significantly improve longevity.

C Idiosyncratic Risk: Risk that mortality rates still vary from the expected outcome as a result of random chance.

Modelling Risk and Idiosyncratic (Random Variation) Risk are greater the smaller the number of scheme members and the greater the distribution of scheme benefits.

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Mortality forecasting models

- ‘Process-based’ models
  - Model process of dying or mortality improvement
    - E.g., Risk Management Solutions (RMS) Longevity Risk Model uses ‘vitagion categories’ or individual sources of mortality improvement:
      - lifestyle trends including smoking prevalence
      - health environment
      - medical intervention
      - regenerative medicine, such as stem cell research, gene therapy and nanomedicine
      - retardation of ageing, including telomere shortening and caloric restriction

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Mortality forecasting models

- ‘Causal’ or ‘explanatory’ models
  - Model causes of death using exogenous explanatory variables
    - e.g. macro-economic variables or socio-economic indicators
- ‘Extrapolative’ projection models
  - Purely data-driven
  - Will only be reliable if the past trends continue:
    - medical advances can invalidate extrapolative projections by changing the trend

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Main extrapolative models

- Lee-Carter model:
  - No smoothness across ages or years
- P-spline model:
  - Smoothness across years and ages
- Cairns-Blake-Dowd (CBD) model:
  - Smoothness across ages in same year

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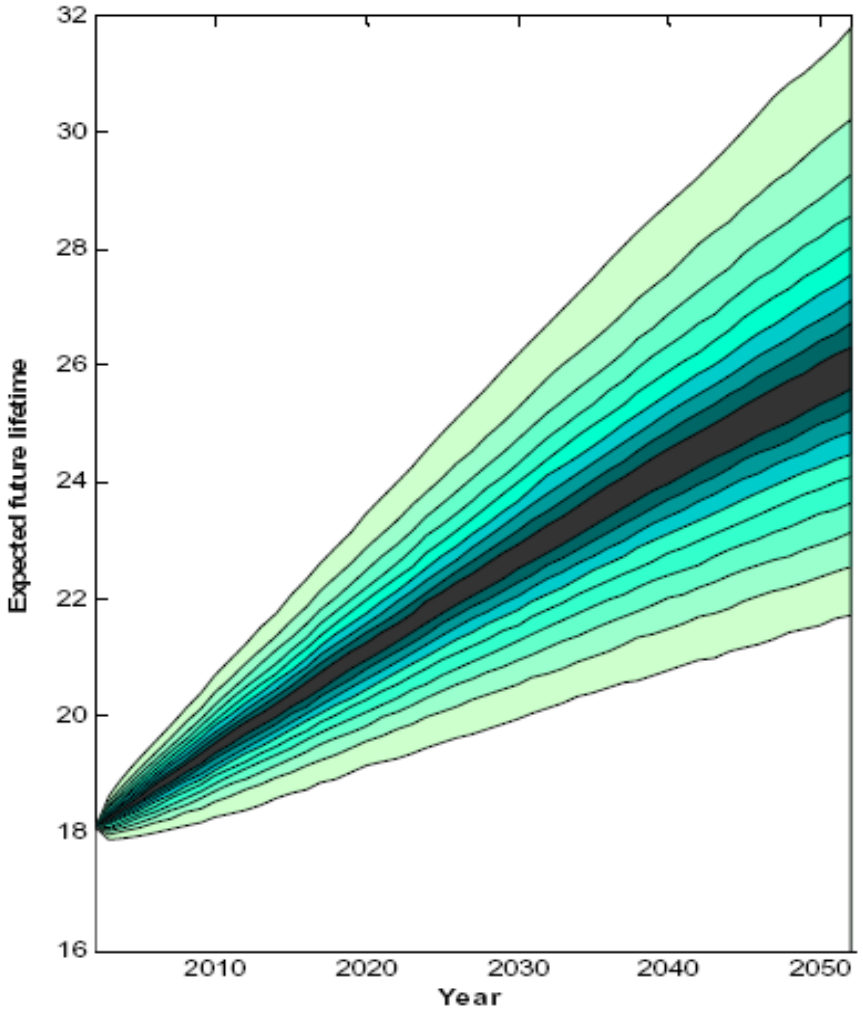
Longevity fan chart for 65-year old male (CBD model)



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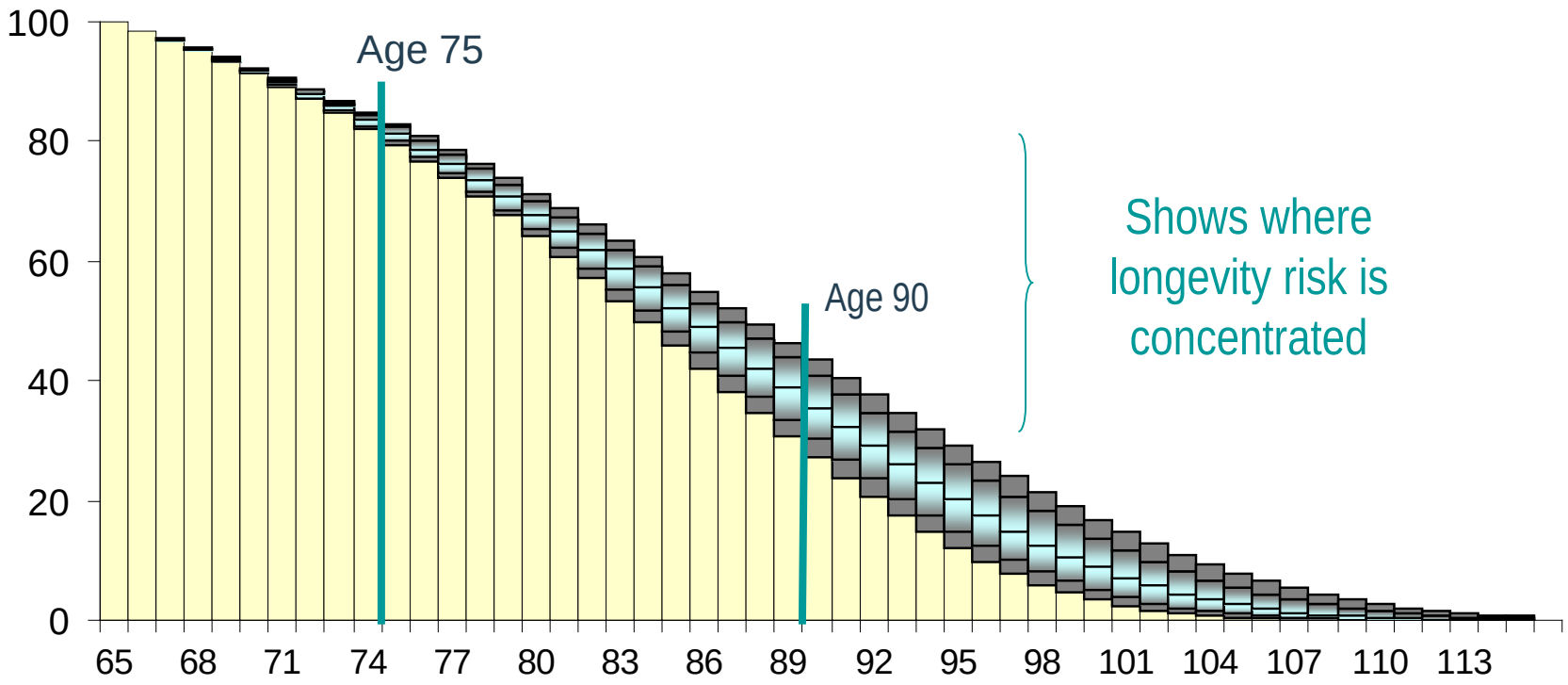
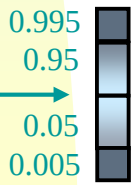
Survivor fan chart for 65-year old male (CBD model)



Expected income value



90% confidence

99% confidence

Note: Derived from the Cairns-Blake-Dowd stochastic mortality model, estimated on English and Welsh male mortality data for 65 year olds over the period 1991-2006

Managing longevity risk using insurance solutions

Managing longevity risk using insurance solutions

- Classified as ‘customized indemnification solutions’
  - since the insurer fully indemnifies the hedger against its specific risk exposure
- These solutions can also be thought of as ‘at-the-money’ hedges
  - since the hedge provider is responsible for any increase in the liability above the current best estimate assumption on a pound-for-pound basis
- Buy-out
- Buy-in
- Longevity insurance contract / insurance-based longevity swap

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Swiss Re – Friends' Provident Longevity swap

- World's first publicly announced swap in April 2007
  - a pure longevity risk transfer
  - but structured as an insurance contract
- Friends Provident's £1.7bn book of 78,000 of pension annuity contracts written between July 2001 – December 2006
- Swiss Re makes payments and assumes longevity risk
  - in exchange for undisclosed premium

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Managing longevity risk using capital market solutions

Managing longevity risk using capital market solutions

- Small number of capital market securities have been successfully launched since 2006:
  - longevity-spread bond
  - longevity swap
  - *q*-forward
  - tail-risk protection (or longevity bull call spreads)

- Key feature of these is that most are index rather than customized solutions
- They provide hedges and help to securitize the risk

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Swiss Re Kortis Bond

- Longevity-spread bond, December 2010
- Issuer: Swiss Re
- Issue: $50m, 8 years
- Purpose: to hedge Swiss Re's own exposure to longevity risk
- Bond holders: exposed to risk of increase in spread between annualized mortality improvements in English & Welsh males aged 75-85 v US males aged 55-65

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JPMorgan – Canada Life longevity swap

- World's first capital market longevity swap in July 2008
- Canada Life hedged £500m of its annuity book:
  - 125,000 lives
  - 40-year swap customized to insurer's longevity exposure
- Longevity risk fully transferred to investors:
  - Hedge funds and ILS funds
- JPM acts as intermediary and assumes counter-party credit risk

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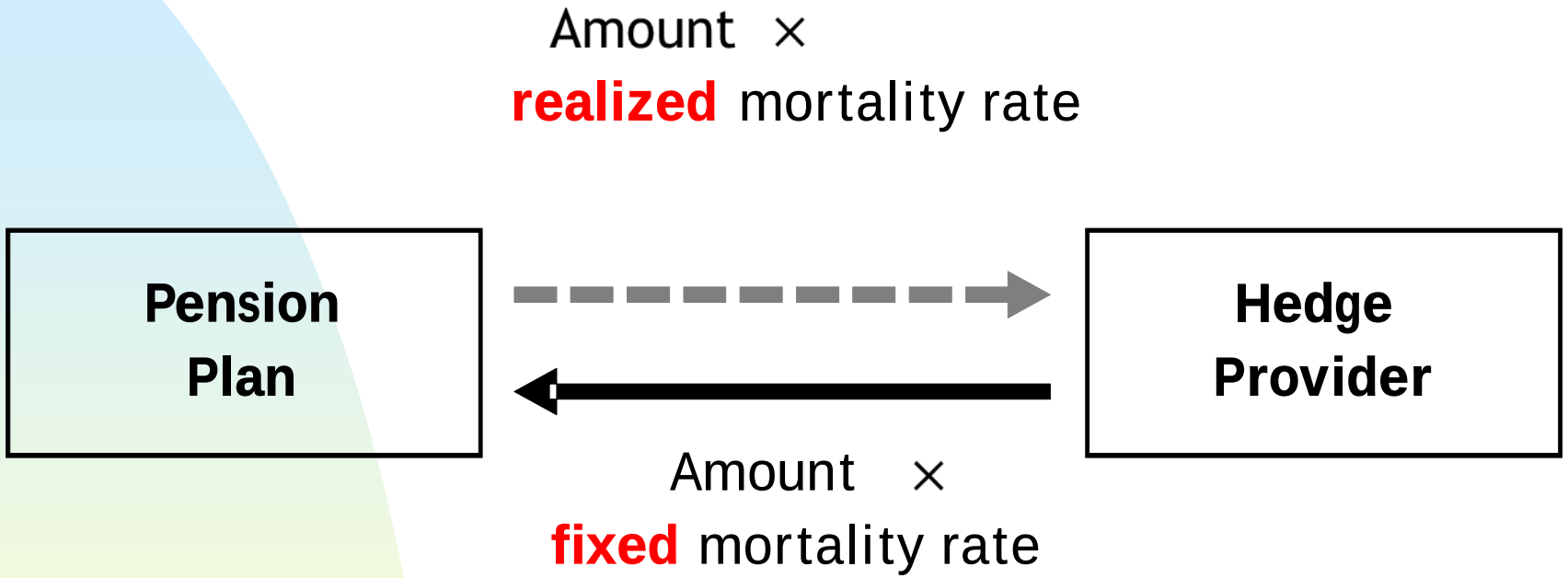
q-forward or mortality forward



The first capital markets transaction involving a *q*-forward took place in January 2008 between buy-out company Lucida and J.P. Morgan

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Illustration of q-forward settlement for various outcomes of the realized reference rate

Reference rate (Realized rate)	Fixed rate	Notional (GBP)	Settlement (GBP)
1.0000 %	1.2000 %	50,000,000	10,000,000
1.1000 %	1.2000 %	50,000,000	5,000,000
1.2000 %	1.2000 %	50,000,000	0
1.3000 %	1.2000 %	50,000,000	-5,000,000

Source: Coughlan *et al* (2007, Table 1): A positive (negative) settlement means the fixed-rate receiver receives (pays) the net settlement amount.

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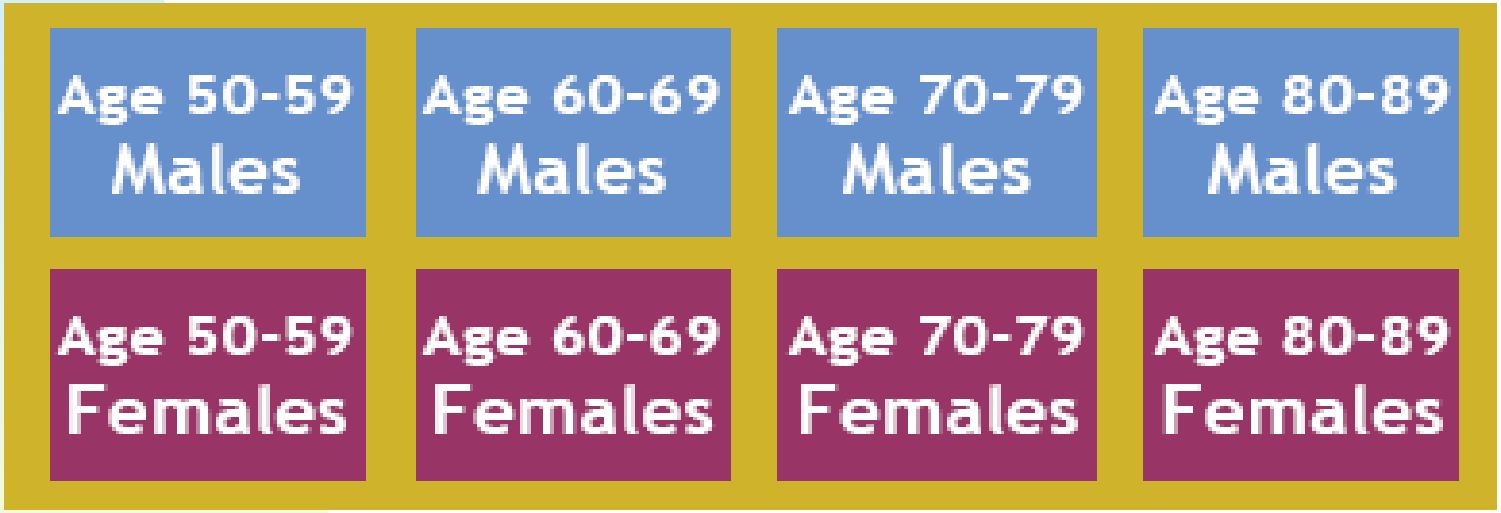
Portfolio of q-forward building blocks



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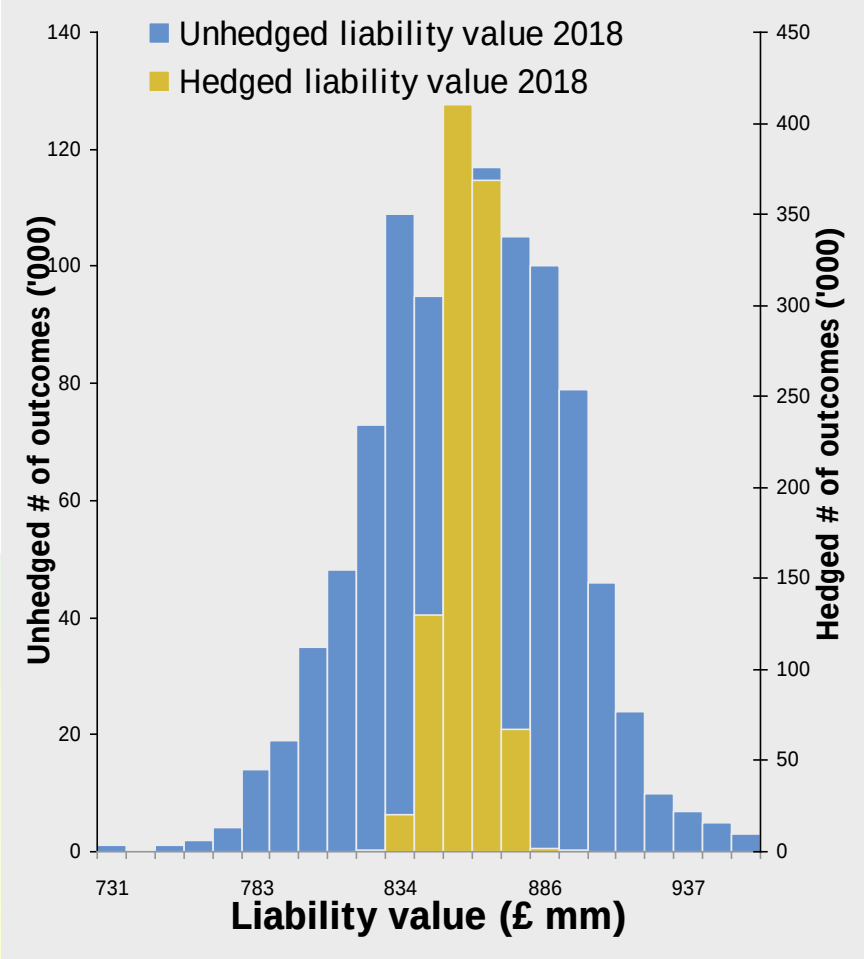
Distribution of liability value in 2018: Before and after hedging



Risk reduction = 86%, Residual risk = 14%

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Tail-risk protection (or longevity bull call spread)

- Five publicly announced deals involving tail risk protection:
  - Aegon with Deutsche Bank in 2012
  - Aegon with Société Générale in 2013
  - Delta Lloyd with RGA Re in 2014 and 2015
  - NN Life with Hannover Re in 2017
- Deep ‘out-of-the-money’ hedge

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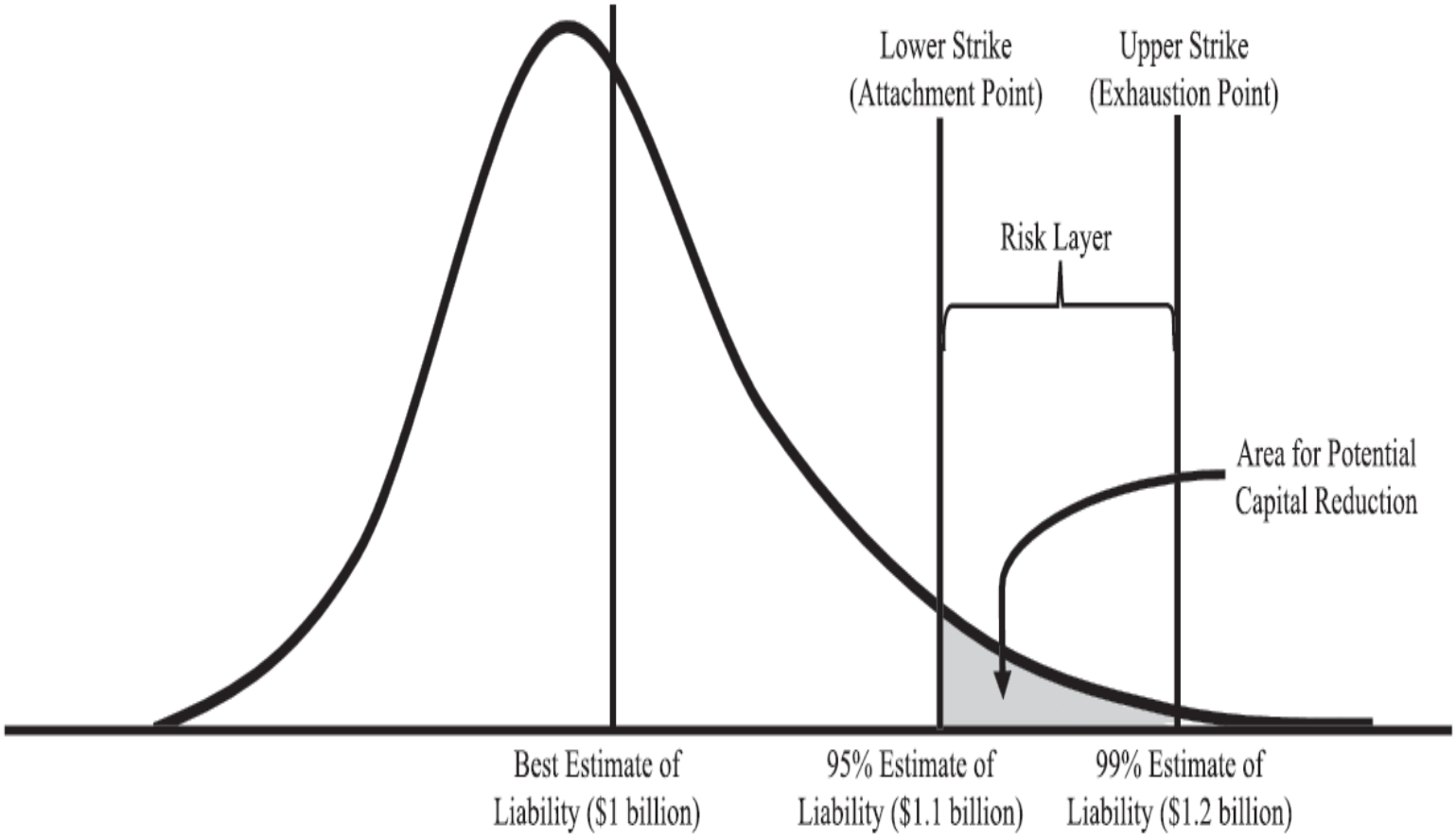
Distribution of Final Index Value and Potential for Capital Reduction



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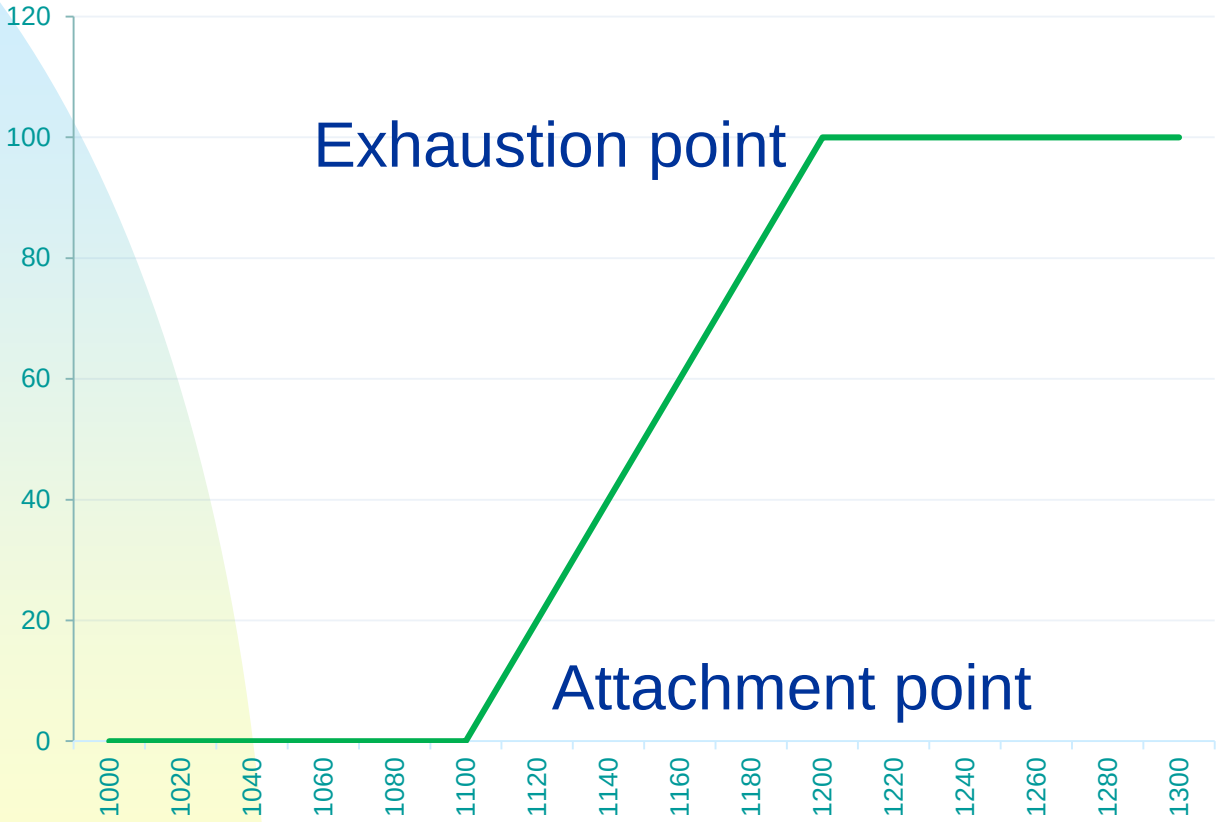
Bull call spread payoff to hedger



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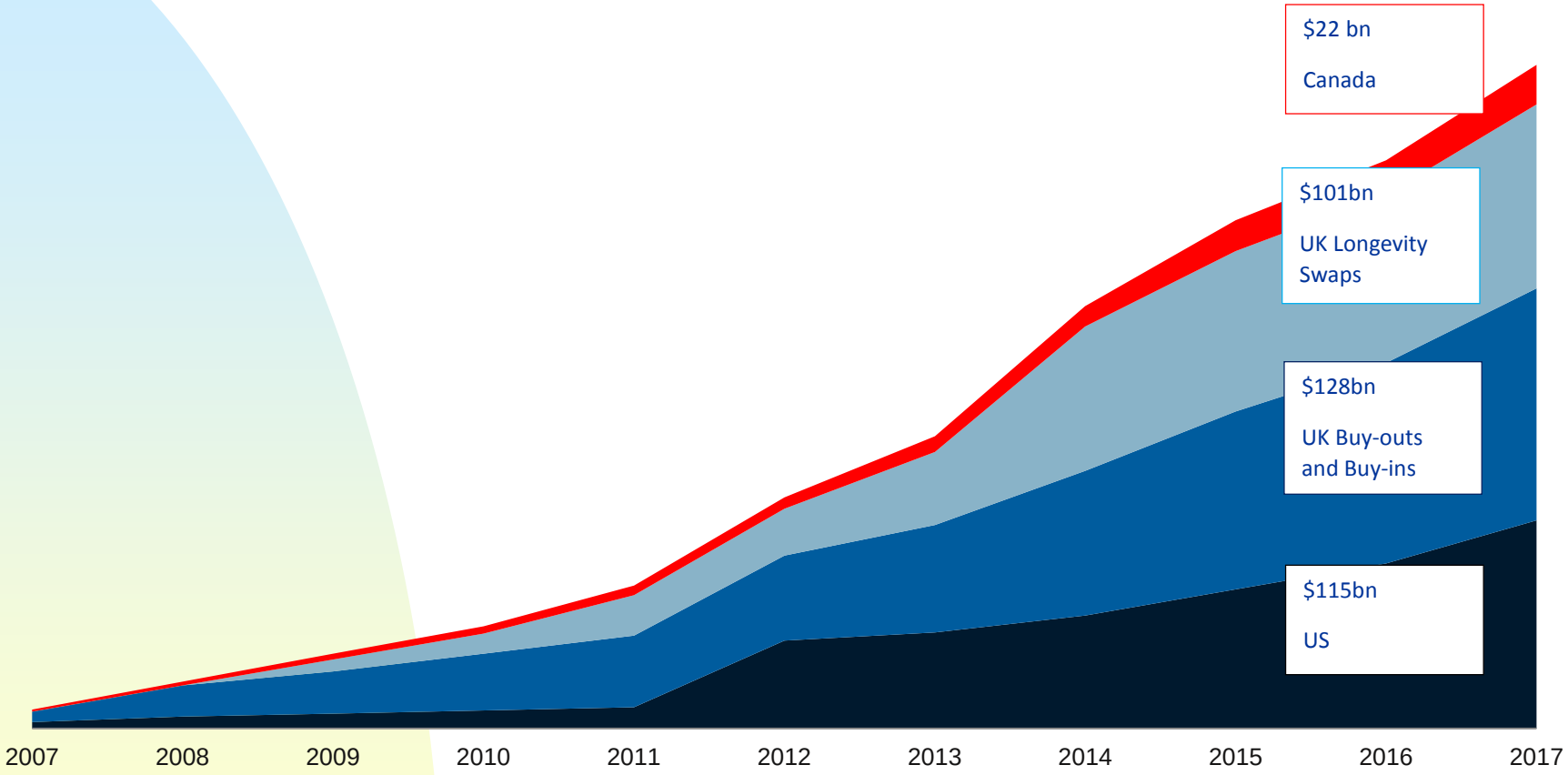
Cumulative Pension Risk Transfers by Product and Country, 2007-17



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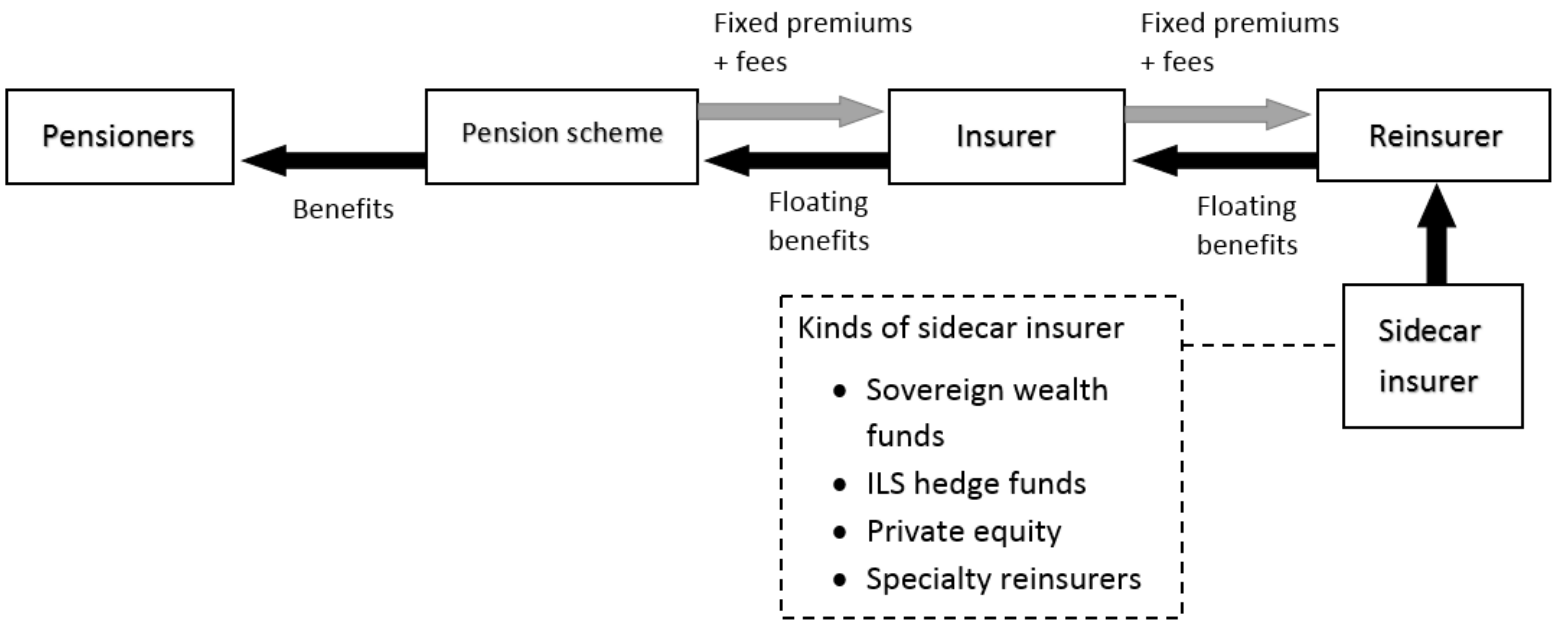
Re-insurance sidecars: Introducing new investors

Sidecar structure



RGA Re and RenaissanceRe set up Langhorne Re in 2018 to target in-force life and annuity business with pension funds and other life companies as third-party sidecar investors

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A role for government: Issuing Longevity Bonds

Three key reasons why governments should issue Longevity Bonds

- Interest in ensuring an efficient annuity market
- Interest in ensuring an efficient capital market for longevity risk transfers
- Best placed to engage in intergenerational risk sharing:
  - will earn longevity risk premium

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Decomposition of longevity risk

Total longevity risk

=

Systematic longevity risk

[Trend risk]

+

Specific longevity risk

[Idiosyncratic

and modelling risks]

Government hedges

Private sector hedges

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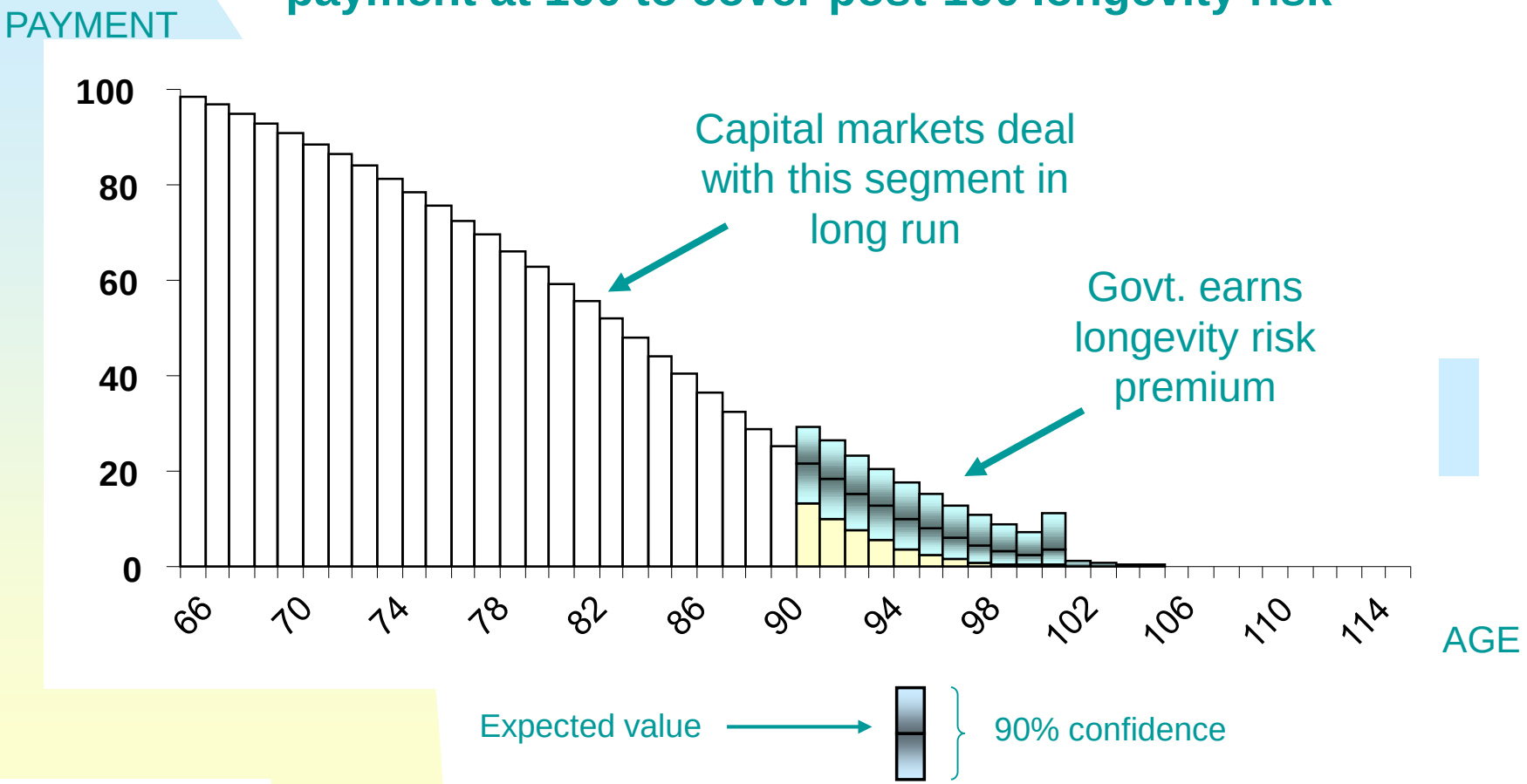
Potential role for government in helping to hedge longevity risk

Tail risk Longevity Bond from age 90 with terminal payment at 100 to cover post-100 longevity risk



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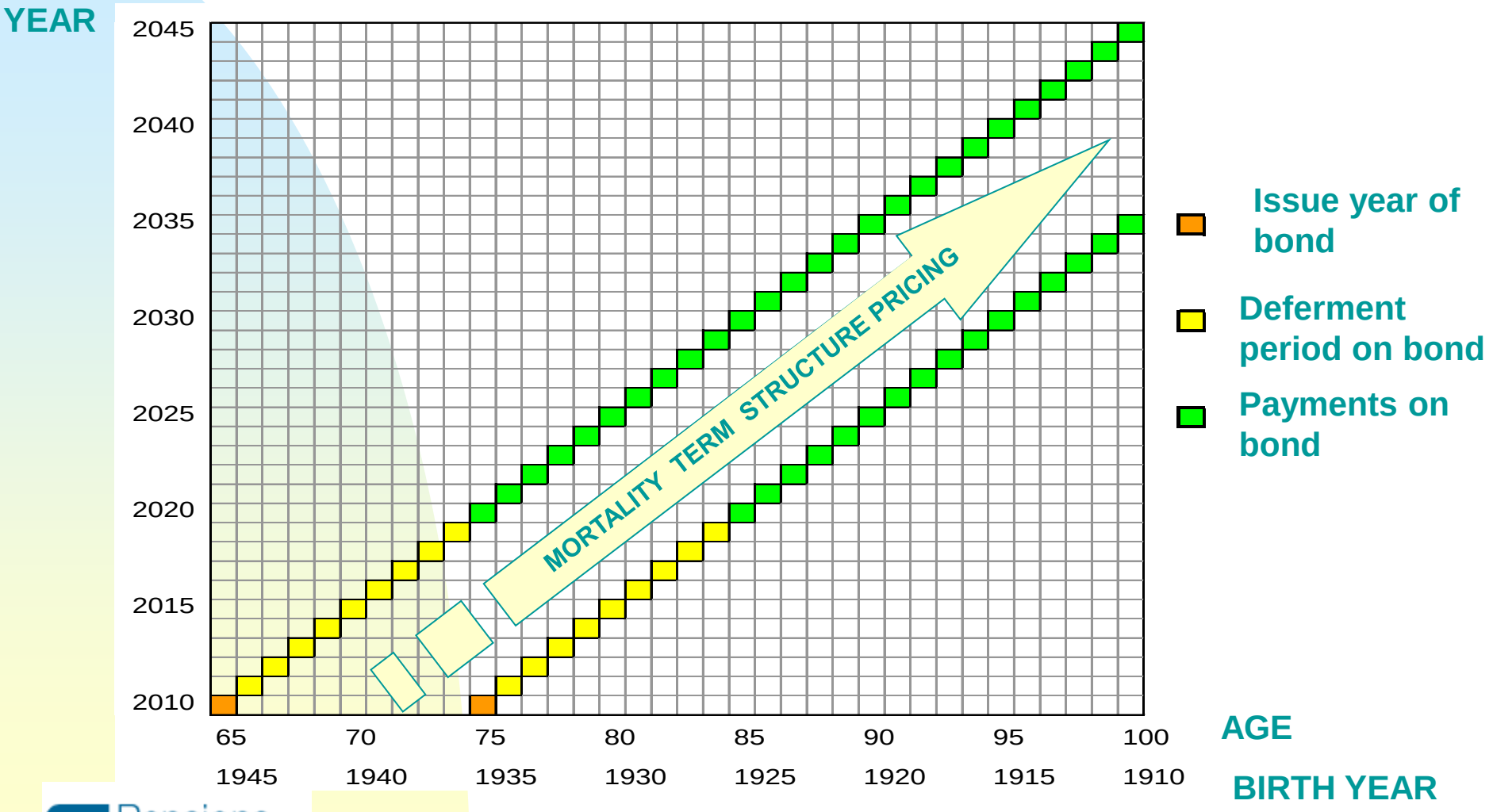
Longevity Bond cash flows across ages and time



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Longevity assets in a diversified portfolio

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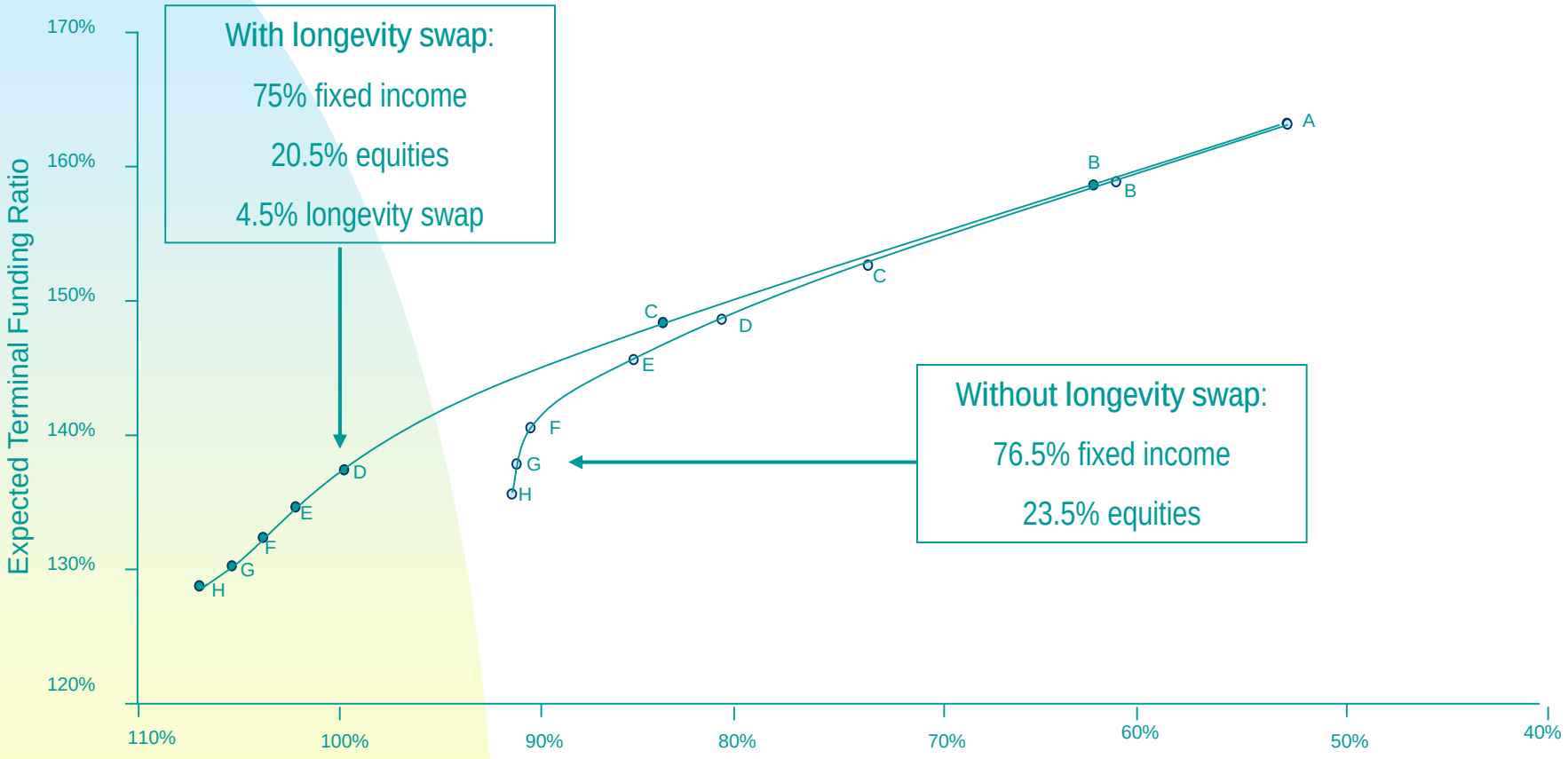
Efficient frontier with and without longevity swaps



Source: Aegon

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Conclusion

Conclusion

- Longevity risk is real, underestimated and expensive
- It needs to be quantified and managed
- Tools have been developed to do both:
  - Insurance solutions
    - Buy-outs and buy-ins
  - Capital market solutions
    - q-forwards and longevity swaps

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Conclusion

- But insufficient capital in insurance/reinsurance industry to deal with global longevity risk:
  - Estimated at $60-80trn
- Capital markets more efficient than insurance industry in:
  - Reducing informational asymmetries
  - Facilitating price discovery
- The Life Market has risks that are uncorrelated with traditional bond and equity markets:
  - which should make it attractive to long-term investors such as SWFs, endowments, family offices, etc

Richard Sandor's Seven Stages of Market Evolution

Number	Stage
1	Structural change – leading to a demand for capital
2	Development of uniform commodity/security standards
3	Introduction of legal instruments providing evidence of ownership
4	Development of informal spot and forward markets
5	Emergence of formal exchanges
6	Introduction of organized futures and options markets
7	Proliferation of over-the-counter (OTC) markets, deconstruction

Thank you!

Longevity 14:

Fourteenth International Longevity Risk and Capital Markets Solutions Conference

20-21 September 2018

Amsterdam

http://longevity-risk.org