The New Life Market:

From Survivor Bonds to Life Settlements Securitisation

Professor David Blake
Director
Pensions Institute
Cass Business School
d.blake@city.ac.uk

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Agenda

- The problem: Longevity risk
- How markets evolve
- Market requirements
- The Life Market: Current capital market solutions
- Barriers to development
- Securitisation
- A role for government?
- Conclusion

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The problem: Longevity risk

The problem

- We systematically underestimate how long people are going to live
- 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

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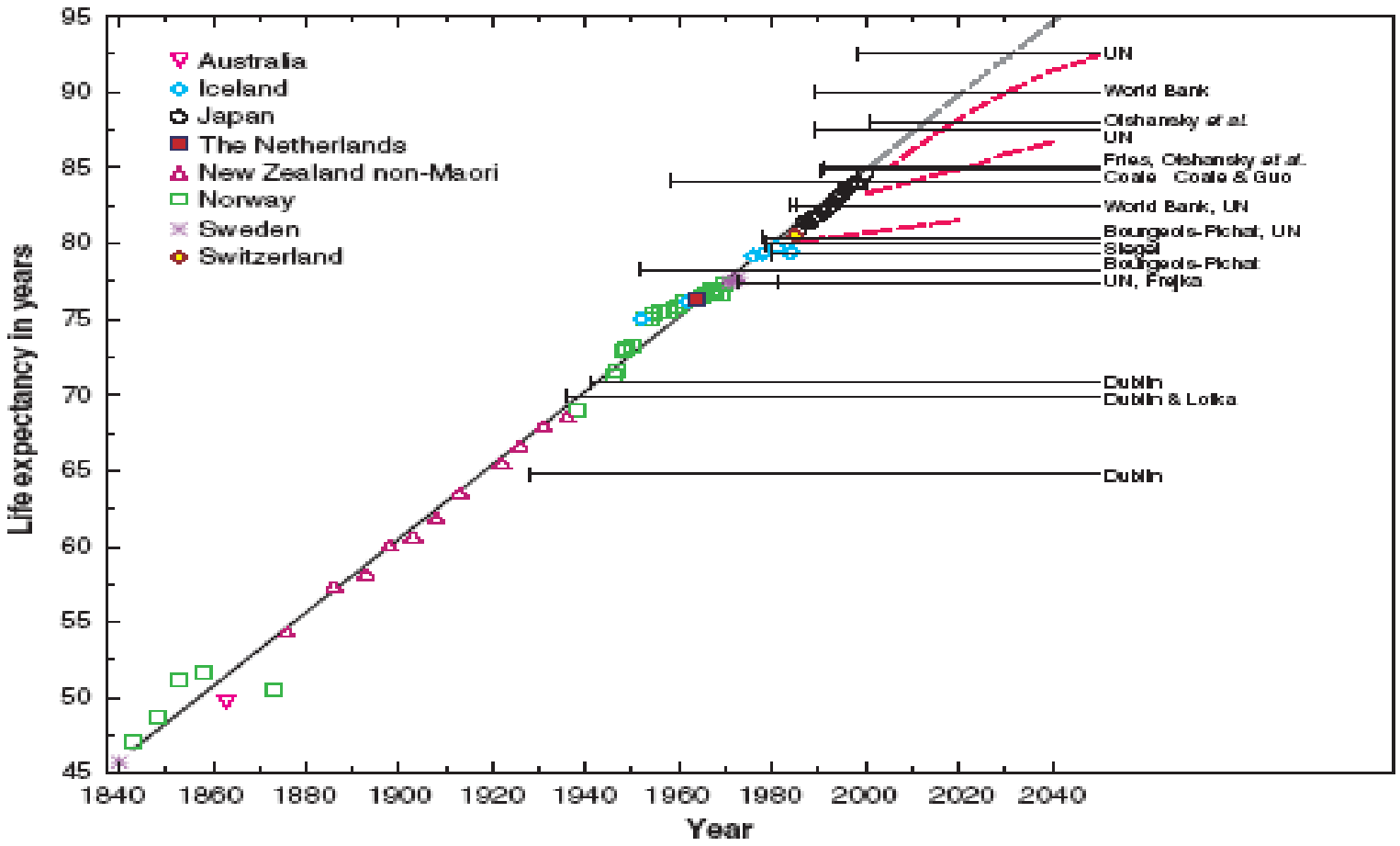
The past

(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 recognised as being a stochastic process

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Alternative expert views

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

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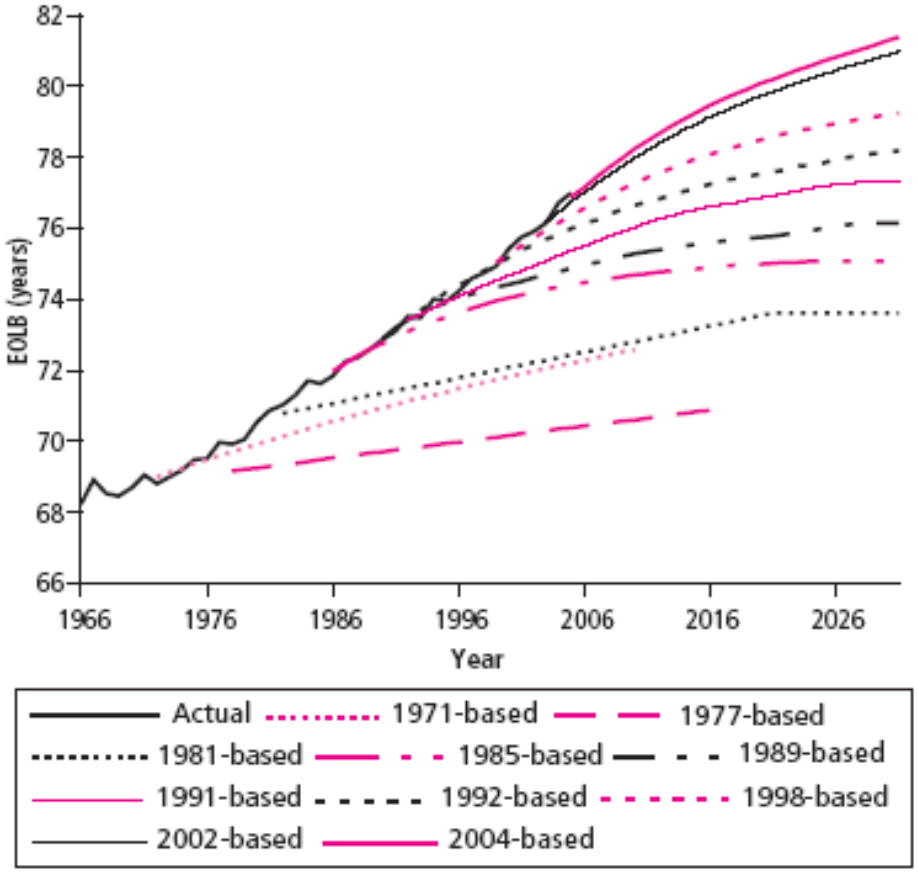
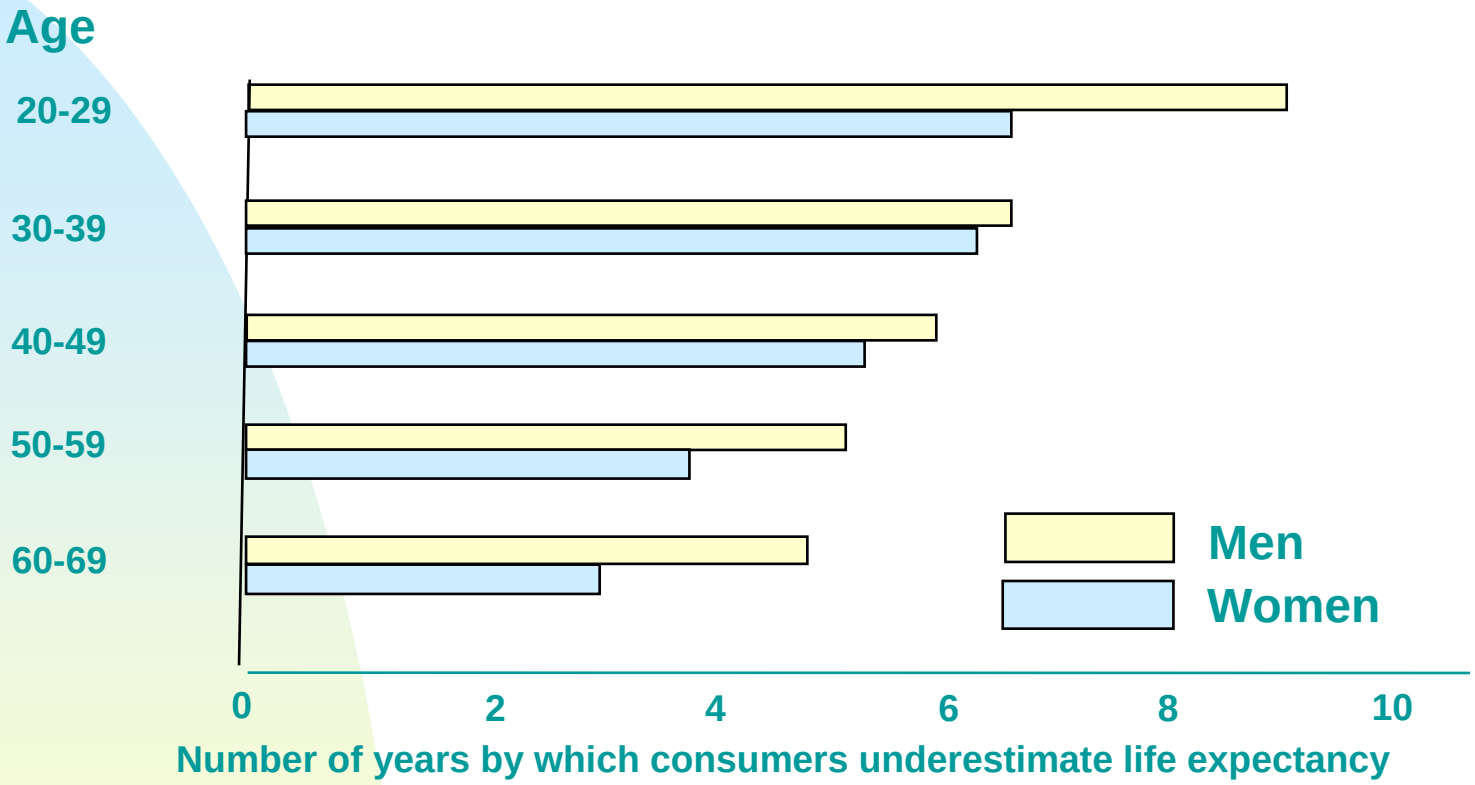
Accuracy of official mortality assumptions:
actual and projected period life expectancy at birth, UK males, 1966-2031



Shaw (2007, page 16)

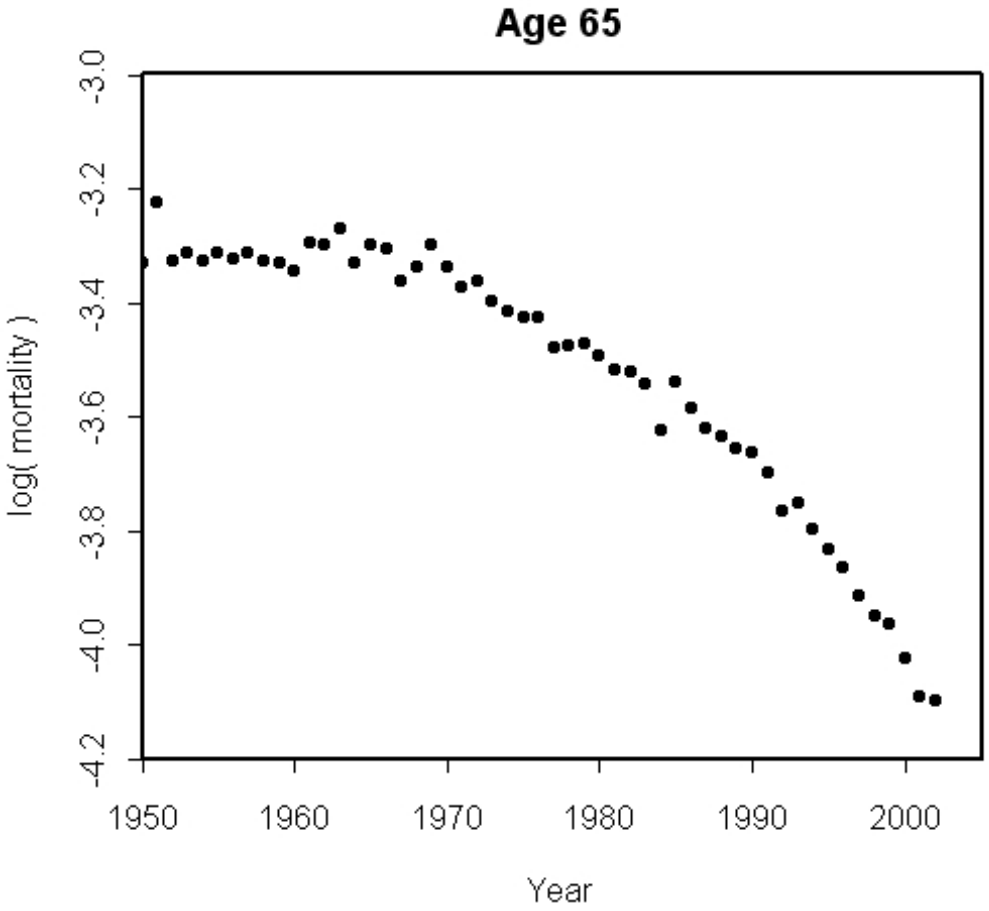
Individual underestimates of life expectancy by age



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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Stakeholders in bearing longevity risk

- Individuals
- Company pension funds
- Annuity providers:
  - Insurance companies
- Government:
  - Public pension systems
  - Insurer of last resort
- Investors in longevity-linked products

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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
- Reinsurance:
  - Buy-outs and buy-ins
- Manage risk with longevity-linked products
- Securitisation

Life Market

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How markets evolve

Peter Drucker, *The Economist*, **1999**

"By providing financial protection against the major 18th and 19th century risk of dying too soon, life assurance became the biggest financial industry…providing financial protection against the new risk of not dying soon enough may well become the next century's major and most profitable financial industry"

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Why does a new capital market succeed?

1. It must provide **effective exposure**, or hedging, to a state of the world that is
2. **economically important**
3. and **cannot be hedged through existing market instruments**
4. It must use a **homogeneous and transparent contract** to permit exchange between agents

Loeys *et al* (2007) argue that 'longevity meets the basic conditions for a successful market innovation'

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Richard Sandor's Seven Stages of Market Evolution

1. Structural change - demand for capital
2. Uniform commodity/security standards
3. Legal instrument providing evidence of ownership
4. Informal spot and forward markets
5. Emergence of exchanges
6. Organised futures and options markets
7. Proliferation of OTC markets, deconstruction

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Sandor is Director of Chicago Climate Exchange

Market requirements

Potential players in the longevity risk marketplace

Buy longevity protection		Sell longevity protection
Hedge	Pension Plans	
Hedge	Annuity Providers	Add synthetic exposure
	Life Insurers	Partial offset of risk in life business
Hedge longevity trend risk	Life Settlement / Premium Finance Investors	Earn risk premium
Hedge	Pension Buyout Funds	Add synthetic exposure
	ILS Investors	Earn risk premium
	Other Hedge Funds	Earn risk premium
	Endowments	Earn risk premium
	Pharma	Issue longevity-linked debt
	Others (reverse mortgage, etc.)	

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Market requirements

- Analysis of causal factors underlying longevity
- Analysis of ageing process
- Quantifying longevity risk:
  - Mortality indices
  - Mortality forecasting models

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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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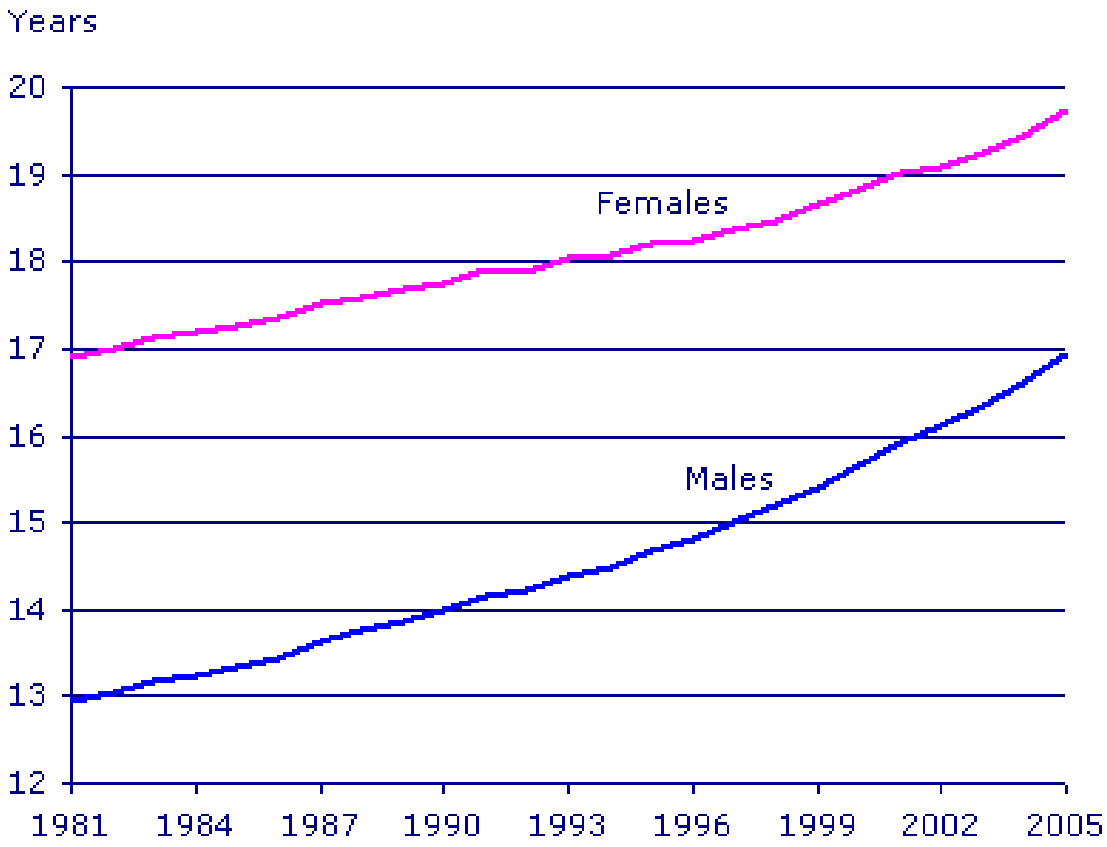
Life expectancy at age 65 in the UK



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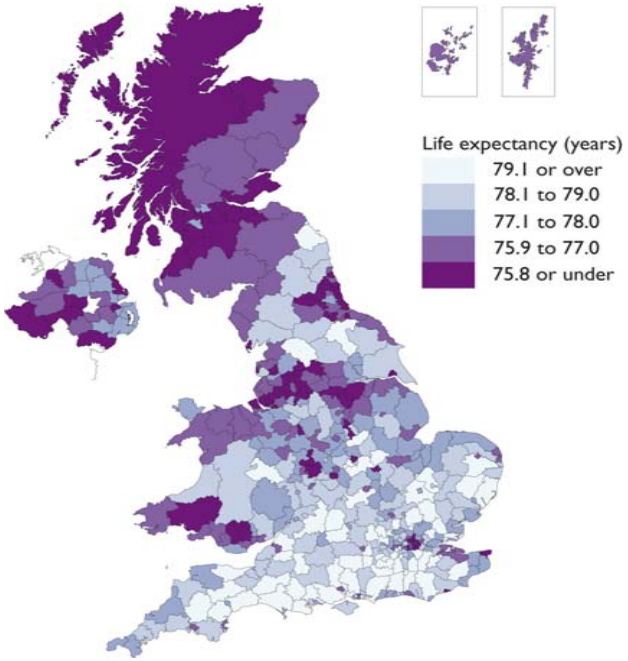
Male life expectancy at birth:
by local authority, 2004-6



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Life expectancy in England and Wales at age 65:

by social class and gender, 2002-5

Class description	males	females
Non-manual		
I Professional	18.3	22.0
II Managerial and technical/Intermediate	18.0	21.0
IIIN Skilled non-manual	17.4	19.9
Manual		
IIIM Skilled manual	16.3	18.7
IV Partly skilled	15.7	18.9
V Unskilled	14.1	17.7
All	16.6	19.4

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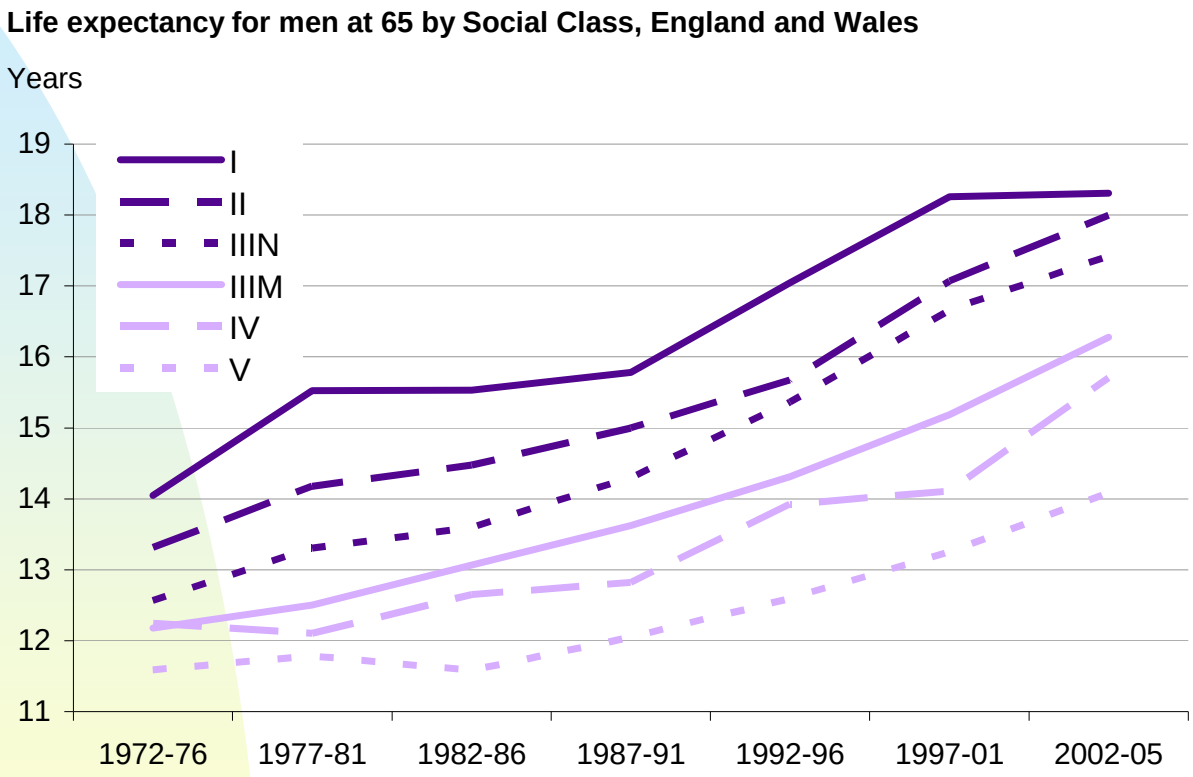
Social class



Source: Longitudinal Study, Office for National Statistics

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Income/wealth

- 65-year old male:
- Probability of dying if pension amount below £3,000 is TWICE that if pension amount is above £13,000

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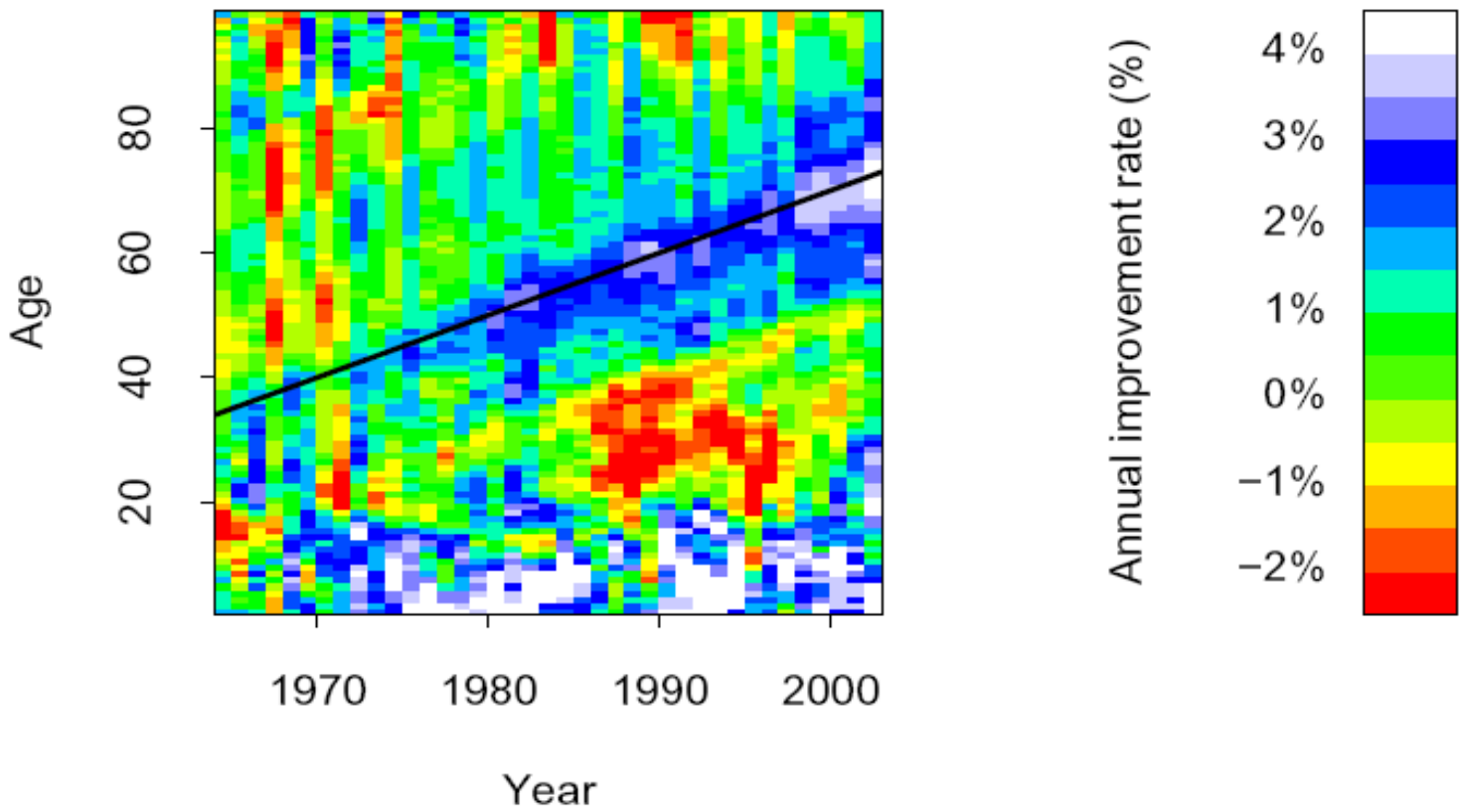
Cohort effect:
1930 cohort



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Analysis of ageing process

Ageing process

- Ageing due to lifelong, gradual accumulation of molecular faults in cells and organs
- About 25% of variation in life span is attributable to genetic differences
- Another 25% due to non-genetic factors that are fixed by age of 30
- Remaining 50% due to environmental factors occurring after 30

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Non-genetic and environmental influences on longevity

- Health care:
  - Clean drinking water from 19th Century onwards
  - Early-life conditions:
    - Malnutrition
    - Infectious conditions
- Nutrition
- Lifestyle:
  - Exercise
  - Smoking
  - Obesity
  - Drugs

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Non-genetic and environmental influences on longevity

- Education
- Housing
- Employment and nature of work
- Emergence of new diseases
- Medical advances:
  - Cholesterol-reducing drug ‘statins’

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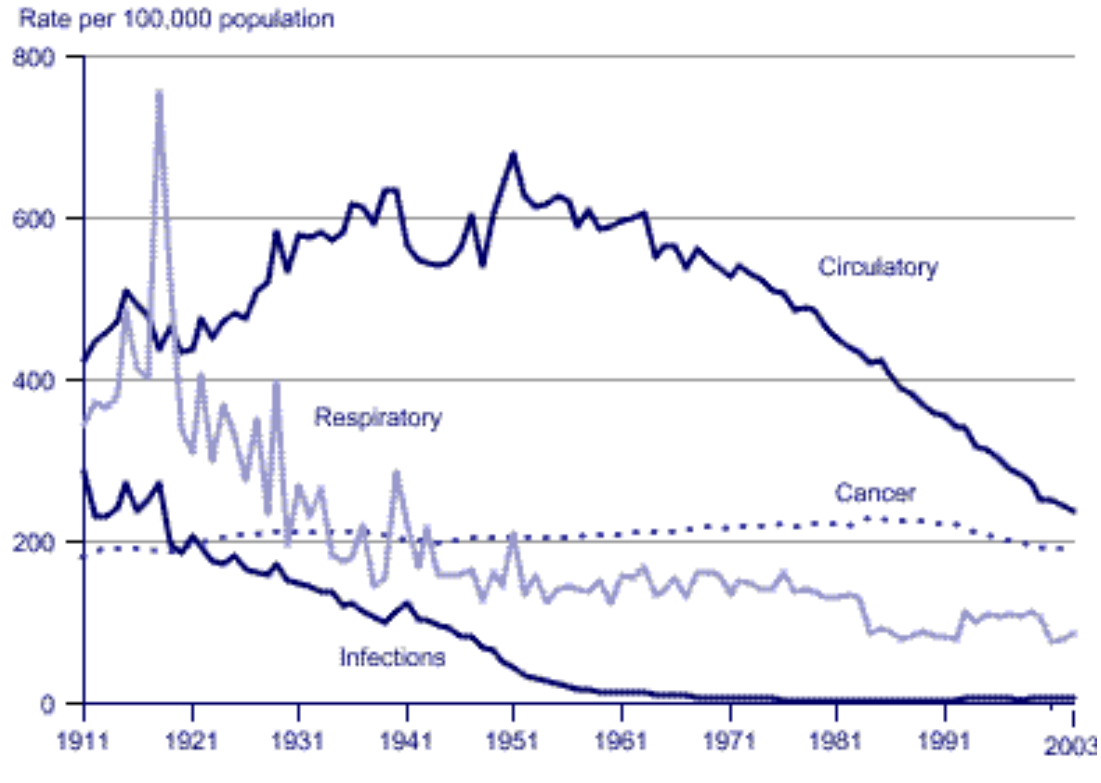
Mortality rates in England and Wales for key disease groups, 1911-2003



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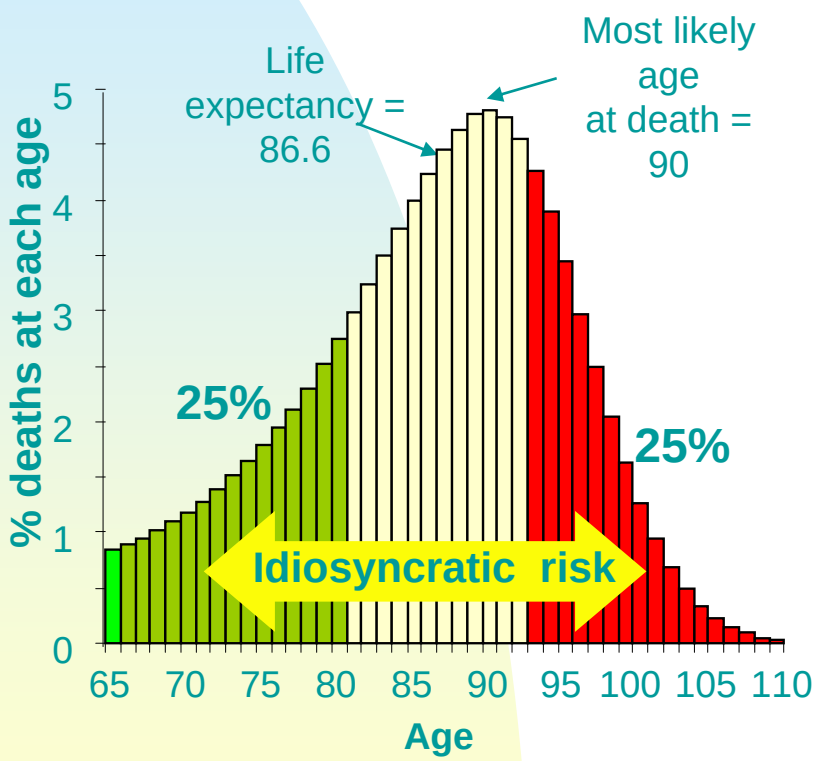
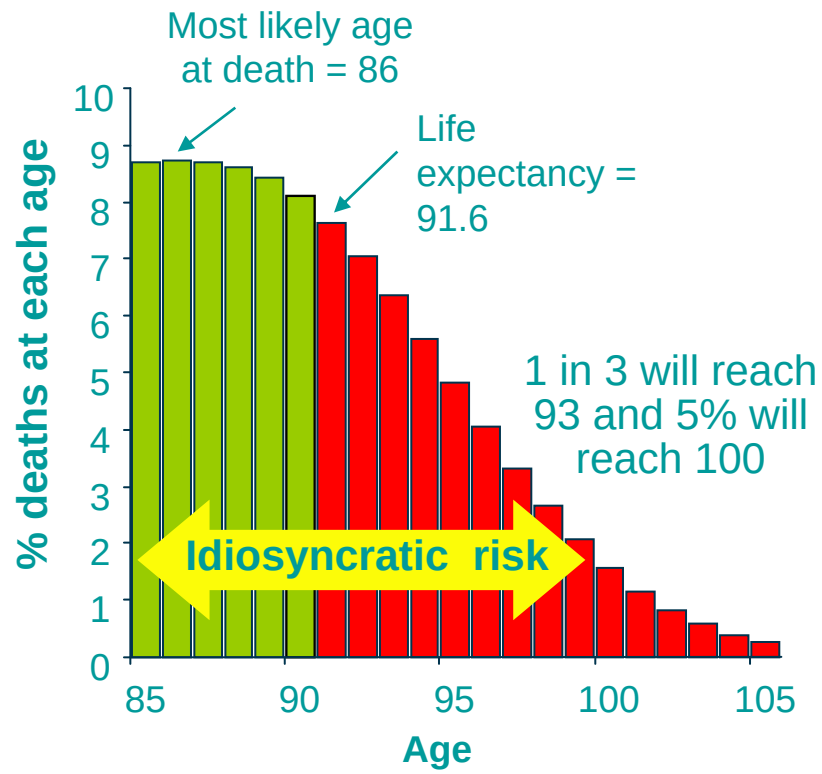
Quantifying longevity risk

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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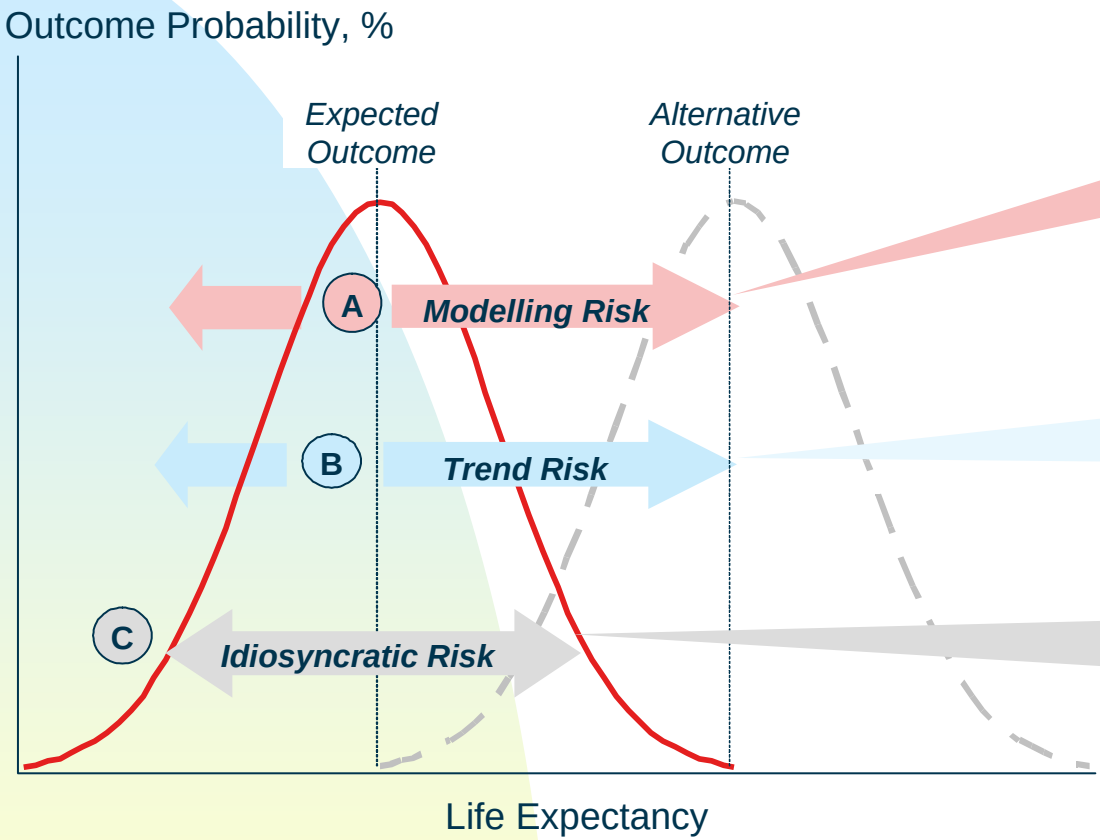
Longevity risk is driven by three underlying risks



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 Random Variation Risk are greater the smaller the number of scheme members and the greater the distribution of scheme benefits.

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Need good mortality index

- Speculative v hedging demand:
  - Liquidity v basis risk
- Credit Suisse Longevity Index 2005
  - Lacks transparency
- LifeMetrics Index 2007
    - JPMorgan
    - Pensions Institute
    - Watson Wyatt
  - Fully transparent and objective
- Goldman Sachs QxX Life Settlements Index 2007
- Deutsche Börse monthly Xpect-Indices on mortality and life expectancy 2008

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Need good mortality forecasting model

- ‘Process-based’ models
  - Model process of dying
    - Not used much yet
- ‘Explanatory’ or ‘causal’ models
  - Model causes of death
    - e.g. heart disease or socio-economic factors
    - Not used much yet, but post-code modelling more common
- ‘Extrapolative’ projection models
  - 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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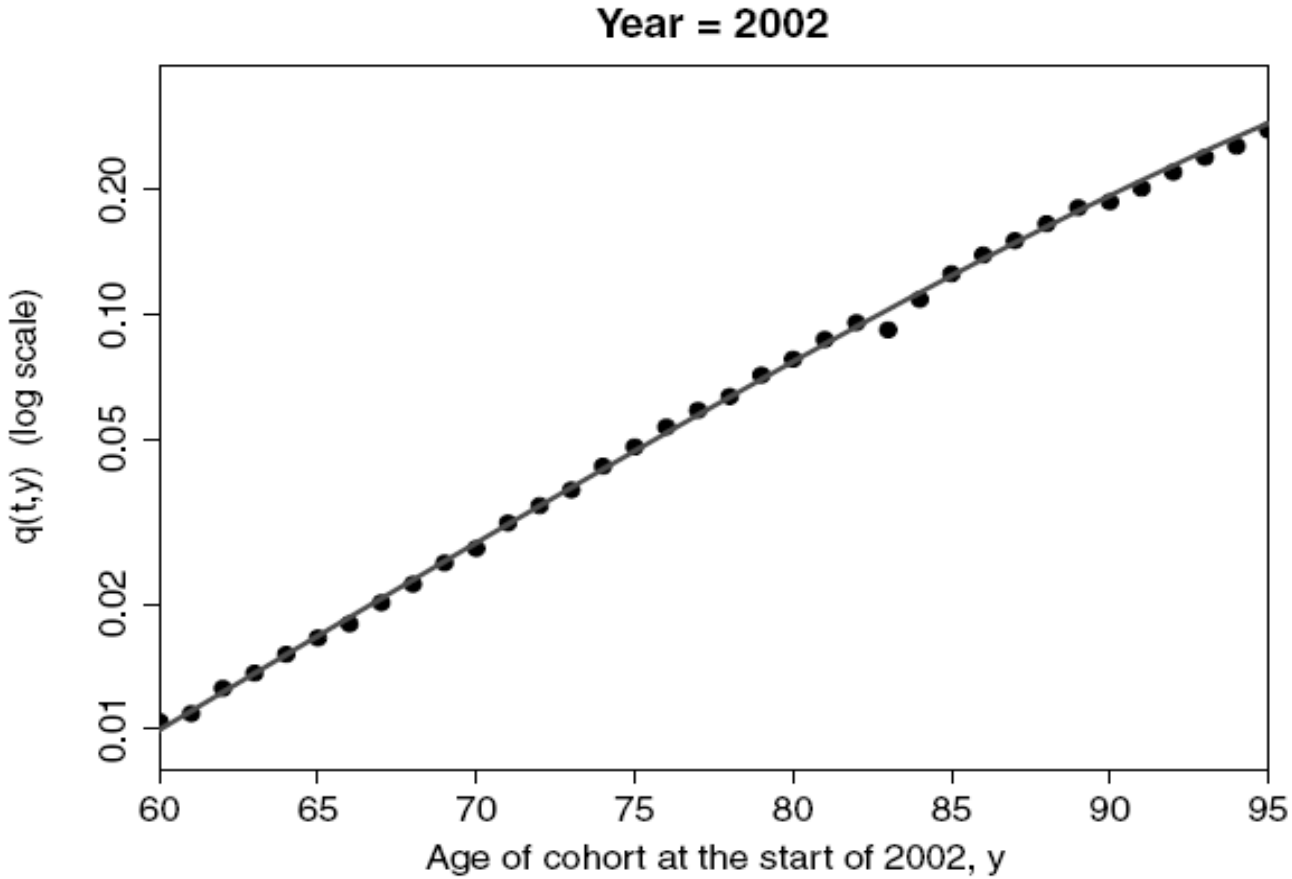
Mortality rates (q) approx. linear



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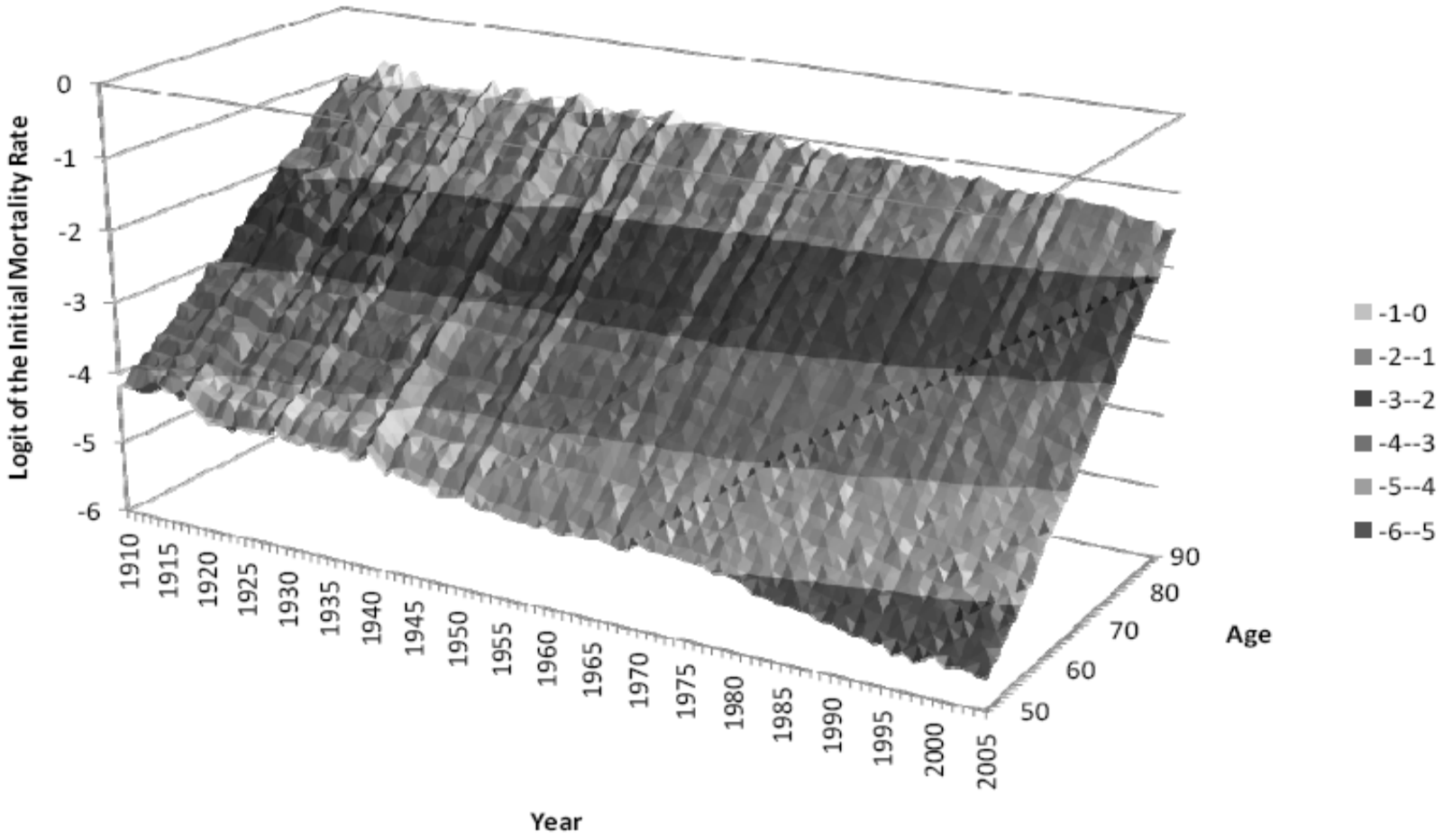
Mortality rates, E&W, 1910-2005



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CBD two-factor model

$$\text{logit}\, q(t,x) \equiv \log\left(\frac{q(t,x)}{1\text{-}q(t,x)}\right) = \kappa_t^{(1)} + \kappa_t^{(2)}(x - \bar{x})$$

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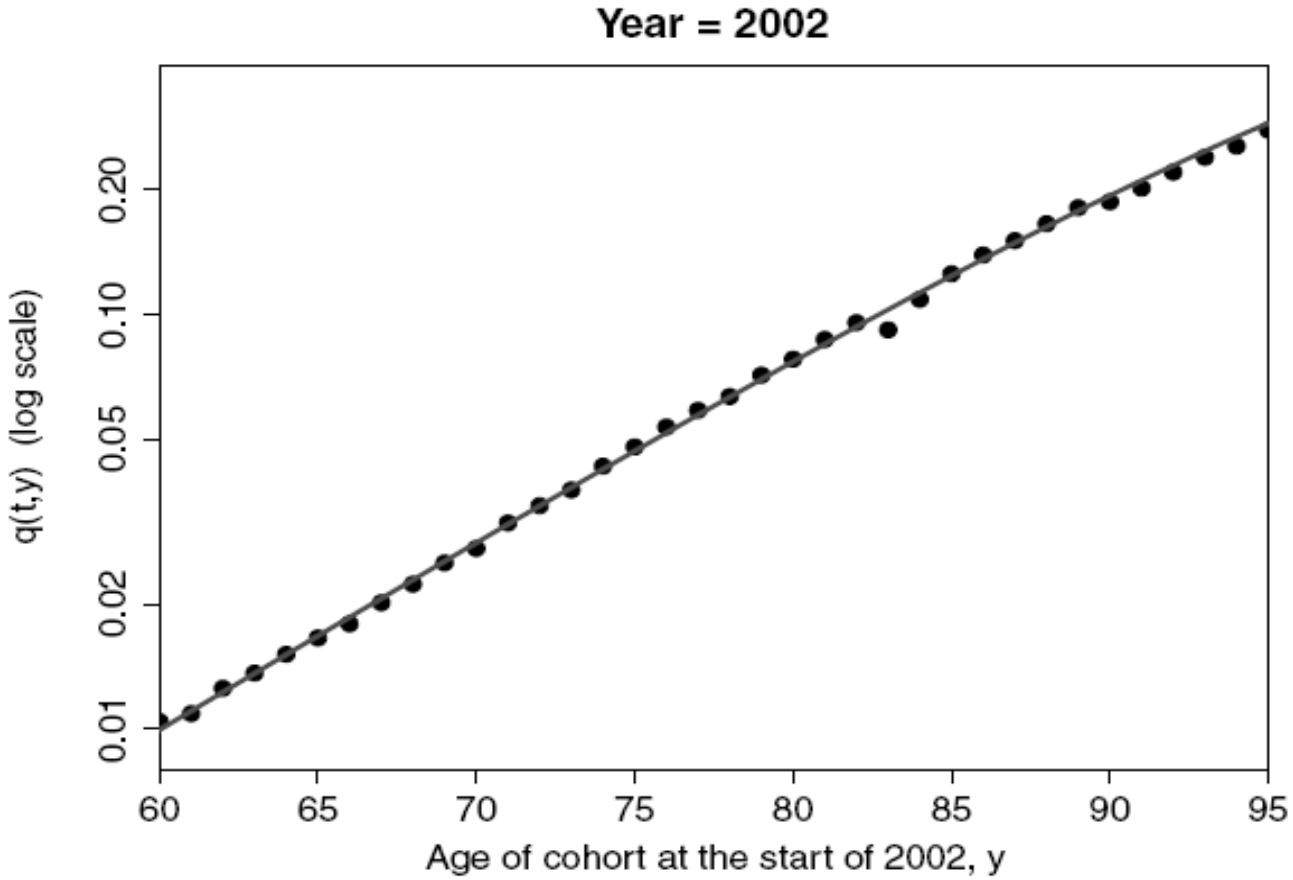
$K^{(1)}$ = intercept, $K^{(2)}$ = slope



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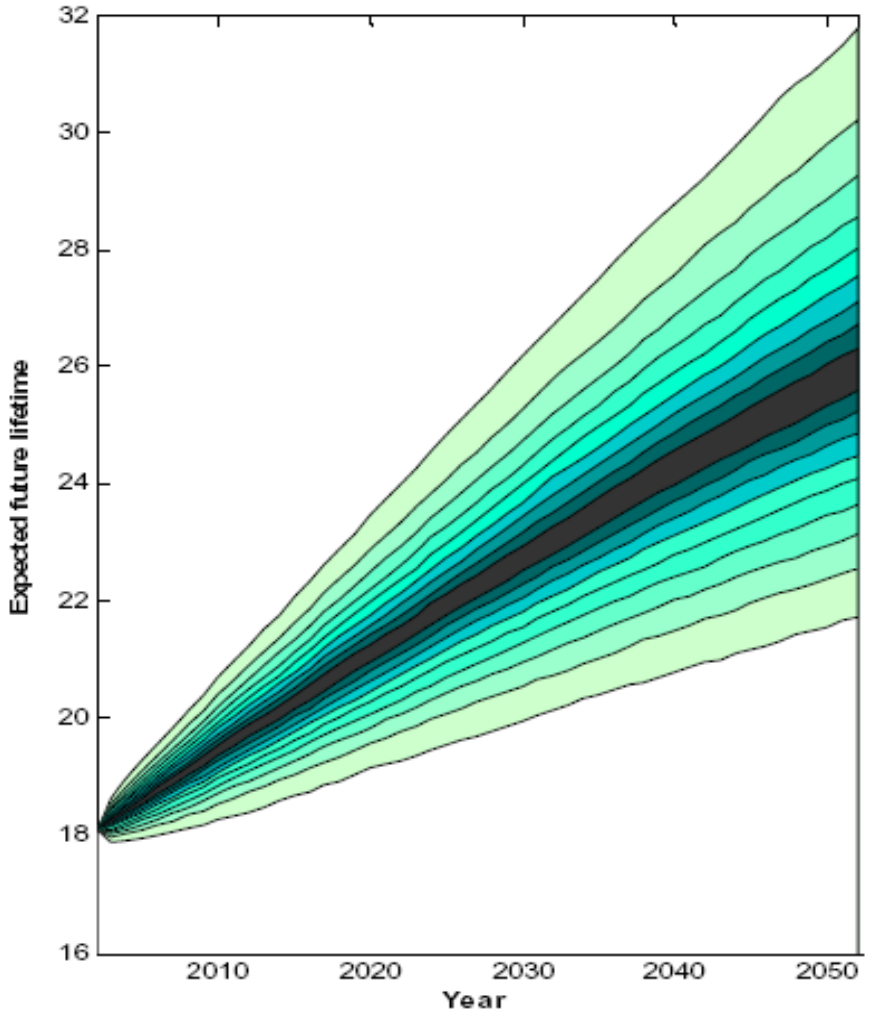
Longevity fan chart for 65-year old male (CBD model)



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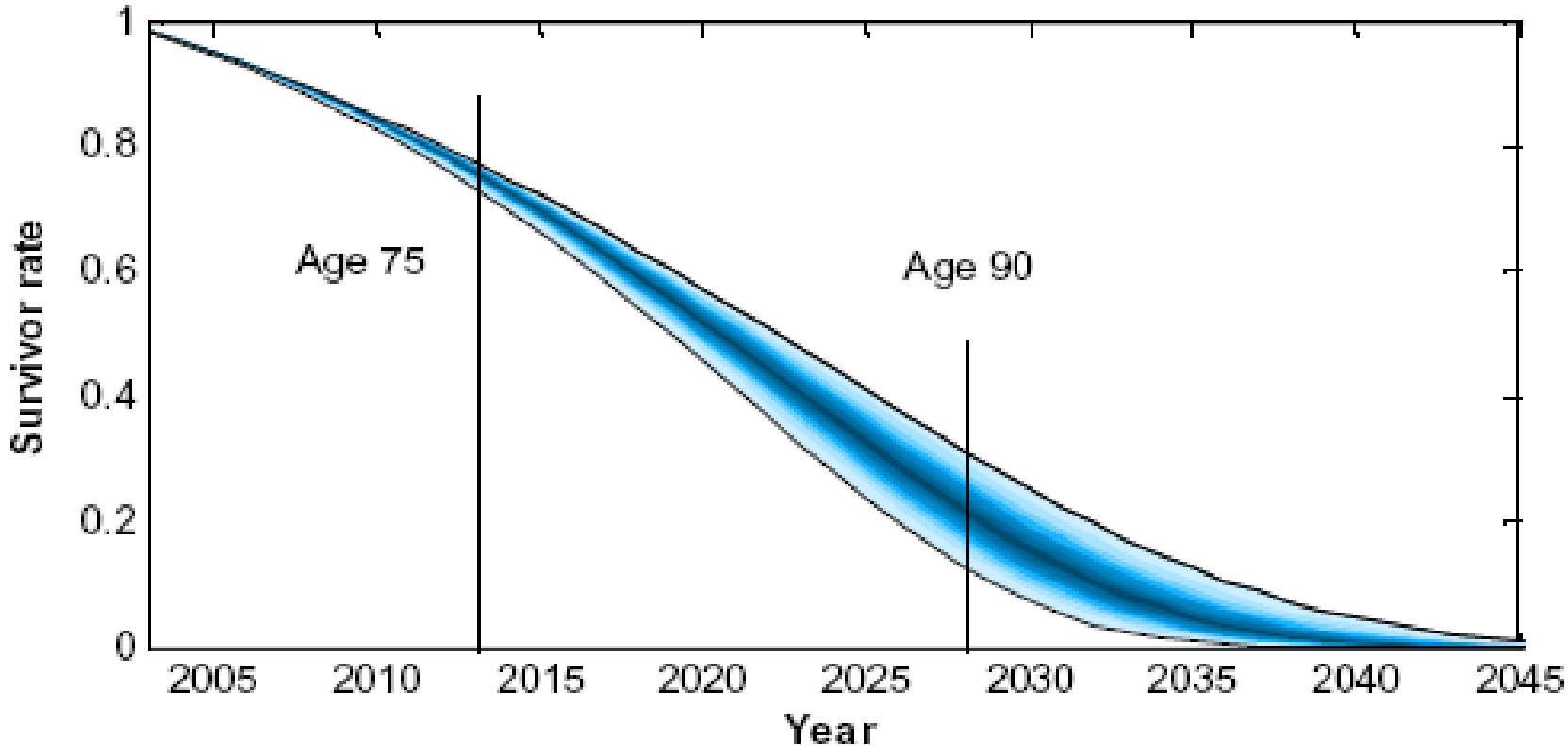
Survivor fan chart for 65-year old male (CBD model)



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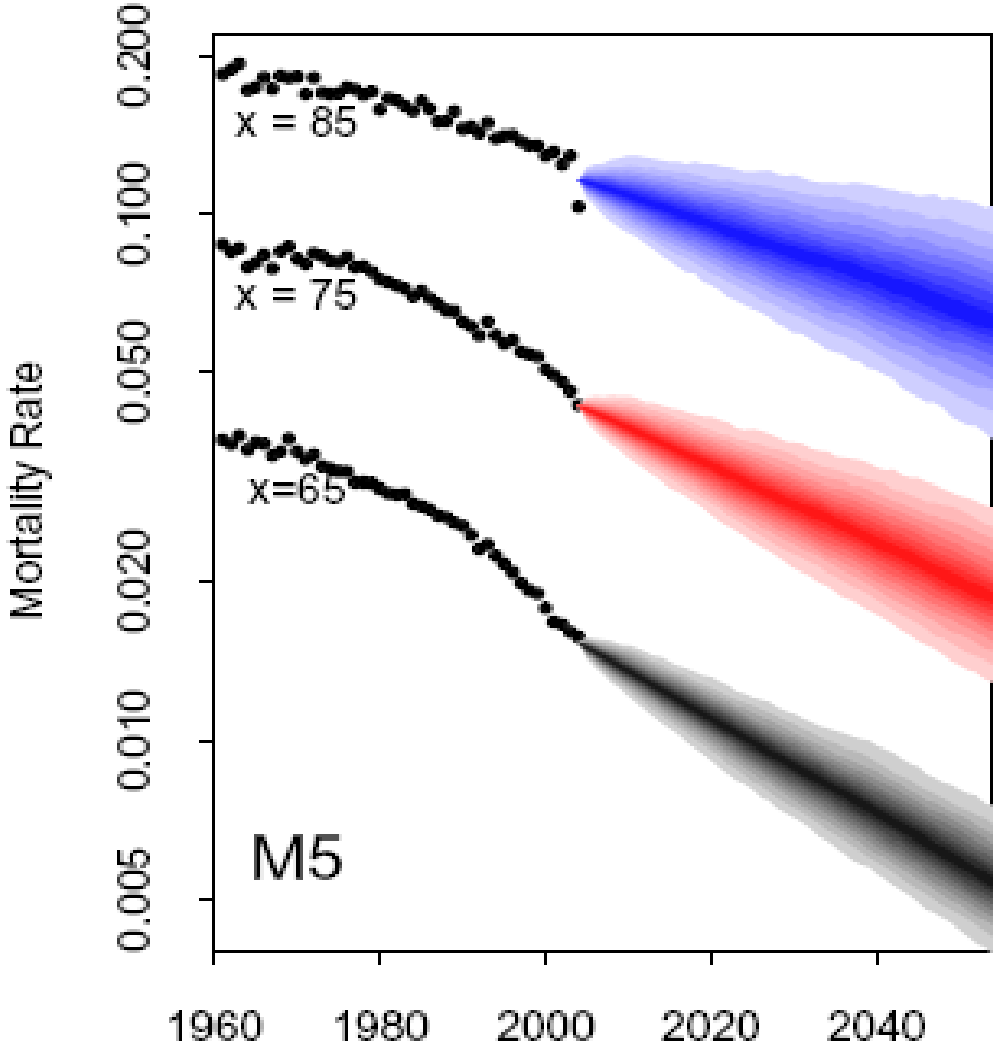
Mortality fan charts (CBD model)



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Fan charts

- Allow us to model quantitatively measurable uncertainty ('risk')
  - And so estimate VaR, Expected Shortfall, etc.
- Take account of parameter uncertainty
- Can be used for reserving/capital requirements
  - Obvious applications to ICAs
- Can be used for trading
- Can be used for hedging
- Can be used for determining asset allocation
- Can be used for pricing purposes

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The Life Market: Current capital market solutions

First generation solutions: bond-based

Bonds

- Linked to mortality:
  - E.g Swiss Re mortality catastrophe bond 2003-2007
    - Principal-at-risk bond
- Linked to survivorship:
  - C.f. EIB-BNP-PartnerRe bond 2004
    - Payments linked to national data
  - PensionsFirst Blue Bond
    - Payments linked to plan specific data

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Second generation solutions: derivatives-based

q-forward

- Exchanges fixed mortality for realized mortality at maturity of the contract
- Based on LifeMetrics index
- Using stochastic mortality model to forecast the fixed rate
- First transaction between JPMorgan & Lucida:
  - February 2008

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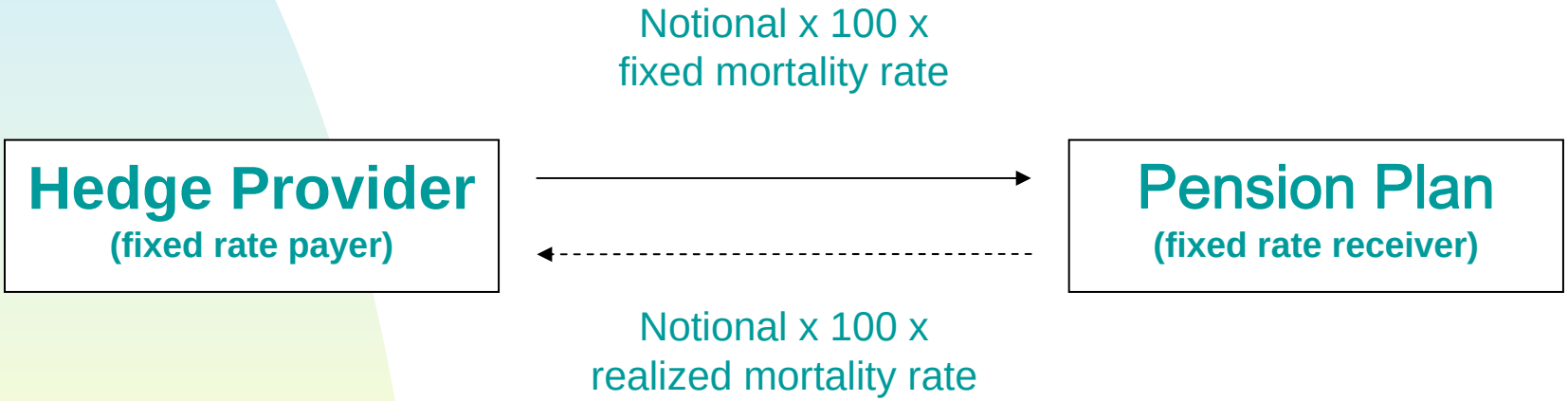
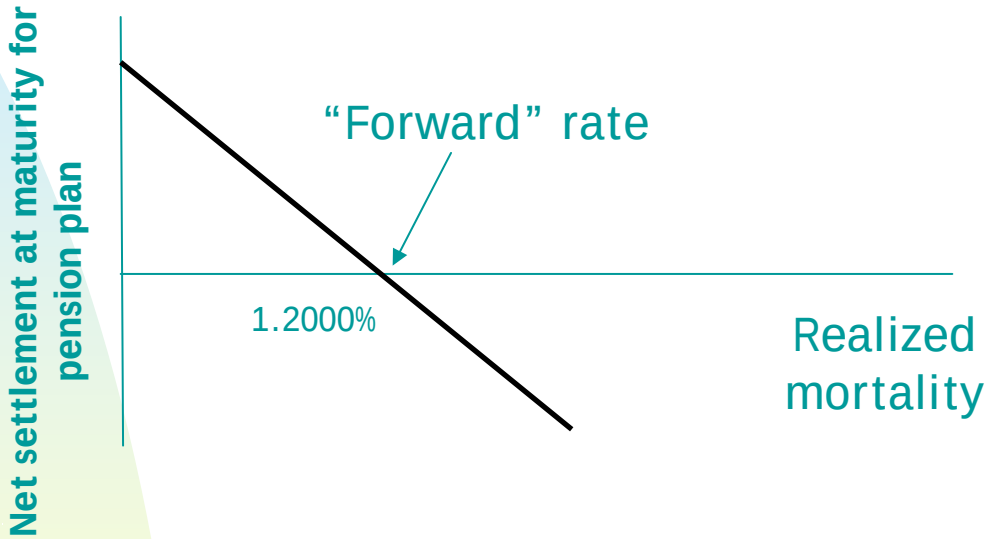
q-forward



Source: Coughlan *et al* (2007)

q-forward settlement in 2018



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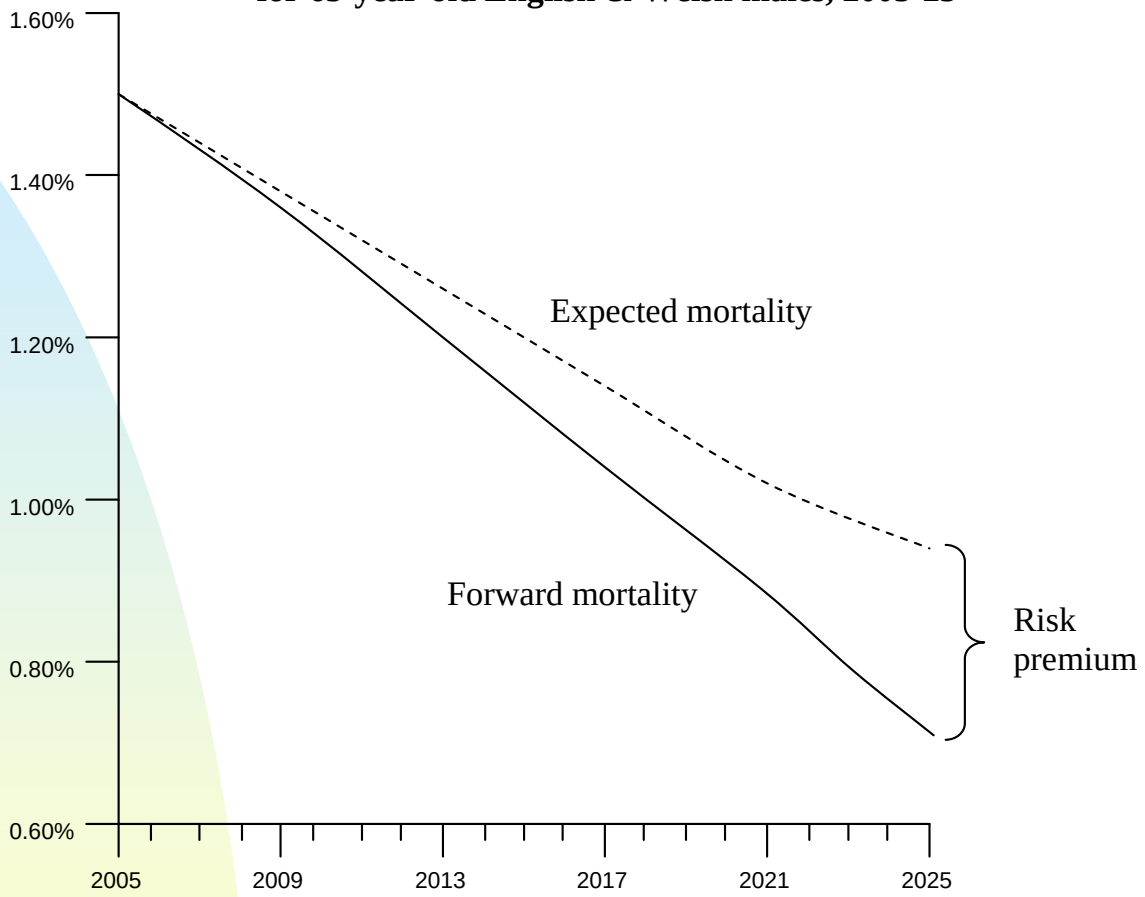
Expected and forward mortality rate curves for 65-year-old English & Welsh males, 2005-25



Source: Coughlan (2007)

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Portfolio of q-forward building blocks

Age 50-59 Males	Age 60-69 Males	Age 70-79 Males	Age 80-89 Males
Age 50-59 Females	Age 60-69 Females	Age 70-79 Females	Age 80-89 Females

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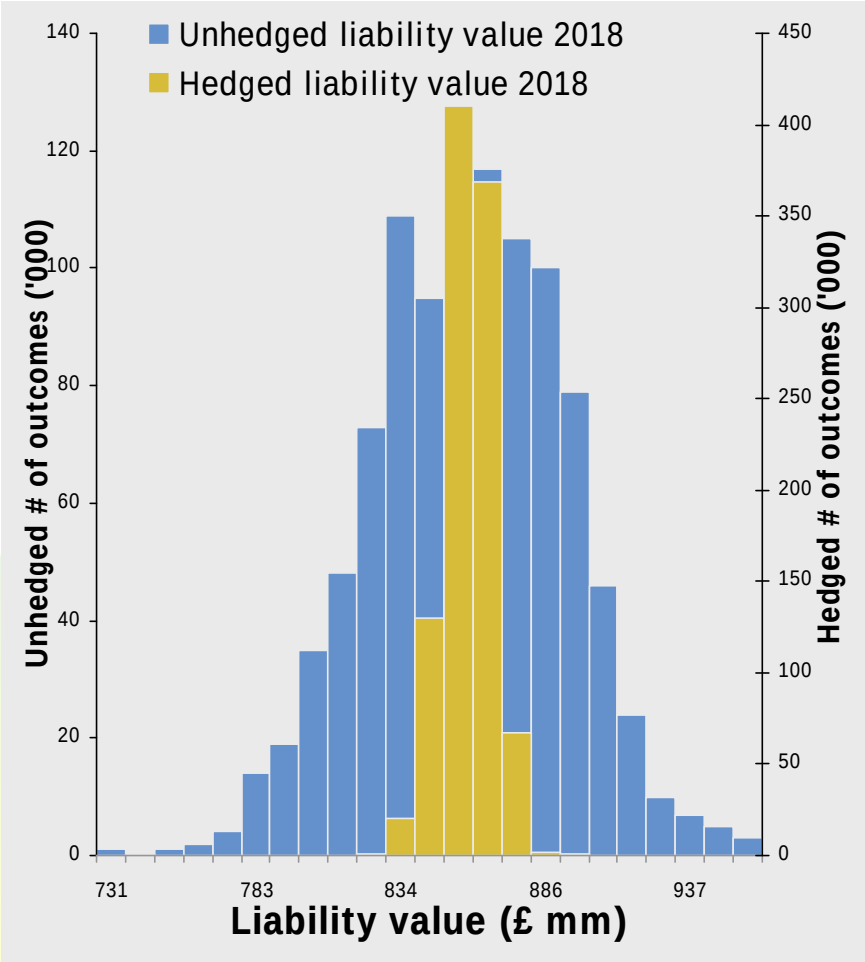
Distribution of liability value in 2018: Before and after hedging



Risk reduction = 86%, Residual risk = 14%

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Swiss Re – Friends' Provident longevity swap

- World's first publicly announced swap in April 2007
  - Pure longevity risk transfer
  - But insurance contract not capital market instrument
- Friends' Provident's £1.7bn book of 78,000 pension annuity contracts written between July 2001 – December 2006
  - Retains administration of policies
- Swiss Re makes payments and assumes longevity risk
  - In exchange for undisclosed premium

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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
  - But based on LifeMetrics Index improvements
- 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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Six longevity swaps in 2008-09

Date	Hedger	Type	Size (£m)	Term (yrs)	Format	Intermediary
Jan 2008	Lucida	Ins	N/A	10	Index-based hedge; exposure placed with capital market investors	JPMorgan
July 2008	Canada Life	Ins	500	40	Exposure placed with capital market investors	JPMorgan
Feb 2009	Abbey Life	Ins	1500	Run-off	Reinsurance contract	Deutsche Bank
Mar 2009	Aviva	Ins	475	10	Exposure placed with capital market investors & Partner RE	RBS
June 2009	Babcock	PF	500-750	50	Reinsurance contract with Pac Life Re	Credit Suisse
July 2009	RSA	Ins	1900	Run-off	Reinsurance contract with Rothesay Life; combined with inflation & interest rate swaps	Goldman Sachs

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Index v customized hedges		
	Advantages	*Disadvantages*

Index hedge	• Cheaper than customized hedges
	• Lower set-up/operational costs
	• Shorter maturity, so lower counterparty credit exposure
		• Not a perfect hedge:
		  ○ Basis risk
		  ○ Roll risk

Customized hedges	• Exact hedge, so no residual basis risk • Set-and-forget hedge, requires minimal monitoring	• More expensive than index hedge • High set-up and operational costs • Poor liquidity • Longer maturity, so larger counterparty credit exposure • Less attractive to investors
Source: Coughlan (2007)		

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Barriers to development

Barriers to development in cash market

Barriers to development in cash market

- Reasons why BNP bond did not launch:
  - Design issues which make bond an imperfect hedge for longevity risk
  - Pricing issues
  - Institutional issues

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Design issues

- Mortality experience of individual pension funds and life insurers may be different from reference UK population.

- Bond only provides hedge for longevity of 65-year old males:
  - Bond is progressively worse hedge for pension liabilities related to younger or older cohorts
  - Pension funds and life insurers also exposed to significant longevity risk from females

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Design issues

- Significant differences in mortality of those receiving larger pensions compared with those receiving lower pensions.

- As payments under bond effectively give equal weight to all the lives in the UK population, the already imperfect hedge provided by the longevity bond is worsened.

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Design issues

- Bond only matches cashflow under level pension
  - Large portion of pensions paid by pension funds and life insurers will be indexed to inflation:
    - RPI/LPI/CPI.

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Pricing issues

- Longevity risk premium built into initial price of bond set at 20 basis points.
- Given that this was first ever bond brought to market, markets have no real feeling as to how fair this figure was.
- However, concern that up-front capital was too large compared with risks being hedged by bond:
  - Longevity and interest rate risks
- Leaving no capital for other risks to be hedged
  - e.g. inflation

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Institutional issues

- Issue size too small to create liquid market.
- Consultants reluctant to recommend it to trustees
- Trustees were never schmoozed!
- Fund managers did not have mandate to manage longevity risk.
- Market makers did not welcome bond:
  - Believed it would be closely held and they would not make money from it being traded.
- PartnerRe was not perceived as being a natural holder of UK longevity risk.

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Institutional issues

- Last point highly significant
- Neither UK-based nor EU-based reinsurer willing to provide cover for BNP bond
- Partner Re not prepared to offer cover above issue size of £540m.
- Has been questioned whether EU's solvency requirements render reinsurance cover within EU prohibitively expensive:
  - Solvency II will make matters worse:
    - Will raise UK annuity prices by 10-20%

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Barriers to development in futures market

Barriers to development in futures market

- Following factors key to success of particular futures contract:
  - Defined as having consistently high volume of trade and open interest:
- Must be large, active and liquid spot market for underlying with good price transparency:
  - By far the most important factor:
  - Indeed no futures contract has ever survived without a spot market satisfying these conditions:
    - Except weather or inflation futures?
    - Is longevity another ‘exotic underlying’?

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Barriers to development in futures market

- Underlying must be homogeneous and/or have well-defined grading system.
- Market in underlying must not be heavily concentrated on either buy or sell side:
  - since this can lead to price manipulation.
- Futures contract must be effective in reducing risk.

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Important lessons for development of longevity-linked futures market

- Mortality index must be fair estimate of true mortality and have minimal time basis risk:
  - CPI index suffers from same potential problems
  - So survival of CPI futures contract on CME suggests these problems can be overcome.
- Although mortality indices are calculated infrequently, spot prices of traded longevity bonds likely to exhibit high degree of volatility on account of bonds' high duration.

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Important lessons for development of longevity-linked futures market

- Underlying mortality indices must be few in number and well-defined:
  - Small number of contracts helps to increase liquidity
  - But also leads to contemporaneous basis risk
    - Arising from different mortality experience of population cohort covered by mortality index and cohort relevant to hedger.

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Securitisation:

Annuity books
Reverse mortgages
Life settlements

Life settlements

- Life policy sold by owner for more than surrender value but less than face value
- Viatical settlements securitised in US in 1990s
  - Viators close to dying
    - Eg AIDS sufferers
  - Market ceased suddenly in 1996 when protease inhibitors introduced
- Senior life settlements (SLS) securitisation began in 2004:
  - Tarrytown Second
    - $63m SLSs backed by $195m life policies
- Institutional Life Markets Association April 2007

Characteristics of US life settlement market

- Average age 77
- Males account for 2/3rds of policies, females 1/3
- Average face amount $1-2 million
  - significantly higher for premium financed policies
- Premium financed policies: policies issued, financed during 2-year contestability period, then resold.
- Realistic portfolio duration c12 years
- 6.3% annual lapse/surrenders
- Estimated net market of **$114 billion** face value by 2017

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Prospects for life settlement securitisations

- Very positive if:
  - More accurate and consistent L.E. underwriting
  - Extension risk products market takes off

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A role for government?

Decomposition of longevity risk

Total longevity risk

=

Aggregate longevity risk

[Trend risk]

+

Specific longevity risk

[Idiosyncratic

and modelling risks]

Government hedges

Private sector hedges

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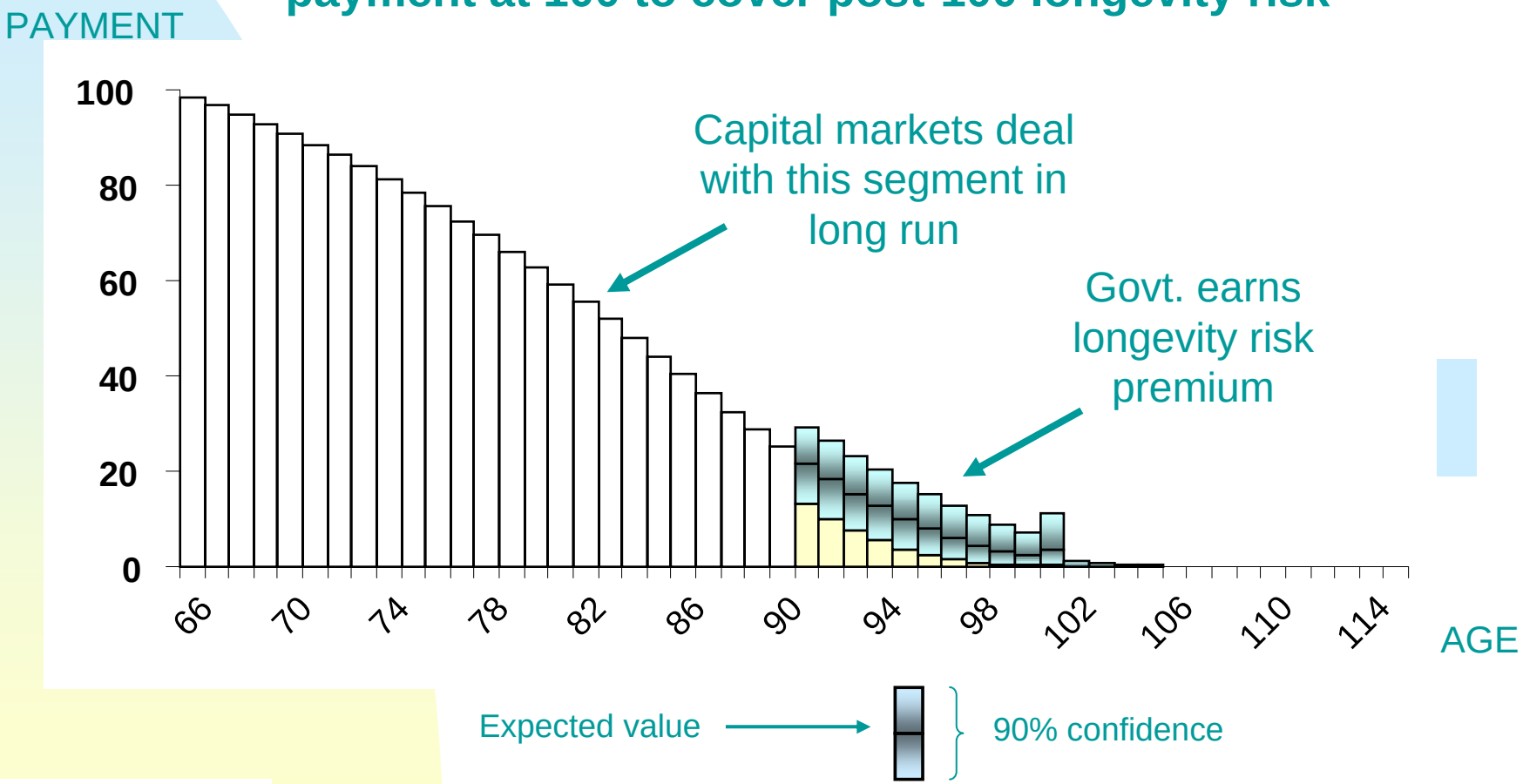
Potential role for government in helping to hedge longevity risk

Tail risk survivor bond from age 90 with terminal payment at 100 to cover post-100 longevity risk



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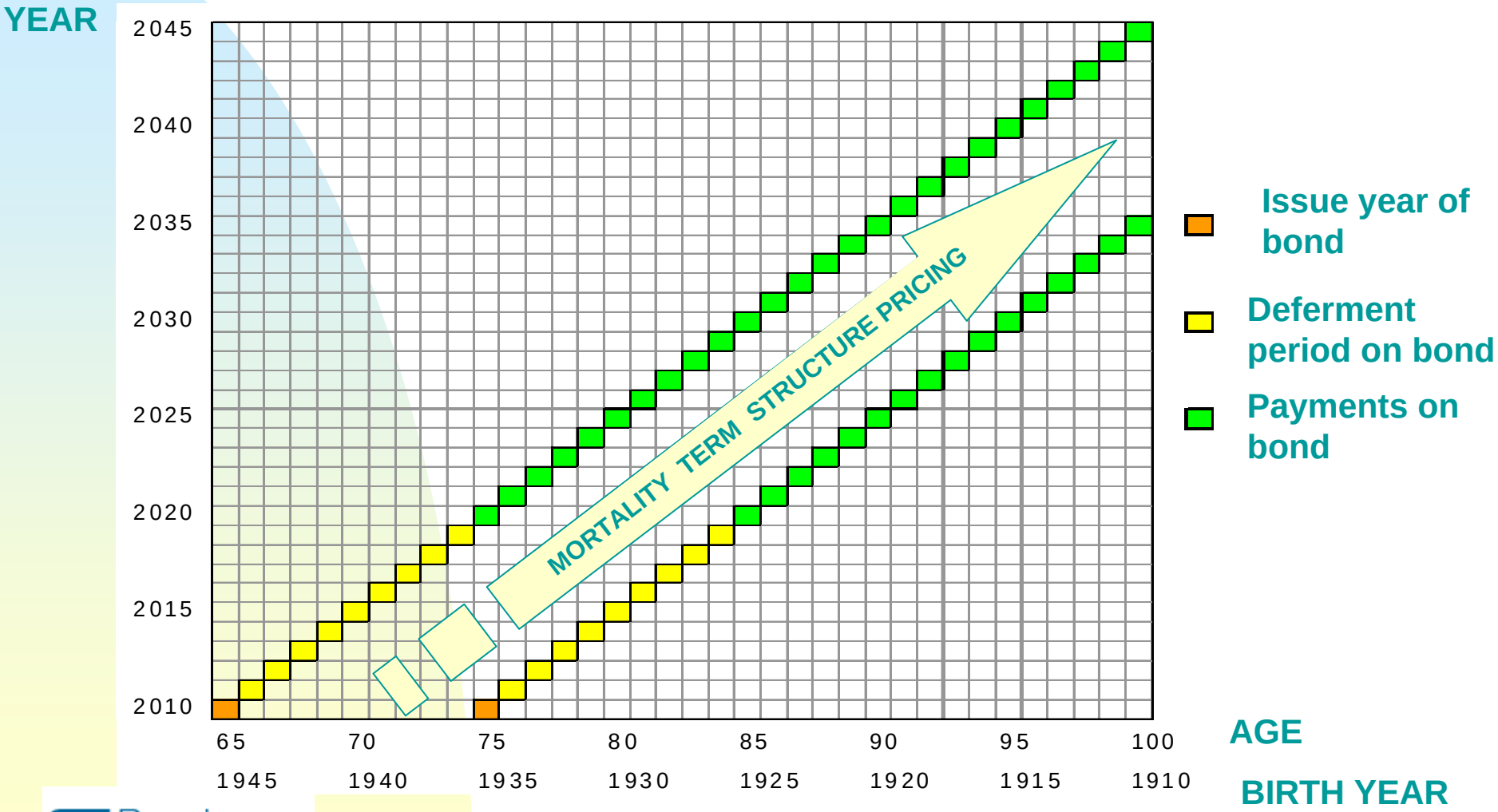
Survivor bond cash flows across ages and time



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Conclusion

Conclusion

- The New Life Market has had a slow and painful birth, but the market should grow rapidly:
  - Insufficient capital in insurance/reinsurance industry to deal with global longevity risk
  - Capital markets more efficient than insurance industry in:
    - Reducing informational asymmetries
    - Facilitating price discovery
  - The market has risks that are uncorrelated with traditional bond and equity markets

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Richard Sandor's Seven Stages of Market Evolution: Where are we now?

1. Structural change - demand for capital
2. Uniform commodity/security standards
3. Legal instrument providing evidence of ownership
4. Informal spot and forward markets
5. Emergence of exchanges
6. Organised futures and options markets
7. Proliferation of OTC markets, deconstruction

Pensions Institute

Thank you!

Longevity 5:

Fifth International Longevity Risk and Capital Markets Solutions Conference

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