The Actuarial Profession
making financial sense of the future

Mortality and longevity seminar

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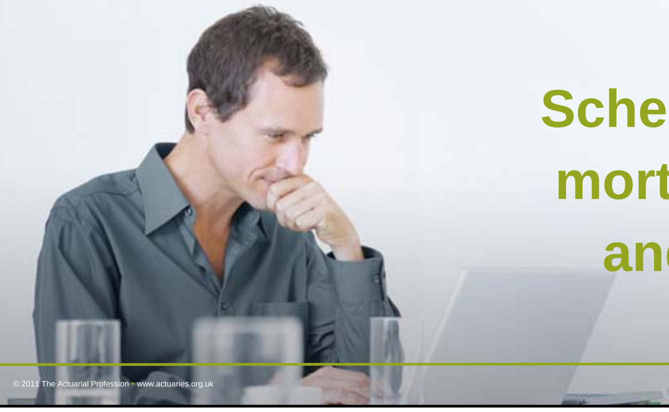


Scheme specific mortality trends and basis risk

22 March 2011

Basis Risk

General Definition

The risk that offsetting instruments in a hedging strategy will not experience price changes in entirely opposite directions from each other. This imperfect correlation between the two instruments creates the potential for excess gains or losses in a hedging strategy, thus adding risk to the position.

Definition in the Context of Longevity Risk

Here we mean the risk that mortality improvements between national population mortality and a subset of the population, typically an employee pension scheme, deviate from one another

- NB we are talking about large insurers/pension schemes where the law of large numbers applies. For small groups, idiosyncratic risk can dominate
- Key issue is improvement trend rather than this year's mortality rates

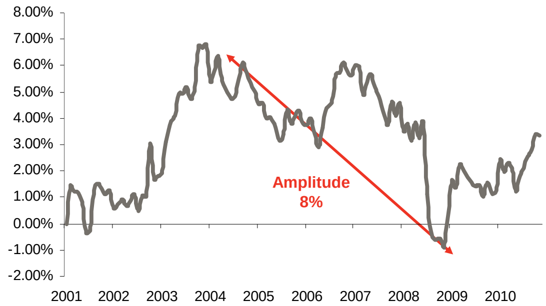
Our thesis:

1. Longevity basis risk is modest compared to other types of basis risk run by UK pensions and insurers
   - 4 examples across insurance company and pension fund asset liability management
2. There has been too much focus on the basis risk on the longevity side
   - Addressing the overall trend ought to be the main focus

Example I : Equity Hedging (Insurers)

- Most UK insurers will have a portfolio of UK + foreign equities
- For tactical reallocation and hedging purposes, they typically use FTSE100 based instruments which offer greater liquidity

- The Chart shows the quotient of total returns for a typical equity portfolio held by an insurance company and the FTSE 100 index
- $\frac{(70\%\ FTSEALLSHARE+30\%Other)}{100\%\ FTSE100}$



Source : Data used references total return indices. Bloomberg screen: FTSE100 TRI – TUKXG/ FTSEALLSHARE TRI – FTPTTALL/ S&P 500 TRI - SPXT

Example 2: Guaranteed Annuity Obligations (Insurers)

- Many UK insurers in the 1970s and 1980s issued savings policies whereby upon retirement the accumulated lump sum would convert into a life annuity at a guaranteed fixed rate
- Value of that guarantee depends on level of interest rates, rates of take-up of the option, retirement behaviour, legal interpretations of policy documents
- Hedging typically involves interest rate based instruments (swaptions) only. Occasionally, € based swaptions were used instead of £
- Valuation of the guarantee could easily rise/fall by 50% depending upon assumptions used
- Gradually hedges have evolved from "set and forget" to rebalanced over time

Example 3: LPI vs RPI hedging (Pension Funds)

- Pensions amounts typically escalate at rate linked to inflation. LPI - Limited price inflation (usually RPI with 0% floor and 5% cap) is commonly used escalation formula
- £ inflation market is perhaps a decade old
- Initial inflation hedging was very precise (typically exact LPI) linked cashflow matching
- Value based/ delta hedging has emerged over time and is now common
  - For significant periods LPI traded at a much less attractive level than RPI simply due to demand for exact matching
  - Gradually take up of RPI as pension funds became more comfortable with the less precise hedge

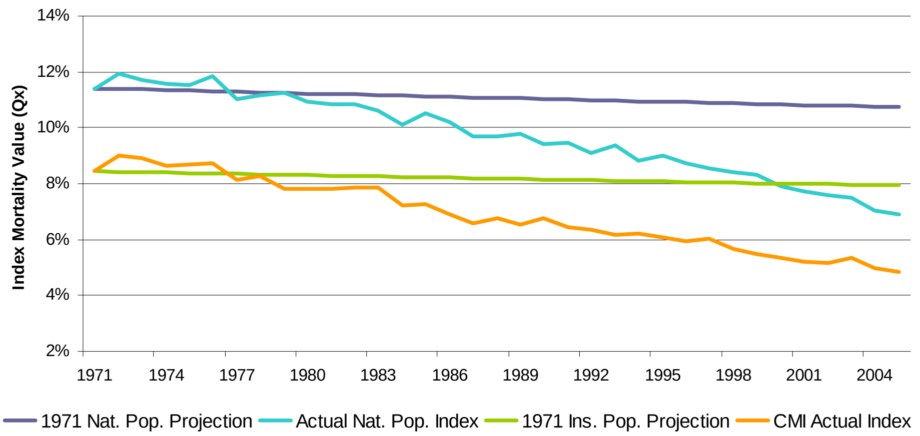
Example 4: Change of inflation linking from RPI to CPI (Pension Funds)

- In June 2010 the Minister for State for Pensions announced that CPI rather than RPI will be used as the basis for future indexation of pension rights in defined benefit schemes
- CPI is typically lower and over the past 20 years it has been higher than the RPI only three times
- This might reduce UK pension liabilities by 10%

Hedging Longevity Risk – Basis Risk

- If in the past I had hedged my pensioner population with a national population based metric, how much basis risk would there have been?
- Projected mortality index value 65-85 (arithmetic average)
  - National Population Data: Office of national statistics
  - Insured Population Data: Continuous Mortality Investigation
  - GAD 1971 projections used (35 years of data)

Mortality Rates Basis Risk



Source : Data used for national data: ONS and GAD / Data used for insured data: CMI

Improvements Summary

- Insured Population figures 2005
  - E1 = Expected drop in Qx is 5.94%
  - A1 =Actual drop in Qx is 42.77%
- General Population figures in 2005
  - E2 = Expected drop in Qx is 5.94%
  - A2 = Actual drop in Qx is 39.49%
- Hedge Effectiveness
  - (E1/A1) / (E2/A2) = **92.33%**
- Conclusion:
  - Based on historical experience, population based hedge would have provided reasonable protection, far better than no hedge at all
  - Basis risk is modest compared to overall trend risk

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Understanding the drivers of basis risk

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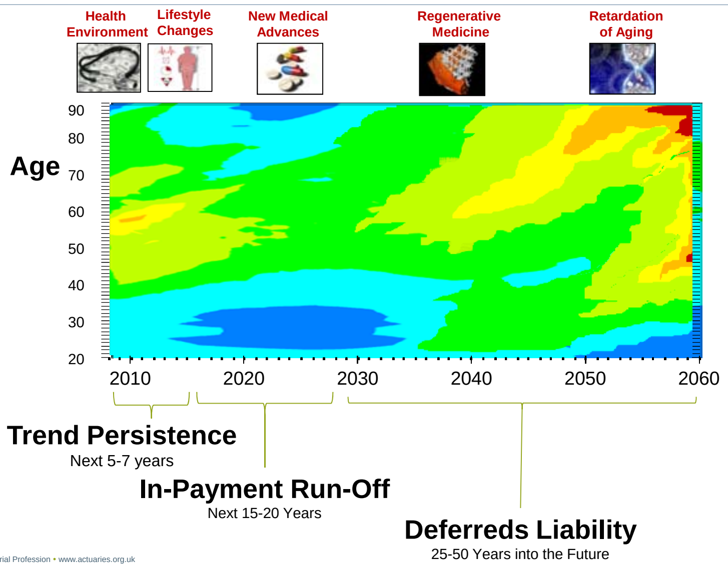
General Population Indices and Projections

- A number of longevity transactions have been structured around an index based on general population mortality, e.g.:
  - LifeMetrics Index (JP Morgan)
  - Kortis (Swiss Re, modeled by Risk Management Solutions)
- Standard mortality projections currently use pension-specific mortality baselines, but blend this with projections extrapolated from general population mortality trends
  - e.g. CMI projections
- Use of general population data is helpful
  - It is objective, transparent and verifiable – more trusted by 3rd parties
  - Larger volume of data provides less noisy trends
- But carries with it 'basis risk' for pension longevity risk analysis

Pension scheme membership and basis risk

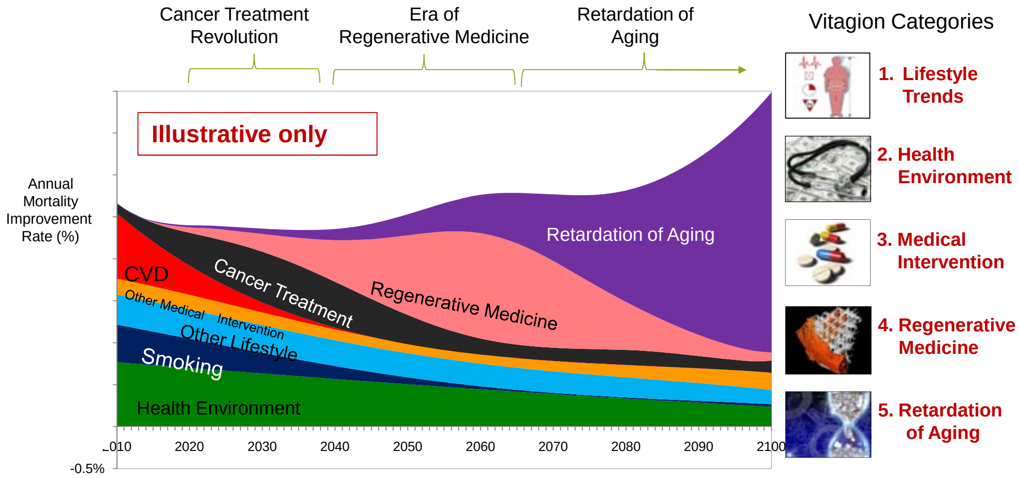
- General population mortality trends are useful indicators of directionality but contain **basis risk** if applied indiscriminately to pension funds, because
- Pension scheme membership is very different to the general population in terms of affluence and social status
  - Each pension scheme is different in its socio-economic mix
- Socio-economic mix translates into different mortality levels, life expectancy assessments and mortality improvement projections
- Understanding the component drivers and causal mechanisms is important to understand and quantify basis risk

Three Outlook Horizons for Mortality Improvements



First-Order Structure of Future Mortality Improvement

Applicable to general population and well-diversified portfolios

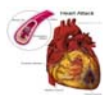


Age-period component of structure of future mortality improvement

Drivers of Basis Risk

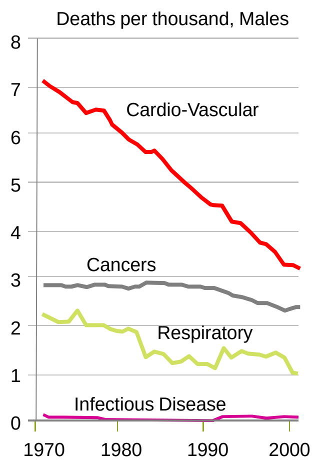
- Longevity risk results from variations in the speed and impact of drivers of mortality improvement ('Vitagions')
- Basis risk under these structural changes will result from divergence between the mortality performance of general population and pension schemes
- In the main time horizon of concern (In-payment run-off), mortality improvement trends will be driven by lifestyle risk factor changes and key medical advances
- Medical modeling techniques can be used to analyse the divergence potential of these vitagions
- They show that basis risk is second order compared to the overall likely variation in timing and magnitude of the vitagion

High mortality improvement since 1970 is mainly a **Cardio-Vascular Disease success story**

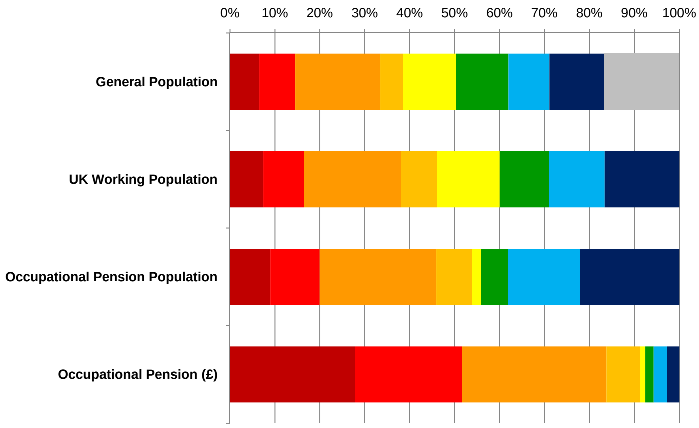


Deaths from CVD have halved since the 70s as a result of:

- People stopping smoking
- Better health consciousness, diet and fitness
- Improved survival rates from heart attacks
- Cholesterol-reduction drugs (statins) now broadly prescribed as a preventative treatment for high cholesterol individuals
- A small proportion of CVD death rate, around 1 per mille, is unpreventable (e.g. Acute Myocardial Infarction)
- Diminishing returns apply to CVD treatments in reducing mortality in future



Basis risk results from a different SEC mix in pensions relative to the general population



Socio-Economic Categories
National Statistical Office (NS-SEC)

- 1.1 Higher Managerial SEC
- 1.2 Higher Professional SEC
- 2 Lower Managerial SEC
- 3 Intermediate SEC
- 4 Self employed & small bizs
- 5 Lower Supervisory SEC
- 6 Semi-Routine SEC
- 7 Routine SEC
- 8 Never worked and long-term unemployed

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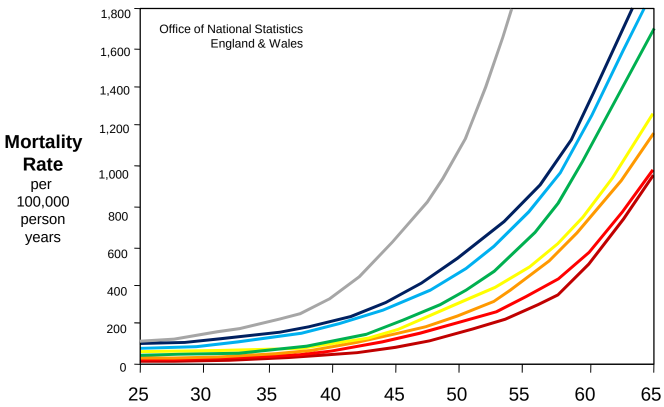
Large mortality variation by socio-economic category



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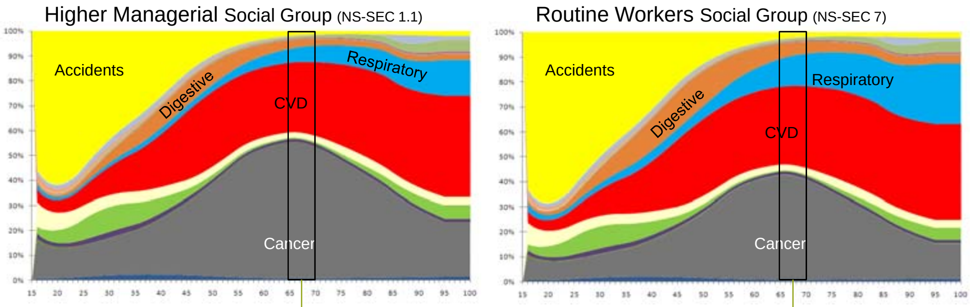
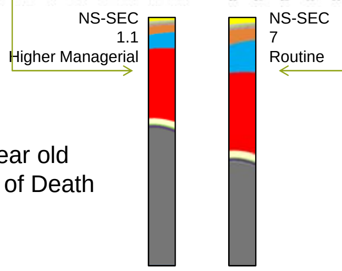
Causes of death are different between SEC groups

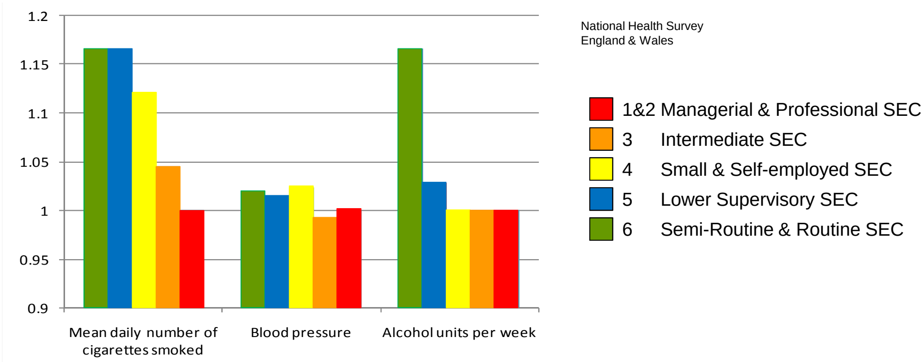




e.g.
65-70 year old
Causes of Death

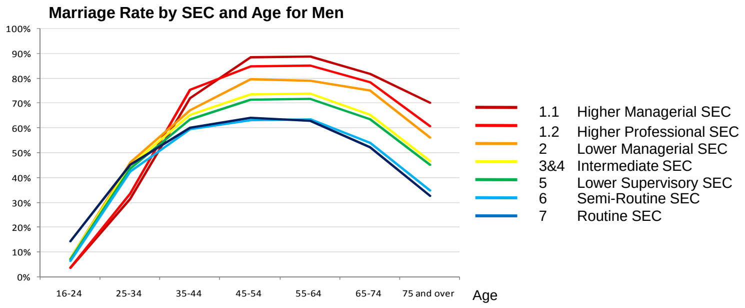
SEC mortality difference is driven by health risk factors

- SEC mortality rates vary because of differences in lifestyle, risk factors, and access to healthcare resources



There are different social patterns by SEC

Marriage rates and spouse age differences are also important for pension liability



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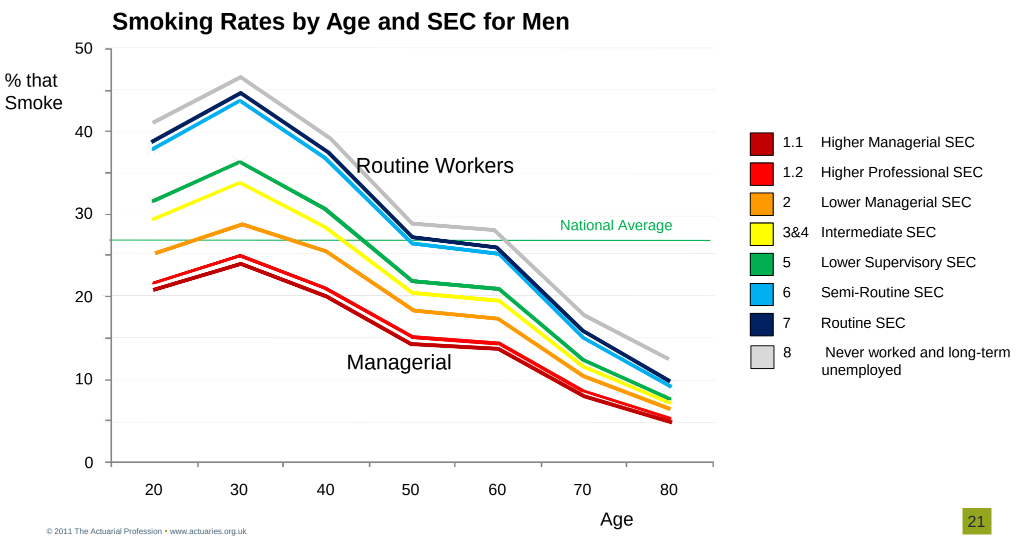
Smoking Rate Differences

By Age and Socio-Economic Category

Smoking



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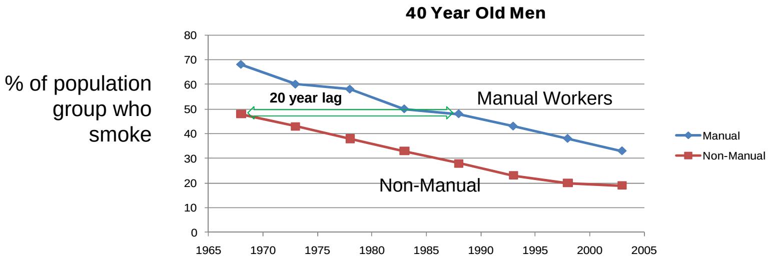
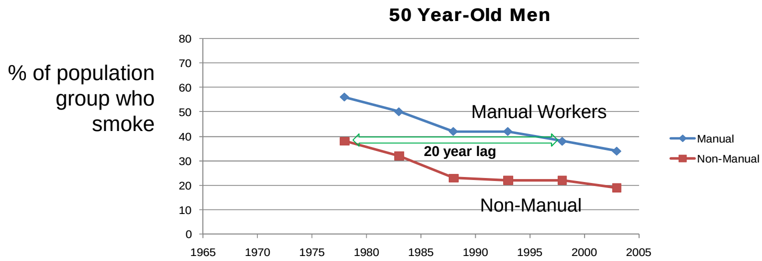
Social lag time in quitting smoking

Manual vs non-manual

Smoking





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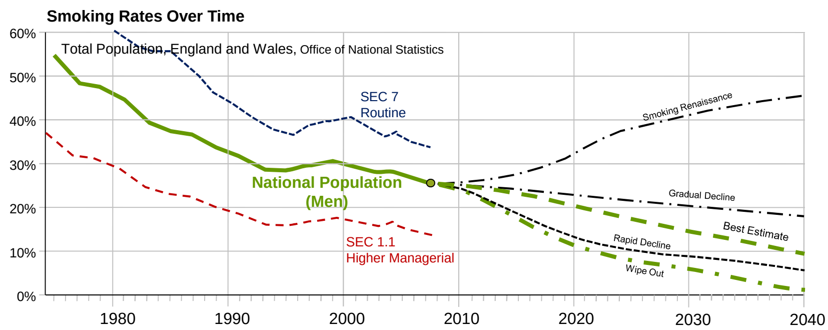
Smoking trends and future projections

Smoking



Future Foundation Projects
Up in smoke: Quitting Smoking in the 21st Century
Nicorette & Shire Health PR
March 2005

- Smoking Rates have halved in the past 25 years
- Strong government action and social attitudes have discouraged smoking
- Smoking rates are forecast to halve again in the next 25 years
  - Could happen faster or be eradicated in 'wipe out' scenarios
- Diminishing returns as smoking rates approach a minimum level
  - Minimum level may be non-zero with persistent residual number of smoking addicts

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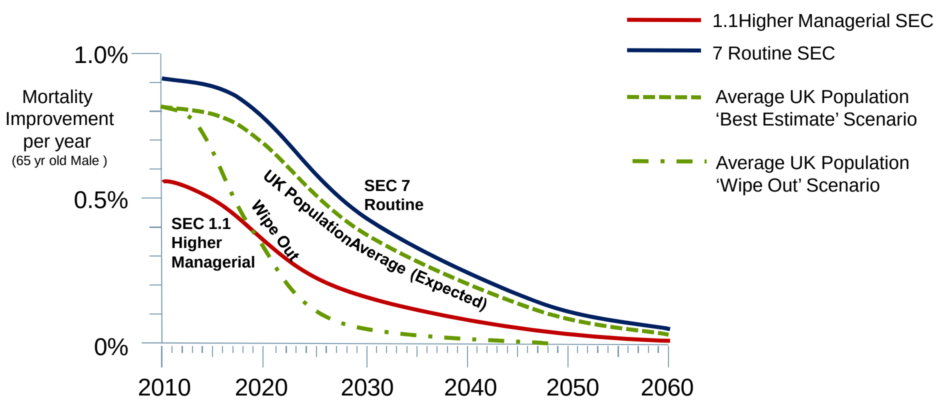
Mortality improvement from quitting smoking

'Best Estimate' Smoking Trend and 'Wipe Out' Scenario



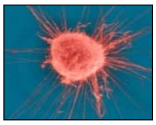
Mortality improvement from future lifestyle trends

Structural risk is significantly greater than SEC variation

- For lifestyle trends like smoking patterns, the uncertainty of timing and trend attenuation drives the risk assessment
- Over the next 15 years, mortality improvement resulting from smoking trends could vary by a factor of 5X, depending on the probability range around the vitagion trajectory (structural risk)
- Over the 15 years, the mortality improvement difference resulting from SEC variation is less than 1.75X

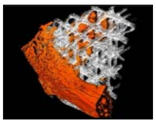
What might cause the next wave of mortality improvement?

- Without new causes of medical improvements, the current period of high mortality improvement will diminish
- But potential major new drivers of MI are on the horizon:



The Cancer Treatment Revolution

New methods of detecting cancers earlier, genetic profiling of cancer mechanisms, new generation of Monoclonal Antibody drugs, and NHS cancer centres planned for 2015



Regenerative Medicine

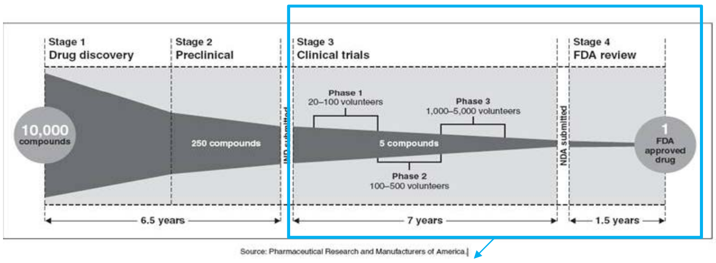
Experimental medical techniques for repairing damaged body tissue, such as stem cell therapy, gene therapy, nanomedicine

Potential Treatments for Retardation of Aging

Early stage research into mechanisms for slowing the degenerative process of aging. Research includes mechanisms for telomere conservation, growth hormone effects and mechanisms stimulated by caloric restrictions

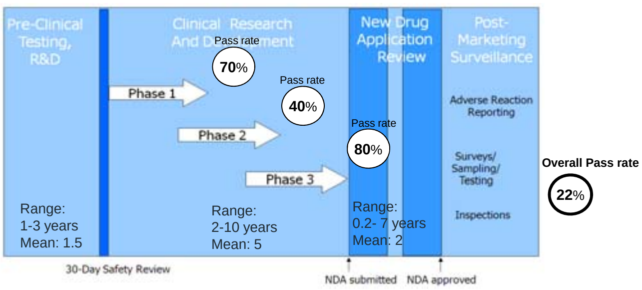
Long lead times for adoption of new medical advances

Drug Discovery Process



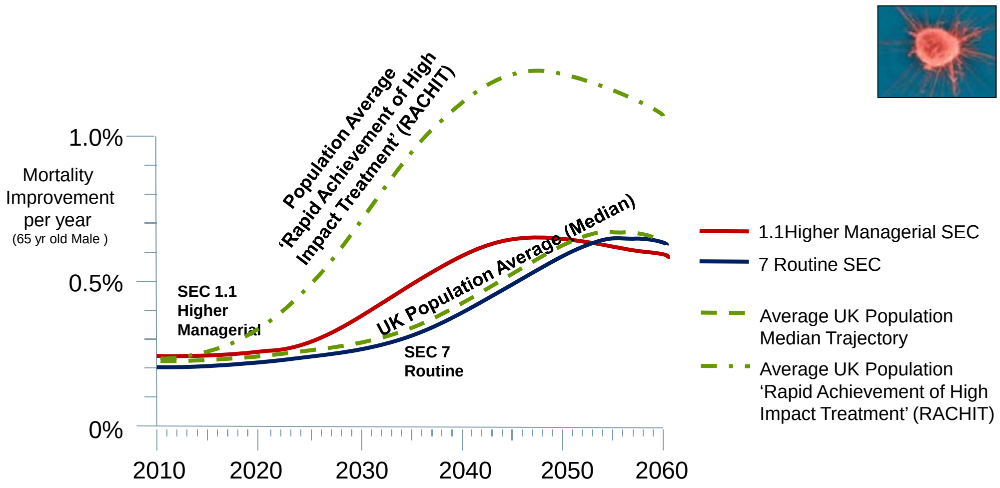
Source: Pharmaceutical Research and Manufacturers of America

FDA Approval Process



Mortality improvement from new cancer treatments

'Median trajectory' of improvements in cancer treatment



Mortality improvement from medical treatment trends

Structural risk is much greater than SEC variation

- For medical treatment trends like new advances in cancer treatment, the structural risk is much greater than SEC variation
- SEC variation in mortality improvement results from earlier access to technologies, through better education and affluence
- The timing of the mortality improvement wave resulting from the vitagion is largely outside the time horizon of 'In-payment run-off'
- Over the 15 years, potential variation in mortality improvement from SEC differences is an order of magnitude smaller than the structural risk

Structural risk of mortality improvement and basis risk

- Structural risk – the uncertainties in impact size and timing of different drivers of mortality improvement (vitagions) is the main issue in quantifying longevity risk in pension portfolios
- Basis risk – the difference between MI of a particular pension portfolio compared to general population – is generally a second-order effect compared with the major drivers of longevity trends
- Basis risk can be quantified through SEC mix in a portfolio
  - Higher SECs have less potential improvement to realise from CVD mortality reduction – short term plateau in MI
  - Higher SECs have more potential for rapid and early MI from future medical advances in cancer and regenerative medicine
- Structural risk can be quantified through probabilistic modeling of vitagion trajectories

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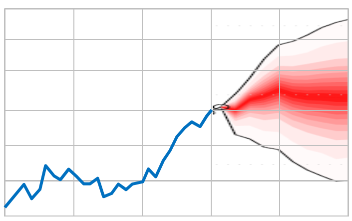
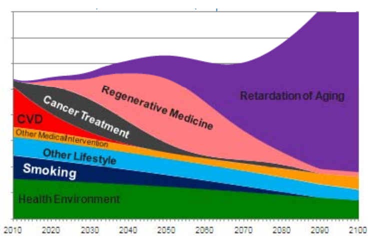
Probabilistic longevity modeling and basis risk

- A population-based longevity index is a useful representation of the structural risk of mortality improvement
- Probabilistic models provide quantification of liability exceedance likelihoods for pricing and risk transfer
- Basis risk is second-order, and quantifiable
- It is important to assess basis risk for your portfolio
  - Understand the socio-economic mix in your pension portfolio
  - Benchmark mortality improvement projections of your portfolio to general population





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Conclusions

- For large well diversified schemes, basis risk for longevity is secondary compared to:
  - First order trend which affects all subsets of the population
  - Basis risk taken by insurance companies and pension funds elsewhere in their ALM
- The probability that a particular pension portfolio would differ significantly from a general population based index is second-order compared to the major drivers of longevity risk trends