

Younger Members' Convention, St Andrews

# Longevity — risk and opportunity

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# Longevity risk — plan of talk

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- Impact of socio-economic group...and how (not) to rate it
- New techniques and tools
- GLMs and survival models
- Summary and questions

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- Established players: Prudential, Legal and General
- Other insurers entering bulks market: NU, AIG, Aegon, Wesleyan
- Start-ups: Paternoster, Synesis, PIC
- More to come: Lucida, Goldman Sachs...

# Stochastic risk

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<u>Scheme</u>	<u>Members</u>
E	40
H	800
C	5,300

Source: Richards Consulting calculations using Prudential data.

\* Concentration is the percentage of members accounting for half of all pensions in payment.

# Stochastic risk

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Scheme	Safety premium*	
	95%	99%
E	25.6%	37.2%
H	4.8%	6.7%
C	2.1%	3.0%

Law of large numbers favours schemes with more members.

Source: Richards Consulting calculations using Prudential data.

\* Safety premium is the extra funds above average in 10,000 simulations to ensure given probability of meeting all benefits in run-off according to PM/FA00 without any future improvements. Benefits valued at 2.5% per annum interest to allow for indexation.

# The buy-out deficit

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<b>Pension scheme</b>	<b>Funding level</b>
1	94%
2	77%
3	88%
4	94%
5	93%

# The buy-out deficit

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<b>Pension scheme</b>	<b>Funding level</b>	<b>Buy-out level</b>
1	94%	93%
2	77%	74%
3	88%	63%
4	94%	55%
5	93%	49%

Buy-out basis usually excludes discretionary pension increases, i.e. true buy-out deficit is at least as large as shown above.

Source: Richards Consulting and Barrie and Hibbert calculations using information from selected scheme statements in October 2006.



# Concentration of risk

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<b>Scheme</b>	<b>Members</b>	<b>Concentration*</b>
E	40	11%
H	800	12%
C	5,300	6%

Largest scheme (C) pays 50% of all pensions to just 6% of members.

Source: Richards Consulting calculations using Prudential data.

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- ... and therefore with the biggest liabilities

# Concentration of risk

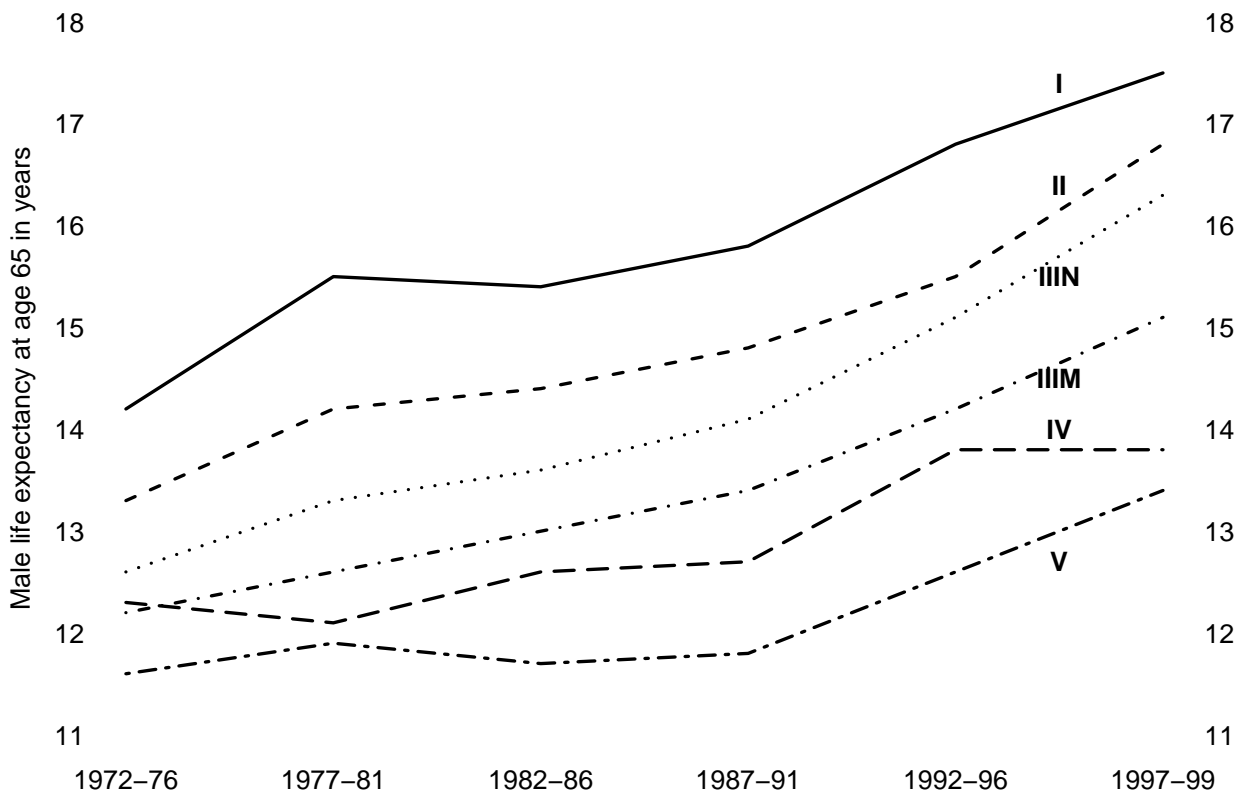
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- Lives not identical
- Longest-lived lives tend to be those with biggest pensions...
- ... and therefore with the biggest liabilities
- Rating socio-economic group *very* important in bulks business

# Impact of socio-economic group

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# Retirement life expectancy by socio-economic group



Source: ONS Longitudinal Survey.



# Financial impact of lifestyle

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## Financial impact of mortality rating factors

<b>Factor</b>	<b>Step change</b>	<b>Reserve</b>	<b>Change</b>
Base case	-	13.39	-
Gender	Female-male	12.14	-9.3%
Lifestyle	Top-bottom	10.94	-9.9%
Duration	Short-long	9.88	-9.7%
Pension size	Large-small	9.36	-5.2%
Region	South-North	8.90	-4.9%
Overall	-	-	-33.6%

Source: Richards and Jones (2004), page 39.

# Why fund size is not reliable

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- Poor? Higher-mortality group?
- But AVC fund elsewhere of £42,808...
- ...giving total fund of £51,391...
- ...so not poor and likely light mortality!

# Solution to socio-economic profiling

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- Mortality group from postcode or address, not fund size

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- Mortality group from postcode or address, not fund size
- Postcode is (much) better than “amounts”
- Household (address) profiling is better still

# New techniques and tools

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- Personal profiling using full name and address

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- Mortality group assigned to matched households

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- Personal profiling using full name and address
- Mortality group assigned to matched households
- Postcode-dominant mortality group where no household match

# Life expectancy at age 65

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<b>Group*</b>	<b>Males</b>	<b>Females</b>
1	20.4	22.9
2	19.8	22.4
3	19.1	21.7
4	18.7	21.5
5	17.9	20.8
6	17.4	20.6
7	16.1	19.3

Source: \*Mortality Group, courtesy of Experian plc.

# Mortality profiling

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- Previous slide uses historical data

# Mortality profiling

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- Previous slide uses historical data
- How would this look if applied to actual 2005 experience\*?

Source: \* Portfolio of around quarter of a million immediate annuitants and bulk buy-out pensioners

# Complete life expectancy at age 65

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<b>Group*</b>	<b>Males</b>	<b>Females</b>
1	20.8	22.6
2	20.2	22.1
3	19.6	21.6
4	19.1	21.1
5	18.4	20.5
6	18.4	20.6
7	17.3	19.6

Source: Longevity Ltd. Survival model of mortality experience of quarter of a million pensioners.

\* Mortality Group, courtesy of Experian plc.



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- Spouse's benefit adds 12% to cost of single-life pension\*
- Proportion-married assumption could be 60–90%
- Personal profiling can also model likely marital status
- Less guesswork in setting proportion-married assumption

Source: \*Richards Consulting calculations for level annuity to male aged 65 using PMA00 and 2.5% discount rate.

# P-splines

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- P-spline software from CMIB Projections Working Party

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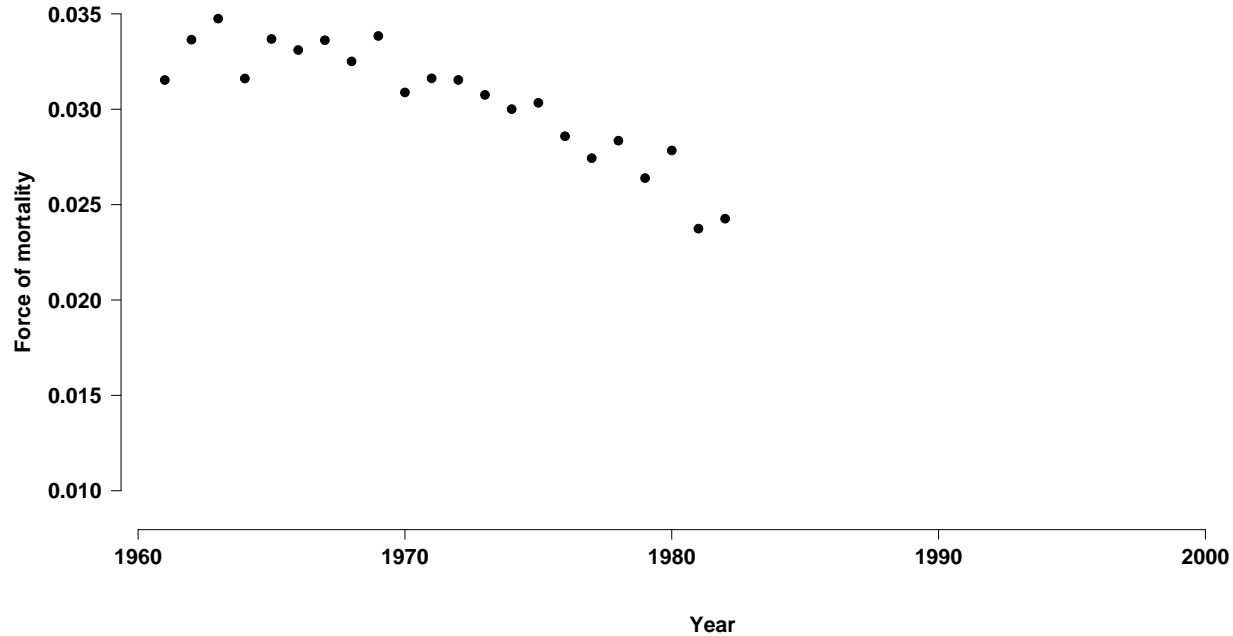
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- P-spline software from CMIB Projections Working Party
- Central projections and percentile projections



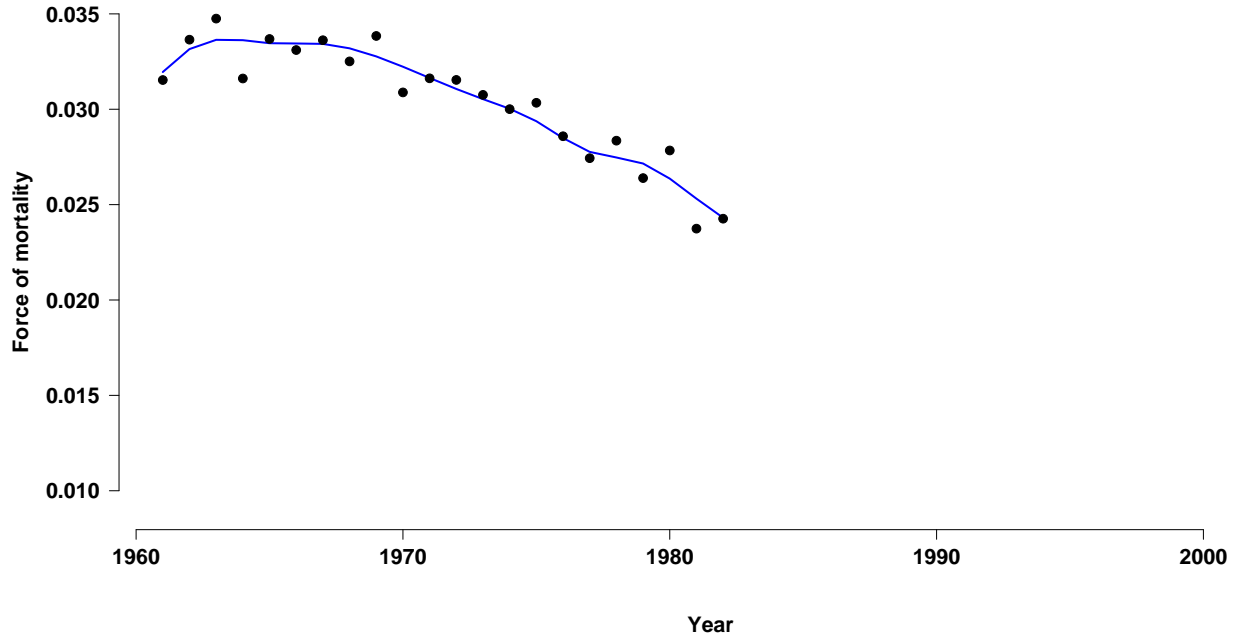
# French male mortality rates at age 65

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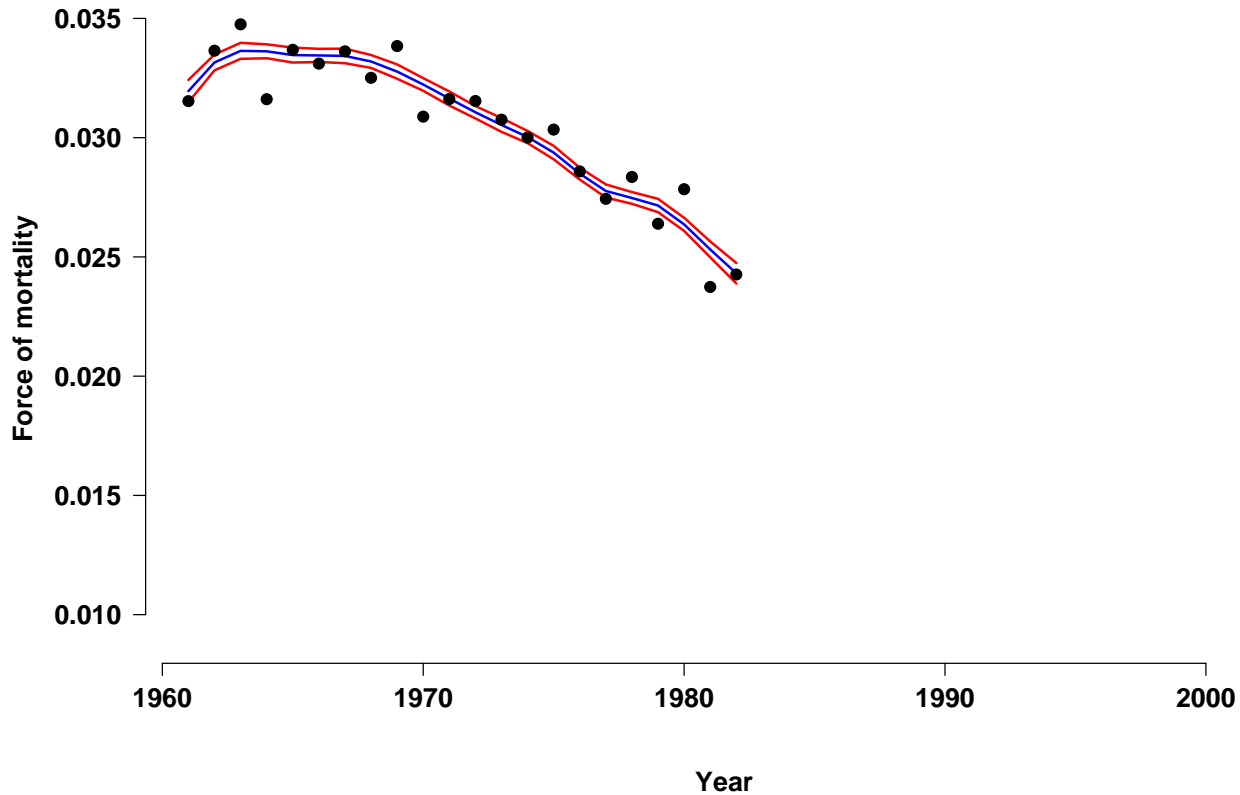
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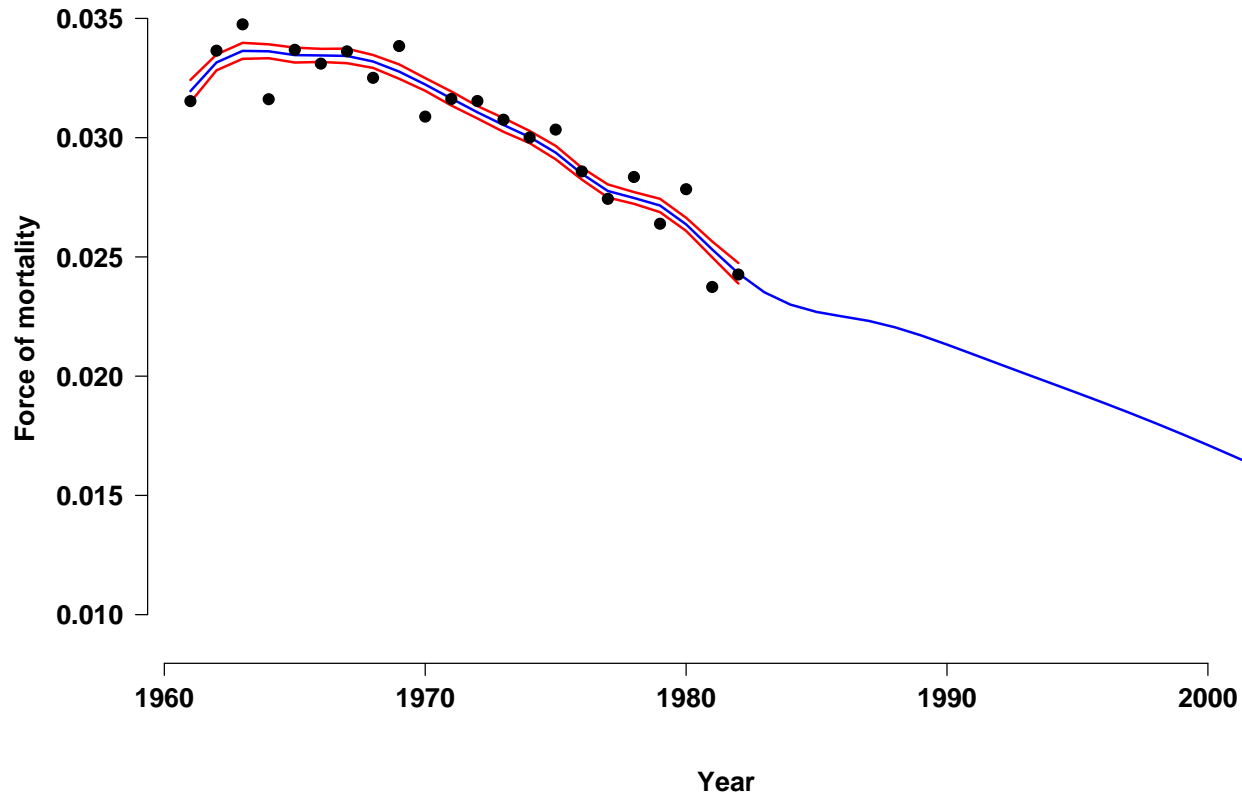
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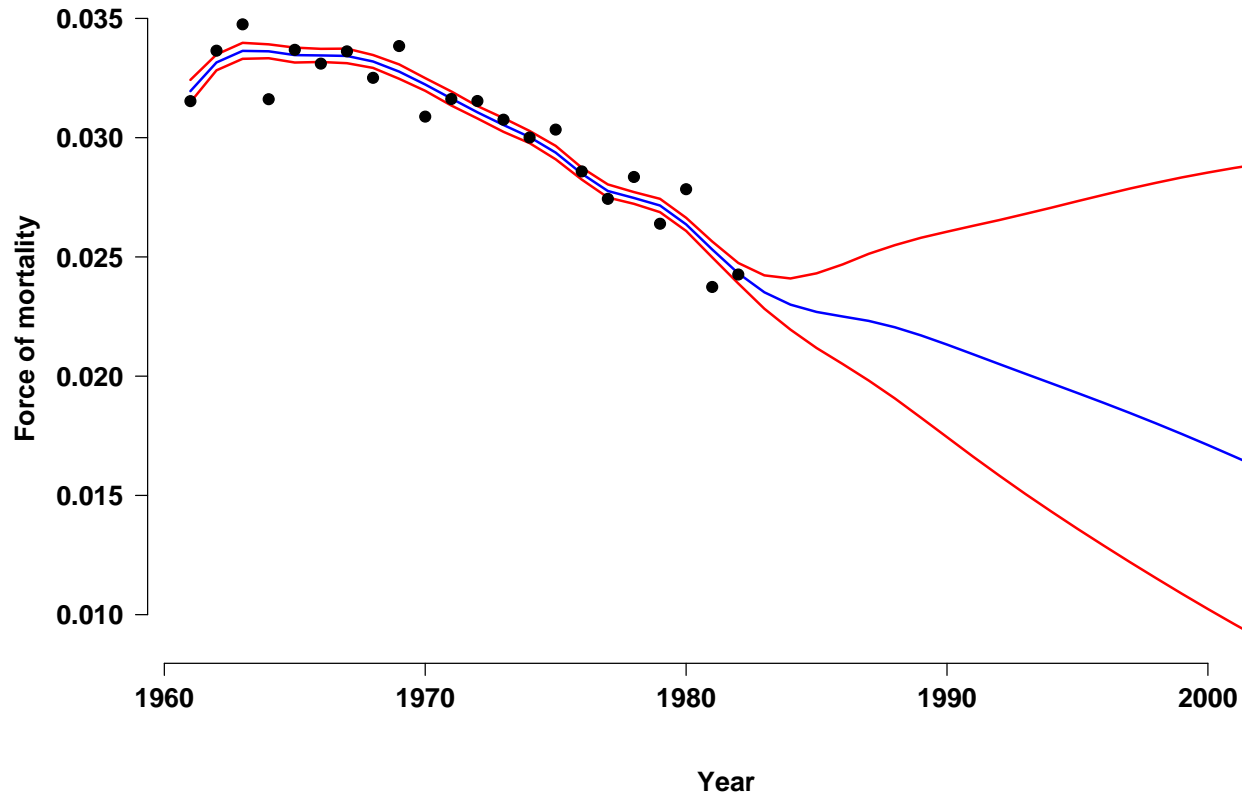
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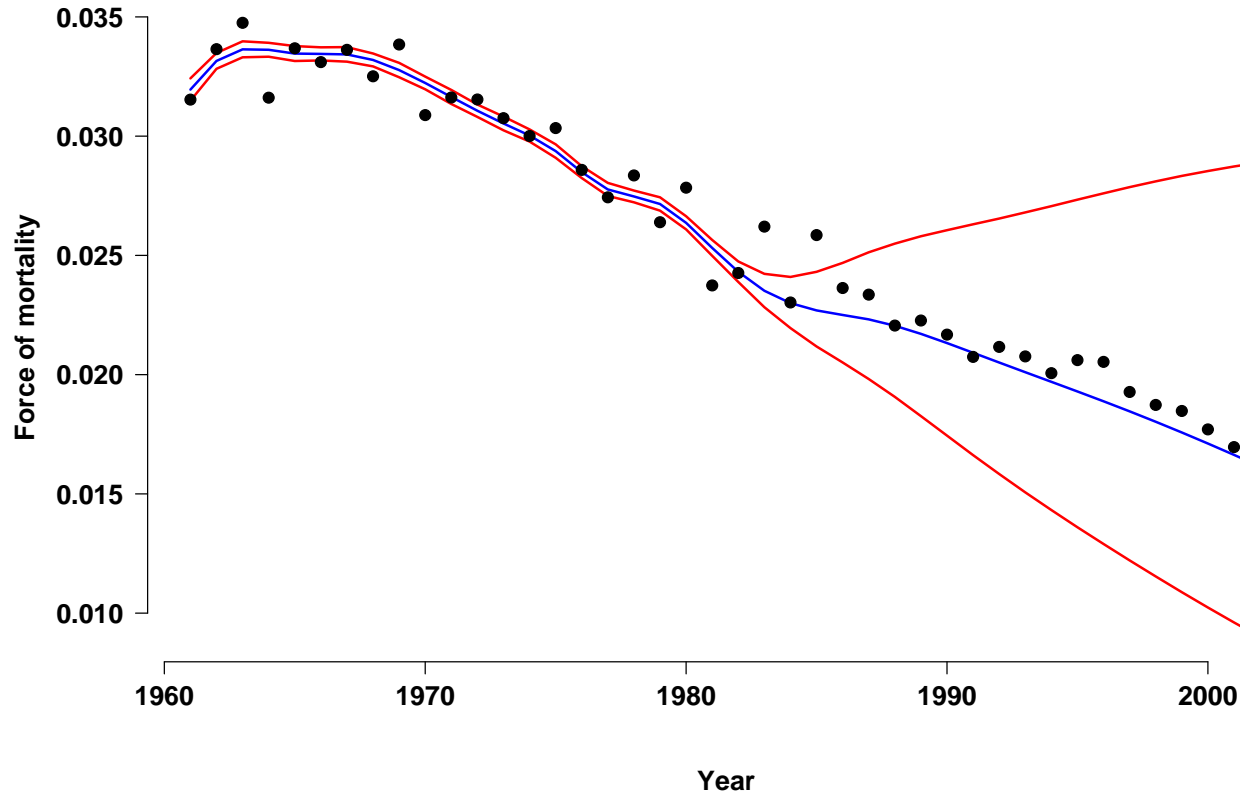
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Source: J. Hubbard, AXA Group Risk Management

# P-splines and trend risk

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<b>Basis</b>	$e_{65}$	$a_{65}$
No improvements	16.53	12.85
Central projection	20.09	14.84
95 <sup>th</sup> percentile	20.92	15.28

- 15.5% extra reserves between “no improvements” and central projection.
- Further 3.1% reserves between central projection and 95<sup>th</sup> percentile.
- Trend risk not diversifiable like stochastic risk.

Source: Richards Consulting calculations using population data for males aged 20–100 in England & Wales between 1961 and 2003. Projection is P-spline with age and cohort penalties. Annuities calculated in arrears using 2.5%.





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- Simple structure

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- Simple structure
- Fitted with free software (R at [www.r-project.org](http://www.r-project.org))

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$$q_{x_i} = \frac{e^{\alpha_i + \beta_i x_i}}{1 + e^{\alpha_i + \beta_i x_i}}$$

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- GLM estimates parameters for risk components



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- Discard data on exact time of death (a bit wasteful)
- Only a single year's experience can be used (very wasteful!)
- Cannot easily use fractional years' exposure

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- Want to model risk of survival ( ${}_t p_x$ ), not mortality risk ( $q_x$ )
- Want to use multiple years' experience
- Want to use exact data on time of death
- Want to use fractional years of exposure
- Want to have similar parameters and interpretation to GLMs

# Survival models: a replacement for GLMs

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- Sophisticated models in commercial packages (e.g. Longevity)

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- Competition driving greater underwriting sophistication
- Profiling reduces uncertainty in pricing mortality...
- ...and spouse's benefits
- GLMs increasingly used for risk analysis
- *But* already being replaced by survival models

# References

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