Standard Life, Dundas House, Edinburgh

Longevity — risk and opportunity

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Longevity risk — plan of talk

- Issues for the bulk buy-out market
- Impact of socio-economic group. . .and how (not) to rate it
- New techniques and tools
- GLMs and survival models
- Summary and questions

New capacity in bulks market

- 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

Scheme	Members
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

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

Pension scheme	Funding level	Buy-out level
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

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

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

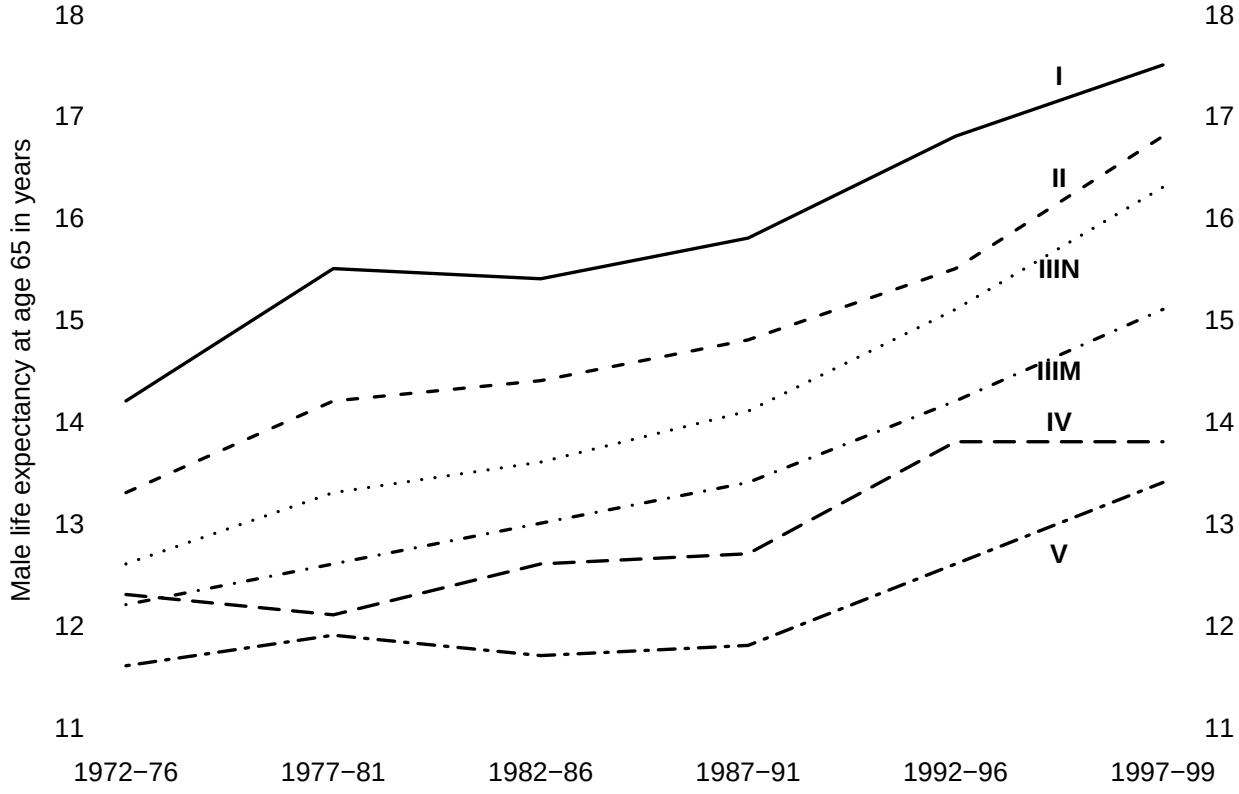
Source: Richards Consulting calculations using Prudential data.

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

Concentration of risk

- 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

Retirement life expectancy by socio-economic group



Source: ONS Longitudinal Survey.

Financial impact of lifestyle

Financial impact of mortality rating factors

Factor	Step change	Reserve	Change
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

- Stakeholder fund of £8,583
- 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

- 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

- Mortality profiling
- Marital-status modelling
- P-spline projections
- GLMs and survival models

Mortality profiling

- 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

Group*	Males	Females
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

- 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

Group*	Males	Females
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: Longevitas Ltd. Survival model of mortality experience of quarter of a million pensioners.

*Mortality Group, courtesy of Experian plc.

Marital-status modelling

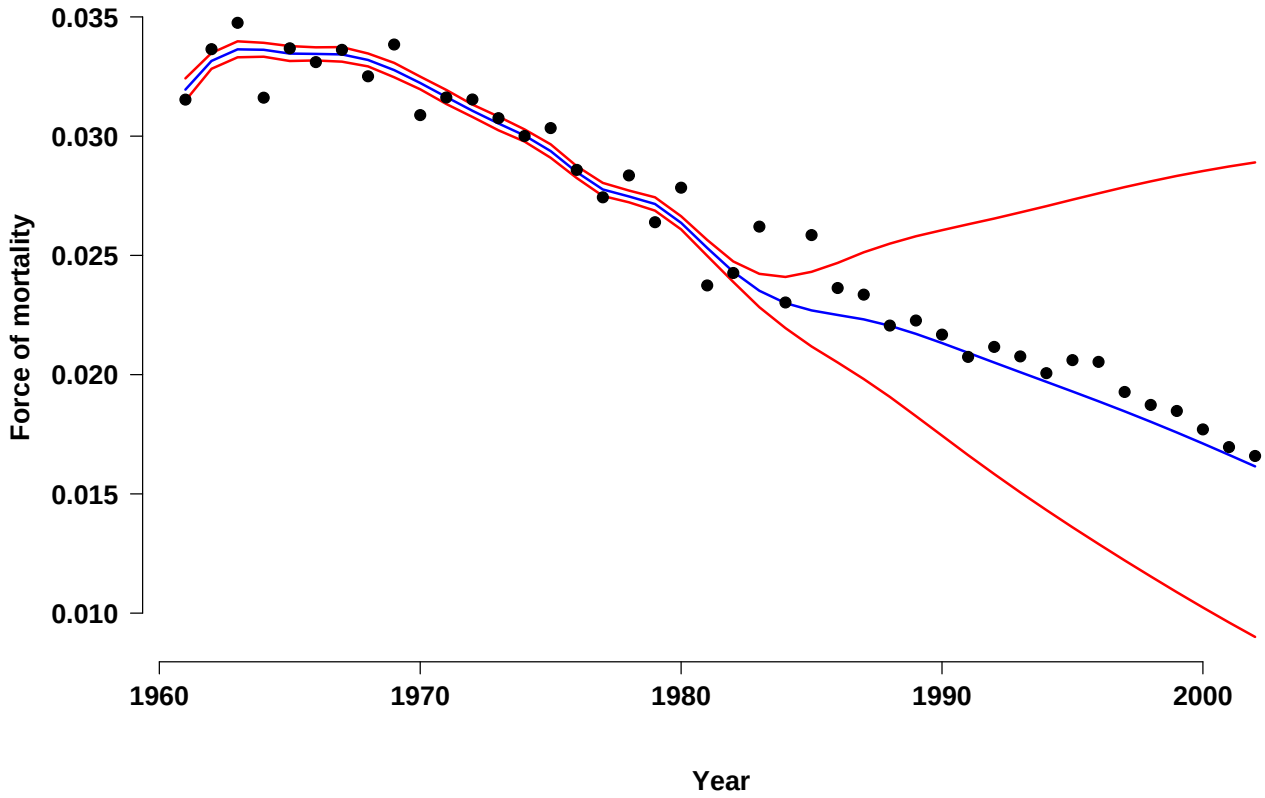
- Spouse's benefit adds 12% to cost of single-life pension*
- Proportion-married assumption could be 60–90%
- Personal profiling can also model likely marital status
- Less guesswork in setting proportion-married assumption

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

P-splines

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

French male mortality rates at age 65



Source: J. Hubbard, AXA Group Risk Management

P-splines and trend risk

Basis	e_{65}	a_{65}
No improvements	16.53	12.85
Central projection	20.09	14.84
95^{th} percentile	20.92	15.28

- 15.5% extra reserves between "no improvements" and central projection.
- Further 3.1% reserves between central projection and 95^{th} 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%.

GLMs

- Widely used for analysing mortality data
- Simple structure
- Fitted with free software (R at www.r-project.org)

What is a GLM?

- Simplest (but least useful) is Poisson count for deaths in a group:

$$D_x \sim \text{Poisson}(E_x^c \mu_{x+\frac{1}{2}})$$

- Most sophisticated (and useful) is *logistic regression* for individual data:

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

- α_i and β_i are built up from risk components for individual i
- GLM estimates parameters for risk components

Limitations of GLMs

- Require relatively large volume of data
- 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

Wish list for replacement for GLMs

- Want to model risk of survival (${}_tp_x$), 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

- Model survival, i.e. ${}_tp_x$
- Use multiple years' experience
- Use exact data on time of death
- Use fractional years of exposure
- Have similar parameters and interpretation to GLMs

Survival models: implementation

- Simple models available (free!) in R (www.r-project.org)
- Sophisticated models in commercial packages (e.g. Longevitas)

Summary and questions

- 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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