PRMIA, Edinburgh Business School

Modern models for longevity risk

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16th May 2013

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1. About the speaker

1. About the speaker

- Consultant on longevity risk since 2005
- Founded longevity-related software businesses in 2006:

- Joint venture with Heriot-Watt in 2009:

2. Why care about longevity risk?

2. Why care about longevity risk?

"By providing financial protection against the major 18th- and 19th-century risk of dying too soon, life insurance became the biggest financial industry of that century [...] 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."

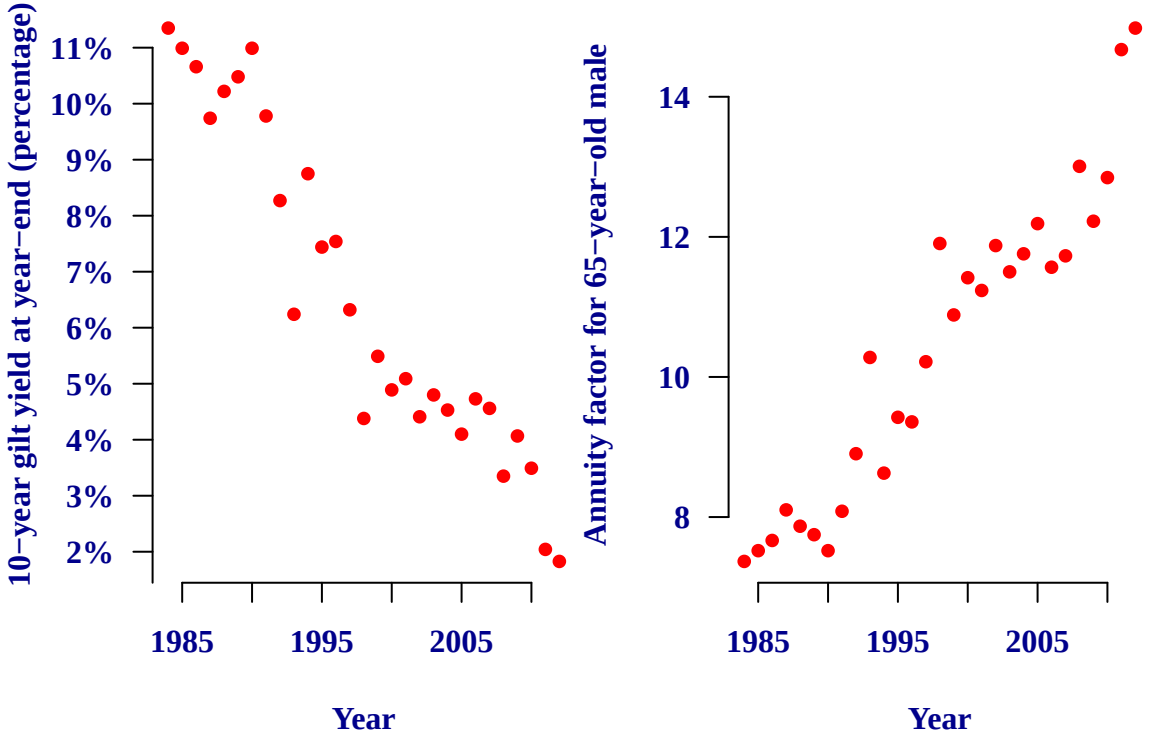
Peter Drucker (1999)

2. Why care about longevity risk?

- Annuities now a large part of the UK life-insurance business.
- They have also become a lot more expensive...

2. Why care about longevity risk?

Gilt yields (left) and cost of annuity to male aged 65 (right)



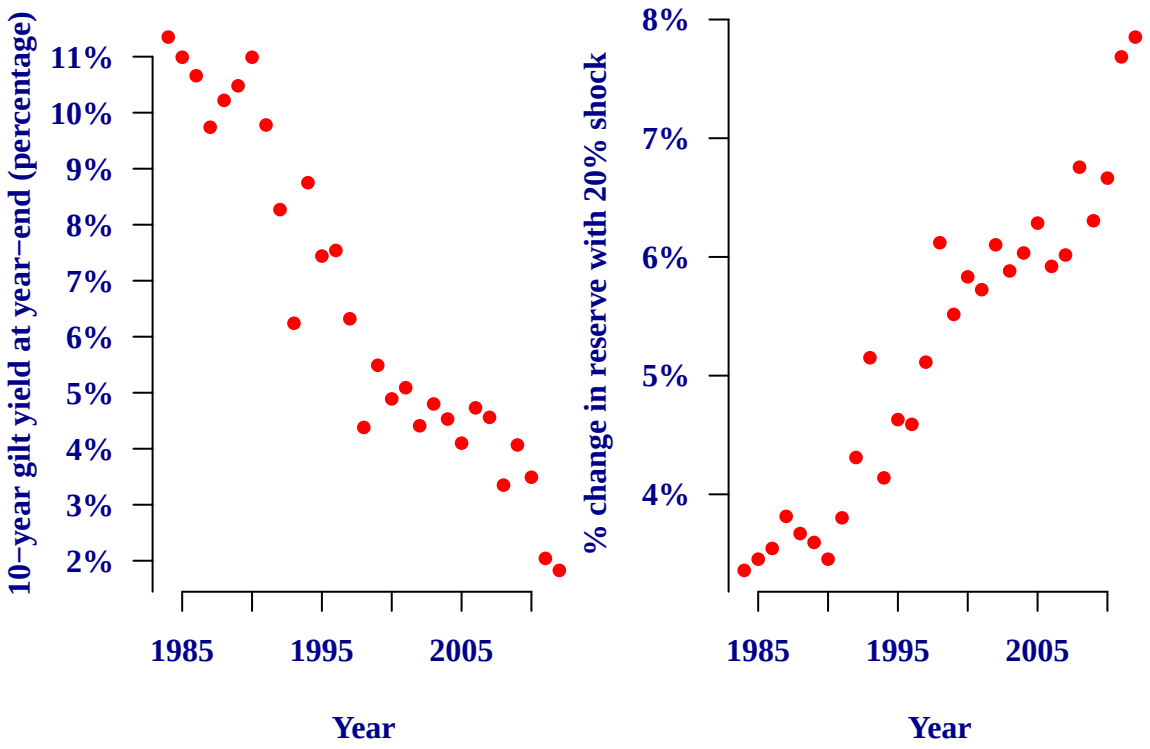
Source: End-year yields from British Government Stock (10-year nominal par yield, series IUAM-NPY from Bank of England) and own calculations for $\overline{a}_{65}$ using S1PA (males) and same yields.

2. Why care about longevity risk?

- Longevity risk is not only important to insurers.
- Increased reserves have also wrought havoc on pension-scheme deficits.
- And those reserves have also become a lot more sensitive to longevity...

2. Why care about longevity risk?

Gilt yields (left) and change in reserve from a 20% mortality shock (right)



Source: End-year yields from British Government Stock (10-year nominal par yield, series IUAM-NPY from Bank of England) and own calculations for $\bar{a}_{65}$ using S1PA (males) and same yields.

2. Why care about longevity risk?

- In a low-interest environment, longevity risk plays a much bigger role.

3. The business need for better models

3. The business need for better models

1. Economic environment has dramatically increased reserve sensitivity.

   $\Rightarrow$ Errors in longevity estimation have a bigger impact.

2. EU law forbids use of gender, the second-most important risk factor.

   $\Rightarrow$ Greater sophistication is needed in analysis and rating.

3. The past

- Historically (pre-computer) actuaries analysed mortality as follows:
  - — Lives were grouped
  - — A few risk factors were considered: age, gender and pension size
  - — Mortality rates (q_x) were compared against an industry table

3. The problem(s)

- Groups don't die, individuals do $\Rightarrow$ not all data is being used.
- Gender no longer legal for pricing individual benefits in EU.
- Portfolio experience can be very different from an industry table.

3. The solution

- Fit a model to your own experience data.
- Treat each pensioner's lifetime as a random variable.
- Use a survival model (μ_x) to utilise all available information.
- Test as many risk factors as your data supports.

4. Longevity risk factors

4. Longevity risk factors

- Actuaries historically rated mortality by age, gender and pension size.
- End-2012 EU ban on using gender in pricing insurance for individuals.
- Actuaries urgently need new rating factors to compensate...

4. Example 1: UK insurer

- Six available risk factors:
    1. Age
    2. Gender
    3. Lifestyle (via postcode)
    4. Duration (time since annuity purchase)
    5. Pension size
    6. Region

Source: Richards and Jones (2004).

4. Relative importance of risk factors

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.

4. Example 2: German pension schemes

- Eight available risk factors:
    1. Age
    2. Gender
    3. Ill-health v. normal retirement
    4. Pension size
    5. First life v. surviving spouse
    6. Sector type
    7. Scheme
    8. Region

Source: Richards, Kaufhold and Rosenbusch (2013).

4. Relative importance of risk factors

Financial impact of mortality rating factors:

Factor	Step change	Reserve	Change
Base case	-	16.114	
Gender	Female→male	14.529	-9.8%
Health	Normal→ill	12.974	-10.7%
Pension size	Large→small	11.717	-9.7%
Region	B→P	11.025	-5.9%
Sector type	Private→public	10.599	-3.9%
Overall			-34.2%

Source: Richards, Kaufhold and Rosenbusch (2013), Appendix 1.

4. Importance of scheme-specific analysis

- Each portfolio is unique.
- Important to analyse your own data.

4. Importance of scheme-specific analysis

- For example, largest city scheme had 10% lighter mortality.
- This was *after* allowing for seven other risk factors.
- Result was highly statistically significant (p-value 0.0001).
- Impact was an extra 2–2$\frac{1}{2}$% on reserves.

4. What risk factors should you use?

- Each portfolio is unique.
- Business practice determines available information.
- Fit models to your data using business-relevant risk factors.

5. Conclusions

- Economic and legal environment demands better mortality modelling.
- Your liabilities are unique, so begin with your own data.
- Survival models for individuals use all of the available information.
- Fit a model using risk factors based on your business practices.

References

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