Understanding pensioner long

Stephen Richards considers new techniques for analysing longevity risk.

The topic of pensioner longevity has dramatically increased in significance in recent years. At the same time as FRS17 disclosed large deficits in corporate pension schemes, a slew of new insurers in the UK has increased the market capacity for bulk buyouts. It has never been more important to understand differentials in pensioner longevity. Fortunately there have been great advances in the techniques and resources available to actuaries advising on pensioner liabilities.

On the one hand, profiling tools from consumer-database companies have greatly enhanced companies' ability to understand who their pensioners and annuitants are and what characteristics they have. On the other hand, the move to using advanced statistical models enables actuaries to get more out of their data than ever before. This article shows how the two combine to give a more detailed picture of pensioner longevity.

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About the data

The data used in this article comprised around a quarter of a million life-office pensioners, including both holders of individual annuities and pensioners from bulk-purchase annuities (bulk buyouts). Using a commercially available profiling tool from Experian, the pensioners were classified for their mortality group using their addresses. The tool was able to identify the mortality group for 78% of pensioners, as shown in table 1.

In addition to profiling for mortality group, the same tool is also able to profile for likely marital status. This is important for the pricing and valuation of spouses' benefits in final-salary schemes, and is therefore useful to insurers in the bulk buyout market.

Table 2 shows that the tool was able to classify 67.0% of cases according to likely marital status. The remaining lives split into 1.6% of pensioners who were matched by the profiling tool but whose marital status could not be modelled, and also 31.3% of pensioners who were not matched at all due to incomplete name or address details.

The total proportion of unknown and unmatched marital statuses (32.9%) is larger than the number of unknown socio-economic groups (21.3%). This is because the latter can also be driven by postcode: where a household is not matched by the tool, a socio-economic group can still be assigned using the dominant group for the postcode.

Methodology

Many life offices use generalised linear models (GLMs) to analyse pensioner mortality. However, GLMs have a number of drawbacks, chief of which is their inefficient use of available data and the restricted ability to model only a single year's data. As a result some life offices are switching to a more powerful set of techniques, called survival models. Survival models make better use of available data, and they are preferable to GLMs in most circumstances as a result.

A survival model can be defined very simply. In this example, each life i is observed alive at 1 January 2005 at exact age x_i, and survives t_i years. We distinguish between deaths and survivors using an indicator variable, d_i, which takes the value of 1 on death and 0 on survival. The probability that life aged x survives t years is ${}_tp_x$, while the force of mortality at age $x + t$ is denoted μ_{x+t}. The likelihood function for a survival model is as follows:

$$L \propto \prod_{i=1}^{n} {}_{t_i}p_{x_i} \mu_{x_i+t_i}^{d_i}$$

where n is the number of lives, Σt_i is the total time lived, and Σd_i is the number of deaths. Σt_i is known to actuaries as the 'central exposed to risk', whereas it is called the 'waiting time' in survival modelling. All that remains is to define ${}_tp_x$ and μ_x. In this case, we use a simple Gompertz model for the force of mortality, namely:

$$\mu_x = e^{\alpha + \beta x}$$

where the values of α and β will be built up individually from risk components for each life i. We also use the general result linking the force of mortality to the survival probability:

$${}_tp_x = \exp\left(-\int_0^t \mu_{x+s}\,ds\right)$$

where the integral is called the integrated hazard function. Fortunately there is software available to do all the calculations for us (we have used the Longevitas system here, which can fit survival models and GLMs, as well as other models).

Results for socio-economic group

As expected, the model produced parameters for age and gender with the highest level of significance. In socio-economic group 1 the model life expectancy at age 65 of a female was 25.1 years, whereas for an equivalent male in the same group it was 23.1 years. Also, as expected, the model produced wide socio-economic differentials, as shown in table 3. A

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Table 1 Breakdown by mortality group

Mortality group	Proportion of: Lives (%)	Deaths (%)	Exposure (%)
1	19.0	13.8	19.0
2	25.7	20.9	25.8
3	13.9	12.4	14.0
4	5.4	4.7	5.4
5	5.1	6.2	5.0
6	7.2	8.6	7.2
7	2.5	3.0	2.4
Unknown	21.3	30.3	21.2
Total	100.1	99.9	100.0

Table 2 Breakdown by likely marital status

Marital status	Mean age	Proportion of: Lives (%)	Deaths (%)	Exposure (%)
Married	69.7	41.1	24.0	41.4
Single	71.9	25.9	23.9	26.0
Unknown	70.6	1.6	1.5	1.6
Unmatched	72.3	31.3	50.6	30.9
All	71.1	99.9	100.0	99.9

Table 3 Mortality for social groups (single males aged 65)

Social group	e_{65}	Force of mortality: (i) 1000 μ_{65}	(ii) as % group 1
1	23.1	3.64	100
4	21.8	6.10	168
7	20.6	9.35	257

Table 4 Mortality by marital status (males aged 65 in group 4)

Marital status	e_{65}	Force of mortality: (i) 1000 μ_{65}	(ii) as % married value
Married	21.9	4.94	100
Single	21.8	6.10	124
Unmatched	16.3	14.26	289

single male aged 65 in socio-economic group 1 had a life expectancy of 23.1 years, while a similar single male in group 4 could expect to live 21.8 years. A male in group 7 could expect to live just 20.6 years.

It is instructive to express these differentials in terms of the pricing assumption a life office might use for an annuity or bulk buyout. To do this we can use the ready reckoner on p54 of the SIAS paper 'Financial aspects of longevity risk'.(1) The difference between the life expectancies of socio-economic groups 1 and 4 is 1.3 years, and this equates to more than a 1% difference in interest rate under current investment conditions. Since a life office pricing margin is typically much less than 1%, not knowing the socio-economic profile of an annuity portfolio could be fatal to profitability.

Results for marital status

Population studies have repeatedly shown that married people have longer life expectancies than unmarried people. However, there is a correlation with socio-economic group: the better off a person is, the more likely they are to be married. Thus the population observation of longer life expectancy for married people might simply be because married people as a group contain disproportionately more better-off people. In this example we have already controlled for socio-economic group explicitly, so we can fit and test marital status as a predictor of longevity. Intriguingly, marital status does still prove to be a significant rating factor for mortality as well, albeit not as strong as socio-economic group. Table 4 shows the impact of marital status on the life expectancy and mortality of males in the middle socio-economic group.

The difference in life expectancy between single and married people is around two months for males in group 4, which roughly equates to a 0.07%, or seven basis points (bps), change in interest rate. While this does not sound like much, 7 bps is a significant proportion of a typical bulk buyout pricing margin, which might be around 50–70 bps at the time of writing. However, this understates the importance of marital status in bulk annuity pricing: as married people are more likely to be drawn from the better off, their financial weighting in a scheme may be more significant than the above analysis implies.

A final word is necessary about the dramatically shorter life expectancy of those annuitants who were unmatched for marital status. One possibility could be due to the age profile of the unmatched group: if they were substantially older and from an earlier birth cohort, they might have heavier mortality for that reason. However, table 2 shows that there is no obvious material difference between the marital statuses with regard to age. Another possible source of difference is that the matching process depends on having full name and address: without either, a pensioner cannot be profiled for marital status. We note, however, that there are two kinds of bulk buyout: those that are individual policies held by named members (individual buyout), and those that are a single policy held by the scheme (group buyout). In the latter case the individual member's details may not be known to the life office as all correspondence and administration is with the scheme, not the member. Thus, the short life expectancy of the unmatched marital status may be because of the more downmarket socio-economic profile of this office's group buyout business.

Improved efficiency

The advent of new profiling services enables actuaries to gain richer detail on the mortality differentials among pensioners and annuitants. More powerful survival models can circumvent the inefficiencies and limitations of traditional GLMs. With these new tools for both data profiling and data modelling, actuaries can now apply greater rigour to the pricing and reserving of annuities and bulk buyouts. □

Reference

(1) Richards SJ and Jones GL (2004) 'Financial aspects of longevity risk', SIAS.

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