Annals of Actuarial Science, Vol. 5, part 2, pp. 139–141.
doi:10.1017/S1748499511000212
First published online 29 June 2011

Guest Editorial

The Usefulness of Stochastic Mortality Modelling

By P.J. Sweeting

The uncertainty over cohort life expectancy continues to concern insurance companies and pension schemes. For pension schemes in particular, the combination of low interest rates and guaranteed pension increases have led to a much greater focus on future mortality rates. This has led to increased interest in stochastic mortality models – that is, models that use stochastic techniques to forecast potential future mortality rates. However, given the high level of uncertainty in such models, is it worth projecting longevity stochastically at all?

The Development of Stochastic Mortality Models

Over the past two decades, there have been considerable advances in the stochastic modelling of mortality. Whilst the mortality law of Gompertz (1825) is nearly two centuries old, it was not until two decades ago that stochastic mortality projection reached maturity with the single-factor model published by Lee & Carter (1992). The cohort effect – identified by Wilmoth (1990) – was used by Renshaw & Haberman (2006) to add sophistication to this model, whilst Gompertz's law itself inspired a range of approaches starting with Cairns *et al*. (2006) and described more fully in Cairns *et al*. (2009).

These models have changed the way we look at longevity improvement, allowing us to consider possible outcomes in terms of centiles as well as scenarios. However, such models have their critics.

Cohort Effects

In the United Kingdom, one area of criticism relates to the "golden cohort" born in the decade centred approximately on 1930, referred to by Willets (2004), Richards *et al*. (2006), Gallop (2008) and others. This unforeseen improvement in longevity resulted in large changes being made to insurance company reserves and pension scheme valuations, and the fact that it was unforeseen could be taken as a criticism of longevity modelling.

An inspection of mortality improvement in the UK over the past 170 years does show that similar cohort effects are evident in the past. There are also numerous period effects resulting from various socioeconomic changes as described by Cutler *et al*. (2006), so missing the possibility of this cohort should be taken as an oversight – albeit a significant one – rather than a failure in the modelling. Indeed, Sweeting (2011) shows how allowing for this sort of change in trend can lead to much greater uncertainty in life expectancy.

However, even greater uncertainty can arise from the choice of model used in projecting mortality, to the extent that the expected mortality rate for one model can lie outside the extreme centiles of another.

Historical Data and Expert Opinion

There is also the more fundamental issue: that this type of stochastic modelling relies on past data to predict the future – and the future is often quite different from the past. All of these factors can be linked to a broader concern about the usefulness of financial modelling, as described by Turner (2009). But what is the alternative?

The only other way in which mortality rates can be usefully predicted is through the use of expert opinions. These more subjective approaches to modelling future longevity rates can take into account medical advances, changes in lifestyle, socioeconomic developments and a range of other factors. As such, they provide a forward-looking alternative to the stochastic models.

However, multi-disciplinary opinion-based modelling does not provide a panacea. For one thing, the range of expert opinions is as wide as that obtained from stochastic modelling. At one end of the spectrum authors such as Olshansky *et al*. (2005) are predicting a fall in life expectancy, whilst at the other end some such as de Grey (2004) predict "negligible senescence".

More importantly, it is difficult to attach any likelihood to the range of opinions – is the chance of near-immortality 50/50 or one in a million?

The usefulness of Stochastic Mortality Models

A consensus view can used to provide expected levels of longevity improvement in the future, if the experts can arrive at a consensus opinion. However, stochastic modelling is still helpful in describing the uncertainty around this central estimate. This is important if – as is often the case – the risk of an extreme outcome is of concern.

The most obvious example of this is in relation to risk capital. Consider a situation where the level of capital that, say, an insurance company must hold in respect of its risks is that which is deemed to be sufficient to avoid insolvency with a particular level of confidence. In this case stochastic mortality models offer the only sensible way of determining the capital requirement for longevity risk. Even with the uncertainties around the choices of models and parameters, it can be used to give a probabilistic assessment of the range of outcomes. This, surely, is where stochastic mortality models are most useful.

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