Session 4B: Mortality Analysis and Trends

Discussant: Eric Stallard, ASA, FCA, MAAA

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Papers Presented:

I. ***Mortality Improvement in the United States: Analysis, Projections and Extreme Scenarios***
By Joseph Lu, Legal & General Assurance Society Ltd.
Wun Wong, Legal & General Assurance Society Ltd.

II. ***Recent Adult Mortality Trends in Canada and the United States: A Comparative Study***
By Nadine Ouellette, Université de Montréal
Robert Bourbeau, Ph.D., Université de Montréal

III. ***Mortality Experience of Three Senior Populations***
By Vincent J. Granieri, FSA, EA, MAAA, 21st Services, LLC

This session presented three excellent papers that provided three different perspectives on recent improvements in mortality.

My comments will address the papers in the same order as they were presented. I will focus on four basic questions:

1. What were the goals of the paper?
2. What were the results?
3. What did we learn?
4. What are the implications of this new information for future modeling activities and other related purposes?

Before getting into the detailed discussion of the papers, I noted it would have been helpful had Paper I provided more details on the two-dimensional P-spline methodology to facilitate comparison with the methods used in Paper II. Moreover, it was not obvious from Paper II how the P-spline projections were generated. Of course, I realized these were independent papers so it was not to be expected that the level of detail of the methodologies would be fully comparable. I made these comments at the outset in the hope that some of these details would be provided in the final versions of the papers in the Online Conference Monograph.

I. Lu and Wong: *Mortality Improvement in the United States: Analysis, Projections and Extreme Scenarios*

1. Goals

The primary goal of this paper was to evaluate the accuracy of Scale AA for U.S. mortality over the period 1995-2006 or 1990-2006 using data from the Human Mortality Database (HMD) and from the Social Security Administration. In this regard, I noted that one of the panelists in a prior session (Session 3A: Comparison of U.S., U.K. and Canadian Annuity Mortality Tables and Studies) had commented that Scale AA was generally considered to be "discredited" for use with Canadian mortality data. Thus, an assessment of its applicability to U.S. data would be of great current interest.

2. Results

The results for 1990-2006 reflected the actual mortality experience with the results for 2010-30 being outputs of the projection models. Age specific results were presented for ages 60, 65, 70, 75, 80 and 85, although the calculations were performed by single years within the age range 60 to 90.

The actual annual rates of improvements in the HMD exceeded those in Scale AA by at least 0.5 percent for all ages for males and most ages for females for the period 1995-2006 (slides 10 and 11).

The actual annual rates of improvements in the SSA data exceeded those in Scale AA for all ages for males and younger than 75 for females for the period 1990-2006 (slides 12 and 13).

For males:

- The projected annual rates of improvements in the SSA projections were substantially below those in Scale AA for all ages for the period 2010-30 (Slide 14).
- The projected annual rates of improvements in the Lee-Carter original HMD projections were substantially above those in Scale AA for all ages for the period 2010-30 (Slide 15).
- The projected annual rates of improvements in the Lee-Carter original HMD projections were substantially below those in the P-spline HMD projections for all ages for the period 2010-30 (Slide 16); the latter were closer to the Lee-Carter Currie-Richards HMD projections.

For females:

- Unlike males, the projected annual rates of improvements in the SSA projections were close to those in Scale AA for most ages for the period 2010-30 (Slide 17).

- Like males, the projected annual rates of improvements in the Lee-Carter original HMD projections were substantially above those in Scale AA for all ages for the period 2010-30 (Slide 18).

- Like males, the projected annual rates of improvements in the Lee-Carter original HMD projections were substantially below those in the P-spline HMD projections for all ages for the period 2010-30 (Slide 19); the latter also were closer to the Lee-Carter Currie-Richards HMD projections.

Slides 20-22 presented prediction intervals and uncertainty bounds using fan charts that highlight the substantial differences between the different models.

3. New Information

The actual annual rates of improvements in the HMD and SSA data exceeded those in Scale AA for most (females) or all (males) ages for the periods 1995-2006 or 1990-2006.

The projected annual rates of improvements in the HMD models exceeded those in Scale AA for both sexes for all ages for the period 2010-30.

4. Implications

Model Risk: The best-estimate forecasts and measures of uncertainty depend on the selected model. Different models yield different results. The best projections are not necessarily derived from the model with the best measure of goodness of fit.

Basis Risk: Annuitant populations may not be adequately modeled using data from the general population. This may become exacerbated by widening socioeconomic differentials in mortality rates in the U.S. in recent years.

The authors calculated that Scale AA may underestimate the values of annuities at age 65 by 1 to 4 percent, leading to their well-supported conclusion that their analysis “raises questions about the adequacy of Scale AA for use in the valuation of annuity liabilities.”

The Society of Actuaries has convened a work group that is currently reviewing the adequacy of Scale AA and is expected to release a revision in the near future which should resolve some of the questions raised in this paper.

II. Ouellette and Bourbeau: *Recent Adult Mortality Trends in Canada and the United States: A Comparative Study*

1. Goals

The primary goal of this paper was to examine changes since 1950 in the age-at-death distribution at older ages in Canada, the United States and eight additional low-mortality countries. Data were obtained from the Human Mortality Database (HMD). The paper presented and applied a two-dimensional smoothing approach based on P-splines to analyze the changes over age and time in the logarithms of the age-year-specific mortality rates, for ages 10 and above.

Using the smoothed age-at-death distribution, the authors focused on two statistics: the modal age at death and the "standard deviation of age at death above the mode."

I noted that this definition of the "standard deviation of age at death above the mode" differed from the usual definition in that the mean value above the mode was replaced by the mode in the computational formula. To better understand what was being computed by this formula, one should consider a symmetric distribution generated by reflecting the unnormalized density values for all points above the mode to all points below the mode. The usual definition of the standard deviation of this artificial distribution would then be equal to the authors' definition of the "standard deviation of age at death above the mode," which I will term the "modal standard deviation" in the remainder of my comments.

2. Results

Figure 4 displayed the time trends in the modal age at death for females in the 10 countries (Slide 14). I was surprised by the decline for U.S. females beginning in 2001-02. The figure indicated that the modal ages at death in 1996 and 2006 were both close to 86.7 years. However, the SSA life tables indicated that female life expectancy at age 65 had increased from 19.1 years in 1996 and 2002 to 19.7 years in 2006. The fact that the modal age at death declined during a period when the age 65 life expectancy increased suggested the changes may be more complex than assumed.

Figure 4 also displayed the time trends in the modal standard deviations for females in the 10 countries (Slide 15). The most notable result was the rapid increase for U.S. females beginning in 2001-02, which may reflect additional aspects of the complex patterns identified in the prior paragraph. The formula for the modal standard deviations suggests there may be some built-in negative correlation between it and the modal age at death.

Figure 5 (and slides 16 and 17) presented the corresponding results for males. Unlike U.S. females, the modal age at death for U.S. males decreased in the late 1990s but then increased. In addition, the modal standard deviations increased in the late 1990s and then flattened out with a very small increase at the terminal point in 2006.

3. New Information

U.S. males and females had distinctive but different patterns of change in the modal age at death and the modal standard deviations. The United States and Canada also had different patterns of change.

4. Implications

Identifying country-specific patterns of mortality change is important for a broad array of applications. The mortality differences between the United States and Canada are often described in terms of the different patterns of changes in life expectancy at birth and at age 65. The measures introduced in this paper extend the richness of these comparisons by moving beyond just life expectancy to the modal ages at death and the modal standard deviations. As noted above, some of the results were quite surprising.

The discussion section of the paper suggested there may be important roles played by differences in health plan coverage, health care access, and health care utilization that may account for some part of the different patterns noted above.

While this may be the case, it is worth noting the modal age at death is close to or above age 85, and that the U.S. elderly at these ages have generally been enrolled in the Medicare program for 20 years or more. Given that about 97 percent of the U.S. elderly are enrolled in Medicare, it would be necessary to attribute some part of the U.S. patterns to changes in the Medicare program itself rather than to coverage differences between the United States and other countries. Of course, there may be long-term effects of coverage differences below age 65 that persist to older ages.

I am looking forward to further development of the model presented in this paper, especially if the development can be conducted in such manner that it allow various explanatory covariates to be directly included in the applications.

III. Granieri: *Mortality Experience of Three Senior Populations*

1. Goals

The primary goals of this paper were to compare the mortality experiences of the general U.S. population with the mortality implied by the 2008 Valuation Basic Tables (VBT population) and the mortality experience of life settlement applicants (LSAs), and to quantify the effects of wealth differences and early antiselection (i.e., higher survival than expected at one or more durations). In these analyses, the VBT mortality served as a proxy for the mortality of life insurance policy holders. The calculations used population matching based on age and gender, or age, gender and smoking.

2. Results

The survival functions indicated a clear ordering with the highest survival for the VBT population, followed by the LSA population, followed by the general U.S. population (Figure 3).

Renormalization of the survival curve to unity at 72, 84, and 96 months, respectively (figures 4 to 6), revealed a convergence of the conditional survival functions by the eighth year for the three populations. This implied that the hazard functions (i.e., the negative derivatives of the logarithm of the survival functions with respect to time or duration) for the three populations were almost identical beyond eight years. Conversely, the marginal survival differences among the three populations shown in Figure 3 can be attributed to differences in the hazard functions in the first eight years.

The presentation indicated that the time to duration varied inversely with age.

The wealth effect was significant (Figure 7). Deciles of income were based on ZIP code statistics from the 2000 Census. The measure of the wealth effect was the change in time required to reach a common value of the survival function. The wealth effect was shown to vary inversely with age with a resulting range of four to 24 months (figures 8 to 12).

The test of antiselection was based on a comparison of the LSA with the general U.S. population (Figure 13). As one can infer from my comments below, I would have liked to have seen a comparison of the LSA with the VBT population in addition to the one provided, or in place of it if space was a constraint.

3. New Information

The convergence of the LSA conditional survival to the VBT conditional survival at later durations (i.e., beyond eight years) is a new result that may allow use of VBT hazard rates at durations where no LSA data are available.

The excess mortality of the LSA population over that of the VBT population was restricted to increased hazard rates in the first eight years. This suggests that the LSA population might be decomposed into two subpopulations, one that is statistically equivalent to the VBT population and a second with much higher mortality rates that is essentially extinct within the first eight years. Methods for prospectively identifying which members of the LSA population belong to the second subpopulation would be of obvious interest to life settlement investors.

Figure 13 showed that an antiselection effect of five to six months was due to a wealth effect.

4. Implications

The LSA population is doubly selected from the general U.S. population. First, the VBT population is selected from the general U.S. population by wealth and health (i.e., via underwriting). Second, the LSA population is self-selected from the VBT population by wealth and health.

We need to better understand the self-selection at the second step if we are to generate accurate survival models for the LSA population.

Though not discussed in the paper, there is a third selection step in which the life settlement transaction (LST) population is selected from the LSA population based on the person-specific life expectancy estimates generated from the person’s medical records and other health-related information.

A priori, one would not expect the LST hazard rates to converge to the LSA or VBT hazard rates at any time except perhaps at the extreme tails of the survival function. Thus, use of the LSA hazard rates for valuation of LST portfolios at long durations would be a conservative strategy. It would be of interest to determine if the strategy were unduly conservative.