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The Relationship of Mortality Projections and the Underlying Mortality Tables Used

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The 1975-80 select and ultimate mortality table has served the actuarial profession very effectively over the decades. Scaling factors were updated and minor adjustments were made to keep this table current. All prototypes, however, need to be re-evaluated from time to time in order to ensure accuracy and appropriateness. Changes in lifestyles, medical advances, new underwriting requirements and risk classifications, etc. can affect mortality patterns and need to be recognized. **In this paper it will be shown that the result of using the 1975-80 select and ultimate table, as opposed to the more modern 1990-95 select and ultimate table, can result in a significant understatement of future mortality, meaning that anticipated profits may prove to be illusory.**

The development of mortality assumptions and projections typically takes into consideration company mortality experience, industry mortality experience or a combination of both.

Projecting future mortality has been referred to as an art, as well as a science. Mortality assumptions and projections are used in many different situations and for many different purposes, from calculating profit margins to demonstrating company solvency. Some examples include pricing new products, cash-flow testing, analysis of reinsurance costs (i.e. reinsurance premiums vs. future expected mortality), self-support testing (under the NAIC Model Illustration Regulation, under New York's Section 4228, etc.), reserve adequacy testing, valuing inforce blocks of business, etc.

The development of mortality assumptions and projections typically takes into consideration company mortality experience, industry mortality experience or a combination of both. The pricing actuary, in establishing a mortality assumption for developing new products, often begins with the mortality experience of recently issued policies of a particular type of product and makes some adjustments for possible changes in underwriting requirements, such as average face amount, persistency, or any other factor that may affect future mortality. The appropriate mortality experience, therefore, would be limited to the early durations of newer products, which would have most likely been issued using underwriting requirements and guidelines similar to what will be used in the near future.

The valuation actuary, in performing cash-flow testing, reserve adequacy testing, valuing an inforce block of business (possibly for sale or acquisition), etc., would begin with the mortality experience of policies issued over a longer time frame, perhaps 10 to 20 or more years, which would be more representative of the company's entire inforce business.

The reinsurance actuary, whether from the ceding company perspective (analyzing reinsurance quotes by comparing them with future expected mortality) or the assuming company perspective (developing a reinsurance quote that properly reflects future expected mortality), would be interested in mortality experience of recently issued policies in reinsuring new business and policies issued "many" years ago in reinsuring inforce business.

General Approach

We started with a simple model, using the assumption that $10,000,000 of face amount was issued each year for each issue age (25, 35, 45, and 55) and experiencing Linton "B" lapse rates (20%, 12%, 10%, 8.8%, 8%, etc.). We also formed a composite issue age by assuming the distribution of face amount by age was 15%, 35%, 35% and 15% for issue ages 25, 35, 45 and 55, respectively.

We used the model described above to calculate actual to expected mortality ratios for policies in particular durations (e.g. the first three or first five policy years). These ratios were calculated by assuming an arbitrary amount of death claims for actual mortality claims experience and applying the qx's of the 1975-80 and the 1990-95 select and ultimate mortality tables to these particular policies to obtain the expected mortality claims experience. Future mortality claims would be projected

over 20 years by applying the previously calculated actual to expected mortality ratios to the mortality table on which the actual/expected mortality ratio was based.

We used this model to calculate actual to expected mortality ratios (for each mortality table) for policies in their first three policy years. Next we calculated the 20-year present value of future claims for a single year of issue (representing new business), using the qx's of each mortality table separately. That is, the actual to expected mortality ratio obtained by using the 1975-80 mortality table was applied to the 1975-80 mortality table in calculating the 20 year present value of claims, and analogously for the 1990-95 mortality table. We then repeated this process using the first five policy years to see if the results would differ significantly. We also used this model to calculate actual to expected mortality ratios (for each mortality table) for inforce blocks represented by policies in later durations. We then similarly calculated the 20-year present value of future claims.

Results

It was shown that, where the actual to expected mortality ratios were based on mortality experience of the first three policy years, using the 1975-80 select and ultimate mortality table produces a present value of future claims (male composite) that is **13%** lower than what would be obtained by using the 1990-95 select and ultimate mortality table. This reduction varies significantly by issue age: 32% lower at issue age 25, and 14% lower, 22% lower, and 2% lower for issue ages 35, 45 and 55, respectively.

The results for females are similar, but the difference is smaller. The present value of future claims (female composite) is 10% lower when using the 1975-80 table, as opposed to using the more recent 1990-95 table.

Furthermore, our analysis showed that, even if the actual to expected mortality ratios were based on the mortality experience of the first five policy years, the relationships would be similar. It was also shown that the relationships are similar for inforce blocks, but the differences are smaller.

It became clear that the 1975-80 table generally produces mortality projections considerably lower than the more recent 1990-95 table. To help put the mortality differentials between these tables into perspective, we compared these differentials to the effect of assuming annual mortality improvements of 1.0% and 1.5%. We developed a simple model to calculate the reduction in the present value of future claims over 20 years based on a single year of issue (assuming Linton B lapses and a discount rate of 6%) resulting from 1.0% and 1.5% annual mortality improvement (reduction) factors for all 20 years. This analysis was done for ages 25 and 55, male and female, and both mortality tables (1975-80 and 1990-95). The results were that a 1.0% annual improvement factor over all 20 years (a somewhat aggressive assumption) produces a decrease in the present value of future claims ranging from 7% to 10%; while using a 1.5% annual improvement factor (a very aggressive assumption) produces a decrease ranging from 10% to 14%.

Observations and Conclusions

The relationship of mortality projections and the underlying mortality tables turns out to be quite

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significant. The majority of companies continue to use the 1975-80 select and ultimate mortality table. **In making the decision to utilize the 1975-80 select and ultimate mortality table, as opposed to the 1990-95 select and ultimate mortality table, the actuary may unwittingly be taking an aggressive posture when it comes to projecting future claims.** For example, our analysis showed that for many issue ages, the decrease in the present value of future claims resulting from using the 1975-80 select and ultimate table, as opposed to the 1990-95 select and ultimate table, is often greater than the decrease in the present value of future claims resulting from using aggressive mortality improvement factors.

This phenomenon results from the fact that the slope of the 1990-95 table is higher than that of the 1975-80 table (i.e. in the early years the ratio of the qx's of the 1990-95 table to the 1975-80 table are lower than they are in the later years.) Each of these tables was based on the Society of Actuaries Intercompany Mortality Study on Standard Ordinary issues in the USA. The 1990-95 table, in addition to being a much more recent table, was based on data where the total dollar amount of exposure was $4.1 trillion for males, and $1.6 trillion for females, more than double that of the earlier 1975-80 table, and hence should have greater credibility. It should be noted that the 1990-95 table was developed with selection factors for 25 years with an emphasis of fit over smoothness, while the 1975-80 table was developed with selection factors for 15 years with an emphasis of smoothness over fit.

Companies with relatively low average issue ages (e.g. issue ages 25 - 45) that are still using the 1975-80 select and ultimate mortality table should be especially careful in setting their mortality assumptions. If mortality is better reflected by the 1990-95 table, which is very likely, they run the risk of significantly understating future claims.

Some state regulations dealing with self-support testing and valuation (e.g. Regulation XXX) prohibit the use of mortality improvement factors prospectively. Since we have shown that using the 1975-80 mortality table is often similar to using the 1990-95 table with aggressive mortality improvement factors, state regulators may consider requiring the use of the 1990-95 mortality table.

Based on a recent survey conducted by Tillinghast-Towers Perrin (The 2000 Pricing Survey of Individual Life and Annuity Products) covering 22 mutual companies and 38 stock companies, very few companies include future mortality improvement when calculating expected mortality in product pricing. Therefore, since companies in general believe it prudent to not reflect future mortality improvement, it is especially important that they fully analyze their choice in selecting the underlying mortality table used in their profit studies and mortality projections. In addition, adjustments and modifications to existing tables may be necessary (e.g. there is an AIDS "hump" in young male middle duration mortality reflected in the 1990-95 mortality table which is probably inappropriate in today's climate of fluid-tested underwriting).

Many companies (direct writers, as well as reinsurers) have reduced profit margins in order to meet competition. Some may have even liberalized (lowered) their mortality assumptions to offset this reduction to profit margin, which increases the likelihood of adverse mortality deviations. In this business environment, the additional vulnerability caused by using a possibly inappropriate mortality table becomes particularly risky.

Mortality studies are becoming less and less rigorous because it is more difficult to get credible experience. This results from the fact that in recent years new underwriting requirements and many differentiated risk classifications have emerged (preferred, super-preferred, preferred-plus, etc). In this climate greater emphasis must therefore be placed on subjective judgment rather than stringent statistical techniques. As mentioned earlier, determining mortality assumptions and projecting mortality is an art, as well as a science. ❖

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