SOCIETY OF ACTUARIES

Article from:

Product Matters!

August 2002 – Issue No. 53

SOCIETY OF ACTUARIES

Product Matters!

The newsletter of the Individual Life Insurance and Annuity Product Development Section

Published in Schaumburg, IL by the Society of Actuaries

August 2002 • Issue No. 53

The Relationship of Mortality Projections

and the Underlying Mortality Tables Used

by Larry Warren

Features...

INTRODUCTION

The 1975-80 select/ultimate mortality table has continued to serve the actuarial profession very effectively over the decades. Scaling factors were updated and minor adjustments were made as an attempt to keep this table current. All prototypes, however, need to be re-evaluated from time to time in order to ensure appropriateness and accuracy. Changes in lifestyles, medical advances, new underwriting requirements and risk classifications, etc. can effect mortality patterns and need to be recognized.

This paper will show that the result of using the 1975-80 select/ultimate table, as opposed to the more modern 1990-95 select/ultimate table, can be a significant understatement of future mortality and hence anticipated profits may prove to be illusory.

Projecting future mortality has been referred to as an art, as well as a science. Mortality projections/assumptions are used in many situations and for many different purposes, from calculating profit margins to demonstrating company solvency. Some examples are:

- Pricing new products
- Cash flow testing
- Analysis of reinsurance costs (e.g. reinsurance premiums vs. future expected mortality)
- Self-support testing (under the NAIC model illustration Regulation, etc.)
- Reserve adequacy testing
- Valuing inforce blocks of business.

The development of mortality projections/assumptions typically takes into consideration company mortality experience, industry mortality experience or a combination of both. Actuaries may include different exposure periods in their analysis, depending on the purpose of the assumptions being developed.

The pricing actuary, when establishing a mortality assumption for developing new products, would begin with the mortality experience of recently issued policies of a particular type of product. They would then make adjustments for any factors that may impact future mortality, including possible changes in new underwriting requirements, average face amount or persistency. The appropriate mortality

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experience, therefore, would be limited to the early durations of newer products, which would have most likely been issued using underwriting guidelines/ requirements similar to what is currently used or will be used in the near future.

The valuation actuary, when 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. These policies may have been issued over a period of 10 to 20 or more years, which would be more representative of the company's entire inforce business.

The appropriate mortality experience, therefore, would be limited to the early durations of newer products...

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) may need both viewpoints. They would be interested in mortality experience of recently issued policies in reinsuring new business, but in mortality experience of policies issued "many" years ago in reinsuring inforce business.

II. GENERAL APPROACH

For our demonstration, we started with a simple model using the assumption that a $10,000,000 face amount was issued each year for each issue age (25, 35, 45, and 55) and experiencing Linton "B" lapse rates (20 percent, 12 percent, 10 percent, 8.8percent, 8percent, etc.) We also formed a **composite issue** age by assuming the distribution of face amount by age was 15 percent, 35 percent, 35 percent, and 15 percent 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. 1st three or 1st 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/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 actual to expected mortality ratios previously calculated, to the same mortality table that the actual/ expected mortality ratio was based on.

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.

III. RESULTS

It was shown that, where the actual to expected mortality ratios were based on mortality experience of the first three policy years, the 1975-80 table produces a present value of future claims **(male composite)** that are **13 percent lower** than what would be obtained by the 1990-95 mortality table. A reduction was seen at each issue age in our test, but varied significantly by issue age as shown on the next page.

Issue Age	25	35	45	55	Overall
Percent Lower	32%	14%	22%	2%	13%

The results for females were similar but not as extreme. The present value of future claims (**female composite**) are **10 percent lower** when using the 1975-80 table, as opposed to, using the more recent 1990-95 table.

Surprisingly enough 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 above relationships would be similar. It was also shown that for inforce blocks this relationship still holds, but is less dramatic.

It became clear that the 1975-80 table generally produced mortality projections considerably lower than the more recent 1990-95 table. To gain insights into the significance of the mortality differentials between these tables, we sought to determine what **future mortality improvement** factors might recreate the significant decrease in mortality.

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 percent) resulting from 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 showed 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 percent to 10 percent. Further, a 1.5 percent annual improvement factor (a very aggressive assumption) produces a decrease ranging from **10 percent to 14 percent.**

IV. Observations and Conclusions

The relationship of mortality projections and the underlying mortality tables turns out to be quite significant. The majority of companies continue to use the 1975-80 select/ ultimate mortality table. **In making the decision to utilize the 1975-80 select/ultimate mortality table, (as opposed to the 1990-95 select/ ultimate mortality table) the actuary may unwittingly be taking an aggressive posture when it comes to projecting future claims.** As we demonstrated for many issue ages, the decrease in the present value of projected claims resulting from this decision is often greater than the decrease in the present value of projected 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 United States. 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

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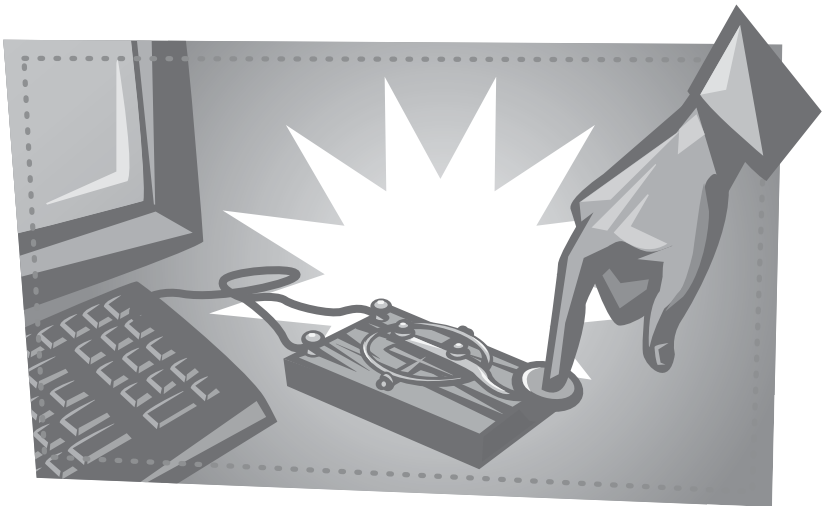

credibility). It should be noted that the 1990-95 table was developed with selection factors for 25 years with an emphasis of fit over smoothness, while the 1975-80 table was developed with selection factors for 15 years with an emphasis of smoothness over fit.

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

Certain 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, it is not beyond comprehension that state regulators may soon consider the need to** *require* **the use of the 1990-95 mortality table.**

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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 in general, companies believe it prudent <u>not</u> to 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.)

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

Mortality studies are becoming less and less rigorous because it is more difficult to get credible experience. This results from the fact that over 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 we mentioned earlier, projecting mortality and determining mortality assumptions is clearly an art, as well as a science.** □