**Appendix L**

# Small Company Monte Carlo Simulation

Smaller companies may be more subject to random fluctuation than are larger companies. To examine the effect of random variation on small company experience, the Academy Task Force ran Monte Carlo simulations of a sample small company. This analysis is very similar to that performed to examine the same issue for the 1980 CSO Table.

In performing the test, expected deaths were calculated using the select and ultimate 2001 VBT. The tables were gender and smoking specific. The composite table was used where smoking status was unknown. This best fit the data under consideration.

The data used for the smaller company consisted of 12,000 policies that were randomly selected from the database of a smaller company that agreed to participate in our analysis (note that this company may not be representative of all smaller companies). The following table summarizes the resulting database and certain expected results:

| Sex | Number of Lives | Amount of Insurance | Expected (2001 VBT) | |
|---|---|---|---|---|
| | | | Number of Claims | Amount of Claims |
| Male | 6,718 | 423,346,127 | 23.58294 | 1,082,548 |
| Female | 5,282 | 187,727,429 | 15.87829 | 308,976 |
| Total | 12,000 | 611,073,556 | 39.46123 | 1,391,525 |

The Monte Carlo simulation involved simulating deaths using a random number generator. One year's experience was simulated one hundred times. Assuming full retention of all amounts, the aggregate number of deaths were the one hundred simulations were as follows:

| Sex | Simulated Number of Claims | Simulated Amount of Claims |
|---|---|---|
| Male | 2,433 | 110,961,638 |
| Female | 1,640 | 31,783,781 |
| Total | 4,073 | 142,745,419 |

The amount of claims shown above assumes no reinsurance, an unlikely situation for a company this small. With a $50,000 retention, the results by amount were as follows:

| Sex | Amount of Insurance | Expected for 100 simulations (2001 VBT) | Aggregate Simulated Amount of Claims |
|---|---|---|---|
| Male | 187,759,902 | 58,535,990 | 60,901,887 |
| Female | 120,721,683 | 23,870,746 | 24,963,281 |
| Total | 308,481,586 | 82,406,736 | 85,865,168 |

The distribution of simulated Monte Carlo results as a percentage of the expected based on the 2001 VBT is shown below:

| | By Number of Claims | | | By Amount of Claims $50,000 Retention | | |
|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total |
| 20-30% | 0 | 0 | 0 | 0 | 0 | 0 |
| 30-40% | 0 | 0 | 0 | 1 | 2 | 0 |
| 40-50% | 1 | 1 | 0 | 2 | 4 | 1 |
| 50-60% | 1 | 5 | 1 | 1 | 5 | 2 |
| 60-70% | 2 | 7 | 0 | 3 | 9 | 1 |
| 70-80% | 6 | 7 | 8 | 8 | 6 | 5 |
| 80-90% | 24 | 14 | 18 | 14 | 14 | 14 |
| 90-100% | 17 | 12 | 22 | 17 | 9 | 25 |
| 100-110% | 17 | 15 | 20 | 16 | 6 | 19 |
| 110-120% | 12 | 18 | 18 | 18 | 15 | 15 |
| 120-130% | 9 | 7 | 9 | 9 | 12 | 10 |
| 130-140% | 9 | 10 | 2 | 5 | 6 | 5 |
| 140-150% | 0 | 0 | 0 | 3 | 3 | 1 |
| 150-160% | 0 | 1 | 1 | 0 | 3 | 0 |
| 160-170% | 1 | 1 | 0 | 1 | 1 | 1 |
| Over 170% | 1 | 2 | 1 | 2 | 5 | 1 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |
| Total over 100% | 49 | 54 | 51 | 54 | 51 | 52 |

The Academy Task Force also ran the database against the 2001 CSO Table to determine expected claims on that basis. A $50,000 retention limit was used in this analysis. The following table shows the results of that work:

| Sex | Expected by the 2001 CSO Table | | Ratio to VBT | |
|---|---|---|---|---|
| | Number of Claims | Amount of Claims | By Number | By Amount |
| Male | 27.06941 | 706,258.12 | 114.8% | 116.0% |
| Female | 19.52026 | 307,191.69 | 122.9% | 123.1% |
| Total | 46.58967 | 1,013,449.80 | 118.1% | 118.0% |

Comparing these numbers to the distribution of Monte Carlo results gives an idea of the amount of random variation in small company results that will be covered by the 2001 CSO Table. This type of crude analysis can be used to give the reader an idea of the adequacy of the table for small companies, but it is still important for valuation actuaries to consider their own company's characteristics and asset adequacy when selecting to use the 2001 CSO Table requirements. Using this comparison, and an analysis of the Monte Carlo results, we get the following results using the $50,000 retention limit:

| | By Number of Claims | | | By Amount of Claims | | |
|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total |
| Percent below 2001 CSO | 78% | 84% | 94% | 76% | 79% | 78% |
| Percent above 2001 CSO | 22% | 16% | 6% | 24% | 21% | 22% |

In considering the results above the Academy Task Force noted the following:

1. The Monte Carlo results did not consider the release of reserve on death.
2. This analysis considers the adequacy of the 2001 CSO Table for a single year's experience but it does not consider its adequacy as a reserve standard. In considering reserve adequacy, fluctuations from year-to-year will have less effect.