SOCIETY OF ACTUARIES

Article from:

CompAct

July 2009 – Issue 32

In Praise of Approximations

By Carol Marler

When I was taking exams in the '70s, the article, "Analysis of Approximate Valuation Methods," was one of my favorite readings. It was written in 1955, by E. Allen Arnold. I found it both interesting and practical. It began, "Since Frank Shailer's paper 'Approximate Methods of Valuation' appeared in 1924, our actuarial literature has omitted any further development of this subject, except for occasional discussions." Not long after I took that exam, the syllabus was changed and the article was removed. Nothing comparable has replaced it. One purpose of this article is to begin some further discussions of when, how and why we need approximations.

Of course the environment has changed a lot over the years. Our personal computers have power exceeding many mainframes of earlier times. In fact, it has been said that with the computer power available today, approximations are no longer necessary. I disagree. The benefits of increasing computer power have led to significant changes in the way we do our work. Organizational structures are flatter. We no longer have an army of clerks to do routine calculations, and typing pools are an anachronism. We must produce results in compressed time frames, and more analysis is expected. The products we offer have become much more varied, more complex and more individualized, while our valuation methods are also growing more complex, reflecting a range of values rather than a single number result.

Before presenting my arguments for using approximations, it seems worthwhile to define a few terms and to provide some distinctions.

- Estimate/Approximation
  - o An estimate is an educated guess. My dictionary says, "Estimate … implies a personal judgment" in a specific context.
  - o An approximation is a methodology for getting close enough. Generally this involves a model or formula.
- Accuracy/Precision
  - o Accuracy is a measure of how close one is to the correct answer.
  - o Precision relates to the possible range of results—more significant digits indicate higher precision.

Here are four reasons why approximations are still a very important part of actuarial work.

First, I believe that most companies have at least one block of business that never grew big enough to justify making system modifications to handle all its unique features. An old term for this category is "shoe box" because all the administrative data was once kept in a box about the size of a shoe box. Even though these cases are probably administered on a computer now, the actuarial analysis is, of necessity, simplified in order to focus on other issues that are more material.

Cost/benefit analysis is always necessary. Good practice calls for putting in the amount of time commensurate with the accuracy that can be added. Experienced actuaries are able to recognize when a judgment call is better than another computer run.

Second, there are a lot of approximations used even in calculations often considered to be "exact." For example, there are two ways to express a person's age as an integer, and both methods are well accepted—age last birthday or age nearest birthday. Unless the calculation is actually done on the person's birthday, though, the integer age is only an approximation. Likewise the use of mean reserves or mid-terminal reserves is well-established. Some companies prefer to use interpolated terminal reserves, but even this is generally done only to the nearest month.

We use a lot of input assumptions that are only approximations. Our mortality tables may look exact, but they always involve some degree of smoothing. Interpolation and/or extrapolation are also necessary because of the sparseness of data, especially at the oldest and youngest ages.

Many companies use early cut-off for administrative systems in order to meet deadlines. Any adjustment to the actual month end-date is a form of approximation. There is often a trade-off between timeliness and accuracy, or a trade-off between the size of the potential error and the cost to make the results more accurate.

Third, the growing use of stochastic models has made it abundantly clear that all our actuarial calculations are merely a point estimate taken from a random distribution. The fact is, we know that the expected value we calculate is almost certain to be wrong, although the law of large numbers does tell us that we can get close enough. How close? A lot of work has gone into analysis of the error involved in various mathematical functions, particularly when these functions are included in a software package. Actuarial judgment is again the correct answer.

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On the other side of the closeness question, consider a pension plan with only about five participants. Assuming pre-retirement mortality using any standard table will in most years result in a fractional short-fall in results because actual gains from mortality are less than expected. For this reason, it is common practice to assume zero pre-retirement deaths in small plans.
Fourth, when the underlying data is missing, inaccurate or otherwise flawed, a good enough calculation is really the most efficient choice. Various terms have been used to describe overexertion in such a situation: False precision, spurious precision or illusionary accuracy.

I once heard of an actuary who claimed that he got more accurate results when he ran his model with quarterly payment patterns. The problem was that he hadn't measured actual quarterly premium collections, but simply divided the annual premiums by four. Spurious precision. And because the input data was of low quality, illusionary accuracy.

Another story involves an actuary who presented a rounded result to his manager: about X thousand dollars. The manager wanted it more accurate, so the actuary went back to the computer output and gave an answer to the dollar. When the manager was still dissatisfied, the actuary pulled some change out of his pocket, counted it, and offered that result to provide dollars and cents. False precision. I wasn't there, but I do hope the manager laughed.

There are other times when approximations are valuable.

Checking for reasonableness: This might be for a complex calculation, such as scenario testing. An approximate calculation could show if the results are unreasonable, and may give some insight into where the problem might be.

Stochastic on stochastic: By this phrase, I refer to those cases where each year of each scenario requires an embedded stochastic model. This is a concern with regard to Embedded Value calculations, since one of the items to be projected is the required surplus, which is defined in terms of a conditional tail expectation (CTE), or in other words a stochastic calculation. The number of calculations is a linear function of the square of the product of the number of scenarios and the number of years projected. There are several methods for reducing the computational intensity. One of the most obvious is to replace the CTE with some approximate formula that does not require stochastic projections. Then the formula for time required becomes linear rather than quadratic.

Finally, some comments about incurred but not reported (IBNR) claim liabilities. Whatever you do for this liability, there will be some volatility that cannot be removed. In other words, nothing will estimate it well. It can be helpful to remember that the objective is to estimate the eventual incurred claims, not the IBNR itself. Thus the error measurement ought to be with respect to the total current estimate of incurred claims.

Of course, you might be in the situation of a company president whose company had only recently begun writing life insurance. With just a few hundred policy holders, the president confidently explained, "I know all of our insured people and they haven't died." Sooner or later, though, there would be a situation in which, through sheer numbers, some death might not be noted in time. A consulting actuary was able to convince the president that he needed to establish a formula-based IBNR while it was small and then allow the provision to grow slowly over the years.

CONSIDERATIONS

Sometimes approximations are necessary, when no better alternative method exists. This is commonly the case when dealing with claim liabilities, including IBNR, as noted above.

Materiality is an important issue. For example, if the aggregate value of approximated item is small, a more complex or detailed approach is not justified. The goal should be substantial accuracy, or in other words, a minimum reasonable error. The method should also be unbiased, or at least have an acceptably small bias. Calculations that can be easily checked are always preferable. Caution should be used when results from one approximate method are used as input to other approximations, to avoid any compounding of errors—the snowball effect. Variations from period to period must also be considered. If a result is too large one time and too small the next, the distortion can have a bad effect on resulting earnings and/or surplus.

Saving time is helpful in meeting deadlines; however, sometimes an approximate method will result in a loss of additional information that was provided by a more detailed approach. This is another trade-off that must be taken into account.

Other issues that must be considered include appropriate utilization of technical personnel, acceptability to auditors if GAAP or to state insurance examiners for statutory, and the value of simplicity. The cost should not be disproportionate to the importance of a particular item.

Mr. Arnold ended his paper with this sentence, "Modern business conditions virtually require that the actuary be continually alert to the opportunities for the extension and improvement of approximate methods of valuation." I think this statement is as true today as it was when he wrote it more than 50 years ago. ■