DISCUSSION BY JOHN P. ROBERTSON

Mr. Stanard's paper offers the reader three things:
1) reserving techniques;
2) a methodology for assessing reserving techniques; and
3) conclusions about the reserving techniques.

Of these three, the methodology for assessing reserving techniques is the most significant. This methodology consists of developing a model of the loss emergence process and then simulating this process, applying the various reserving techniques, and keeping score of the results. This methodology is important because it is the most scientific system yet presented for assessing the validity and the accuracy of alternative reserving techniques. It is a general method, as readily applied to other models of the claim emergence process as to the model used in the paper.

The reserving methods Mr. Stanard presents are fundamental to casualty actuarial work. He is "filling out" familiar loss triangles and forecasting the next year's result. This is obviously the basis for most reserving methods and is also a key part of most ratemaking.

Previous literature on reserving techniques generally has concentrated on overcoming the effects of changes in the underlying mix of business, changes in the individual claim reserving and settling policies, and changes in claims reporting systems. Most of this prior literature assumes that once these changes are accounted for and the data has been restated so as to have relatively constant underlying conditions, then any number of loss development methods can be applied to obtain valid forecasts.

For instance, in Berquist and Sherman [1], examples are given of adjusting historical data to eliminate the effects of changes in the relative adequacy of case reserves and to eliminate the effects of changes in the rate of settlement of claims. Following these adjustments, standard loss development methods are applied with no question being raised as to the validity of these methods. Clearly, making adjustments for changes in the mix of business, etc., is an important part of reserve analysis; but the question of the validity of reserving methods, even in the face of completely uniform historical conditions, is also an important one.

Prior to this and Mr. Stanard's previous paper [2], there have only been a handful of attempts at evaluating reserving techniques. In one of these, Professor

Bühlmann, et al., sharply contrast the bases for development of reserving techniques between life and casualty actuaries [3]:

> "Since the early days of Life Insurance it has been understood that 'reserves for future payments of claims . . . had to be calculated from the probabilistic model describing the process of death within a specified population.'. . . . Strangely enough when actuaries were asked to put their skill to work in Non Life Insurance, they did not feel it necessary to have a probabilistic model for the setting of claims reserves. . . . The reason for the absence of probabilistic models leading to reserving techniques in Casualty Insurance may be explained (to some extent) by the common fashion in this field of assuming the individual claim amount to 'occur' suddenly even if in practice it is delayed portionwise over long periods of time. This paper takes exception to this fashion and models the individual claim amount as a random process over time."

Professor Bühlmann, et al., then proceed to develop a stochastic model of the claims process and to test several reserve estimation techniques against this model. They draw no conclusion about possible bias of the various methods, but do observe that the standard deviations of all the methods they consider seem quite high, and offer the opinion that the search for better methods should continue. They cite [4] and [5] as papers also exploring the validity of loss reserving methods based on stochastic models of the claims process.

It is easy to criticize Mr. Stanard's model of the loss development process as being too simple to be realistic. He only allows three sources of loss development: 1) late reporting of claims, 2) inflation from the the time a claim reserve is opened to the time the claim is settled, and 3) random variation between the estimated value of the claim and the final value of the claim. In particular, he does not allow for changes in the estimated value of a claim while the claim remains open, nor does he allow for any systematic development in the value of a claim, except for that due to inflation.

Does use of such a simple model invalidate Mr. Stanard's results? I think not. Any of the features which would make his model more realistic, i.e., more complicated, might just as well add to the biases and variances as they might subtract from them. If, for example, standard loss development methods really work so well, they should work in artificially simplified situations. The fact that Mr. Stanard has presented a situation where the standard loss development methods are biased may not quite prove that they fail in other more realistic situations, but it does show that they need to be tested and justified in relation to possible models of the claims development process they are used to forecast.

I continue to find the "Adjustment to Total Known Losses" or "Cape Cod" technique to be of interest. In addition to the possible advantages pointed out as a result of the simulations and in Appendix B, this technique complements the Bornhuetter-Ferguson technique in a way no other technique can, as discussed below.

Consider the case where there is no change in real exposure from year to year and there is no inflation (or past years' losses have been adjusted to eliminate these effects). Then an obvious estimator for R_5 is the average of R_0 to R_4, or $(1/5)(R_0 + \ldots + R_4)$. In Mr. Stanard's paper, both the "Modified Bornhuetter-Ferguson" method and the "Adjustment to Total Known Losses" method start by computing R_5. The former uses the formula:

$$R_5 = \frac{1}{5} \sum_{h=0}^{4} K_h \times f_h.$$

The latter computes R_5 by:

$$R_5 = \left(\sum_{a=0}^{4} K_{a*} \right) \div \left(\sum_{a=0}^{4} \frac{1}{f_a} \right).$$

In each method, this value of R_5 is used to calculate R_0 through R_4. Once R_0 to R_4 are computed, their average can be compared to R_5. Under the "Adjustment to Total Known Losses" method, this average will always be exactly R_5. A proof of this is given in the Appendix to this discussion. Under the "Modified Bornhuetter-Ferguson" method, this average will not necessarily equal R_5. The consistency between the original estimate of R_5 and the average of R_0 to R_4 in the "Adjustment to Total Known Losses" method indicates, I believe, that this method makes the best use of loss information from all the years in order to project any given year. If the average of R_0 to R_4 is less than R_5 then one could argue that too high an R_5 had been selected, as reported development would appear to be occurring at a lower rate than predicted by R_5. The converse argument could be made if the average were higher than R_5. This inconsistency cannot happen under the "Adjustment to Total Known Losses" method.

It may be that there is reason to choose an R_5 from external sources or by some other method when the Bornhuetter-Ferguson method is being used. But in situations where one is estimating R_5 from the loss information, the consistency discussed above argues strongly for the use of the "Adjustment to Total Known Losses" method.

In conclusion, I believe Mr. Stanard's paper offers a valuable method for assessing whether common actuarial methods are accurate and reliable. As actuaries are called upon to look at smaller and smaller insurance, reinsurance, and self-insurance programs, and as determination of confidence levels for reserves becomes more important, then the usefulness of the methods in this paper should become more apparent. Additionally, the conclusions reached should spur development of improved models of the loss development process and improved reserving techniques.

REFERENCES

[1] James R. Berquist and Richard E. Sherman, "Loss Reserve Adequacy Testing: A Comprehensive, Systematic Approach," *PCAS* LXIV, 1977.

[2] James N. Stanard, "Experience Rates as Estimators: A Simulation of Their Bias Variance," *Pricing Property and Casualty Insurance Products*, Casualty Actuarial Society, 1980 Discussion Paper Program, p. 485.

[3] Hans Bühlmann, René Schnieper, and Erwin Straub, "Claims Reserves in Casualty Insurance Based on a Probabilistic Model," *Mitterlungen der Vereinigung Schweizerischer Verucherungsmathematiker* 80, 1980.

[4] F. DeVylder, "Estimation of IBNR Claims by Least Squares," *Bulletin of the Association of Swiss Actuaries*, Vol 78/2, 1978.

[5] Charles Hachemeister, "A Stochastic Model for Loss Reserving," *Transactions of the 21st International Congress of Actuaries*, Vol 1, 1980.

APPENDIX

Purpose

This table will show that $R_5 = \frac{1}{5}(R_0 + \ldots + R_4)$ for the "Adjustment to Total Known Losses" method, as claimed in the review.

Proof

Given:

$$(1)\ R_5 = \left(\sum_{a=0}^{4} K_{a*}\right) \Big/ \left(\sum_{a=0}^{4} \frac{1}{f_a}\right)$$

$$(2)\ R_a = K_{a*} + R_5\left(1 - \frac{1}{f_a}\right); \qquad a = 0 \text{ to } 4$$

Then:

$$\frac{1}{5}(R_0 + \ldots + R_4)$$

$$= \frac{1}{5}\left[K_{0*} + R_5\left(1 - \frac{1}{f_0}\right) + \ldots + K_{4*} + R_5\left(1 - \frac{1}{f_4}\right)\right] \qquad \text{(By (2))}$$

$$= \frac{1}{5}\left[K_{0*} + \ldots\ K_{4*} + 5R_5 - R_5\left(\frac{1}{f_0} + \ldots + \frac{1}{f_4}\right)\right] \qquad \text{(Rearranging)}$$

$$= R_5 + \frac{1}{5}\left(K_{0*} + \ldots + K_{4*} - R_5\left(\frac{1}{f_0} + \ldots + \frac{1}{f_4}\right)\right) \qquad \text{(Rearranging)}$$

$$= R_5 + \frac{1}{5}\left(K_{0*} + \ldots + K_{4*} - \frac{K_{0*} + \ldots\ + K_{4*}}{(1/f_0) + \ldots\ (1/f_4)} \times \left(\frac{1}{f_0} + \ldots + \frac{1}{f_4}\right)\right) \qquad \text{(By (1))}$$

$$= R_5 \qquad \text{(Cancelling)}$$

Q.E.D.