

much as three, four, or more times as effective. This is true because the first .25 is much easier to get from a rating criterion than is the second .25 and so on up the scale. I suspect that raising the coefficient from .90 to .99 would be as difficult as raising the speed of a particle from 185,000 to 185,400 miles per second.

The most important feature of the paper for this reviewer is the great use these principles should have among those actuaries who must frequently make critical decisions relative to rates and rating plans. Those rating differentials which, after being based on experience representative of the population, show little or no effectiveness can be and should be dropped from the rate structure. Furthermore, the cost of obtaining the information necessary to properly classify a risk under a given rating plan may be weighed against the effectiveness of that plan.

Mr. Bailey has added a new, original and very valuable tool to the actuaries' working procedures and processes. The paper is indeed a significant one.

DISCUSSION BY L. H. ROBERTS

At the seminar in which the paper was discussed, this writer sided with what appeared to be the consensus (although not unanimous): that the coefficient of variation is a good measure of the efficiency of a classification system. He did, however, mention certain reservations with which he believes the author of that excellent little paper to be in agreement.

It should be emphasized that the absolute value of the C.V. of rates is meaningless as a measure of their propriety. What counts, assuming the overall level is correct, is the spread between rates (the C.V. being a measure of this) as compared with the spread between the hazards of individual risks. This, too, has no significance unless rates are closely related to the experience of the respective classes to which rates apply. Since in a perfect rating system there is a one-to-one correspondence between the rate for a given homogeneous class of risks and the hazard of that class (which might include but a single member), it follows that any rate schedule for which the C.V. of rates is less than the C.V. of hazard in the population of risks will be less than 100% efficient, and the C.V. of the rate schedule will decrease with decreasing efficiency in classification.

If, however, rates are based on judgment rather than on credible experience, the C.V. of rates will not necessarily be related to the efficiency of classification. In such cases it may indeed exceed the C.V. of hazard, as where differentials are established for imaginary or exaggerated differences in hazard. It will often be the case, moreover, that the C.V. of hazard is unknown, since knowledge of this statistic requires analysis of experience by individual risk. For these reasons, the most appropriate use of the C.V. will be often only to compare the efficiency of one class plan with that of another, no attempt being made to estimate their absolute efficiency.

Where the C.V. of hazard is known, a measure of absolute efficiency is provided by dividing the square of the C.V. of indicated rates by the square of the C.V. of hazard. (The same result would be obtained if variances are used.) The quotient, called the coefficient of determination, gives the

proportion of the total variance in the population that is accounted for by the class plan.

It is well to keep in mind that a single statistic cannot possibly provide a complete basis for comparison of class plans with more than two classes. Thus, of three different plans, all with the same C.V., one may isolate a particularly good category of risks, producing a concentration of sweet cream; another may concentrate the sour cream; the third may distribute the cream almost equally among classes. The first two situations are quickly recognized and tend to disappear in subsequent rate revisions. It is the third situation in which the cream is most difficult to skim, and for that reason offers the greatest opportunity for profit to the carrier that finds a way to do so.

AUTHOR'S REVIEW OF DISCUSSIONS

The discussions have contributed some important points, most of which I heartily agree with but on some points I feel it would be helpful to offer some clarification.

Mr. Roberts and Mr. Simon both very properly urged caution in interpreting the coefficient of variation of the rates, and discussed the problems which should be considered in order to make a proper interpretation. Mr. Roberts brought out the point that a measure of absolute efficiency of the indicated rates in a class plan is provided by dividing the square of the C.V. of indicated rates by the square of the C.V. of hazard. (A^2/K^2 in the terminology of Messrs. Lange and Muniz) Mr. Simon made much the same point when he said "If coefficient A is .25 and coefficient B is .50, we can say that B is at least twice as effective as A but might be as much as three, four or more times as effective." Both these observations mean that I was too optimistic in saying that the present class plan takes care of half of the total variation among risks. One quarter might have been a better estimate.

Messrs. Lange and Muniz, however, carried some of the statements in my paper beyond their actual meaning. For example, they said that "Mr. Bailey gets a value for A/K equal to 0.5 and concludes that the rating system is only half as effective as it could be" whereas my conclusion was simply that "the present multiple classification system . . . takes care of only half of the total variation among risks." They ignored the fact that I recognized the practical limitations in classification refinement. Moreover, my paper went into the interpretation of the coefficient of variation very little and did not go so far as to state that the ratio A/K times 100 gives the percent effectiveness of the rating system as Messrs. Lange and Muniz credit me with saying.

Messrs. Lange and Muniz also said that the merit rating distribution in Pennsylvania used in my paper is atypical because it is substantially different from the National Bureau distribution in Pennsylvania. Such a conclusion is unwarranted because in my paper I pointed out that the company whose experience I used was using the California-type merit rating plan in Pennsylvania which differs substantially from the Pennsylvania plan of the National Bureau, in that it has a shorter experience period and assigns only one point per accident instead of two. On the basis of the differences between the two merit rating plans, I estimated that the National Bureau merit rating