DISCUSSIONS OF PAPERS PUBLISHED IN VOLUME XLIX

AN INTRODUCTION TO CREDIBILITY THEORY

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DISCUSSION BY ARTHUR L. BAILEY

Mr. Carlson has given you a rather complete picture of statistical developments in casualty insurance. His picture was a general overall view of the business and its statistical problems. It would appear that it can be discussed only by describing, in somewhat more detail, one or more aspects of that picture.

Active statisticians in other fields, teachers of insurance in general, or teachers of statistical techniques, whether of insurance or not, should be especially interested in those philosophies of casualty insurance which serve to make its statistical procedures different from those of other fields. For those of us who are active in the statistics of casualty insurance, it is good to pause occasionally and to meditate on the reasons why we do things differently in our business. For these reasons I have chosen to enlarge on Mr. Carlson's presentation by dwelling on differences, particularly the differences in the philosophies or beliefs of causalty insurance statisticians and those in other fields. I will mention specifically three beliefs held by casualty people which have produced procedures, either peculiar to that field, or found only occasionally in other fields.

First, there is the belief of casualty underwriters that they are not devoid of knowledge before they have acquired any statistics. This belief is probably held by operating personnel in all businesses. When a new form of insurance is initiated or a new classification or territory established, there may be a considerable variety in the opinions of individual underwriters as to what the rate should be; but the consensus of opinion invariably produces a rate. This rate soon becomes embedded in the minds of the underwriters as the "right" rate. Later, when statistics as to the actual losses under the new coverage, classification, or territory, finally are acquired, the problem is not "what should the rate have been?" but "How much should the existing rate be changed as a result of the facts observed?" In revisions of rates for regular coverages, classes, and territories, this is always the question.

The statistical methods, developed by the mathematicians and available in the standard textbooks on statistical procedures, deal with the evaluation of the indications of a group of observations, but under the tacit or implicit assumption that no knowledge existed prior to the making of those particular observations. The credibility procedures, which Mr. Carlson has mentioned as used in the revisions of casualty rates, have been developed by casualty

Editor's Note: This discussion of CREDIBILITY by the late Arthur L. Bailey appeared in Volume 17 (1950) of the *Journal of the American Teachers of Insurance*. We believe his views will be of interest in connection with the report on this subject by L. H. Longley-Cook in *PCAS XLIX*.

actuaries to give consistent weightings to additional knowledge in its combination with already existing knowledge.

A second belief of casualty actuaries is that they are in a continuing business. Also that a more or less wide spread of risk is being taken at any one time. The ratemaker in such an organization as the National Bureau of Casualty Underwriters, which Mr. Carlson represents, literally has thousands and thousands of rates to be revised at relatively frequent intervals. Being called upon to make a large number of estimates, the casualty statisticians can relinquish the condition, usually imposed by other statisticians, that each estimate be unbiased. In its place they may impose the less restrictive condition that a particular group of estimates be unbiased in the aggregate. This permits them to make a material reduction in the error variances below what could be obtained by applying the usually taught and presented methods of statistical estimation. It produces another type of credibility formula which appears to be unique to casualty insurance.

The third peculiarity that I want to mention is that casualty underwriters consider each insured to differ from all other insureds. For example, each automobile driver is assumed to have habits and eccentricities unlike any other; each fleet of trucks is assumed to travel routes and engage in operations which make its hazards different from all others, even those engaged in the same industry in the same territory. The propriety of this assumption has been verified in so many instances that the differences between risks has become a basic concept or axiom. Experience rating plans are used in almost all lines of casualty insurance to measure the peculiarities of individual risks.

Despite this uniqueness of the "inherent hazard" of different insureds, each and all of them are subject to the vagaries of chance and the random errors of classification and measurement common to all statistics. Statistical methods generally taught and published in textbooks deal with populations for which the entire variation is produced by the vagaries of chance or the random errors of measurement. Populations in casualty insurance, however, consist of individuals having a variation of expectations other than that due to these two items. Their inherent hazards must be assumed to differ even if it is impossible to postulate or to precisely measure the differences.

This dealing with heterogenous populations produces some very interesting results which most statisticians would sneer at as "impossible," but which are, nevertheless, wholly sound and justifiable. One of these is the "split" of losses in the experience rating plans of casualty insurance. The first N dollars of each loss is given a greater weight (that is, more credibility) than the amounts of any loss in excess of N dollars. The result of this separation and weighting is to produce a better estimate of the average loss than would be obtained by the use of the observed average. Although it is axiomatic to most statisticians that the observed mean of the sample is the best estimate of the mean of the parent population, this is only true in the case of homogenous populations and can be materially improved if the populations are heterogenous.

I personally entered the casualty insurance field from the completely unassociated field of statistical research in the banana business. The first year or so I spent proving to myself that all of the fancy actuarial procedures of the casualty business were mathematically unsound. They are unsound, if one is bound to accept the restrictions implied or specifically placed on the development of the classical statistical methods. Later on I realized that the hard-shelled underwriters were recognizing certain facts of life neglected by the statistical theorists. Now I am convinced that casualty insurance statisticians are a step ahead of those in most fields. This is because there has been a truly epistemological review of the basic conditions of which their statistics are measurements. I can only urge a similar review be made by statisticians in other fields.