not immoral. Mr. Tarbell's paper indicates that we can learn from the N.A.U.A. He has clearly demonstrated that the N.A.U.A.'s ratemaking procedures are not crude. The N.A.U.A has done an excellent job—one worthy of actuarial approbation.

Once papers such as Mr. Tarbell's are printed in the P.C.A.S., another end is accomplished. We then have something available for all to discuss and to improve upon. This is a most desirable end. Our business is not static and our ratemaking procedures cannot be allowed to become staid or sterile. We must be alert to the requirements of the insuring public—probably the largest public of any American industry. What better way to lay the groundwork for this activity than by a general airing of the facts in the form of papers on ratemaking?

Papers on the fundamental ratemaking procedures of the various casualty, property and fire and accident and health lines have been sorely needed. Is not ratemaking basic to our industry? Is it not the actuary's main stock in trade? Regardless of where we work—for ourselves or for another; a private concern, an insurance department, a rating bureau, or an insurance company; an independent company or a bureau company; a stock company or a mutual company—regardless of our primary concern in our own particular job, do not all of our activities eventully devolve to ratemaking?

A start has been made, but additional papers on ratemaking are still needed. We should have a paper on General Liability ratemaking—an enormous task. The areas of burglary, fidelity and surety also require coverage. An important ratemaking area, almost completely devoid of papers in our *Proceedings,* is the Accident and Health field. We should have ratemaking papers on both Group and Individual Accident and Health. Accident and Health, incidentally, is a most timely and important topic.

These are the thoughts Mr. Tarbell's excellent paper has evoked from me.

DISCUSSIONS OF PAPERS READ AT THE NOVEMBER 1959 MEETING

AN ACTUARIAL NOTE ON THE CREDIBILITY OF EXPERIENCE OF A SINGLE PRIVATE PASSENGER CAR

BY

ROBERT A. BAILEY AND LEROY J. SIMON

Volume XLVI, Page 159

DISCUSSION BY W. J. HAZAM

The authors are to be congratulated for their very valuable contribution to our knowledge of credibility. Presented, as it was, at a time when a large segment of the industry is embarking on merit rating programs for individual private passenger risks, it provides a basis for the actuarial evaluation of plans now available and perhaps many we have yet to see.

While the data underlying the paper are exclusively the results under the

Canadian Merit Rating Plan,[a] the conclusions are not so geographically restricted. The most provocative of these conclusions is that the experience for one car-year has significant and measurable credibility. In the years prior to the current flurry of merit rating plans, this demonstrable fact had been all but lost, if at all recognized, in the generally prevailing opinion that merit rating was unfeasible. Our current plans may yet prove to be unfeasible. However, this paper demonstrates a means or concept by which to measure the actuarial justification for experience credits (credibilities) for one, two, three, etc., claim-free years.

In developing their credibilities, the authors have placed heavy reliance on frequencies in terms of premiums to correct for the maldistribution deriving from the use of an exposure base. I would be remiss as a reviewer to fail to point out that of which the authors are no doubt aware: that a premium base eliminates maldistribution only if (1) high frequency territories are also high premium territories and (2) if territorial differentials are proper. However, premium, although not perfect, is an improvement over exposure as a base for this type of study. The fact that either or both of these inherent assumptions may not always exist does not detract from the qualitative nature of the conclusions but may alter somewhat the basic relative frequencies of Table 1 and the consequent values in Tables 2 and 3.

The authors make the statement, ". . . the credibilities for experience periods of one, two, and three years would be expected to vary approximately in proportion to the number of years." This holds largely true only for low credibilities; large credibilities would render such a statement inaccurate. However, even in a low credibility area such as the authors are working with in the Canadian results, the theoretical relative credibilities would be less than 1.00, 2.00, and 3.00 for one, two, and three years claim free. For example, using the actuarially accepted $\frac{P}{P+K}$ formula for credibility in experience rating, the theoretical relativities to .046 (1 year credibility of class 1—see Table 2) would be as follows (Note: the k value of 2074 used below was derived on the assumption of 100 claims per year producing a one-year credibility of .046):

Credibility	Relative Credibility	Observed Result (Table 3)
$100 \quad \frac{100}{+\ 2074} = .046$	1.00	1.00
$200 \quad \frac{200}{+\ 2074} = .088$	1.91	1.48
$300 \quad \frac{300}{+\ 2074} = .126$	2.74	1.74

[a] See also "The Canadian Merit Rating Plan for Individual Automobile Risks" Herbert E. Wittick, CAS XLV, p. 214.

This observation should be added to the other reasons why the observed relative credibilities in Table 3 are not 1.00, 2.00, and 3.00.

It may be surmised from this approach to the Canadian results that, in a balanced merit rating plan, there is not enough credibility by class to warrant the magnitude of credits now being offered by many U. S. plans. We must remember, however, that these results are based strictly on claim frequencies, not claim frequencies plus convictions frequencies. Adding convictions no doubt helps substantiate larger credits but it is dubious that it will support current merit rating differentials, if the Canadian experience is at all indicative of what we might expect in this country.

This paper with its original concepts sets forth a basis for analysis of current U. S. plans when the data by class becomes available.

SOME CONSIDERATIONS ON AUTOMOBILE RATING SYSTEMS UTILIZING INDIVIDUAL DRIVING RECORDS

BY

LESTER B. DROPKIN

VOLUME XLVI, PAGE 165

Discussion by R. A. Bailey

As Mr. R. E. Beard, secretary and editor of Astin, said,[1]

> "The literature in the English language relating to analytical expressions of the risks involved in general insurance is scanty and largely limited to papers presented to International Congresses of Actuaries and the *Proceedings* of the Casualty Actuarial Society. There are, however, a number of contributions to the subject in various other languages, scattered over various journals, mainly, insurance publications of European countries, e.g. *Skandinavisk Aktuarietidskrift* and a few books."

The C.A.S. can rightfully be proud of its contributions in this field which have been ably enhanced by Mr. Dropkin's treatment of the negative binomial distribution.

The analytical expression of risk distributions provides a valuable insight into many practical problems. One of the important results of Mr. Dropkin's paper is a realization of the large amount of variation among individual risks. Automobile risks even within a single class or merit rating group are far from being all alike. In order to help visualize this variation there are shown in Figure 1 the graphs of the distribution of risks which Mr. Dropkin shows to be inherent in the negative binomial distribution. Four graphs are shown, all for an average accident frequency $\frac{r}{a} = .100$, and with variances of the accident frequency (not the variances of m, the inherent hazard) of $.120(r=\frac{1}{2})$, $.110(r=1)$, $.105(r=2)$ and $.101(r=10)$.

[1] Transactions of the XVth International Congress of Actuaries, Volume II, 1957, p. 230.