AUTHOR'S REVIEW OF DISCUSSIONS

I guess it would be impossible to consider any ratemaking scheme which is at odds, to any degree, with current methods without many practical transitional problems surfacing early in the game. Each of the reviewers has done an excellent job of considering the practical difficulties which would accompany the scheme outlined in my paper and I am indebted to each of them for their thorough, incisive discussions. I am in general agreement with the reviewers' comments and, moreover, the only point of disagreement I have with them may be due mostly to a poorly worded definition of an important concept in the original paper. My comments are as follows:

Absolute Frequency and Risk Characteristics

Some poor wording in the original paper led two of the reviewers to interpret that the efficacy of the entire ratemaking formula depended on the "absolute frequency" being constant for all repair cost groups. The reviewers correctly observed that such an asumption is not likely to be true because of the fact that frequency-related risk characteristics of one cost group might well be different than another. However, the workability of the model does not depend on the truth of such an assumption and, furthermore, it isn't the assumption the author intended to make in the first place.

The assumption on which the model is based is that a given risk within a particular class/territory/age group subset would develop about the same absolute frequency regardless of the cost group his car would fall in and whatever deductible he might choose. Of course, it is true that "the group of people who purchase $50-deductible collision is a completely different set of people than those who purchase $100-deductible," as Mr. Frame and Mr. Gillam have reminded us. Indeed, I have seen recent statewide statistical reports which show that the average annual premium (and probably statewide pure premium, as well) for $100-deductible collision is actually higher than the average for $50-deductible, even though for one individual risk the rate for $100-deductible is from 70 to 85 per cent of the corresponding $50-deductible rate. But, again, this heterogeneity, caused by a marked selection of the higher deductible as age, territory, and symbol classifications tend to the higher side of the rating scale, has no bearing on the validity of our presumed relationship between the various deductibles.

To further clarify the absolute frequency/risk characteristic assumption, perhaps the full expression for net loss cost needs some work. The formula, as originally set forth, would apply as a "base" absolute frequency corresponding to a particular class/territory combination, both of whose absolute frequency relativities are unity. For other classes and territories, appropriate absolute frequency relativities would have to be determined and included as an additional factor in the full formula. Just how class and territory relativities would be superimposed on our repair cost grouping would be of utmost importance in the actual implementation of our ratemaking scheme. This facet of the overall problem was virtually ignored in the original paper, and, by implication, the reviewers wisely advised that the class and territory considerations require much further study.

Severity Differences by Territory

Can class and territory relativities be based on frequency differences only? I suppose there is an implicit assumption in the original paper that they can. Mr. Sawyer has pointed out that automobiles in an urban environment might be expected to develop a lower average repair cost than rural autos because of lower average impact speed. This would cause a slightly different relationship between deductibles in urban areas compared to rural territories. In our original paper we defined the average repair cost underlying a given repair cost group as the average cost of repair and labor charges for a given group of automobiles when subjected to the full spectrum of possible collisions, weighted by the relative incidence of the particular types of collisions. It was implied that this "full spectrum" would embrace all geographical conditions, urban and rural. It is probably true, as Mr. Sawyer has observed, that urban areas would be weighted slightly to the lower side of the overall mean expected repair cost, and vice versa. Also implicit in the original thinking was that the necessary territorial distinctions in the final gross rate would be a function of measurable differences in absolute frequency only. However, in going through the process of self-assessment, particularly after the review of Mr. Sawyer, I find that the ignoring of severity differences by territory and its effect on the overall ratemaking scheme is that portion of my paper which requires much further study.

One possible solution would be to divide all territories into two groups—urban and rural—and vary the formula for the two groups. In-

stead of simply determining the average expected repair cost over the full spectrum of collision situations, using weights which reflect the overall incidence in both rural and urban environments, perhaps the weighted mean expected cost could be done separately for urban and rural situations. For example, let us say that a group of cars developed an expected average repair cost of $400, weighted proportionately for both urban and rural situations. But using weights characteristic of urban accidents alone, let us say the average was $380, and the "rural" average was $425. Perhaps some reasonable generalization could be made that the "urban" average would be X% lower than the overall average and the "rural" average would be Y% higher than the overall—for any cost group.

From a practical standpoint, most any block of data you look at these days seems to bear out the fact that most urban-rural distinctions, as far as rating characteristics are concerned, are beginning to fade somewhat. More and more these days, automobile owners who can be classified as rural drive into the urban areas rather frequently instead of once a week (Saturday morning, maybe). One indication of this change in rural driving habits is the gradual diminution of the justifiable "farm discount" on private passenger automobiles over the past ten years. It would seem to follow that the expected severity differences within one overall cost group between those garaged in urban areas and those in rural areas would tend to diminish in like fashion. Perhaps before two separate average expected repair costs are computed for urban and rural territories, an effort should be made to determine exactly how much difference there would be and if it would necessitate a distinction from a practical standpoint.

How "Real" is Real World Data?

Mr. Frame and Mr. Gillam suggest that, even if the industry is successful in developing repair cost groups, there would be "no reason why the appropriate relationships (between deductibles) cannot be determined from the real world data for $50-deductible and $100-deductible." I would assume that this means, as is customary in present ratemaking procedures for ratemaking organizations and for many large companies, that countrywide loss ratios by symbol (or repair cost) groups would be analyzed with premiums adjusted to the base symbol group, and symbol or repair cost group relativities calculated therefrom. There is a very big reason why "the appropriate relationships" cannot be determined accurately from this type of "real world" data—unless it can be assumed that

within each symbol/repair cost group each subdivision by state, territory, class, age group, etc., produced the same loss ratio as the whole group—a very unlikely event. Otherwise, such an analysis almost inevitability leads to distorted, biased results, particularly when using companywide statistics. There are ways to eliminate much of the bias when all elements of a multi-dimensional rating structure (symbol, age, territory, etc.) are analyzed simultaneously[1] but, apparently because of the complexities of such analysis, such an effort to avoid the bias has not customarily been made. Indeed, it is the author's strong recollection that, in the most recent adjustment made by the rating organizations of symbol relativities, the revised relativities were identical for $50-deductible and $100-deductible collision, perhaps with a view towards convenience at the expense of accuracy.

Mr. Frame and Mr. Gillam also state that, "in the standard ratemaking procedure, the overall statewide rate levels and the base premiums for each territory are determined separately for $50-deductible and $100-deductible based on actual experience, which reflects all the characteristics of the two groups of risks that will affect their losses." Again, because of the same inherent bias which is present in what I presume they are calling the "standard ratemaking procedure", some interesting situations can result. Suppose that in a given state the base rate for $50-deductible collision in territory 1 is 125% of the remainder-of-state $50-deductible rate, but the $100-deductible base rate for the same territory is only 105% of the $100-deductible remainder-of-state rate (such a situation, I think the reader will find, is not uncommon). If one policyholder driving the same car moved from the remainder-of-state territory to territory 1 his rate would go up 25% if he carried $50-deductible but only 5% if he carried $100-deductible. I submit that this is absurd. The different "characteristics of the two (symbol) groups which will affect their losses" should be provided for in class plan, age group, etc., relativities to such a large degree that different territorial relativities for different deductibles are, in my opinion, indefensible.

Actual Crash Experience vs. Prior Estimates

Despite the above critique of present day "real world" analytical techniques as far as symbol groups are concerned, I agree wholeheartedly with Mr. Nelson's comment that "once a new automobile model has been in-

[1]See, for example, R. A. Bailey and L. J. Simon, "Two Studies in Automobile Insurance Ratemaking," *PCAS XLVII* and Bailey, "Insurance Rates With Minimum Bias, *PCAS L.*

troduced, and some actual crash experience is available, it would be foolhardy to rely completely on the prior estimates of the expected repair cost." Based on some pilot studies being undertaken at the present time to measure actual repair cost differences by model from actual crashes[2] it seems that the earliest possible date that any credible, real world crash data would be available would be after the model year is over half-way expired. But once this actual crash data is available, I agree that the revised repair cost grouping should be a weighted average of the original expected repair cost and the actual crash data.

Technical Notes Concerning the Model

Mr. Nelson is correct in his observation that the method I used to eliminate the "spread" parameter S^2 is a little on the rough side. Actually, the value I assumed for S is not as arbitrary as would appear at first glance. The estimate for S is based roughly on a countrywide exposure distribution by symbol groups and a rough correlation between symbol groups and average repair cost. Mr. Sawyer correctly observed that in the process of evaluating a truncated distribution as we did in the original paper, with the point of truncation being the deductible amount, we have run the risk of what he terms deductible "padding". The author was aware of such a hazard and, moreover, in attempting to fit the truncated distribution to a straight line on the probability graph paper there was an unnatural "hump" in the data around the point of deductible which simply couldn't be smoothed out no matter what value of F(50) was used in the process of fitting the data. The "padding" problem is something we simply had to live with. It is my feeling, however, that the error produced by the rough estimation of S and the "padding" problem would not be beyond the tolerance we had originally set up. Our final estimate of the coefficient of variation based on the original data was 1.3. Even allowing for the possible errors Mr. Sawyer and Mr. Nelson have called to our attention, we believe that the estimate of 1.3 should be correct within the tolerance of, say, plus or minus 0.1.

Application to Other Coverages

I believe that the type of deductible analysis illustrated in the original paper would also lend itself to other coverages. Mr. Nelson suggested that

[2]For example, the tests currently in process in conjunction with the Insurance Institute for Highway Safety.

automobile comprehensive could be analyzed the same way once an allowance is made for the disproportionate share of total losses. Mr. Sawyer suggested this type of analysis for Homeowners. One other coverage I would like to add to the list which would be perhaps even a more likely candidate for such an analysis is Crop Hail. This coverage is written with various types of deductibles—some straight deductibles and some disappearing deductible forms. It is my understanding that, in the present rating structure, the relationship between one deductible and another is a constant percentage relationship. I wouldn't be a bit surprised to find that, after an analysis of the losses by size in crop hail, the proper relationship between these various deductibles would be more of a constant dollar relationship as was found to be the case in automobile collision.

Again, I would like to thank each of the reviewers for their very helpful comments concerning the paper—particularly those comments which called attention to areas in the original paper which required substantial clarification.