NO-SPLIT EXPERIENCE RATING PLANS

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As experience rating evolved over the years, a great deal of effort went into the refinement of the multi-split experience rating plan of Workmen's Compensation. Perhaps because of this emphasis, attention has been directed away from no-split experience rating plans. The purposes of this paper are: to draw together some ideas on no-split plans by comparing a no-split compensation plan with the multi-split compensation plan, to measure these two plans as to their ability to respond to theoretical requirements and to discuss these implications on currently used no-split plans in lines of business other than Workmen's Compensation.

WHAT IS EXPERIENCE RATING?

Experience rating may be described as a process which prospectively alters the premium of each member of a class, based on each member's recent past experience. The process attempts to balance the indications of a risk's classification rate and the risk's own experience. A review of the early writings[1] on the subject reveals that experience rating is an attempt to measure four critical input items: exposure, hazard, credibility of the manual rate and dispersion of risks within a class. Present experience rating plans reflect the first characteristic, exposure, by assigning varying credibility by size of risk. For the very large risk, the rate for the risk will be based solely on the risk's own experience; whereas, in the case of the small risk, very little credence can be given to the risk's own experience and his rate will depend largely on the experience of the class to which that risk belongs. The varying hazard (frequency of loss) of the risk is treated in experience rating in much the same manner as exposure is treated. For a very hazardous risk, one which may, because of its hazard, develop many losses for similar exposure, the credibility will be high. It is therefore easier to identify the average loss experience of that risk.

A large hazard will affect the class rate as well as the individual risk's experience. It is not difficult to imagine examples of large risks in relatively small states where the size of the risk heavily influences the manual rate. In these instances, the risk's experience serves a dual rating purpose and the net effect of this varying credibility is not immediately clear.

[1]Whitney, A. C., "The Theory of Experience Rating", *P.C.A.S. IV.*

To be theoretically precise, an experience rating plan should account for the variation in the credibility of the manual rate. Again, we can picture the single state situation where manual rates are often constructed for classes with small volumes of experience. If the manual rate is stable, more weight can be given to it and, hence, less weight can be given to the individual risk (all other things being equal). For the unstable rate, greater relative credibility can be given to the risk's experience.

It is obvious that every risk in a class is not typical of the class. The classification system does a better job in some cases than in others. The problem is to measure the dispersion of risks within a class. The frequency distribution of the loss ratios of risks in a class, like "bakeries", will differ sharply from a class like "roofers". (I am assuming that "bakeries" is a class with many small and medium losses, while "roofers" is a class with relatively more larger losses.) For a class with a concentrated distribution about the mean, we can surmise that a risk's experience that departs from the average of the class can be accounted for as due to chance rather than an inherent difference in the degree of hazard for the risk. On the other hand, if risks are diverse it is likely that a risk's experience that departs from the average will be accounted for by a real difference in hazard. To be theoretically more precise, an experience rating plan should have a credibility weighting that varies by class (as well as size).

Early experience rating plans grappled with these problems. In spite of the obvious difficulties, plans were developed which have stood the test of time, at least in their basic theoretical construction. Perhaps their strength lies in the fact that they satisfy the primary functions of individual risk rating plans[2]:

1. To achieve greater equity in rating of insurance
2. To stimulate loss prevention control
3. To abet competition.

No-Split Plans

A no-split plan has been defined as one in which no attempt is made to divide losses into primary and excess elements. Examples of no-split plans are: the Pennsylvania Workmen's Compensation Experience Rating Plan,

[2]Kulp, C. A. and Hall, J. W., *Casualty Insurance* (The Ronald Press Company, New York, 1968), 4th edition, Chapter 22.

the Automobile Liability Experience Rating Plan, and the Liability other than Auto, or as we will refer to it, the General Liability Experience Rating Plan. Though the Auto and General Liability plans may differ by company, I will refer to the plans of the Insurance Services Office for uniformity. In all of these plans the usual formula for experience rating applies (with variations), *viz.*:

$$M = \frac{AZ + (1\text{-}Z)E}{E}, \text{ where,}$$

M = Modification

A = The actual losses

Z = Credibility

E = The expected losses

Comparison Of A Workmen's Compensation No-Split Plan With A Workmen's Compensation Multi-Split Plan

To begin our understanding of no-split plans, let us compare the Pennsylvania Workmen's Compensation no-split experience rating plan with a multi-split experience rating plan. In Workmen's Compensation, a given risk begins with the same manual rate and the identical loss experience as it enters the experience rating process regardless of the company that writes the risk. Each company arrives at the same price for the risk prior to the application of premium discount, dividends or retrospective rating plans. An example of the experience rating plan for Pennsylvania is given on Exhibit I-A.

In the no-split formula for Pennsylvania, $M = \frac{AZ + (1\text{-}Z)E}{E}$, the entire value of each loss enters the rating unless the loss exceeds the "Maximum Value of One Accident" figure that is shown in Exhibit I-A. In the multi-split plan, each loss enters the rating in two pieces: the primary portion of the loss and the excess portion of the loss. The primary value is determined by the formula, primary loss value $= \frac{\text{actual loss}}{\text{actual loss} + 3000} \times 3750$; therefore

the excess loss value equals actual loss value minus primary loss value. The multi-split formula can be written as,

$$M = \frac{ApZp + (1\text{-}Zp)Ep + AeZe + (1\text{-}Ze)Ee}{E}, \text{ where,}$$

Ap = Primary actual losses
Ep = Primary expected losses
Zp = Primary credibility
Ae = Excess actual losses
Ee = Excess expected losses
Ze = Excess credibility
E = Ep + Ee.

With this background, let us compare these plans in four areas: off-balance, expected loss, the ability to reflect differences in hazard and the ability to respond to the theory of minimizing the variance of the loss ratio distribution.

OFF-BALANCE

In no-split plans the column entitled "Maximum Value of One Accident" (Exhibit I-A) implies that, when losses of a certain size occur, the actual amounts of losses entering the rating are diminished to the tabular value. Total actual losses, therefore, must be less than the total expected losses of risks entering experience rating in the aggregate. The fact that actual losses used in experience rating (in the aggregate) are less than expected losses (in the aggregate) can be termed "off-balance". In addition to the off-balance created by limiting individual losses that enter rating, there are other reasons for off-balance. It has been noted that larger risks tend to have loss ratios less than smaller risks. A distribution of loss ratios by size of risk (see Exhibit II) would, therefore, indicate that risks that do not qualify for rating, that is those that are too small to be rated, would have loss ratios in excess of the expected loss ratios built into rates. Risks that are subject to experience rating tend to have loss ratios (in the aggregate) less than the expected loss ratios built into rates. The fact that these actual losses for risks subject to rating are, in the aggregate, less than the expected losses anticipated by rates is another contributing factor to the off-balance of experience rating.

Multi-split experience rating plans also have off-balance. To the extent that loss ratios vary by size of risk and primary and excess actual loss is less than primary and excess expected loss, there will be off-balance. Also, individual losses are limited to the state's accident limitation under multi-split plans. These limitations also reduce the dollars of actual loss and, therefore, contribute to off-balance. The off-balance which may exist in plans for lines other than Workmen's Compensation is not recognized in rate level calculations as is the off-balance in Compensation plans. This will be discussed later.

EXPECTED LOSSES—HAZARD

Expected losses and the ability of an experience rating plan to reflect hazard are two concepts which should be discussed jointly. Expected loss refers to the column of expected losses or expected loss rates as shown in Exhibit I-B. The expected loss rate times the payroll provides the dollars of expected loss for the individual risk for the experience period under consideration in experience rating. Expected losses in multi-split experience rating plans are similar to those calculated in the Pennsylvania Workmen's Compensation no-split plan, in that an expected loss rate is published for each class in both plans. The multi-split plans further subdivide the expected losses into the expected primary losses and expected excess losses. To determine the expected primary losses, the expected losses are multiplied by the classification "D" ratio. The "D" ratio is a direct reflection of varying hazard. A high "D" ratio indicates that a larger percentage of total losses are coming from smaller type losses. We would expect the class "bakeries" to have a high "D" ratio and "roofers" to have a low "D" ratio.

The calculation of an expected loss rate is shown in Marshall's paper on Workmen's Compensation ratemaking[3]. The purpose of calculating an expected loss rate is to arrive at a value of expected loss which is comparable to the actual losses that are used in experience rating. Instead of adjusting the actual losses (which may be two or three years old) to current benefit levels, the expected losses are adjusted to the benefit levels at the time the actual losses were incurred. This will be important later in our comparison of no-split plans for third party lines.

[3]Marshall, R. M., "Workmen's Compensation Ratemaking", *P.C.A.S. XLI.*

MEASURING THE PLAN'S ABILITY TO RESPOND

As indicated earlier, an experience rating plan has many functions. In the absence of experience rating, we would expect that a group of risks would distribute themselves about an average loss ratio. The experience rating process attempts to more tightly distribute the same group of risks about the average. By increasing the premium on poor risks and lowering the premium on good risks, the plan attempts to adjust each risk's loss ratio to the average. If we accept this as one of the standards that an experience rating plan should meet, we are then left with the problem of measuring a plan's ability against this standard.

To measure this ability, I suggest that we calculate the standard deviation of the loss ratio distribution of a group of risks without experience rating (the manual premium loss ratio distribution) and compare it to the standard deviation of the loss ratio distribution of the same group of risks after experience rating (the standard premium loss ratio distribution). This information is available for the Pennsylvania Experience Rating Plan. The experience is included in Exhibits III-A and III-B.

All experience rated risks for Pennsylvania for policy years 1966 and 1967 were analyzed. The risks were divided by arbitrary size groupings in order to see if the plan worked better for the larger sizes of risks. One year (1966) was at first report, while the other (1967) was at second report. I wanted to see if the later reporting of losses affected the distributions. One conclusion that I drew was that the additional development of losses to second report has little or no effect on the pattern of results. On the first report basis, the standard deviations of the two loss ratio distributions are not markedly different. On the second report basis, there is no apparent improvement in this pattern. We will be safe if we concentrate on Exhibit III-A for further analysis.

We note some peculiarities on Exhibit III-A:

1. Though the standard deviations for the two loss ratio distributions are similar, our size groupings are made up of broad ranges of risks and this may be biasing our result. We note that the loss ratio on a manual premium basis begins to depart significantly from the mean loss ratio as size of risk increases (weighted mean versus unweighted mean).

2. There is a significant difference in the overall premium developed on a manual basis as opposed to a standard basis.

In answer to the first point, I have attached an appendix which shows the same data carried through a weighting procedure. This should dispel any fears that the standard deviations are being affected by either the size groupings of the risks or the disparity in loss ratio. The weighted standard deviation of the manual premium loss ratio distribution is not reduced by the experience rating process. Or, to put it another way, the weighted standard deviations of the standard premium distributions are not significantly less than the weighted standard deviations of the manual premium distributions.

Now that we know that the data on Exhibit III-A are unbiased, we can turn to the second point: the reduction of premium. The application of the Pennsylvania Experience Rating Plan generates roughly a 20% reduction in overall premium each year. Let us assume for the moment that we have no experience rating plan. Wouldn't we want to credit the class "large risks" because they have better than average experience? Let us assume further that we give large risks (those subject to experience rating) a 20% flat credit. If we now look at the standard deviations of this loss ratio distribution and compare it with the standard deviation of the loss ratio distribution of experience rated risks (Exhibit III-C), we see that experience rating does tighten the loss ratio distribution. When measured against a plan that generates only flat credits, we find that the Pennsylvania no-split plan is superior.

This same type of analysis was performed on a sample of risks that were rated under the multi-split experience rating plan. The sample contained one policy year of "intra-state only" risks. The risks were at first report. The standard deviations, by size of premium groupings similar to Pennsylvania, were very close over all sizes of risk on both the standard and manual premium bases. The aggregate premium on the standard premium basis was very close to the aggregate premium on a manual premium basis. For this body of experience there was no evidence that the loss ratio distribution was tightening after experience rating. Perhaps a more interesting study would be one where the manual premium loss ratio distribution is measured against a standard premium loss ratio distribution when the standard premium loss ratio covers a longer period than one year. This should reduce the variation in the one-year test of standard premium loss ratios considerably, and it should conclusively prove that the experience

rating plan does indeed indentify the "better than average" and "worse than average" risks.

Conclusion on Compensation Plans

Before any testing of the loss ratio distribution after experience rating, why should we expect the multi-split plan to be superior to the Pennsylvania Workmen's Compensation Plan? I think the one big advantage of the multi-split plan is the "D" ratio concept. For the majority of risks, those below the Q point, there is no excess credibility. For these risks,

$$M = \frac{ZpAp + (1\text{-}Zp)Ep + Ee}{E}.$$

Here, in the simple case, we can see the importance of the *Ep* term. For any two risks with the same primary credibility, the "D" ratio *(Ep)* distinguishes between the inherent hazard of risks (bakers vs. roofers). A high "D" ratio reflects the high incidence of small loss. The claim-free "baker" will get a larger credit modification than the claim-free "roofer". Exhibit IV shows the relationship of the "D" ratio and the modification for the claim-free risk. For a given primary credibility, a larger credit is given to the claim-free risk with the highest "D" ratio.

The "D" ratio was non-existent in the earliest experience rating plans. The earliest plan calculated two partial premiums: one for the death and permanent total loss portion and the other for the remaining indemnity and medical losses. The splitting of losses, therefore, is an ingenious way to incorporate, within the workings of the plan, the catastrophe type of loss (death or permanent total injury) with the run-of-the-mill loss. It satisfies a fundamental principle of experience rating stated by Michelbacher, ". . . experience rating . . . should not excessively penalize an assured for the occurrence of an accident which, as regards the individual risk, may be considered fortuitous."[4]

Both the no-split and the multi-split plans create off-balance. Both types of plans retain overall manual rate level by adjusting class rates for this off-balance in Workmen's Compensation. The no-split plan would

[4] Michelbacher, G. F., "The Practice of Experience Rating", P.C.A.S. IV

seem to be easier to implement because the calculations of the modification are easier. Perhaps the ultimate test would be to apply both plans to the same group of risks to see if the increased calculations of the multi-split plan warrant its use in favor of the no-split plan.

Comparison of Workmen's Compensation Plans With Third Party Line Plans

The Insurance Services Office promulgates a number of individual risk rating plans. States have responded differently to these plans. In those states that permit maximum rating flexibility, the ISO has filed its Experience and Schedule Rating Plan for Auto Liability and General Liability. These states are referred to as "open states". Only four states are currently referred to as "closed states" (North Carolina, Texas, Louisiana and Virginia). These states do not permit schedule rating in the aforementioned lines of business, so the ISO files its Experience Rating Plan in these states. New York was a member of this group, but the Open Competition Rating Law in New York now permits the filing of a schedule rating plan. Exhibit V shows a sample page of the North Carolina Automobile Liability Experience Rating Plan (a closed state plan). Exhibit VI shows a sample page of an open state's plan: the Maryland General Liability Experience and Schedule Rating Plan.

Closed States' Plan

Though there are only four closed states, it is worth identifying features of this type of plan because the construction is different from other types of no-split plans. The closed states' plan uses a "D" ratio concept and an excess limits credibility for risks developing more than $30,000 of basic limits premium. The "D" ratio that is used in this plan is the measure of the off-balance created by limiting losses to the maximum single loss values. To the extent that it represents the ratio of small losses to total losses, it is similar to the "D" ratio of the Compensation Plan. That "D" ratio is defined as the ratio of primary losses to total losses. Besides the "D" ratio, it is also worth noting that the closed states' plan uses a modification formula with loss ratios in lieu of dollars of actual and expected loss. All General Liability risks, for example, would use the same expected loss ratio. For risks developing less than $30,000 of basic limits premium the formula is:

$$M = \frac{\text{Actual Basic Limits Ratio} \times Z + (1\text{-}Z)\ \text{Expected Loss Ratio} \times \text{"D" Ratio}}{\text{Expected Loss Ratio} \times \text{"D" Ratio}}$$

The use of loss ratio, as opposed to dollars, does not distort the result. It was noted earlier, however, that the expected loss rates in the Compensation Plan were used to adjust the expected losses to the same benefit levels as actual losses. In the closed states' plan, no attempt is made to put the actual and expected loss ratios on the same economic level, i.e., the actual loss ratio is comprised of losses which are valued at some date approximately three months prior to the rating date and premiums which are adjusted to current levels. Losses, at this time, are basic limits paid losses and outstanding reserves on reported cases. For basic limits losses, it is safe to assume that most of the actual loss dollars are known at this time, although some losses will be unreported. To the extent that losses were paid in the earlier part of the experience period, some adjustment of these losses should be made to bring these losses to expected cost levels. If a company's liability reserves indicated an upward loss development pattern, it would be safe to assume that this, too, would cause an understatement of actual loss dollars at the time of calculation of the modification.

Open States Plan

Exhibit V gives us an idea of the way that the open states' plan of the ISO is constructed. This plan is very similar in construction to the Pennsylvania Workmen's Compensation Experience Rating Plan. Neither of these plans employs a "D" ratio. The General Liability Plan and Auto Liability Plan are used in conjunction with schedule rating. The maximum credibility assigned in the liability plans is .75; the Pennsylvania Compensation Plan identifies the self-rating value as $208,567 of expected loss (25 times the average death and permanent total loss for Pennsylvania).

There are some major differences in these two plans. Let us segment these differences as follows:

A. Historical developments
B. Effects on rate level.

A. *Historical Developments*

Workmen's Compensation rates and rating plans have received a great deal of scrutiny over the years. I think the evidence is clear that the

ratemaking process develops rates which are more appropriate, risk by risk, than can be developed in any other commercial line of business. As the political climate has changed with respect to compensation over the years, the ratemaking process has reflected these changes. As benefit levels and wage levels have increased, rates have responded with minimum delay. Since rates are reviewed annually, large swings in manual rates are kept at a minimum. State regulators, employers and the insurance companies tend to view the rating process as responsive to their needs.

Perhaps, as we look back into the Fifties and early Sixties, General Liability also responded well to the rating needs of employers and state regulators. However, in the late Sixties, as the rate of inflation increased and attitudes of the public were reflected in changes in the interpretation of the law, premium levels for this line of business came under great stress. We have seen malpractice and products liability claims increasing in frequency and severity in reflection of this change in attitude.

The rating plans in this line of business are geared to give the underwriter maximum flexibility. In many instances, the underwriter needs this flexibility. In other instances, the lack of appreciation of the workings of individual risk rating plans have surely caused problems. In a line of business where significant loss development is continuing three years after the close of a policy year, responsiveness of rates can be a serious problem.

B. *Effects on Rate Levels*

I had previously indicated that Compensation maintains overall rate level by adjusting all class rates for the off-balance created by the experience rating plan. In General Liability and Commercial Automobile there is no formal procedure to adjust rate levels for off-balance. In the closed states' plan, the "D" ratio helps to reduce off-balance, but in the open states' plan, off-balance is assured by the limitation on individual loss amounts. We have already identified other factors that contribute to off-balance in the Liability Plans, such as unreported losses, possible upward loss development and losses which have not been adjusted for economic changes. This off-balance is not restored to class rates in General Liability and Commercial Automobile.

There are explanations for ignoring this off-balance. One is that the plan is not mandatory. Another might be that schedule rating can offset the off-balance created by experience rating. To the first argument, I

would reply that the plan is probably applied as if it were mandatory. Credit risks will demand to be rated. Debit risks will be glad to pass up the opportunity. Of course, passing them up increases the off-balance. To the second argument, there is no clear answer. We might argue that to schedule debit risks that have proven themselves to be better than average, under experience rating, is discriminatory.

Schedule rating, like experience rating, is unmeasured. Current statistical plans do not require the recording of either experience or schedule modifications for individual risks. Perhaps the Commercial Risk Statistical Plan will start a precedent in that it requires the coding of the "Percentage Premium Modification".

REVISION OF A PLAN

What options are open to us in revising an experience rating plan of the "open states' type"? In a relatively stable insurance pricing mechanism, the revision of the experience rating plan is not necessarily a problem. Recently, however, because of our rising economy, we have seen the necessity to modify certain of the factors inherent in the ISO experience rating plans and in the Pennsylvania Workmen's Compensation Plan. As values of individual losses increase due to increased costs in medical expenses, etc., the values will more often exceed the maximum single loss value as published in our present plans. Increased frequency of large loss tends to accentuate the off-balance in the present experience rating plans. As loss experience in the third party lines continues to deteriorate, companies are taking a more realistic view of the third party experience rating plan. The loss experience on which experience modifications are calculated in the third party lines is the risk's own experience as produced on individual account loss runs. These loss runs are usually subject to some deficiencies such as losses which have been incurred that are not yet reported. This inadequacy of total loss dollars, of course, is built into the calculation of the experience modification. In attempting to get more dollars of loss into rating, some revision of the experience rating plan has taken place. Some changes have been made in the swing of the experience rating plan, in self-rating point or in the credibility formulas, i.e., the "K" value in the credibility formula. Since, in the third party line experience rating plan, the dollars of actual losses are very difficult to adjust to a final fully developed value, and since it is very difficult to identify all losses which have been incurred but are not yet reported, there is a tendency to look at the

dollars of expected losses with anticipation of adjusting these instead of trying to adjust the actual losses. Those plans with a current off-balance due to maximum single loss (or the other dollars of missing loss) cannot necessarily be adjusted to full value as far as the actual losses are concerned. It is possible, however, to measure the total dollars of off-balance in the plan and to bring the plan back into balance, *i.e.*, to strengthen the plan by adjusting the dollars of expected loss to a truer expected loss value than that anticipated in overall rate level. In other words, the expected loss ratio should be adjusted to some lesser value, as was done in the closed states' plan with the "D" ratio. However, we need not restrict the role of the "D" ratio to the adjustment for maximum single loss only.

SUMMARY

The currently used no-split experience rating plans affect large premium volumes. These plans have not been revised frequently. Since many of these plans have not been formally tested, there should be concern as to the values used in the plans, such as: the credibility curve, the self-rating point and the swing of the plan. Perhaps we should also be concerned with the way that the relative hazard of a risk is reflected in these plans. The "D" ratio of the multi-split plan segregates hazard. In the liability no-split plans, any two risks of equal premium size are treated the same, though one may be a risk with heavy OL&T exposure, and the other may have heavy products exposure. Off-balance is a measure of difference from established manual rate level. Underwriters must recognize this fact. With the advent of detailed Commercial Multiple Line experience from the Commercial Risk Statistical Plan, developments of experience rating plans for Commercial Package risks can be anticipated.

Experience rating plans are very useful tools in fostering competition and safety. As shown previously, some compensation plans, as presently constructed, do not minimize the loss ratio variance, *i.e.*, they are not necessarily distributing costs equitably. To the extent that this may be judged important, factors in the plans should be adjusted. An additional implication is that the third party line plans may also fail on this point. They too should be tested. I hope the items discussed in this paper will be beneficial to those who periodically come in contact with these plans.

Exhibit I-A

Pennsylvania Experience Rating Plan

Expected Losses (1)	Credibility "C" (2)	Maximum Value of One Accident (3)
1420 or less	.050	6750
1421-1564	.055	6786
1565-1709	.060	6825
1710-1856	.065	6862
1857-2004	.070	6896
.	.	.
.	.	.
.	.	.
5347-5534	.175	7773
5535-5725	.180	7821
5726-5918	.185	7869
5919-6114	.190	7917
6115-6312	.195	7967
.	.	.
.	.	.
.	.	.
12777-13066	.335	9643
13061-13360	.340	9716
13367-13659	.345	9791
13660-13963	.350	9866
13964-14271	.355	9942
.	.	.
.	.	.
.	.	.
94078-95816	.815	29125
95817-97574	.820	29480
97575-99362	.825	29839
99363-101176	.830	30202
101177-103012	.835	30567
.	.	.
.	.	.
.	.	.
173932-178666	.975	45205
178667-183964	.980	46254
183965-190077	.985	47468
190078-197615	.990	48951
197616-208566	.995	51028
208567 & over	1.000	55873

Exhibit I-B

PENNSYLVANIA EXPERIENCE RATING PLAN

Manual Rates and Expected Loss Rates

Code No.	Manual Rate	Exp. Loss Rate	Code No.	Manual Rate	Exp. Loss Rate	Code No.	Manual Rate	Exp. Loss Rate
005	3.50	1.99	251	.63	.35	505	1.85	1.05
007	3.55	2.02	255	1.10	.62	506	.88	.50
009	7.70	4.38	257	1.25	.71	507	1.75	.99
025	4.00	2.27	281	.51	.29	508	2.35	1.33
028	1.60	.91	305	1.95	1.11	509	.85	.48
050	3.50	1.99	323	1.05	.59	510	4.25	2.42
051	3.20	1.82	401	1.70	.96	512	1.90	1.08
053	3.00	1.70	402	3.30	1.88	513	.91	.51
055	2.35	1.33	404	1.40	.79	533	2.15	1.22
101	1.75	.99	406	1.35	.76	535	.63	.35
103	.37	.21	407	1.30	.74	551	1.30	.74
105	1.00	.56	408	1.30	.74	553	.70	.39
107	.90	.51	409	.80	.45	555	.48	.27
108	1.30	.74	411	2.55	1.45	557	1.30	.74
109	1.30	.74	413	1.45	.82	563	1.00	.56
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
163	.44	.25	458	.35	.19	651	1.55	.88
165	.93	.52	459	.30	.17	653	1.50	.85
167	.67	.38	461	.87	.49	654	2.00	1.13
201	1.55	.88	463	1.65	.93	655	5.95	3.39
204	.47	.26	467	.54	.30	656	3.05	1.73
205	.70	.39	473	.54	.30	658	2.00	1.13
221	1.30	.74	475	1.15	.65	661	.94	.53
222	1.10	.62	483	.29	.16	662	.66	.37
225	1.20	.68	487	.28	.15	663	.99	.56
227	.79	.44	501	.60	.34	665	2.50	1.42
.	.	.	.	.	.	.	.	.
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Exhibit II

WORKMEN'S COMPENSATION

Size of Risk Premium Range	Total Standard Premium	Loss Ratio
$ 1,678—$ 6,623	$265,776,009	60.4
$ 6,624—$13,687	$149,737,975	59.3
$13,688—$47,340	$222,551,145	57.6
$47,341 and over	$217,213,861	56.6

Source: Simon, LeRoy J., "The 1965 Table M", *P.C.A.S.*, LII

This exhibit does not show the loss ratio for risks not subject to experience rating but it does demonstrate that loss ratios diminish as risk size increases.

Exhibit III-A

PENNSYLVANIA WORKMEN'S COMPENSATION
Policy Year 1966 (1st Report)

Size of Policy	Number of Policies	Incurred Losses	Standard				Manual			
			Premium	Loss Ratio	Mean	Std. Dev.	Premium	Loss Ratio	Mean	Std. Dev.
*1(Under— 500)	390	$ 150,643.	$ 103,494.	145.56	115.55	581.94	$ 107,643.	139.95	115.45	589.60
2(500— 999)	1,207	509,966.	966,714.	52.75	54.38	208.40	997,198.	51.14	53.16	202.15
3(1,000— 2,499)	1,968	1,617,372.	3,332,414.	48.53	47.90	144.03	3,441,004.	47.00	47.30	142.01
4(2,500— 4,999)	2,463	4,536,414.	8,661,421.	52.37	51.95	116.47	9,022,956.	50.28	51.26	118.12
5(5,000— 9,999)	1,921	7,206,209.	13,299,927.	54.18	54.40	91.83	14,220,821.	50.67	52.98	91.07
6(10,000—49,999)	1,389	13,953,419.	26,214,228.	53.23	52.38	50.72	29,670,060.	47.03	49.04	48.59
7(50,000—99,999)	161	6,265,718.	11,265,167.	55.62	56.34	38.25	15,848,688.	39.53	44.70	31.29
8(100,000—Over)	71	7,807,874.	14,685,593.	53.17	55.46	25.86	25,176,272.	31.01	43.98	29.00
ALL SIZES	9,570	42,047,615.	78,528,958.	53.54	54.67	171.03	98,481,645.	42.70	53.16	170.93

*Size group #1 is included for completeness. Modifications were calculated for these risks before it became evident that the premium was too small to qualify the risks for experience rating.

Exhibit III-B

PENNSYLVANIA WORKMEN'S COMPENSATION
Policy Year 1967 (2nd Report)

Size of Policy	Number of Policies	Incurred Losses	Standard				Manual			
			Premium	Loss Ratio	Mean	Std. Dev.	Premium	Loss Ratio	Mean	Std. Dev.
*1(Under— 500)	343	$ 119,473.	$ 64,045.	186.55	145.59	977.21	$ 69,149.	172.78	140.99	804.10
2(500— 999)	839	410,045.	670,690.	61.14	61.37	445.07	696,672.	58.86	67.99	587.68
3(1,000— 2,499)	1,779	1,554,003.	3,086,803.	50.34	50.46	193.84	3,176,823.	48.92	49.58	185.32
4(2,500— 4,999)	2,656	4,625,417.	9,406,756.	49.17	48.91	125.81	9,822,967.	47.09	47.99	125.04
5(5,000— 9,999)	2,205	8,076,203.	15,409,702.	52.41	52.11	128.33	16,422,798.	49.18	50.73	127.17
6(10,000—49,999)	1,702	17,793,889.	32,899,856.	54.09	55.78	80.91	37,033,594.	48.05	53.21	85.46
7(50,000—99,999)	217	8,205,736.	14,951,246.	54.88	54.93	42.90	19,325,803.	42.46	47.62	40.42
8(100,000—Over)	124	12,843,856.	24,146,269.	53.19	52.75	31.37	36,756,781.	34.94	42.17	25.77
ALL SIZES	9,865	53,628,622.	100,635,366.	53.29	52.21	256.60	123,300,911.	43.49	51.17	259.05

*Size group #1 is included for completeness. Modifications were calculated for these risks before it became evident that the premium was too small to qualify the risks for experience rating.

Exhibit III-C

PENNSYLVANIA WORKMEN'S COMPENSATION
LOSS RATIO BY EXPERIENCE MODIFICATION
MEAN AND STANDARD DEVIATION OF LOSS RATIOS
MANUAL YEAR 1966

Size of Policy	Number of Policies	Incurred Losses	Standard				Manual (Adjusted)			
			Premium	Loss Ratio	Mean	Std. Dev.	Premium	Loss Ratio	Mean	Std. Dev.
1(Under— 500)	390	$ 150,643.	$ 103,494.	145.56	115.55	581.94	$ 86,115.	174.93	144.31	737.00
2(500— 999)	1,207	509,966.	966,714.	52.75	54.38	208.40	797,758.	63.92	66.45	252.68
3(1,000— 2,499)	1,968	1,617,372.	3,332,414.	48.53	47.90	144.03	2,752,801.	58.75	59.13	177.51
4(2,500— 4,999)	2,463	4,536,414.	8,661,421.	52.37	51.95	116.47	7,218,361.	62.85	64.07	147.65
5(5,000— 9,999)	1,921	7,206,209.	13,299,927.	54.18	54.40	91.83	11,376,644.	63.34	66.23	113.84
6(10,000—49,999)	1,389	13,953,419.	26,214,228.	53.23	52.38	50.72	23,736,023.	58.79	61.30	60.73
7(50,000—99,999)	161	6,265,718.	11,265,167.	55.62	56.34	38.25	12,678,948.	49.42	55.88	39.11
8(100,000—Over)	71	7,807,874.	14,685,593.	53.17	55.46	25.86	20,141,017.	38.77	54.97	36.25
ALL SIZES	9,570	42,047,615.	78,528,958.	53.54	54.67	171.03	78,785,067.	53.37	66.45	213.66

Exhibit IV

WORKMEN'S COMPENSATION

Let E = Expected Losses
Ze = Excess Credibility
Zp = Primary Credibility
Q = Q Point

M = Modification
Ap = Primary Actual Loss
Ep = Primary Expected Loss
Ee = Excess Expected Loss
E = Ep + Ee

For $E < Q$, $Ze = 0$

$$M = \frac{ZpAp + (1-Zp)Ep + Ee}{E}$$

If $Ap = 0$, $M = \frac{Ep(1-Zp) + Ee}{E}$

But $Ep = \text{"D"} \times E$ and $Ee = E - Ep$

Therefore, $Ee = E - \text{"D"}E$

Now $M = \frac{\text{"D"}E(1-Zp) + E - \text{"D"}E}{E}$

$M = \text{"D"}(1-Zp) + 1.0 - \text{"D"}$

$M = 1.0 - \text{"D"}Zp$

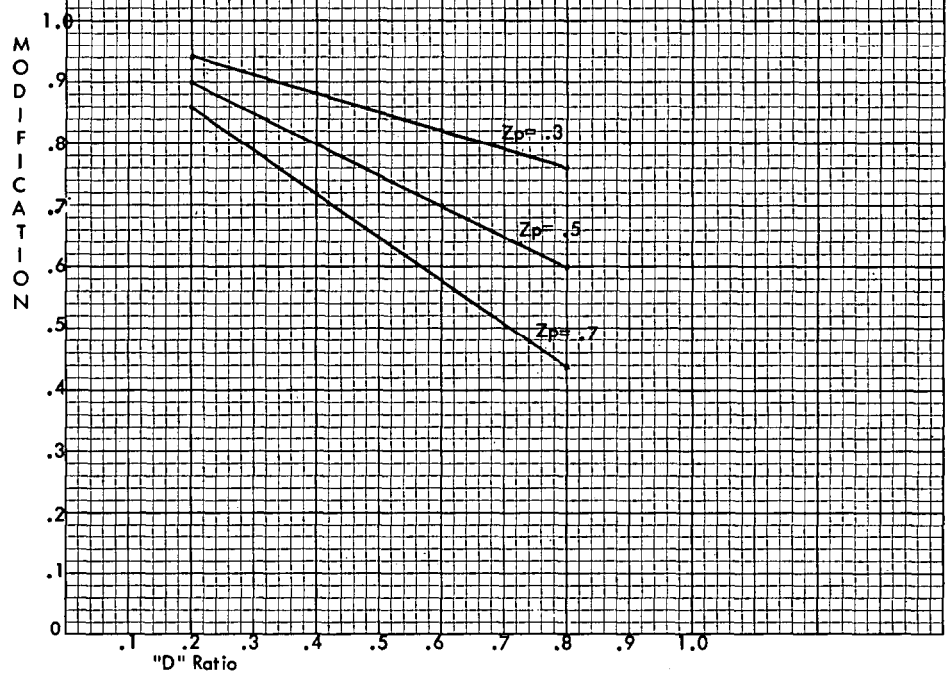

Exhibit V

INSURANCE SERVICES OFFICE

Automobile Liability Experience Rating Plan—North Carolina Credibility Table

Premium	Basic Limits Credibility Z	"D" Ratio	Basic Limits Maximum Loss Including Allocated Claim Expense All Other	Taxis	Garages	Excess Limits Cred. Ze
24,944- 25,977	.56	.899	7,400	7,700	7,100	—
25,978- 27,058	.57	.902	7,600	7,900	7,300	—
27,059- 28,192	.58	.904	7,800	8,100	7,500	—
28,193- 29,382	.59	.906	8,000	8,400	7,700	—
29,383- 30,632	.60	.909	8,200	8,600	7,900	.10
30,633- 31,948	.61	.911	8,400	8,800	8,100	.10
31,949- 33,333	.62	.913	8,700	9,100	8,400	.11
33,334- 34,794	.63	.915	8,900	9,400	8,600	.11
34,795- 36,338	.64	.918	9,200	9,600	8,900	.11
36,339- 37,971	.65	.920	9,500	9,900	9,200	.12
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
82,565- 88,108	.81	.956	18,100	19,000	17,500	.24
88,109- 94,285	.82	.958	19,200	20,100	18,500	.25
94,286-100,503	.83	.961	20,300	21,300	19,600	.26
100,504-106,721	.84	.963	21,400	22,400	20,700	.27
106,722-112,939	.85	.965	22,400	23,600	21,700	.29
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
207,457-216,071	1.00	.990	30,000	30,000	30,000	.44
216,072-225,000	1.00	.990	30,000	30,000	30,000	.45
225,001-234,259	1.00	.990	30,000	30,000	30,000	.46
234,260-243,867	1.00	.990	30,000	30,000	30,000	.47
243,868-253,846	1.00	.990	30,000	30,000	30,000	.48
253,847-274,999	1.00	.990	30,000	30,000	30,000	.49
275,000 and over	1.00	.990	30,000	30,000	30,000	.50

Exhibit VI

INSURANCE SERVICES OFFICE

Maryland
General Liability Experience Rating
Credibility and Maximum Single Loss Table

Premium	Credibility	Maximum Single Loss	Premium	Credibility	Maximum Single Loss
1- 304	.01	2,850	12,521-13,057	.39	4,600
305- 512	.02	2,900	13,058-13,613	.40	4,700
513- 725	.03	2,900	13,614-14,188	.41	4,800
726- 942	.04	2,950	14,189-14,782	.42	4,850
943- 1,164	.05	2,950	14,783-15,393	.43	4,950
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
3,669- 3,952	.16	3,350	23,011-23,956	.54	6,100
3,953- 4,242	.17	3,400	23,957-24,943	.55	6,300
4,243- 4,539	.18	3,450	24,944-25,977	.56	6,400
4,540- 4,844	.19	3,500	25,978-27,058	.57	6,600
4,845- 5,157	.20	3,550	27,059-28,192	.58	6,700
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
8,777- 9,197	.31	4,100	43,493-45,573	.69	9,100
9,198- 9,629	.32	4,150	45,574-47,796	.70	9,400
9,630-10,075	.33	4,200	47,797-50,175	.71	9,700
10,076-10,534	.34	4,250	50,176-52,727	.72	10,100
10,535-11,007	.35	4,350	52,728-55,471	.73	10,400
11,008-11,496	.36	4,400	55,472-58,431	.74	10,900
11,497-12,000	.37	4,500	58,432 and over	.75	.188 x Prem.
12,001-12,520	.38	4,550			

APPENDIX

It was noted that the results on Exhibit III-A may be heavily biased by the method of grouping the risks. If we are given a set of numbers $X_1, X_2, \ldots X_N$, the standard deviation would be defined as:

$$S = \sqrt{\frac{\sum_{j=1}^{N} (X_j - \overline{X})^2}{N}} .$$

In our case, each X is a loss ratio. If $X_1, X_2, \ldots X_N$ occur with frequencies $f_1, f_2, \ldots f_N$, then the standard deviation would be defined as:

$$S = \sqrt{\frac{\sum_{j=1}^{N} f_j (X_j - \overline{X})^2}{N}} .$$

If we want to remove any doubt concerning the effects of grouping the risks in this study, we can consider the premium as a weighting factor similar to frequency. On Exhibits A and B of this appendix are shown the weighted standard deviations for each size group and for all risks combined. For each size group the difference in the weighted standard deviations from Exhibit A (standard premium) to Exhibit B (manual premium) is very small. We can conclude that the grouping of risks on Exhibit III-A has not biased our result.

Exhibit A

PENNSYLVANIA WORKMEN'S COMPENSATION

LOSS RATIO BY EXPERIENCE MODIFICATION

MEAN AND STANDARD DEVIATION OF LOSS RATIOS
POLICY YEAR 1966
STANDARD (UNADJUSTED) PREMIUMS

SIZE OF POLICY	NUMBER OF POLICIES	INCURRED LOSSES	STANDARD PREMIUM	LOSS RATIO	MEAN	STANDARD DEVIATION	WEIGHTED STD. DEV.
1(Under — 500)	390	$ 150,643.	$ 103,494.	145.56	115.55	581.94	622.51
2(500— 999)	1,207	509,966.	966,714.	52.75	54.38	208.40	193.38
3(1,000— 2,499)	1,968	1,617,372.	3,332,414.	48.53	47.90	144.03	145.98
4(2,500— 4,999)	2,463	4,536,414.	8,661,421.	52.37	51.95	116.47	116.67
5(5,000— 9,999)	1,921	7,206,209.	13,299,927.	54.18	54.40	91.83	89.80
6(10,000—49,999)	1,389	13,953,419.	26,214,228.	53.23	52.38	50.72	48.63
7(50,000—99,999)	161	6,265,718.	11,265,167.	55.62	56.34	38.25	36.82
8(100,000—Over)	71	7,807,874.	14,685,593.	53.17	55.46	25.86	23.13
ALL SIZES	9,570	42,047,615.	78,528,958.	53.54	54.67	171.03	76.41

Exhibit B

PENNSYLVANIA WORKMEN'S COMPENSATION

LOSS RATIO BY EXPERIENCE MODIFICATION

MEAN AND STANDARD DEVIATION OF LOSS RATIOS
POLICY YEAR 1966
MANUAL (READJUSTED) PREMIUMS

SIZE OF POLICY	NUMBER OF POLICIES	INCURRED LOSSES	STANDARD PREMIUM	LOSS RATIO	MEAN	STANDARD DEVIATION	WEIGHTED STD. DEV.
1(Under — 500)	390	$ 150,643.	$ 107,643.	139.95	115.45	589.60	618.93
2(500— 999)	1,207	509,966.	997,198.	51.14	53.16	202.15	188.08
3(1,000— 2,499)	1,968	1,617,372.	3,441,004.	47.00	47.30	142.01	142.47
4(2,500— 4,999)	2,463	4,536,414.	9,022,956.	50.28	51.26	118.12	114.89
5(5,000— 9,999)	1,921	7,206,209.	14,220,821.	50.67	52.98	91.07	86.17
6(10,000—49,999)	1,389	13,953,419.	29,670,060.	47.03	49.04	48.59	44.85
7(50,000—99,999)	161	6,265,718.	15,848,688.	39.53	44.70	31.29	27.15
8(100,000—Over)	71	7,807,874.	25,176,272.	31.01	43.98	29.00	24.31
ALL SIZES	9,570	42,047,615.	98,481,645.	42.70	53.16	170.93	68.64