### ESTIMATING ULTIMATE INCURRED LOSSES IN AUTO LIABILITY INSURANCE

BY

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### INTRODUCTION

For many years insurance executives have been vitally concerned with the ravages of inflation. Primarily their direct concern has been with the stark reality of collecting premiums during one period of time and paying out losses at a time subsequent when the dollar has become devalued in some degree. They have felt that the insurance company is placed upon a treadmill which is inclined uphill. On an inflationary trend, if insurance contracts are priced according to last year's costs it is inevitable that when claims pay-out occurs several years hence, there simply will not be enough dollars available out of this year's premiums to pay such losses at the increased loss settlement level.

Some attempts have already been made to adjust past years' observed costs so that they will reflect current conditions more accurately. Invariably, such adjustments cover a period of time beyond the average date contained in normally reported ratemaking statistics; however they fall considerably short of the time when new rates are promulgated.

If we are to avoid predicting or guessing at the future course of our economy as it will affect future insurance experience and if we are to remain within the time covered by actual experience, serious limitations necessarily are imposed on any adjustment factors that may be used. Nevertheless we should search for direct insurance information which will narrow the average time encompassed by the data normally used for ratemaking and the actual date of rate revision.

The insurance information which comes to mind is the calendar year experience shown in the New York Supplemental Insurance Expense Exhibit; more particularly the latest policy year component of such calendar year experience is the most recent available data from a time standpoint. If the latest policy year component of the calendar year experience can be demonstrated to be predictable and can be shown to follow specific mathematical patterns of evolution then we can have substantial confidence in using this most recent segment of experience for adjusting normal ratemaking data to reflect more nearly the most recent insurance facts of which we have knowledge. Such an adjustment factor has been developed in Part V of this paper. It takes a form which is somewhat analagous to the rate level adjustment factor which has been used for several years in workmen's compensation insurance.

The paper is divided into five parts.

Part I demonstrates and develops the idea that policy year experience reported as of 36 months and subsequent can be predicted as to its ultimate outcome by applying specific discount factors to the out-

standing losses.

Part II demonstrates and develops the idea that stable relationships exist between paid losses and ultimate incurred losses if the policy year experience is at least 36 months old. It proceeds from there and demonstrates that specific relationships between paid losses and ultimate incurred losses apply for policy year experience reported at 12 months and at 24 months as well.

Part III demonstrates that the use of the written premium-paid loss ratios at the end of 12 months and 24 months for predicting ultimate loss ratios gives results which are consistent with the actual ulti-

mate loss ratios.

Part IV develops a theoretical equation which accurately describes the percentage of total policy year incurred losses which have been paid as of any reporting date.

Parts I through IV lay the foundation for concluding that paid policy year loss experience reported as of 12 months gives a reliable

measure of the ultimate incurred loss experience.

Part V suggests a program for adapting policy year paid losses

reported as of 12 months to supplementary ratemaking.

While this paper treats of the facts as they are, no one can fail to recognize that the specific percentages which are applicable today are subject to change and adjustment; however the available evidence suggests that such change will be small and more importantly, will be observable by the analyst in time to be reflected in revised specific percentages.

### NEW YORK STATE AUTO LIABILITY INSURANCE EXPERIENCE

Several years ago the New York Supplemental Insurance Expense Exhibit was modified to require the reporting of New York State Auto Liability (bodily injury) experience for calendar year by policy year. A sufficient body of experience has now been compiled so as to enable a preliminary analysis to be undertaken.

In order to make the data comparable the raw losses were expressed in terms of each million dollars of premium. This facilitates comparisons of developments within the policy year as well as enables com-

parisons between policy years.

### Part I

### DEVELOPMENT OF A PROCEDURE

### FOR RECOGNIZING THE MOVEMENT OF OUTSTANDING LOSSES

Exhibit I contains the raw data for stock and mutual companies converted to a base of one million dollars of earned premium. Each

policy year of experience is shown as of December 31 carried forward at 12 month intervals. Column 1 shows the incurred loss\* ratio expressed in millions of dollars of earned premium. Columns 2 and 3 provide a split of incurred losses as between outstanding and paid amounts respectively. For the sake of completeness, figures are also shown reported as of 12 and 24 months. However, as will be explained in Part II, these figures have to be considered in a somewhat different light than those reported at 36 months and subsequently.

By the time the policy year is 36 months old virtually all premiums and all claims have been entered on the company's books (except for relatively minor retrospective adjustments, etc.). This signifies that effectively from 36 months reporting until the ultimate closeout of cases the policy year experience encompasses a closed system wherein no new premiums are added and no new claims of significance can affect the total result. Examination of Exhibit I shows a steady downward progression of incurred losses per million dollars of earned pre-

mium after the 36 months reporting date.

If a reliable means of predicting the ultimate results could be found then we will have added to our knowledge of the ebb and flow of insurance experience taking into account economic and other elements which affect insurance experience. In an attempt to evaluate the movement of incurred losses we have departed from the usual method of estimating loss development factors on the total incurred losses. Instead we have arbitrarily considered the change in incurred losses between periods as related to the change in outstanding losses. This effectively assumes that the change in incurred losses could be assigned to those cases which have been disposed of between the two reporting dates. At first glance this might appear inconsistent with actual company practices of evaluating claims regardless of whether those claims have been paid during the year. We believe, however, that it is immaterial in the final analysis as to whether that assumption is completely valid or not. Our ultimate interest lies in determining the ultimate loss cost and not necessarily the 12 month progression of such loss cost. Because of the convenience of dealing with the figures of 12 month intervals we proceeded on this basis, retaining some reservations.

The results of this approach are shown on Exhibit II. That exhibit shows the amounts of change in losses outstanding as well as the savings incurred expressed as a percentage of the change in outstanding losses in the aggregate. Despite our prior reservations we are impressed with the results of this computation. The results show little variations in percentages from year to year. In the aggregate the average approximates the percentage for the individual year. The average estimated savings beyond 36 months is approximately 12% of the outstanding losses. What is most remarkable about the figures

<sup>\*</sup>Pure losses only. Loss adjustment expenses are not included here but are reported elsewhere in accordance with the instructions for the Uniform Classifications of Expenses.

in Exhibit II is the clustering about the average for each policy year in the aggregate and for all policy years at 12 month intervals. Tests were likewise made on these same policy years for stock and mutual companies separately. The variations from the average are somewhat larger because smaller bodies of data are being considered. In the aggregate, however, the average savings from 36 to 84 months is likewise 12% separately for stock companies and for mutual companies. The stock and mutual company figures shown in Exhibit II for policy year 1952 from 36 to 48 months is somewhat lower than the average but is offset by higher than average developments beyond 48 months. Policy year 1954 exhibits the same characteristic from 36 to 48 months and is the lowest of any of the figures on that exhibit. However, this could well be offset in subsequent reportings of policy year 1954 and will not be known until 1958 and later.

The actual loss ratios at successive reporting dates are shown for

each policy year:

Table A
STOCK & MUTUAL COMPANIES
NEW YORK STATE AUTO LIABILITY
ACTUAL LOSS RATIOS

	$Policy \ Year \ Loss \ Ratio$				
Reported As of Dec. 31	1950	1951	1952	1953	1954
1953	.649	.646			
1954	.642	.635	.583		
1955	.637	.627	.576	.543	
1956	.636	.623	.569	.534	.595
1957		.620	.566	.529	.588

The results of applying this 12% discount to outstanding losses are dramatically revealing. For comparative purposes the loss ratios for the same years are shown on a discounted basis:

Table B

STOCK & MUTUAL COMPANIES
NEW YORK STATE AUTO LIABILITY
DISCOUNTED LOSS RATIOS

	$Policy\ Year\ Loss\ Ratio$				
Reported As of Dec. 31	1950	1951	1952	1953	1954
1953	.635	.622			
1954	.635	.623	.561		
1955	.634	.620	.563	.522	
1956	.634	.620	.563	.522	.572
1957		.618	.562	.522	.575

For each policy year the year to year fluctuation in loss ratios has been practically eliminated by utilizing this discounting process. This is summarized in the table below which shows the average deviations (reflecting signs) from the latest reported loss ratios on an actual and a discounted basis:

### Table C

# STOCK & MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY EXPERIENCE DEVIATIONS OF ACTUAL & DISCOUNTED LOSS RATIOS

### Deviation from Latest Reported Loss Ratios

Policy Year	Actual Basis	Discounted Basis
1950	+.007	+.001
1951	+.013	+.003
1952	+.010	+.000
1953	+.010	+.000
1954	+.007	003

Our conclusion is that with minor variations an estimated average saving of 12% on outstanding claims very closely approximates the true situation with respect to each and all policy years. Upon reflection we would normally expect some savings to occur because of the conservative practices required by prudent company operations. This is true with respect to precautionary reserves and is also true with respect to evaluation of doubtful liability cases.\* Finally the magnitude of the savings is in keeping with the opinion expressed in some quarters that for tax purposes the Internal Revenue Service will allow a substantial savings on the run-off of claims before recomputation of income tax will be required.

The estimated savings of a fixed percentage of outstanding losses is a rather significant figure. It fills the gap which is created by using a cut-off date in the normal rate making process. Consider the experience as it is used at the final reporting for rate making purposes. If the outstanding amounts are known then the ultimate incurred loss cost may be accurately predicted simply by discounting the outstanding losses by that percentage. For example, policy year 1955 experience as shown on Exhibit I indicates incurred losses are \$690,021 per

If this is true then the paid losses are the only pure loss elements which are common to all carriers.

<sup>\*</sup>Another possible partial explanation of a portion of the run-off runs as follows: Some carriers may not record loss adjustment expenses according to annual statement requirements. If a carrier included loss adjustment reserves with pure losses (i.e., failed to separate properly items belonging in Column 12½ from Column 12 of Schedule P Part 1A) and did the same thing as respects New York Auto Liability reserves, then a credit run-off would occur as unpaid claims expense which is included with unpaid losses become transferred into the paid category.

million dollars of earned premium. On the basis described the ultimate incurred loss would be that amount less 12% of the outstanding losses of \$223,728 shown in Column 2, or an ultimate incurred

loss of \$663,174 per million dollars of earned premium.

The experience of one large stock carrier (Bureau) and one large mutual carrier (Bureau) was also examined to see whether the pattern of savings for all carriers holds. Somewhat greater variability in savings was discovered. For the sake of completeness the savings are shown below for all available years comparable to that of Exhibit II:

### Table D

### NEW YORK STATE AUTO LIABILITY AVERAGE SAVINGS ON OUTSTANDING LOSSES FOR TWO INSURANCE CARRIERS

	Savings		
All Available Years	1 Stock	1 Mutual	
36 to 48 Mos.	5.7%	13.5%	
48 to 60 Mos.	9.8	17.4	
60 to 72 Mos.	25.8	3.5	
72 to 84 Mos.	34.0	22.7	
36 to 84 Mos.	8.0%	13.0%	

Before concluding Part I, it is pertinent to cite the results obtained for stock and mutual companies exclusive of two large independent carriers with substantial premiums in New York State. The resulting savings on outstanding losses is approximately 14%. For all available years comparable to that of Exhibit II the average savings is as follows:

### Table E

### STOCK & MUTUAL COMPANIES (EXCLUDING TWO LARGE INDEPENDENT CARRIERS) NEW YORK STATE AUTO LIABILITY AVERAGE SAVINGS ON OUTSTANDING LOSSES

All Available Years	Savings
36 to 48 Mos.	13.2%
48 to 60 Mos.	15.6
60 to 72 Mos.	15.0
72 to 84 Mos.	<u>13.8</u>
36 to 84 Mos.	14.2%

Actual loss ratios with these two independent carriers eliminated are likewise shown in Table A-X:

### Table A-X

### STOCK & MUTUAL COMPANIES

### (EXCLUDING TWO LARGE INDEPENDENT CARRIERS) NEW YORK STATE AUTO LIABILITY

ACTUAL	LOSS	RATIOS
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	Policy Year Loss Ratio				
Reported As of Dec. 31	1950	1951	1952	1953	1954
1953	.656	.655			
1954	.646	.639	.588		
1955	.642	.630	.578	.541	
1956	.640	.624	.571	.532	.595
1957		.622	.567	.525	.586

Similarly, the application of the 14% discount to outstanding losses is shown in Table B-X:

### Table B-X

### STOCK & MUTUAL COMPANIES (EXCLUDING TWO LARGE INDEPENDENT CARRIERS) NEW YORK STATE AUTO LIABILITY

### DISCOUNTED LOSS RATIOS

	Policy Year Loss Ratio				
Reported As of Dec. 31	1950	1951	1952	1953	1954
1953	.639	.626			
1954	.638	.624	.562		
1955	.638	.622	.563	.517	
1956	.638	.620	.563	.518	.569
1957		.620	.563	.518	.571

The average deviations from the latest reported loss ratios on an actual basis are greater with the two independent carriers excluded while the average deviations from the latest loss ratios on a discounted basis are smaller. Essentially, therefore, for carriers which are members or subscribers of rating organizations, it is fair to conclude that an estimated average saving of 14% on outstanding claims very closely approximates the true situation with respect to each and all policy years.

With the two independent companies excluded and allowing for a 14% saving on outstanding losses the actual policy year 1955 loss

ratio of .688 at 36 months should ultimately become .657.

One other important feature needs to be emphasized. It is the adaptability of this device to methods of reporting other than policy year reporting. While the savings are derived from policy year data throughout, we believe that the same results would flow under other systems of compilation of statistics, provided it is a closed system in the sense that no new premiums and no new claims could be injected on subsequent reporting dates. This signifies an important area of utility with respect to more recent rate making procedures which are based on calendar-accident year experience. Aggregate information developed on this latter basis by rating and statistical organizations should be most welcome.

### Part II

### DEVELOPMENT OF STABLE RELATIONSHIPS BETWEEN PAID AND ULTIMATE INCURRED LOSSES

In Part I reference to experience reported prior to 36 months was made, and excluded from consideration there. This is because the fiscal reporting of experience at 12 and 24 months is too immature in that the data are seriously affected by estimates of earned premiums and also that claims are not entirely known. At 24 months reporting, the policy year reporting has not yet become a closed system in the sense described heretofore. At 12 months reporting the earned premiums are estimated; they are approximately 55% of the policy year written premiums. It may be that individual company practices of distributing countrywide earned premiums on a pro rata basis to the several States, produces this result. If the 55% of written premium result is something other than the net result of actual seasonal variation in premium writings then the earned-incurred loss ratios at 12 months are unduly distorted. In order to avoid the possibly distortionary effects of the foregoing it is believed that the 12 month losses related to written premiums are more appropriate. Exhibit III shows the experience of the available policy years at 12 months. The losses are expressed in terms of millions of dollars of written premiums.

With respect to loss experience at 24 months, for practically all policy years the incurred losses per million dollars of earned premiums are understated in comparison to ultimate incurred losses at 36 months. The explanation for this phenomenon may be that in using the cut-off date of December 31, companies include insufficient amounts for the year-end cases which have not been processed as of December 31. In the succeeding 12 months as these cases are entered on the company's books they will serve to increase the loss ratios. Here again the inadequacy of the 24 month reported figures may be related to the lack of a closed system for evaluation purposes.

In Part I we developed a means of predicting ultimate incurred losses. We have adapted the results of this predictive process to take advantage of the latest policy years reported at 12 and 24 months. Exhibit IV furnishes a comparison of the actual and the estimated ultimate incurred losses for each policy year. It will be noted that the estimated ultimate incurred losses for policy years 1954 and prior are extremely close to the actual reported incurred losses. As respects

policy year 1955 the difference is a little less than 4% and stems from the larger proportion of outstanding losses to incurred losses.

We have taken the actual paid losses and related them to the estimated ultimate incurred losses. Exhibit V shows the distribution of policy year paid losses at successive reporting dates. The remarkable feature of this exhibit is the lack of variation in the proportion of the total paid out as of any specified reporting date. In reading the figures across we found virtually no difference in the proportion of ultimate incurred loss paid out at the end of 12 months for policy years 1953, 1954 or 1955. An examination of the figures at 24 months and subsequently shows the pattern to hold almost as well. In order to develop this information in more usable form averages of these relationships are shown on Exhibit VI and VI-a. It should be noted that it makes very little difference whether the latest two years, three years, four years or five years are used. This is of course due to the fact that the individual years tend to cluster around a central average. In this connection, it is interesting to note Mr. A. H. Mowbray's paper in Volume VI of the Proceedings of the Casualty Actuarial Society on "The Actuarial Problems of the 1920 National Revision of Workmen's Compensation Insurance Rates and the Solutions Developed by the Actuarial Committee of the National Council." On Pages 274-275 he reports the conclusions of the committee that the ratios of losses paid at the end of the calendar year in which the policies were issued to the ultimate incurred losses under such policies were stable. He states "the preliminary investigations of the committee based on New York Schedule W returns indicate that the Losses Paid at the end of the calendar year in which the policies were issued bore a remarkably stable percentage relationship to the ultimate incurred losses on that same year of issue. \*

Exhibit VI may be used to develop a figure which is comparable to the ultimate incurred loss ratio. For example, policy year 1950 reported at 84 months is actually 63.6%. After eliminating 12% of the outstanding reserves it becomes 63.4 and this coincides with the actual paid loss divided by .9808. The results for other years compare favorably with the discounted loss ratios.

Exhibit VI-a provides a means for estimating the ultimate loss ratios for policy years 1956 and 1957. Exhibit VI-a shows the stability of the averages even at 12 months and 24 months reporting. If reliance can be placed upon these distributions of paid losses it would be possible to improve the predictions of ultimate loss costs.

Exhibit V was recomputed with the two large independent carriers excluded. While not shown here, in no case did any paid figure deviate

<sup>\*</sup>In the State of New York these percentages for a representative group of companies were on '16 Issues 13.9 per cent., on '17 Issues 14.2 per cent., on '18 Issues 13.7 per cent, Average of 3 years 13.8 per cent., and similar stability has been shown by the figures for other states on a much smaller volume of data after allowance has been calculated for the effect of intervening amendments."

more than \$80 per \$10,000 of ultimate incurred losses from Exhibit V. Policy year 1954 and 1955 at 12 months became \$698 and \$700 respectively in lieu of \$700 and \$698. The average of the 12 month paid figure for the latest two years on Exhibit VI-a was unaffected while the average of the 24 month period figure became \$4293 in lieu of \$4237.

### Part III

### DEVELOPMENT OF A PROCEDURE FOR PROJECTING RECENT INSURANCE EXPENSE EXPERIENCE TO AN ULTIMATE BASIS

Part I develops a method of converting loss experience to an estimated ultimate incurred cost provided that the basic experience is at least 36 months old.

Part II uses the information developed in Part I for the purpose of developing the distribution of paid losses as of specified maturity dates. The remarkable consistency of adjacent policy years shown on Exhibit V is carried forward in the averages shown on Exhibits VI and VI-a. The closeness of the figures on Exhibit VI leads us to infer that the figures on Exhibit VI-a can likewise be relied upon as a measure of ultimate incurred losses. In this way we are able to eliminate the restriction that the system as defined heretofore must be a closed system. The figures appear to indicate that even though unknown claims will be included in the figures subsequent to 12 month and 24 month reports the amounts paid up to the cut-off date bear an approximately fixed relationship to the ultimate cost of all claims including the as yet unknown claims. Thus the conclusion to be drawn from Exhibit VI-a (two year average basis) is that the paid losses at 12 months are 6.99% of the ultimate incurred losses. The further inference to be drawn from this is that one need know only the amount of paid losses and the reporting date in order to determine the ultimate incurred losses. The amazing thing about this concept is that the application of these procedures to the 12 month figures shown on Exhibit III produces results for policy years 1953, 1954 and 1955 which are almost identical with loss ratios that would be produced by application of the methods described in Part I to the latest available experience for these policy years. The projection of 24 months experience to an ultimate incurred loss cost by the use of paid ratios also develops ultimate incurred losses which agree remarkably well with those obtained through Part I procedures.

A table is shown below disclosing these results using the two year averages of Exhibit VI-a for application to the paid losses. Also shown for comparative purposes are the discounted loss ratios as of December 31, 1957.

### Table F

# STOCK & MUTUAL COMPANIES NEW YORK AUTO LIABILITY EXPERIENCE POLICY YEAR LOSS RATIOS DEVELOPED FROM PAID LOSSES

### AND COMPARED WITH ULTIMATE LOSS RATIOS

70.11	Loss Ratio Developed From Paid Losses		
Policy			Loss
Year	12 Months	24 Months	Ratio
1952		.558	.562
1953	.525	.536	.522
1954	.576	.565	.575
1955	.662	.675	.663
1956	.662	.661	N.A.
1957	.701	<del></del>	N.A.

N.A.—not available.

Similar results are shown in Table F-X with the two large independent carriers excluded.

### Table F-X

# STOCK & MUTUAL COMPANIES (EXCLUDING TWO LARGE INDEPENDENT CARRIERS) NEW YORK AUTO LIABILITY EXPERIENCE POLICY YEAR LOSS RATIOS DEVELOPED FROM PAID LOSSES AND COMPARED WITH ULTIMATE LOSS RATIOS

Policy	Loss Ratio From Pa	$Ultimate\ Loss$	
Year	12 Months	24 Months	Ratio
1952		.561	.563
1953	.528	.532	.518
1954	.570	.563	.571
1955	.658	.667	.657
1956	.651	.662	N.A.
1957	.730	N.A.	N.A.

N.A.-not available.

If the foregoing procedure holds currently, and indications seem to point that way, then policy year 1956 and policy year 1957 incurred loss costs can be predicted reasonably well as respects ultimate costs even though all the facts on cases recently arisen and cases not yet reported are not fully reflected.\*

### Part IV

### AN EQUATION TO EXPRESS PAID LOSSES AS A FUNCTION OF TIME

When Exhibits VI and VI-a were consolidated, the following distribution of amounts paid was formed:

### Amount Paid

t (in years)	To Year End	During Year
ì	.0699	.0699
$ar{2}$	.4237	.3538
3	.7050	.2813
4	.8333	.1283
5	.9090	.0757
6	.9602	.0512
7	.9808	.0206

The amount paid during the year, when plotted, appears very much like a Pearson type curve. After considerable experimentation with the form  $y = C_t^B e^{-A_t^{-1}}$  it was found that (1)

$$y = 3500t^{-5.33942}e^{-10.911t^{-1}}$$
 (2)

fit reasonably well. The fit could be improved slightly by adding the  $-.015t^{3}e^{-1.1t}$  cosine t. term (2a)

However, this form was found inconvenient to use for obtaining the amount paid to the year end.

Instead a fresh approach was made using the cumulative amounts paid to the year end. A curve of the form

$$\log_{10} y = At^{-B}10^{-ct}$$
 (3)

was fitted to the observed values for t=1, 2, 3.

Through trial and error\*\* and after much painstaking effort ably executed by Mr. Lester Dropkin, we found that

$$\log_{10} y = -2.0674 t^{-.80599} 10^{-.24841t}$$
 (4)

produced values which were extremely close to the observed values. The differences between values computed from equation (4) and the observed values are shown below:

<sup>\*</sup>A note of caution should be made here. It is assumed that the distribution of policies will not vary substantially from year to year. If there should be sudden changes which would tend to change the distribution of exposures then the paid proportion of the total incurred losses will shift somewhat.

<sup>\*\*</sup>See Appendix A for a description of the procedure used.

### Differences From Observed Values

t (in years)	Amount	Per Cent
1	0018	-2.6%
2	0036	$-0.8^{\circ}$
3	0025	-0.4
4	+.0205	+2.5
5	+.0192	+2.1
6	+.0041	+0.4
7	+.0013	+0.1

Having satisfied ourselves that the percentage error was not large at any time for t greater than 1, we attempted to compare the function with actual observations at quarterly intervals for t less than 1.

Through the cooperation of two large statistical organizations we obtained policy year 1956 data paid by quarter year intervals. By equating the observed data at December 31, 1956 to .0699 of all losses we developed a distribution comparable to equation (4). We found the values to compare as follows:

	y from	Observed Values From Statistical Organization I II .0005 .0005 .0056 .0059 .0232 .0227		
t	Equation $(4)$	Statistical Organization		
	-	I	II	
.25	.0000	.0005	.0005	
.50	.0019	.0056	.0059	
.75	.0209	.0232	.0227	
1.00	.0681	.0699	.0699	

It should be mentioned that the observed values include allocated claim expense and this might account for some of the difference. Even if it did not, the overall fit of the function to the data is quite good.

A table of values of y for various t's may be constructed from equation (4). Such a table is shown in Exhibit VII. The amounts paid between periods and cumulative amounts paid are illustrated in Figure I.

### Part V

### ADAPTATION OF PAID LOSSES TO SUPPLEMENTARY RATEMAKING

One of the chief dilemmas in insurance ratemaking practices is that concerned with closing the time gap between the reporting date of the detailed statistics to the ratemaking organization and the time of rate revision. Various conjectures based on external statistics (accident statistics, consumer price indices, wage rates, etc.) have at times been made in attempts to close this gap. More recently, trends of average insurance paid claim costs and paid claims have also been

utilized with some limited success. In workmen's compensation insurance ratemaking, calendar year experience has been utilized in order to supplement the normal policy year data used for ratemaking.

As a result of the dramatic demonstration of the stability of various paid ratios, it appears to us that supplemental insurance expense exhibit loss statistics might well be utilized to augment normal detailed ratemaking data. In the first place, the latest policy year component of the calendar year experience is approximately 10 months closer to the present time than is the latest detailed accident year statistics used for ratemaking. Secondly, the policy year component, properly developed, has been demonstrated to produce an error of less than 2.5% in the ultimate loss ratio. Therefore, it should be feasible to develop a program which will begin with the results indicated from an evaluation of accident year experience and advance it an additional 10 months,\* and thus improve the ratemaking process as a whole.

Concretely, as a beginning, a rate level adjustment factor somewhat analogous to that used in workmen's compensation insurance could be used, except that the 12 month policy year would be used rather than the calendar year. The procedure could be expressed as follows:

$$1.0 + \left\{ \frac{L_{p}}{.0699 \; P_{p}} \div \frac{L_{A}}{P_{A}} \; \bullet \; \frac{1}{r_{A}} \right\} - r_{p} \; \pm \; .025 \; = \; F$$

where  $.900 \le F \le 1.100$ 

In explanation of the foregoing,

 $L_p = 12$  month policy year losses paid

P<sub>p</sub> = 12 month policy year premiums written on current rate level

.0699 = proportion of ultimate losses paid as of 12 months

 $L_A =$  accident year losses incurred

 $P_A^n =$ accident year premiums earned on current rate level

 $r_A$  = accident year permissible loss ratio

 $r_p$  = policy year average permissible loss ratio for all auto liability

- $\pm .025$  = neutral zone, based on maximum observed error in developing paid to ultimate losses
  - $.900 \pm F \pm 1.100$ ; limits of  $\pm .100$  from unit, based on the assumption that the influence of economic and other factors reasonably to be reflected in insurance data should be limited to 10% over a period not exceeding 10 months.

 $r_A$  would be the average permissible loss ratio for all auto liability, which presupposes a simultaneous rate revision for private passenger,

<sup>\*</sup>For example, in June 1959 the most recent ratemaking data that would be expected would cover the calendar-accident year ending June 30, 1958 with an average date of accident at December 1957. Policy year 1958 as contained in the Insurance Expense Exhibit as of December 31, 1958 has an approximate average accident date of September 1958.

commercial and all other cars; however since private passenger comprises the vast majority of the business, it might be considered alone if agreement could be reached on this point.

The neutral zone of  $\pm .025$  would of course be applied to bring the factor closer to unity; as a further limitation, reversals above or below unity due to the use of  $\pm .025$  by specific proviso could result in a

factor of unity.

The neutral zone notion incorporates the concept of a sliding scale of credibility between the smallest and the largest allowable departure from the permissible loss ratio; the factor is therefore utilized to its greatest extent only when the experience shows extreme changes have occurred.

As an alternative, the influence of the latest 12 months might be dampened further by bringing in the last half of the preceding policy year into the computations. In this case

$$\frac{L_{p}}{.0699 P_{p}}$$
 (6)

would be replaced by

$$\left\{\frac{L_p}{P_p} + \frac{{}_1L_p}{{}_1P_p}\right\} \times \frac{1}{.4237} \text{ where}$$
 (7)

- 1. the prescript, 1, refers to the developments during the latest calendar year on the next latest policy year,
- 2. the first fraction in the bracket is the paid-written loss ratio on present rate level for the *latest* 12 month policy year,
- 3. the second fraction in the bracket is the paid-written loss ratio on present rate level for the second half of the preceding 24 month policy year, and
- 4. the .4237 is the proportion of all losses paid by the end of 24 months.

This alternative approach would somewhat de-emphasize the 12 month policy year in favor of utilization of a larger volume of paid data. In either instance, both the .0699 and .4237 would be subject to periodic reexamination.

### CONCLUSION

Some final observations are worth noting.

It seems to us that the foregoing analysis points to an underlying kernel of universality as respects the net effect of economic fluctuations together with the social impact of claim consciousness and traffic density as they have a bearing upon average insurance loss costs.

The consistency of Table B is improved when the experience of two large independent automobile insurers is excluded. These independent companies exhibit a volume growth which is radically different from that of members and subscribers of rating organizations. As stated earlier the average saving on outstanding losses is 14% with the two companies excluded and closer to the average year by year. The exclusion of these two carriers produces year to year results equally consistent with those shown on Exhibit V and consequently Exhibits VI and VI-a.

Although criticism might be directed against inclusion of excess limits claims, the figures are available only on this basis; it is also believed that the size of the New York state volume of business and the use of \$10,000/\$20,000 limits in ratemaking minimizes such criticism.

Lest anyone be left with the impression that we believe the relationships derived are immutable, we hasten to add no such inference is intended. What does appear true is that the relationships change very slowly. This lethargy of change makes the averages which are developed along the lines of Exhibits II, VI and VI-a and applied as described for Tables F and F-X a useful tool for estimating ultimate costs.

It is hoped that these comments may afford the opportunity for exploration and analysis which will penetrate further into this uncharted field. With appropriate safeguards and further observation of data, perhaps a program may evolve which will recognize up to date experience earlier than is being done currently.

Exhibit I

### STOCK AND MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY INSURANCE DISTRIBUTION OF POLICY YEAR LOSSES

(Per Million Dollars of Earned Premium)

			Losses	
Policy Year	$egin{aligned} Reported \ As \ Of \end{aligned}$	$\stackrel{(1)}{Incurred}$	$\stackrel{(2)}{Outstanding}$	$\mathop{Paid}\limits^{(3)}$
1950*	48 Months	\$648,819	\$114,382	\$534,437
	60 Months	641,676	56,612	585,064
	72 Months	637,455	26,012	611,443
	84 Months	635,927	13,623	622,304
1951*	36 Months	\$646,395	\$201,608	\$444,787
	48 Months	635,197	103,832	531,365
	60 Months	627,166	58,354	568,812
	72 Months	622,769	25,611	597,158
	84 Months	620,133	13,705	606,428
1952*	24 Months	\$579,689	\$343,083	\$236,606
	36 Months	583,434	185,605	397,829
	48 Months	576,037	108,157	467,880
	60 Months	569,489	57,094	512,395
	72 Months	565,778	28,777	537,001
1953	12 Months	\$492,572	\$426,673	\$ 65,899
	24 Months	546,856	319,791	227,065
	36 Months	542,855	176,744	366,111
	48 Months	534,036	100,379	433,657
	60 Months	528,871	55,278	473,593
1954	12 Months	\$521,595	\$449,478	\$ 72,117
	24 Months	588,243	348,726	239,517
	36 Months	594,707	188,022	406,685
	48 Months	588,269	107,197	481,072
1955	12 Months	\$599,354	\$516,547	\$ 82,007
	24 Months	679,797	393,918	285,879
	36 Months	690,021	223,728	466,293
1956	12 Months	\$605,198	\$521,835	\$ 83,363
	24 Months	709,689	429,579	280,110
1957	12 Months	\$675,227	\$587,920	\$ 87,307

<sup>\*</sup>Only experience of those carriers able to furnish complete data for these policy years has been included.

Exhibit II

# STOCK AND MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY INSURANCE CHANGE IN POLICY YEAR LOSSES BY CALENDAR YEAR

(Per Million Dollars of Earned Premium)

Policy Year	Calendar Year	(1) Incurred	In Losses (2) Outstanding	(3) Per Cent Savings (1) ÷ (2)
1950*	48 to 60 Months 60 to 72 Months 72 to 84 Months 48 to 84 Months	$ \begin{array}{rrr} -\$ & 7,143 \\ - & 4,221 \\ - & 1,528 \\ -\$12,892 \end{array} $	$ \begin{array}{rrr} -\$ 57,770 \\ -\$ 30,600 \\ -\$ 12,389 \\ -\$ 100,759 \end{array} $	12.4% $13.8$ $12.3$ $12.8%$
1951*	36 to 48 Months 48 to 60 Months 60 to 72 Months 72 to 84 Months 36 to 84 Months	$\begin{array}{l} -\$11,198 \\ -\$0,031 $	$\begin{array}{l} - & 97,776 \\ - & 45,478 \\ - & 32,743 \\ - & 11,916 \\ - & \$187,913 \end{array}$	11.5% $17.7$ $13.4$ $13.2$ $13.4%$
1952*	36 to 48 Months 48 to 60 Months 60 to 72 Months 36 to 72 Months	-\$ 7,397 - 6,548 - 3,846 -\$17,791	-\$ 77,448 - 51,063 - 28,339 -\$156,850	9.6% 12.8 13.6 11.3%
1953	36 to 48 Months 48 to 60 Months 36 to 60 Months	-\$ 8,819 - 5,165 -\$13,984	-\$ 76,365 - 45,101 -\$121,466	$\frac{11.5\%}{11.5\%}$
1954	36 to 48 Months	<b>-\$</b> 6,438	<b>-\$</b> 80,825	8.0%
All Available Years	36 to 48 Months 48 to 60 Months 60 to 72 Months 72 to 84 Months 36 to 84 Months	$\begin{array}{l} -\$ \ 8,463 \\ - \ 6,722 \\ - \ 4,155 \\ - \ 1,549 \\ -\$20,889 \end{array}$	$\begin{array}{l} -\$ 83,104 \\ -\$ 49,853 \\ -\$ 00,561 \\ -\$ 175,671 \end{array}$	10.2% $13.5$ $13.6$ $12.7$ $11.9%$

<sup>\*</sup>Only experience of those carriers able to furnish complete data for these policy years has been included. For policy years 1951 and 1952, consolidated reporting of one group as of December 31, 1957 necessitated exclusion of two companies in that group for calculating the change from 72 to 84 months and 60 to 72 months respectively.

### Exhibit III

### STOCK AND MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY INSURANCE DISTRIBUTION OF POLICY YEAR LOSSES REPORTED AS OF 12 MONTHS

(Per Million Dollars of Written Premium)

		Losses	
Policy	(1)	(2)	(3)
Year	Incurred	Outstanding	$\mathop{Paid}\limits^{(3)}$
1953	\$274,178	\$237,497	\$36,681
1954	291,123	250,871	40,252
1955	335,120	288,820	46,300
1956	336,106	289,810	46,296
1957	379,081	330,066	49,015

Exhibit IV

### STOCK AND MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY INSURANCE ACTUAL AND ULTIMATE† POLICY YEAR LOSSES (Per Million Dollars of Earned Premium)

			Losses	
Policy Year and Report	Item	$\stackrel{(1)}{Incurred}$	(2) Outstanding	$\mathop{Paid}\limits^{(3)}$
1950* (84 Months)	Actual Ultimate†	\$635,927 634,292	\$ 13,623	\$622,304
1951* (84 Months)	Actual Ultimate†	\$620,133 618,488	\$ 13,705	\$606,428
1952* (72 Months)	Actual Ultimate†	\$565,778 562,385	\$ 28,277	\$537,001
1953 (60 Months)	Actual Ultimate†	\$528,871 522,238	\$ 55,278	\$473,593
1954 (48 Months)	Actual Ultimate†	\$588,269 575,405	\$107,197	\$481,072
1955 (36 Months)	Actual Ultimate†	\$690,021 663,174	\$223,728	<b>\$466,293</b>

<sup>†</sup>Ultimate equal to actual incurred less 12% of outstanding losses.
\*Only experience of those carriers able to furnish complete data for these policy years has been included.

Exhibit V

# STOCK AND MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY INSURANCE DISTRIBUTION OF POLICY YEAR PAID LOSSES

(Per \$10,000 of Ultimate Incurred Losses)

Reported		. <i>1</i>	Policy Year Paid Losses				
As Of	1950*	1951*	1952*	1953	1954	1955	
12 Months				\$702	\$700	<b>\$698</b>	
24 Months			\$4207	4348	4163	4311	
36 Months		\$7192	7074	7010	7068	7031	
48 Months	\$8426	8591	8320	8304	8361		
60 Months	9224	9197	9111	9069			
72 Months	9640	9655	9549				
4 Months	9311	9805					

<sup>\*</sup>Only experience of those carriers able to furnish complete data for these policy years has been included.

Note: Ultimate incurred losses obtained from Exhibit IV.

12 months figures based on Exhibit III.

Other figures based on Exhibit I.

Exhibit VI

## STOCK AND MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY INSURANCE AVERAGE DISTRIBUTION OF POLICY YEAR PAID LOSSES

(Per \$10,000 of Ultimate Incurred Losses) (From Exhibit V)

		Average	of Latest	
Reported As of	2 Yrs.	3 Yrs.	4 Yrs.	5 Yrs.
36 Months	<b>\$7</b> 050	\$7036	\$7046	<b>\$7</b> 075
48 Months	8333	8328	8394	8400
60 Months	9090	9126	9150	N.A.
72 Months	9602	9615	N.A.	N.A.
84 Months	9808	N.A.	N.A.	N.A.

N.A.-not available.

### Exhibit VI-a

# STOCK AND MUTUAL COMPANIES NEW YORK STATE AUTO LIABILITY INSURANCE AVERAGE DISTRIBUTION OF POLICY YEAR PAID LOSSES

(Per \$10,000 of Ultimate Incurred Losses) (From Exhibit V)

Reported	Average	Paid Losses F	or Latest
Reported As Of	2 Yrs.	3 Yrs.	4 Yrs.
12 Months	\$ 699	\$ 700	N.A.
24 Months	\$4237	\$4274	\$4257

N.A.-not available.

### Exhibit VII

### Proportion of Total Amounts Paid, y As of Specified Time, t

(From  $\log_{10}y = -2.0674 t^{-.80599}10^{-.24841t}$ )

t	y	t	y	t	y
1 mo.	.0000	1 yr. 9 mos.	.3281	5 yrs.	.9282
2 mos.	.0000	1 yr. 10 mos.	.3592	5 yrs. 6 mos.	.9495
3 mos.	.0000	2 yrs.	.4201	6 yrs.	.9643
4 mos.	.0001	2 yrs. 2 mos.	.4776	6 yrs. 6 mos.	.9747
5 mos.	.0005	2 yrs. 4 mos.	.5309	7 yrs.	.9821
6 mos.	.0019	2 yrs. 6 mos.	.5802	7 yrs. 6 mos.	.9872
7 mos.	.0052	2 yrs. 8 mos.	.6252	8 yrs.	.9909
8 mos.	.0110	2 yrs. 10 mos.	.6658	8 yrs. 6 mos.	.9935
9 mos.	.0201	3 yrs.	.7025	9 yrs.	.9953
10 mos.	.0326	3 yrs, 2 mos.	.7355	10 yrs.	.9976
11 mos.	.0487	3 yrs. 4 mos.	.7648	11 yrs.	.9987
1 yr.	.0681	3 yrs, 6 mos.	.7912	12 yrs.	.9993
1 yr. 2 mos.	.1158	3 yrs. 8 mos.	.8146	13 yrs.	.9997
1 yr. 4 mos.	.1718	3 yrs. 10 mos.	.8353	14 yrs.	<b>.9</b> 998
1 yr. 6 mos.	.2332	4 yrs.	.8538	15 yrs.	.9999
1 yr. 8 mos.	.2966	4 yrs. 6 mos.	.8977	16 yrs.	1.0000



