SEASONAL FLUCTUATION IN LOSS RATIOS FOR
AUTOMOBILE BODILY INJURY COVERAGE

BY

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Actuaries, underwriters, executives, claim adjusters, agents, and others connected with the business of casualty, indemnity, and fire insurance have long recognized that the number and amount of claims rise and fall with the seasons of the year. A glance at the figures reported monthly for fire claims by the National Board of Fire Underwriters shows the seasonal swing on top of the general increase in burning rate that has plagued the fire insurance business for the past few years. Companies writing accident and health insurance and using a notice average reserve frequently use a lower figure for average cost per claim during the winter months than during the spring and summer months. This paper attempts to analyze the claim figures for automobile bodily injury liability to determine the quantitative as well as the qualitative effect of the seasonal variation in a particular line of insurance. The paper is divided into two chief parts, the development of adjustment factors, and the application of these factors.

DEVELOPMENT OF ADJUSTMENT FACTORS:

The most striking figures that show the seasonal fluctuation in automobile accidents are the figures for fatalities each month put out by the National Safety Council. Table I below brings the situation to the fore:

TABLE I

Percentage of Fatalities in Automobile Accidents
in the United States by Month
National Safety Council

Month	Per cent of Total			Month	Per cent of Total			Month	Per cent of Total		
	1939-41	1944	1947		1939-41	1944	1947		1939-41	1944	1947
Jan.	7.6	9.8	7.4	May	7.3	7.3	7.8	Sept.	9.3	8.2	8.9
Feb.	6.2	7.8	6.6	June	7.6	6.9	7.5	Oct.	10.1	9.0	9.3
March	6.8	7.8	7.1	July	8.5	6.9	8.6	Nov.	10.1	9.8	9.4
April	6.8	7.3	7.3	Aug.	9.0	7.8	9.5	Dec.	10.7	11.4	10.6

The years were selected as typical prewar, wartime, and postwar experiences. The prewar pattern of 1939-41 is repeated in 1947 except that the proportions for January and December are low in 1947. The 1944 figures show the effect of

the wartime curtailment of summer (non-essential) driving. The National Safety Council lays great stress on the daylight versus darkness driving in the summer and winter months. Pedestrian deaths, for example, reached a minimum at 23% below the monthly average for the summer months of 1947. In the late fall, short days brought darkness during the peak traffic hours and pedestrian deaths reached a maximum at 42% above the monthly average.

Although mileage increases during the summer months, the death rate related to miles traveled decreases in the summer. The death rate per 100,000,000 vehicle miles in 1947 varied from about 9.2 in January to a minimum of 7.3 in June to a maximum of 10.2 in November and fell slightly to 10.0 in December.

These figures indicate very clearly the existence of the seasonal trend. They are, however, of little use to an insurance company because they do not distinguish insureds exposed and because fatalities are a small proportion of automobile liability claims. Therefore, the figures of one insurance company have been analyzed to determine the trend in insurance claims. These figures will be used in the balance of this paper.

The company whose figures are being analyzed pays its claims under the automobile bodily injury liability coverage through a network of claim adjusting offices spread over the United States and the southern part of Canada. The Canadian business represents about two per cent. of the total. Claims are reported to these offices and the adjusters there make up a file and report to the home office. These reports to the home office must be submitted within 30 days and are usually submitted sooner. At the time of the report the adjuster estimates the amount the company can expect to pay on each individual claim. A series of tests over the years has proved these estimates to be reasonably accurate in the aggregate. The response of estimates to increasing cost per claim has been somewhat slow, especially during 1948. Further discussion of this factor, showing the negligible effect, is given later in the section entitled "further comments on adjustment factors."

When the adjuster's report is received in the home office, the actuarial department prepares a punched card. The charge date to incur the claim on the books is determined by the date punched on this card. All reports received in a given month are punched as of that month. The claims reported plus an estimated figure for claims incurred but not reported equal the incurred claims for the month and are so reported in the monthly financial statements.

The basic raw data were recorded from the actuarial punched cards. The years 1937-41 give the last prewar experience. The years 1946 and 1947 are years in which the exposure increased during the year as additional business was written. During 1948, the written premiums continued to increase but much of the increase was from rate adjustment rather than new policies. These raw data show immediately the seasonal fluctuation. They are not, however, of much value for determining factors to damp this seasonal fluctuation. Therefore, an adjustment was made in the figures to compensate for the different number of days in different months. Ratios were then calculated for the adjusted figures to the average for the appropriate period. These ratios show the seasonal trend even more clearly.

Two facts inherent in the data should be considered for their possible effect on the results. The company writes a substantial volume of Massachusetts

statutory coverage. This business all expires on December 31 of each year but it does not renew automatically on January 1 of the following year. This produces less exposure in the early months of the year. The second factor is the increasing exposure by number of policies in general.

A check was made of the effect of increasing exposure by number of policies for the years 1947 and 1948. The ratio of the number of claims actually reported to the number of policies in force was computed each month. During 1947, the number of policies increased from 708,000 at the end of January to 858,000 at the end of December, and during 1948 from 843,000 to 927,000. The increase thus fell off from 21% in 1947 to 10% in 1948. The effect of the Massachusetts statutory business expiring in December and failing to renew at once is seen in the drop of 15,000 policies in force from December 1947 to January 1948. A special study of the Massachusetts figures shows, taking the number for twelve months of 1948 at 100%, that only 58% were on the books at the end of January and 76% at the end of February. This shows the powerful influence of the slow renewal of that business. Because January and February are high claim months, this slow renewal holds down the January and February claim figures.

The ratio of premium on the policies in force to the number of policies in force shows a steady increase over the twelve months. These figures represent all business in force during the month, not new business paid during the month. This amount of premium increased from $22,185,000 at the end of January, 1947 to $31,320,000 at the end of December, 1947, and during 1948 from $30,837,000 to $37,370,000. Again the percentage increase fell from 41% to 21%.

The real financial effect on a company's operations is wrought by the amounts rather than the number of claims where the amount of a claim exceeds substantially the expense of paying it. The ratios by amounts for the periods 1937-41 and 1946-48 were analyzed to obtain correction factors to reduce the effect of seasonal fluctuation. These ratios were graduated by the Henderson-Whittaker "A" Difference Equation method to smooth the chance fluctuations. The value of $a=1$ in the formula was chosen to minimize the smoothing effect and maximize the reproduction of the underlying curve. The graduating equations were:

$$u'_x = u'_{x-1} - \tfrac{1}{3} u'_{x-2} + \tfrac{1}{3} u''_x$$

$$u_x = u_{x+1} - \tfrac{1}{3} u_{x+2} + \tfrac{1}{3} u'^x$$

where u'' is the ungraduated function, u' an intermediate series, and u the final graduated value. This method produced satisfactory values. Several graduations by fitting to forms of curves distorted the data badly. Graphic graduation reproduces substantially the data determined by the difference equation.

Ratios were computed for the periods 1937-41 and 1946-48 for the monthly values in the raw data by amounts. The data adjusted for the number of days in the month and graduated gives the pattern to be expected in the parent universe of the sample with equal divisions. The difference between the adjusted and the graduated adjusted ratios is the correction toward the true picture with equal intervals. Application of these differences to the ratios in the raw data

gives the true pattern with intervals of actual months. The final answer was rounded to the nearest whole per cent. These figures are given in Table II.

TABLE II

Graduated and Corrected Monthly Amount Ratios
Automobile Bodily Injury Liability

Month	Graduated Adjusted Ratios		Basic Ratios		Final Corrected Ratios	
	1937-41	*1946-48*	*1937-41*	*1946-48*	*1937-41*	*1946-48*
Jan.	110.4	112.3	112.4	114.7	113	114
Feb.	103.7	105.8	99.5	100.2	96	98
Mar.	97.0	99.5	101.1	103.4	99	101
Apr.	91.6	94.2	80.9	88.7	91	93
May	89.5	91.4	93.0	89.5	91	93
June	89.6	91.2	89.2	90.9	88	90
July	91.4	92.6	92.1	95.9	93	94
Aug.	94.7	95.0	97.6	96.8	97	97
Sept.	98.9	98.3	100.3	94.2	98	97
Oct.	103.9	102.3	104.4	112.4	106	104
Nov.	110.5	106.1	102.9	94.8	109	105
Dec.	118.9	111.5	126.7	118.3	121	114

The prewar period ratios show a much greater variation than the postwar period ratios. The pattern, however, is very much the same. Although the data for 1937-41 show a variation of 33 points from lowest to highest against 24 points for the 1946-48 data, each has a minimum in June and a maximum in December in the final corrected ratios. The pattern and size of the figures indicate that adjustments made on the basis of the 1946-48 figures would be conservative. These 1946-48 figures will be used in discussing the effect of this seasonal fluctuation on statement figures.

APPLICATION OF ADJUSTMENT FACTORS:

Each insurance company licensed to operate in one or more states must file with the state authorities an annual statement. One item in this statement is the liability for unearned premiums. This liability is computed in general as the pro-rata portion of the premiums from the date of the statement, December 31, to the date of expiry of the policy then in force. The reserve for unearned

premiums computed on a straight pro-rata basis may be overstated or under-
stated, depending on the date of the statement and the distribution of business.
A policy written in June, for example, has had some over-average and some
under-average loss months on December 31, with an approximately equal share
of each yet to come. A policy written in September has, however, on December
31 already passed through three of its worst months and has all its good
months yet to come. Clearly the liability for its unearned premium is over-
stated.

On the assumptions that a company writes the same amount of business in
each month and calculates its unearned premium reserve by assuming that all
policies written in a month are written in the middle of the month, a set of
figures has been calculated to adjust the unearned premium reserve at the end
of each month. The first set of figures is gross, assuming that the loss dollar
and the expense dollar can be released together. The second set of figures
assumes a normal 53% loss ratio and releases only the loss dollar. The 53% is
based on the Bureau permissible loss ratio at 55.4% less 2.4% for allocated
loss expense included. These figures are listed in Table III.

TABLE III

Ratios Percent to Apply to Unearned Premium Reserve at End of
Month Indicated to Adjust for Seasonal Fluctuation
Automobile Bodily Injury Liability

Month	*Gross Ratios*	*Corrected to Normal* *53% Loss Basis*
Dec.	−0.8333%	−0.4417%
Jan.	−3.1667	−1.6783
Feb.	−2.8333	−1.5017
Mar.	−3.0000	−1.5900
Apr.	−1.8333	−0.9717
May	−0.6667	−0.3533
June	1.0000	0.5300
July	2.0000	1.0600
Aug.	2.5000	1.3250
Sept.	3.0000	1.5900
Oct.	2.3333	1.2367
Nov.	1.5000	0.7950

As a test of the difference between the theoretical and an actual distribution of business, the adjustment was calculated as of December 31, 1948 for the company whose figures are being analyzed. This company calculates its unearned premium on the assumption that the business written in a month averages to the middle of the month. It writes a large amount of Massachusetts business, all expiring December 31, but is otherwise normal. The adjustment amounted to a reduction of about $111,000 in the unearned premium reserve, or 0.676 per cent. on the gross basis. This was a reduction of about $58,800 or 0.36 per cent. on the normal 53% loss ratio basis.

This reduction in the unearned premium reserve anticipates a profit yet to be realized. It is fallacious only if the experience does not develop as expected and as cancelations on a pro-rata or short term rate basis may change the picture. As to the development of the experience, the comparison of the 1946-48 figures used with the 1937-41 figures makes the adjustment look conservative. The cancelation problem is fluid. As of January 1, a cancelation of any policy that runs up to but not beyond May 31 produces a profit and a cancelation of a policy running beyond May 31 produces a loss.

Although this type of adjustment is proper on theoretical grounds and can be applied easily as part of the procedure of calculating the reserve for unearned premium, the small relative size of the change produced vitiates its value for this purpose. Application of such an adjustment in the annual statement would require a change in the rules for calculating unearned premium. The amount of the adjustment in statement reserves does not warrant any consideration of a change in rules.

A more important use for the adjustment is to reduce fluctuations in monthly loss ratios because of normal seasonal variation so that any real non-seasonal trend can manifest itself. All insurance men are familiar with the trend in the automobile loss ratio—bad in the winter, good in the summer. All make mental adjustments in looking at the bare figures. The percentages here derived can be used as a quantitative correction.

The simplest and most direct application is to increase or decrease the earned premium for the month by the per cent. that the corrected ratio differs from 100% or by .53 times such per cent. The revised loss ratio of claims to premium computed on this basis takes account automatically of increases in business by the writing of more policies. It debits or credits a portion of any rate adjustments effective in the earned premium. Another method is to adjust the losses themselves. The best way to do this seems to be to compute a normal loss at 53% of the earned premium, obtain the correction as a per cent. of the normal loss, and compute the adjusted amount of claim as actual plus or minus the correction. These adjustments are not intended for use in financial statements but as underwriting, rate-making, and production guides. The adjustments must themselves be watched to see that they sum to a small figure for the whole year.

Each of these adjustments was applied to the monthly figures of the company being analyzed and the results are given in Table IV. The net adjustment on claims was a net increase of $12,000 on $20,000,000 or about 0.06 per cent. The premium adjustment on the basis of the .53 modification amounted also to about $12,000 on over $37,000,000 or about 0.03 per cent.

TABLE IV

Monthy Loss Ratio Adjusted for Seasonal Fluctuation
Automobile Bodily Injury Liability

Month	1948 Loss Ratio	Loss Ratio Claims Adjusted	Loss Ratio Premiums Adjusted
Jan.	66.2	58.7	61.6
Feb.	50.9	52.0	51.4
Mar.	57.3	56.8	57.0
Apr.	52.9	56.6	54.9
May	48.6	52.3	50.4
June	52.2	57.5	55.2
July	49.3	52.5	51.0
Aug.	46.8	48.4	47.5
Sept.	54.9	56.5	55.8
Oct.	51.7	49.6	50.6
Nov.	51.3	48.6	49.9
Dec.	60.7	53.3	56.5
Total	53.4		

The loss ratios in Table IV include an adjustment for claims incurred but not reported and are after all adjustments for changes and corrections. The effect of rate increases and other improvements in the automobile bodily injury liability line is clear from all three columns. It is startlingly clear from the second and third columns. The spread of the loss ratio is reduced from 19.4 points to 14.1 points in the premium adjustment and only 10.3 points in the claim adjustment.

The value of figures of this kind to an underwriter should be great. Unlike the life insurance business where the sins and graces of the father are usually visited upon the son, the casualty business reacts quickly to underwriting judgment and adequacy of the rate structure. With these figures, the underwriter can go a long way toward eliminating one variable from his study of how good his judgment has been.

More important than the question of underwriting profit and loss itself is the question of capacity. Many casualty and fire companies in the past few years have been plagued by the reduction in surplus from financing new business. Increased rates for a time further aggravate this problem before they relieve it. A basic question in establishing an underwriting program for the next year becomes how much new business can be financed out of surplus and how much will that surplus be. The bare loss ratio may well lead to an excess of optimism or pessimism according to the time of the year at which it is examined. True, a study of the cumulative loss ratio will reduce the tendency to excess, but this cumulative ratio is often studied along with the ratio for the last few months as a guide for projection. Specifically on the figures in Table IV, the months of October and November are really better than they look, and December is only normal instead of bad. This type of figure is particularly important when the figures of the last few years are distorted and require a great deal of mental adjustment before they can be used for comparisons.

FURTHER COMMENTS ON ADJUSTMENT FACTORS:

During the course of the study of seasonal fluctuations of claims, many other analyses of the figures were made beside those reported here. The figures by number showed the same pattern as the figures by amount but to a lesser degree. As would, therefore, be expected, the figures for average amount of claim showed a similar pattern overlaid in the post-war experience on the general increase. The only startling item was a large average amount in January 1948 that offset a small number. This appears to be a normal accidental fluctuation in data of this size.

The statement was made earlier in this paper that the exposure was increasing during the period because of increasing numbers of policies and increasing average size. The ratios of claims to policies in force by number again reveal the general seasonal pattern of lower in the summer and higher in the winter. The ratio by number is only part of the picture, and figures for average size claim were also studied. These, too, show the seasonal pattern. Hence the product of number and amount shows a definite pattern. Figures for average annual premium on the policies in force by month show the trend of the increase. The major part of this increase is, of course, rate changes. Some part may be due to an increase in the number of cars per policy.

The figures used to compute the adjustment ratios were based on adjusters' original estimates. Mention was made earlier that these estimates had fallen behind the rising claim cost in the post-war experience. These estimates are changed by the adjusters as development of the claim picture warrants. The changes, however, are recorded in the month received rather than related back to the month in which the claim is first reported. Thus the effect of the changes on the record because of the way it is compiled is not a true seasonal effect. The average claim after changes was about 10% greater in 1946 and 1947 and about 15% greater in 1948. Calculations similar to those made for the reported figures were made for the figures after correction for changes reported in the month. The results were similar. The figures for the graduated ratios of the claims adjusted for the number of days in the month are set out in Table V.

TABLE V

Comparison of Reported and Changed Estimates
Automobile Bodily Injury Liability

Month	Graduated Monthly Original Report	Ratios 1946-48 After Changes
Jan.	112.3	111.2
Feb.	105.8	105.2
Mar.	99.5	99.3
Apr.	94.2	94.0
May	91.4	90.8
June	91.2	90.1
July	92.6	91.7
Aug.	95.0	95.2
Sept.	98.3	99.6
Oct.	102.3	103.7
Nov.	106.1	107.2
Dec.	111.5	111.5

Both sets of figures produce the same answer within the limits of accuracy of the method and the data. Hence either set could be used. The choice was made in favor of original reports for several reasons. The original report picture is clear and shows the true seasonal effect. The actuary watches the changes and makes corrections for his estimates of incurred claims as the changes indicate. These changes are a measure of the adjusters' inability to evaluate claims accurately in the initial stages of development, particularly during a period of changing economic conditions. The prewar experience shows adjusters do very well in a reasonably stable claim situation. The correction adjustments are calculated to apply to the total figure for incurred claims including the incurred but not reported. Hence the use of adjustments based on the corrected estimates would produce a double correction when the actuary corrects his estimates for the same effect. The question is academic because the figures are so close, but the reasoning may be of some interest.

CONCLUSION:

The effect of the adjustment for seasonal fluctuation in claims applied to the unearned premium reserve is too small to be of any practical importance. The effect of the adjustment in bringing out the true picture of the change in loss ratio by month may have considerable value for underwriting and pro-

duction planning. Any company using such figures would probably prefer to calculate such an adjustment on the basis of its own experience. The National Safety Council makes a big point of the relation between the hours of dusk and the hours of heavy vehicle and pedestrian traffic. The company whose figures have been analyzed does not have monthly state records in satisfactory form and amount for a geographic analysis. Perhaps this might be undertaken by companies that write business principally in the north or south of the country.