A REFINED MODEL FOR PREMIUM ADJUSTMENT

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Many ratemaking problems accompany the expansion of an insurance company into a new line of business. Not the least of these is the problem of accounting for the distortion in on-level factors created by a rapidly expanding exposure base. The authors suggest an interesting extension of the familiar parallelogram method of adjusting the rate level which introduces a third dimension representing the rate at which new exposures are entering the insurer's book of business. Their method is theoretically sound and appears to be rather easy to use as shown by the authors' example. The authors are to be commended for the elegance with which they attacked this rather thorny problem.

One practical consideration which may appear in the application of this three dimensional technique is obscured by the simplicity of the authors' example. One cannot ordinarily expect to find a simple equation that will exactly fit a series of increasing exposures. In a real life situation, development of a suitable equation could well require the use of a skilled technician and a sophisticated computer program. Even with such resources, a perfect fit cannot be expected and the resultant rate level adjustment will be in error to the extent that the equation does not exactly track the data.

A more direct method for accounting for increasing exposures is easily demonstrated using the authors' numbers.

QUARTER	WRITTEN EXPOSURES	EARNED IN 1st YR.	EARNED IN 2nd YR.
1st	125	109.375	15.625
2nd	375	234.375	140.625
3rd	625	234.375	390.625
4th	875	109.375	765.625
Subtotal		687.500	1312.625
5th	1125		984.375
6th	1375		859.375
7th	1625		609.375
8th	1875		234.375
Subtotal			2687.500
GRAND TOTAL			4000.0

Each earned value in the table is found by assuming an earning pattern by quarter of 1/8, 1/4, 1/4, 1/4, 1/8. This discrete method gives a result which is nearly identical to that using the authors' continuous method.

	CONTINUOUS METHOD	DISCRETE METHOD
Exposures at Base Rate Level	33.3%	32.8%
Exposures at 1.200 Rate Level	66.7%	67.2%
Average Rate Level	1.133	1.134
Premium Adjustment Factor	1.059	1.058

The assumption of even writings within each quarter in the discrete method slightly understates the effect of increasing exposures and accounts for the minor differences in the two sets of figures; otherwise, the methods are equivalent. The continuous method produces a slightly more accurate result in this case only because a simple straight line fits the data exactly.

From a theoretical standpoint, I believe the continuous method is superior to the discrete because it enables the actuary to visualize the true nature of increasing exposures and their effect on rate level.

The authors' method could also be applied to lines of insurance in which expected loss levels show significant seasonal variation. Thus, just as the authors adjust for the variation in number of exposures over time, one could also adjust for the fluctuation in the inherent risk of each exposure during the year. The development of a seasonalized exposure curve would enable the actuary to quantify and characterize the seasonal fluctuation and would lend itself to further analysis. It would be enlightening to discover, for example, that loss levels in the auto collision line over time can be approximated by an equation such as

$$y = a + b\ (\sin x)$$

where y is the seasonal loss level index, x is the month as represented by some appropriate fraction of π, and a and b are constants. It is obvious that to ignore seasonality where it is significant could cause distortion in data of incomplete accident years. It may not be intuitively obvious, but it can also be shown that, under certain conditions, seasonality could also significantly distort the data for complete accident years as well. These conditions include increasing or decreasing premium or exposure levels. (The degree of the distortion depends, of course, on the nature—primarily the skewness—of the seasonality curve.) This suggests the use of a fourth dimension incorporating both exposures and seasonality considerations. In four dimensions, the advantage of the continuous method—that it allows the situation to be visualized—is lost on all but the most imaginative among us and a return to the discrete method is probably advisable.