

EXPERIENCE RATING - EQUITY AND PREDICTIVE ACCURACY

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1. INTRODUCTION:

- Workers Compensation (WC) experience rating relates an insured's premium to its own loss experience, to the extent that its experience is a believable indicator of the insured's exposure to loss.
- Losses for the most recently available **three year period** are compared to losses expected to arise in a business of similar size and risk, according to manual classification rates, for each experience-rated risk.
- The insured's standard premium is calculated by applying a credit or debit to the manual premium.

2. FUNDAMENTAL QUESTIONS:

- A. What are the goals of the experience-rating process?
- B. How much of a charge for individual experience is equitable? (see C. below)

Two primary goals of experience-rating are:

1. Safety incentive. Note: this is the only goal shared in common with Gillam.
2. Predictive accuracy (see next page).

- a1. A **financial incentive for safety** is added by charging insured's something for accident occurrence. This in turn **allows the premium to be tailored more closely to each insured's loss potential**, and to the extent of its predictability, **represents the equity contribution of experience rating**.
- a2. However, the **incentive value cannot be used to define equity**. Although it seems the more incentive for safety, the better, **at some point it would be unfair to charge back losses that were random and essentially unpredictable**.
- b1. **In terms of loss prediction, it is easier to define equity. When loss experience produces true differences from class averages, it appears equitable to charge for it**, otherwise the risk should be spread among all insureds.
- b2. Compare the modification to the future experience it was designed to predict to determine how much the insured's experience is indicative of its loss potential.

From this perspective, *the degree to which an insured should be charged for past losses is the degree to which that experience is predictive of future losses*.

- **An insurer's viewpoint:** All insureds have the same expected profit potential, after experience rating.
- **A detached economist's viewpoint:** The optimal and most equitable allocation of resources results from the market charging each insured according to its identified loss potential.

Equity is achieved by maximizing predictive accuracy. Thus, experience rating is an important step in satisfying the statutory requirement that rates not be unfairly discriminatory.

- C. How much can an insured's past history be relied upon to predict future losses?

3. STATISTICAL APPROACH :

Definition: **Predictive accuracy measures the difference between predicted and actual losses.**

The two most intuitively appealing **methods for defining what is most accurate**:

1. The **expected squared error**.
2. The expected *absolute* error.

The **expected squared error is preferred** because:

- a. It leads to mathematically solvable equations.
- b. It mitigates against large individual errors.

The expected squared error is minimized by using the **conditional expected value function**. This function is not widely used because:

- I. It requires additional statistical assumptions.
- II. It is sometimes cumbersome to compute.
- III. It is not always readily understood.

The most commonly used approach to experience rating requires the **modification** to be a linear function of the losses. Thus, **the formula that minimizes the expected squared error, subject to the linearity constraint, is sought.**

The formula that does this (under popular, but overly simplified statistical assumptions) is

$$\text{Modification} = \frac{(A+K)}{(E+K)}, \text{ Formula 1.}$$

A = Actual losses, E = Expected Losses, K = the credibility constant.

Formula 1 minimizes the expected squared error, if K is chosen correctly.

Multi-Split Formula

Since 1940, the multi-split formula has been used in WC.

- Both actual and expected losses are divided into primary and expected losses. The **primary component** is intended to be a relatively small dollar amount, reflecting loss frequency. (echoed by Gillam and Snader). The **excess component**, associated with individual large claims, is the amount above the primary component. The maximum cap on the excess component limits the experience rating charge on large losses.
- The experience modification can be calculated by minimizing the squared error of the primary and excess losses separately.

The shift to a multi-split plan was based on difficulties with the then existing formula.

The **difference** between the unconstrained optimal estimate (the conditional expected value) and the best linear estimator is small or zero for some distributions but **substantial for highly skewed distributions (typically found for WC loss ratios).**

Additional comments:

- The recent NCCI study suggests that although primary losses should have much more credibility, excess losses do have predictive value.
- **Both primary and excess losses are less heavy tailed** than are total losses. Although this may seem obvious for primary losses, it may not for excess losses.

For excess losses, the elimination of the 1st smaller portion of the ground up loss:

1. **Increases the average value** of the loss.
2. **Reduces the probability of a loss being a large multiple of the average value.**

This makes excess losses less heavy tailed and more predictable than total losses.

- The experience rating plan defines any loss below \$2,000 as primary. For losses above \$2,000, the primary value is determined by multiplying the total loss, X, by the primary factor: **(See FIRR: this is the 1961 plan)**

$$\text{Primary factor} = \frac{(10,000)}{(X + 8,000)}. \quad (\text{Formula 2})$$

Since the factor starts at 1.00 for X = 2,000 and decreases for larger values of X, **the primary value of a loss is always greater for larger losses.**

The maximum possible primary value is \$10,000.

The **No-Split** Modification Formula: (See Gillam and Snader)

Formula 1 (Modification = $\frac{(A+K)}{(E+K)}$), arises from a credibility weighting of actual and expected losses.

2 Forms of Expressing Modified Expected Losses (ME):

1. Basic Formula: $ME = Z*A + (1-Z)*E$. *Formula 3.*

$$\text{If } Z = \frac{E}{E+K}, \text{ then}$$

2. K Formula: $ME = \frac{(A+K)}{(E+K)}*E$.

The **Split** Modification Formula: (See Gillam and Snader)

2 Forms of Expressing Modified Expected Losses (ME):

1. $ME = Z_p*A_p + (1-Z_p)*E_p + Z_e*A_e + (1-Z_e)*E_e$. *Formula 4.*

Since there are two credibilities Z_p and Z_e , two credibility constants, B and K, are needed.

$$\text{If } Z_p = \frac{E}{E+B} \text{ and } Z_e = \frac{E}{E+K}, \text{ then } W = \frac{E+B}{E+K} = \frac{Z_e}{Z_p}, \text{ and}$$

2. $ME = \{[A_p + W*A_e + (1-W)E_e + B] / (E+B)\}*E$. *Formula 5.*

This is the modification formula that NCCI currently uses, except that B and K are not constants but vary by size of risk.

B, K, and W:

- The **theory that B and K should be constants** assumes that:
 - a) Larger insureds are more stable than smaller insureds and
 - b) Increased stability follows a mathematical form related to the law of large numbers.
 - c) Variance of the Formula 5 loss ratio is inversely proportional to the firm's premium.
- **In practice**, however, B and K should vary by size of insured and should increase for larger firms.
- The B and W values **were** designed with two goals in mind:
 1. To prevent too large a swing for small insureds.
 2. To provide self-rating (100% credibility) for the largest firms.

The result **was** that B & K **decreased** for larger insureds, while current theory and data suggest that they increase.

In terms of the weight given to individual experience, as opposed to the manual rates:

Too much weight was given to large insureds and Too little given to small insureds.

Large insureds had been given too much credit for good experience, leading to less profit potential than for the debit modified firms; because too much credibility was given to achieve self-rating.

Small insureds with credit modifications came to be regarded as preferred business.

Thus, **the modification did not fully reflect the actual predictive power of the experience.**

NCCI's Recent Review of Experience Rating Values:

A proposed modification formula was developed which incorporates increasing values of B and K according to the current theoretical and empirical findings.

The theory of changing conditions mentioned above would lead to values of B and K that increase as a linear function of the insured's expected losses.

However, the best performance was obtained with values that increased in a non-linear pattern.

This is consistent with a risk theoretic model that considers, in addition to changing conditions, the possibility of large firms being composed of diverse operations with different exposure to loss.

(1991 Plan) Under this model, small firms get more credibility than the linear B & K would provide.

The *proposed rating formula* is exactly the same as the *current formula* (i.e. formula 5) with two differences.

1. Table B and Table W values are different.
2. The primary-excess split is simplified. The primary value of a loss (below split point) is

$x,$	for $0 < x < \$5,000$
$\$5,000$	for $x \geq 5,000$

The reason for the split was to simplify the operation of the plan.

Two tests of plan performance were developed.

1. The ability of the plan to identify risk differences was tested.
2. How well the plan corrects for the differences it identifies.

First Test: Ability of the plan to identify risk differences:

Insureds with lower modifications should have better experience in the next period to which the mod applies on a manual premium loss ratio basis and the higher mods should have higher loss ratios. **Thus, the greater the dispersion of the subsequent period manual loss ratios, the better the plan works.**

On a standard premium basis, the loss ratios should be less dispersed and ideally all equal.

Small Risks (2,500-5,000)
Manual Loss Ratio

Risks with	Plan	
	Current	Proposed
Lowest mods	.75	.70
Next lowest	.79	.78
Middle	.89	.91
Next highest	1.1	1.12
Highest	1.4	1.43

This table seems to indicate that the proposed plan works a little better, based on the greater dispersion of the manual loss ratios.

Second Test: How well the plan corrects for the differences it identifies.

The closer to unity, the better, and the proposed plan seems to work better. For small firms, the plan is more responsive, and brings both credit and debit risks closer to unity after experience rating.

Standard Loss Ratios

Risks with	Small Risks (2,500-5,000) Plan		Medium Risks (10,000-25,000) Plan		Large Risks (> 100,000) Plan	
	Current	Proposed	Current	Proposed	Current	Proposed
Lowest mods	.83	.89	.88	.96	1.08	1.00
Next lowest	.85	.96	1.05	1.08	1.03	1.01
Middle	.94	1.06	1.03	1.02	1.01	.98
Next highest	1.11	1.09	1.02	1.04	.96	1.00
Highest	1.17	.97	.99	.95	.99	1.02

For the medium sized risks, the lowest and highest groups are closer to unity using the proposed plan.

For the large risks, the **current plan** is somewhat over-responsive. The experience for credit risks is worse than expected because the credits are too high and the experience for debit risks is better than expected, thus the debits were also too high.

CONCLUSIONS:

1. The **incentive value** associated with experience rating plans **cannot be used to define equity** among insureds, **because**, for incentive, **more weight to individual experience is always better**.
2. The predictive ability of experience rating can be related to equity.
 - a) Both equity and predictive ability require the right balance of responsiveness be maintained.
 - b) The same degree of responsiveness is appropriate for each.
3. Experience rating values:
 - The current values provide a very good balance of responsiveness.
 - The proposed values work better, especially for the largest and smallest, lowest and highest mods.