AN ACTUARIAL ANALYSIS OF SIMPLIFIED EXPERIENCE RATING ADJUSTMENT (SERA)

by Howard C. Mahler

Recently the National Council on Compensation Insurance has significantly revised the Experience Rating Plan for Workers' Compensation. This followed a detailed actuarial study of the performance of the current plan and possible alternatives. The new plan that is the result of this study has been given the acronym SERA (Simplified Experience Rating Adjustment).

This note compares SERA to the current experience rating plan. While the NCCI study is mentioned in passing, the details of that interesting study are beyond the scope of this note.

While the tables at the end are based on the SRP for one state (Massachusetts) the overall pattern and conclusions should follow in general.

Comparison of Workers' Compensation Experience Rating Plans

Current	SERA
Primary and Excess Losses	Primary and Excess Losses
Multi-split Plan: Primary portion of a loss is determined via formula[1] or from a table.	Single Split Plan: Primary portion of a loss is the first $5000.
Experience Modification depends on a comparison of actual losses to expected losses, taking into account credibilities.	Experience Modification depends on a comparison of actual losses to expected losses, taking into account credibilities.
Users of the plan look up W and B values in a table.	Users of the plan look up W and B values in a table.
The table of W and B values depends on a state specific value, the Self-Rating Point.	The table of W and B values depends on a state specific value, the State Reference Point.

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[1] $A_p = \frac{A\ 10000}{A + 8000}$. For losses less than 2000, the whole loss is considered primary.

Credibilities, Current vs. SERA

Under SERA the credibilities differ from the current plan. As can be seen in the attached table:

1. For small risks, Primary Credibilities are larger.

2. For large risks, Primary Credibilities are smaller. The maximum Primary Credibility is 91%, rather than 100% as under the current plan.

3. For small risks, Excess Credibilities are a little larger. Even very small risks have a small non-zero Excess Credibility, as opposed to zero under the current plan.

4. For large risks, Excess Credibilities are much smaller. The maximum Excess Credibility is 57%, rather than 100% as under the current plan.

Thus one important change is that under SERA there are no longer self-rated risks. The primary losses are assigned a maximum credibility of 91%, while the excess losses are assigned a maximum credibility of 57%.

Under SERA, as a function of the size of risk the credibilities are of the form $\frac{\text{linear}}{\text{linear}}$. This can be written as:

$$Z = \frac{E + I}{JE + K}$$

with one formula for primary credibility and one excess credibility, each with different constants I, J, and K. The particular parameters in SERA satisfy $0 \leq I \leq K$ and $J \leq I$. This is the form of credibility one expects if both parameter uncertainty and risk homogeneity are important.[2] The more usual formula for credibility is a special case of this above formula, with $I = 0$ and $J = 1$.

The formulas for Z_p and Z_e are:

$$Z_p = \frac{E + .0228S}{1.1E + .01308S}$$

$$Z_e = \frac{E + .0204S}{1.75E + .8357S}$$

where S is the State Reference Point. The actual values for the credibilities may differ slightly due to the rounding process involved in establishing a table of W and B values.

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[2] See Equation 1.6 in Howard Mahler's discussion of "An Analysis of Experience Rating" by Glenn Meyers, PCAS 1987.

Actuarial Formulas Underlying Experience Rating

The following formula is used in both the current plan and SERA in order to get the experience modification.

$$M = \frac{A_p + B + WA_e + (1-W)E_e}{E_p + B + WE_e + (1-W)E_e}$$

Where M = Experience Modification

A_p = Actual Primary Losses

A_e = Actual Excess Losses

E_p = Expected Primary Losses

E_e = Expected Excess Losses

B = Ballast Value

W = Weighting Value

Under both plans the W and B values vary with the expected losses and are displayed in a table. However, the formulas used to determine W and B are significantly different under the two plans. In order to compare the plans, it is useful to reframe the formulas in terms of credibilities. Following the development in "Fundamentals of Individual Risk Rating and Related Topics" by Richard Snader:

Let $Z_p = \frac{E}{E + B}$

$$Z_e = \frac{E}{E + \frac{B + (1-W)E}{W}} = \frac{WE}{E + B} = WZ_p$$

This can also be written in terms of the usual Bayesian formula for credibility as:

$$Z_p = \frac{E}{E+K_p}$$

$$Z_e = \frac{E}{E+K_e}$$

with the credibility parameters K_p and K_e depending on the expected losses E; through W and B:

$$K_p = B$$

$$K_e = \frac{B + (1-W)\,E}{W}$$

Then the modification formula becomes in terms of the credibilities:

$$M = \frac{(1-Z_p)\,E_p + Z_p\,A_p + (1-Z_e)\,E_e + Z_e\,A_e}{E}$$

under the current plan:

$$B = (1-W)\ 20000$$

$$W = \begin{cases} 0 & E \leq 25000 \\ \dfrac{E-25000}{S-25000} & S \geq E \geq 25000 \\ 1 & E \geq S \end{cases}$$

Where S is the self-rating point.

Under SERA the values of the credibility parameters K_p and K_e are given via formula[3], and then B and W follow from them:

$$K_p = E\left[\frac{E + .1028S}{10E + .028S}\right]$$

K_p is subject to a minimum of 7500.

$$K_e = E\left[\frac{.75E + .8153S}{E + .0204S}\right]$$

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[3] The NCCI calls $K_p = B$ and $K_e = C$. Also they introduce a parameter $g = \frac{S}{250000}$.

K_e is subject to a minimum of 150,000.

Where S is the State Reference Point.[4]

Thus under SERA, the credibility parameters have the form $E\frac{\text{Linear}}{\text{Linear}}$.

This is the form that is expected when the phenomena of Parameter Undertainty and Risk Homogeneity are important.[5] The NCCI determined the particular coefficients by empirical testing.

Then one can determine W and B from K_p and K_e using the solution of the set of equations that expressed K_p and K_e in terms of W and B:

$$B = K_p$$

$$W = \frac{E + K_p}{E + K_e}$$

W is subject to minimum of .07.

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[4] The State Reference Point will be determined as 250 times the average claim cost in that state.

[5] See Howard Mahler's discussion of "An Analysis of Experience Rating" by Glenn Meyers, PCAS 1987. In Appendix VII the result for a split plan is given as $E\frac{\text{Quadratic}}{\text{Quadratic}}$. However, when the covariance of excess and primary losses is not extremely important, the no-split plan result of $E\frac{\text{Linear}}{\text{Linear}}$ is a sufficiently close approximation.

Workers' Compensation Experience Rating

Credibilities

Expected Losses ($000)	Primary		Excess	
	Current*	SERA**	Current*	SERA**
5	20%	39%	0%	3%
10	33	49	0	3
15	43	56	0	4
20	50	61	0	4
25	56	65	0	5
50	72	75	2	7
75	80	79	5	9
100	85	82	8	11
125	88	84	11	12
150	90	85	13	14
200	93	86	19	16
300	96	88	32	21
400	97	88	43	25
500	98	89	55	28
750	100	90	86	33
1000	100	90	100	37
2000	100	90	100	44
3000	100	91	100	48
4000	100	91	100	50
5000	100	91	100	52
7500	100	91	100	54
10000	100	91	100	54
∞	100	91	100	57

* Current NCCI Experience Rating Plan, using Self-Rating Point of $870,000 (assumes average serious case of $87,000)

** Simplified Experience Rating Adjustment (SERA), using State Reference point of $1,250,000 (assumes average case of $5,000)

Workers' Compensation Experience Rating

W and B Values

Expected Losses ($000)	B ($00)		W	
	Current*	SERA**	Current*	SERA**
5	200	79	0	.07
10	200	103	0	.07
15	200	116	0	.07
20	200	126	0	.07
25	200	135	0	.07
50	194	167	.03	.09
75	188	194	.06	.11
100	182	221	.09	.13
125	176	247	.12	.14
150	170	272	.15	.16
200	158	323	.21	.19
300	134	424	.33	.24
400	112	524	.44	.28
500	88	624	.56	.31
750	28	874	.86	.37
1000	0	1125	1.00	.41
2000	0	2125	1.00	.49
3000	0	3125	1.00	.53
4000	0	4125	1.00	.55
5000	0	5125	1.00	.57
7500	0	7625	1.00	.59
10000	0	10125	1.00	.60

* Current NCCI Experience Rating Plan using Self-Rating Point of $870,000 (assumes average serious case of $87,000).

** Simplified Experience Rating Adjustment (SERA), using State Reference Point of $1,250,000 (assumes average case of $5,000).