

Robert A. Bailey and LeRoy J. Simon,
"An Actuarial Note on the Credibility of Experience of a Single Private Passenger Car";
Discussion by W. J. Hazam,
PCAS XLVI, 1959, pp. 159–64; *XLVII*, 1960, pp. 150–52.

OUTLINE

I. INTRODUCTION

A. The Problem

What credibility should be assigned to the accident experience of an automobile in determining its liability premium?

B. The Authors' Solution

Automobiles are divided by class, reflecting use and driver characteristics, and by subclass, reflecting claim experience over three years. Their claim frequency per \$1,000 of premium for two subsequent years was then compiled and each class's frequency was compared to the average. Credibility equals the ratio of the future relative frequency less unity to the past relative frequency less unity.

C. Symbols

1. A - subclass with three or more accident-free years
2. B - subclass with no accident-free years
3. m - claim frequency of a class
4. N - radix, number of persons in the population
5. R - ratio of actual to expected losses
6. X - subclass with only two accident-free years
7. Y - subclass with only one accident-free years
8. Z - credibility

II. THE AUTHORS' APPROACH

A. Determination of Subclass Relative Frequency

1. Convert each subclass's earned premium to earned premium at rates for subclass B
2. Divide the earned premium by \$1,000
3. Divide the number of claims by the premium in 2.
4. Take the ratio of subclass frequency to the average frequency for all classes
5. Compute the relative frequency for the following classes:
 - a. A
 - b. (A + X)
 - c. (A + X + Y)

B. Determination of Accident-Free Credibilities

1. One-year credibility equals unity minus the relative frequency for (A + X + Y)
2. Two-year credibility equals unity minus the relative frequency for (A + X)
3. Three-year credibility equals unity minus the relative frequency for A

C. Determination of Credibility for Risks Having at Least One Accident in the Last Year

1. Calculate past relative frequency for these risks
 - a. Assume Poisson applies with average frequency m
 - b. Determine the percentage of persons with at least one claim, unity minus the percentage of persons with no claims, i.e., $(1 - e^{-m})$
 - c. Average frequency for those with at least one claim

$$AF = \frac{m}{1 - e^{-m}}$$

- d. Substitute actual frequency for m
- e. Relative frequency

$$RF = \frac{1}{1 - e^{-m}}$$

2. Determine the future relative frequency for this group of risks
3. Apply the following formula:

$$Z = \frac{\text{Future Relative Frequency} - 1.0}{\text{Past Relative Frequency} - 1.0}$$

PAST CAS EXAMINATION QUESTIONSA. The Credibility Equation

- A18. Based on Bailey and Simon's "An Actuarial Note on the Credibility of Experience of a Single Private Passenger Car," and using the information below, calculate the number of claims incurred for group C. Show all work.

<u>Group</u>	<u>Number of Years Claim Free</u>	<u>Earned Car Years</u>	<u>Earned Premium at Present Group D Rates (000)</u>	<u>Number of Claims Incurred</u>
A	3 or more	700,000	\$420,000	62,376
B	2	175,000	105,000	15,957
C	1	100,000	60,000	?????
D	0	25,000	15,000	?????
Totals		1,000,000	\$600,000	98,000

The credibility for the group of risks with one or more claim-free years (Z) equals .086. (98-9-26a-2)

- A19. Based on Bailey and Simon's "An Actuarial Note on the Credibility of Experience of a Single Private Passenger Car" and the table below, answer the following.

Private Passenger Automobile Liability – Non-Farmers Class 3 – Business Use

<u>Merit Rating</u>	<u>Earned Car Years</u>	<u>Earned Premium at Present B Rates</u>	<u>Number of Claims Incurred</u>	<u>Claim Frequency per \$1,000 of Premium</u>	<u>Relative Claim Frequency</u>
A	247,424	\$25,846,000	31,964	1.237	0.920
X	15,868	1,783,000	2,695	1.511	1.123
Y	20,369	2,281,000	3,546	1.555	1.156
B	37,666	4,129,000	7,565	1.832	1.362
Total	321,327	34,039,000	45,770	1.345	1.000

where: Class A - three or more years claim-free
 Class X - two years claim-free
 Class Y - one year claim-free
 Class B - zero years claim-free

Calculate the credibilities for a single private passenger car for one year, two years, and three years. Show all work. (00-9-32a-1.5)

- A20. Use Bailey and Simon's "An Actuarial Note on the Credibility of Experience of a Single Private Passenger Car," and Hazam's discussion to answer the following questions. Using the information below on class 1, calculate the credibility for one-year and two-year claim-free periods for that class. Show all work.

<u>Class 1</u>	<u>Number of Years Claim Free</u>	<u>Earned Premium at Present Rates</u>	<u>Number of Claims Incurred</u>	<u>Earned Car Years</u>
	2 or more	\$5,000,000	7,000	15,000
	1	\$7,000,000	10,000	12,250
	0	\$1,000,000	2,000	400
	Total	\$13,000,000	19,000	27,650

(01-9-22a-2.5)

Bailey

- A18. 1) Calculate future absolute claim frequencies. Let X equal the number of claims incurred for risks who are claim-free for one year.

$$FACF_1 = \frac{\text{Number of Claims}}{\text{Earned Premium at Present Rates}} = \frac{62,376 + 15,957 + X}{420,000 + 105,000 + 60,000}$$

$$FACF_1 = \frac{78,333 + X}{585,000}$$

$$FACF_{\text{Overall}} = 98,000/600,000 = .16333$$

- 2) Calculate the future relative claim frequency:

$$FRCF_1 = FACF_1/FACF_{\text{Overall}} = \frac{78,333 + X}{(585,000)(.16333)} = \frac{78,333 + X}{95,548}$$

- 3) Calculate X:

$$.086 = Z_2 = 1 - FRCF_1 = 1 - \frac{78,333 + X}{95,548} \quad X = 8,998, \text{ pp. 159-60.}$$

- A19. 1) Calculate future absolute claim frequencies:

$$FACF = \frac{\text{Number of Claims}}{\text{Earned Premium at Present Rates}}$$

$$FACF_1 = \frac{31,964 + 2,695 + 3,546}{25,846,000 + 1,783,000 + 2,281,000} = .001277$$

$$FACF_2 = \frac{31,964 + 2,695}{25,846,000 + 1,783,000} = .001254$$

- 2) Calculate the future relative claim frequencies:

$$FRCF_1 = FACF_1/FACF_{\text{Overall}} = .001277/.001345 = .949$$

$$FRCF_2 = FACF_2/FACF_{\text{Overall}} = .001254/.001345 = .932$$

- 3) Calculate the credibilities:

$$Z_1 = 1 - FRCF_1 = 1 - .949 = .051$$

$$Z_2 = 1 - .932 = .068 \quad Z_3 = 1 - .920 = .080, \text{ pp. 159-60.}$$

- A20. 1) Calculate future absolute claim frequencies:

$$FACF = \frac{\text{Number of Claims}}{\text{Earned Premium at Present Rates}} \quad FACF_{\text{Overall}} = \frac{19,000}{13\bar{M}} = .001462$$

$$FACF_1 = \frac{10,000 + 7,000}{7\bar{M} + 5\bar{M}} = .001417 \quad FACF_2 = \frac{7,000}{5\bar{M}} = .001400$$

- 2) Calculate the future relative claim frequencies:

$$FRCF_1 = FACF_1/FACF_{\text{Overall}} = .001417/.001462 = .969$$

$$FRCF_2 = FACF_2/FACF_{\text{Overall}} = .001400/.001462 = .958$$

- 3) Calculate the credibilities:

$$Z_1 = 1 - FRCF_1 = 1 - .969 = .031$$

$$Z_2 = 1 - .958 = .042, \text{ pp. 159-60.}$$