

→ **Q.7** → Complements of credibility

- **Definition** → The complement of credibility is the most experience that is paired with the latest experience to determine an estimate. It can be more important than the observed data due to low credibility.
- **Desirable qualities** of complement of credibility
  - That are six desirable qualities for a complement of credibility:
  - **1) Available** → The complement should be close to the current rates being estimated.
  - **2) Unbiased** → The complement should not be consistently higher or lower than the observed experience. In other words, on average, it should be equal to the observed experience.
  - **3) Statistically independent from its base statistics** → Being statistically independent from the base statistics means that any error in the base statistics do not compound.
  - **4) Available** → The data required to compute the complement should be readily available for the complement to be practical.
  - **5) Easy to compute** → The calculation of the complement should be relatively straightforward, so that justification can be provided when required.
  - **6) Logical relationship + fair practice** → The complement should have a logical relationship to the observed experience so that it can be easily justifiable.

→ **Methods for developing complements of credibility**

- Here we will discuss various approaches for developing complements of credibility for both large claim reserving & excess reserving.

→ **First claim reserving** applies to products that have claims from the first year or earlier some years minimum, up to a specific limit. Examples of such products include personal automobile, homeowners, workers compensation, & professional liability insurance. In first claim reserving, additional losses are used as the base statistic.

→ **Excess reserving** is used for claims insurance products that have claims occurring some high attachment point. Examples of excess products include personal liability, crop liability, commercial products, & excess reinsurance.

→ **First claim reserving**

- That are six commonly used methods for developing complements for first claim reserving:
- **1) Data out of a larger group** that includes the prior rates needed.
- **2) Data out of a larger related group**
- **3) Data statistic from the larger group applied to the current rates**
- **4) Harmonic method**
- **5) Trended present rates**
- **6) Complement rates**

→ We will discuss each method to assess how well they satisfy the six desirable qualities for a complement of credibility.

→ **Let's start with a larger group that includes the prior rates needed**

→ The complement of credibility can be a larger group to which the subject experience belongs. For example, catastrophe or regional data can serve as a complement to state experience, or the data from prior years (data) can supplement the experience of newer rates. The complement can either or include the subject experience.

→ **Evaluation of complements against the six desirable qualities:**

- **1) Available** → Usually requires data based on a larger volume of data.
- **2) Unbiased** → Can be biased when there is no clear tie subject experience has been selected from the larger group.
- **3) Statistically independent from its base statistics** → Independent if the subject experience is excluded from the complement or does not dominate the larger group.

→ **4) Available** → Data is typically available.

→ **5) Easy to compute** → Computation is easy.

→ **6) Logical relationship + fair practice** → Has a logical relationship w/ the subject experience if all rates in the larger group have something in common.

→ **Let's look at a larger related group**

→ The complement can be a larger group that is a complement but smaller to the group to which the subject experience belongs. For example, the last experience for auto can be used as a complement of credibility for estimating loss rates for homeowners.

→ **Evaluation of complements against the six desirable qualities:**

→ **1) Available** → May be inaccurate if the experience is different as the data may not be same.

→ **2) Unbiased** → Generally biased.

→ **3) Statistically independent from its base statistics** → Independent since the complement doesn't include the subject experience.

→ **4) Available** → Data is typically available.

→ **5) Easy to compute** → Computation is easy.

→ **6) Logical relationship + fair practice** → Has a logical relationship to the subject experience if the group chosen is closely related to the group which the subject experience belongs.

→ Rate changes from the larger group applied to previous rates

→ As previously discussed, the last rates are a larger related group owing to a valid complement of credibility. To reduce bias, the following adjustment can be made when calculating the complement, C:

$$C = \frac{\text{Current Loss Cost} - \text{Larger Group Indicated Loss Cost}}{\text{Larger Group Indicated Loss Cost}}$$

→ **Evaluation of complements against the six desirable qualities:**

→ **1) Available** → Assumes over the long run.

→ **2) Unbiased** → Having unbiased.

→ **3) Statistically independent from its base statistics** → Depends on the size of the subject experience relative to the larger group.

→ **4) Available** → Data is typically available.

→ **5) Easy to compute** → Computation is easy.

→ **6) Logical relationship + fair practice** → Has a logical relationship to the subject experience if the group chosen is closely related to the group which the subject experience belongs.

→ **Harmonics method**

→ Harmonics method is used when the related experience has a significantly different distribution from the subject experience. One typical example is when the subject experience is in a stable state & the related experience is in a different state w/ distinctly different loss rates.

→ **We will illustrate harmonics method w/ an example**

Given the following information:

State Class Exposure Losses Pure Premium

A 1 120 300 2.50

A 2 160 450 3.00

B 1 200 600 3.50

B 2 250 800 4.50

C 1 200 500 2.75

C 2 400 1,800 4.00

Calculate the complement for Class 1 in State A using Harwayne's full method.

→ Step 1 → Calculate the weighted average pure premium for State A

$$\bar{x}_A = \frac{120 \times 2.50 + 160 \times 3.00}{120 + 160} = 2.78$$

→ Step 2 → Calculate the weighted average pure premium for State B

$$\bar{x}_B = \frac{200 \times 3.50 + 250 \times 4.50}{200 + 250} = 3.74$$

$$\bar{x}_C = \frac{200 \times 2.75 + 400 \times 4.00}{200 + 400} = 3.24$$

→ Step 3 → Calculate the adjustment factors

→ Let  $F_A$  &  $F_B$  represent the adjustment factors for State A & State B, respectively. Calculate these factors by dividing the weighted average pure premium for State B & C, which we calculated in Step 2.

$$F_A = \frac{\bar{x}_B}{\bar{x}_C} = \frac{3.74}{3.24} = 1.16$$

$$F_B = \frac{\bar{x}_C}{\bar{x}_A} = \frac{3.24}{2.78} = 1.16$$

→ Step 4 → Apply the adjustment factors to the class 1 pure premiums in States B & C

→ This results in the loss rates for Class 1 in States B & C to the loss in State A.

$$L_{1,B} = \bar{x}_{B,C} \times F_A = 3.74 \times 1.16 = 4.29$$

$$L_{1,C} = \bar{x}_{B,C} \times F_B = 3.74 \times 1.16 = 4.29$$

→ Step 5 → Calculate the complement of credibility.

→ C is calculated by weight the results from Step 4 w/ their exposures.

$$C = \frac{L_{1,B} \times x_{1,B} + L_{1,C} \times x_{1,C}}{x_{1,B} + x_{1,C}}$$

$$= \frac{3.74 \times 120 + 3.74 \times 200}{120 + 200} = 3.27$$

→ The table below summarizes the calculations.

State	Class	Exposure	Losses	Pure Premium	Weighted Average State Losses	Weighted Average State Exposure	Adjustment Factor	Adjusted Class 1 Pure Premium	Class 1 Exposure
A	1	120	300	2.50					
A	2	160	450	3.00					
B	1	200	600	3.50					
B	2	250	800	4.50					
C	1	200	500	2.75					
C	2	400	1,800	4.00					
Complement								2.57	

→ **Evaluation of complements against the six desirable qualities:**

→ **1) Available** → Generally occurs if there is sufficient data.

→ **2) Unbiased** → Calculated as it relates to distributional features.

→ **3) Statistically independent from its base statistics** → Mostly independent.

→ **4) Available** → Data is typically available.

→ **5) Easy to compute** → Computation is easy.

→ **6) Logical relationship + fair practice** → Has a logical relationship to the subject experience but may be hard to explain due to computational complexity.

→ **Trended present rates**

→ If the larger groups are available, the complements can be calculated at the current rates w/ the following adjustments:

→ Will adjust the current rates to what was originally reported rather than what was implemented.

→ To get the current rates for any reported losses, we change the loss date. What may have occurred between the time the current rates were implemented & the time of the losses, the trend will appear from the actual experience data of the current rates to the future effective date of the new rates.

→ If the information above, the complement of credibility is calculated as follows:

$$C = \frac{\text{Current Loss Cost} - \text{Last Year Implement Loss Cost}}{\text{Last Year Implement Loss Cost}}$$

→ **Evaluation of complements against the six desirable qualities:**

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