3.4.2 → Complements of Credibility

→ The complement of credibility is the related experience that is blended with the subject experience to determine an estimate. It can be more important than the observed data if the observed data has low credibility.

→ Desirable qualities of a complement of credibility

→ There are six desirable qualities for a complement of credibility.

- 1) Accurate → The complement should be close to the expected losses 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 the base statistic → Being statistically independent from the base statistic ensures that any errors in the base statistic 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 calculations of the complement should be relatively straightforward, so that justification can be provided when required.
- 6) Logical relationship to base statistic → The complement should have a logical relationship to the observed experience so that its use can be easily justifiable.

→ Methods for developing complements of credibility

→ First dollar ratemaking applies to products that cover claims from the first dollar of loss or after some small deductible, up to a specific limit. Examples of such products include personal automobile, homeowners, workers compensation, & professional liability insurance. In first dollar ratemaking, historical losses are used as the base statistic.

→ Excess ratemaking is used for excess insurance products that cover claims exceeding some high attachment point. Examples of excess products include personal umbrella policies, large deductible commercial policies, & excess reinsurance.

→ First dollar ratemaking

→ There are six commonly used methods for developing complements for first dollar ratemaking:

→ 1) Loss costs of a larger group that includes the group being rated

- → e.g.) State X + CW data (including X)
- → Highlights → Accurate (based on more data), Mostly unbiased, Independent (if subject experience is only a small portion)

→ 2) Loss costs of a larger related group

- → e.g.) using losses on cars as complement for losses of trucks
- → Highlights → Maybe inaccurate, Biased, Independent

→ If complement is "All other states" & given CW data, then need to subtract out the state of interest's numbers

→ 3) Rate change from the larger group applied to the present rates

- → Reduces bias from (2)
- → $C = \text{Current loss cost of subject experience} * \frac{\text{Larger group adjusted loss cost}}{\text{Larger group current avg loss cost}}$
  - ↳ Complement

→ 4) Harwayne's method

- → unbiased b/c it adjusts for distributional differences
- → Highlights → unbiased, independent, computation is complicated, mostly independent

State B PP assuming state A's exposure distribution → Adjustment factor (B → A = A/B) ↓ A relative to B; Class 1 PP (loss cost) × Adjusted class 1 PP × multiply → Class 1 exposure → wtd avg

→ 5) Trended present rates

- → used if no larger group available
- → PP approach → $C = \text{Present rate} * \text{Loss trend factor} * \frac{\text{Prior indicated loss cost}}{\text{Loss cost implemented last review}}$
  - ↳ complement
- → LR approach → $C = \left(\frac{\text{Loss trend factor}}{\text{Premium trend factor}}\right)^{\text{trend period length}} * \left(\frac{\text{Prior indicated rate change factor}}{\text{implemented ------}}\right)$ (old indication effective date to new indication eff date)
  - ↳ can leave as factor OR subtract 1
  - ↳ just need to be consistent when doing
  - Cred-weighted indicated rate change factor = Indicated factor (Z) + complement factor (1 − Z)
  - OR
  - ---- % = Indicated rate change % (Z) + Complement % (1 − Z) ↓ i.e. c−1 relative 1
- → Highlights → unbiased (since pure trended loss costs are unbiased), accurate, easy to compute

→ 6) Competitor's rates

- → Used in new/small companies
- → Highlights → Inaccurate + unbiased (due to company differences), may be difficult to obtain
- → Mix of business is the main difficulty in comparing w/ competitors' rates (to correct for this, can compare rates for particular segments)

→ Excess ratemaking

→ There are four commonly used methods for developing complements for excess ratemaking:

- → 1) Increased limits analysis
- → 2) Lower limits analysis
- → 3) Limits analysis
- → 4) Fitted curves

?

↳ skipping for now, seems too technical

4.1 → Constraints + Considerations

4.1.1 → Regulatory + operational constraints + 4.1.2 → Marketing considerations

< just reading >

↳ Considerations + constraints that influence the rate implementation. These can be broken into three categories:

- → Regulatory constraints
- → Operational ----
- → Marketing considerations

↳ Factors that affect a policyholder's likelihood to renew are:

- → Prices of competing products
- → Total cost of the product
- → Rate changes
- → characteristics of the insured / sensitivity to the price
- → Customer satisfaction + brand loyalty

4.2 → Finalizing rates

4.2.0 → Overview + 4.2.1 → Handling an imbalanced fundamental insurance equation

→ Non-pricing + pricing solutions to an imbalanced fundamental insurance equation (i.e. current rates do not yield an avg premium sufficient to cover expected costs + target uw profit)

Underwriting adjustments → Tighter control (limit exposure)
Coverage modifications → Adjust deductibles/limits
Operational improvements → Better claims management
Reduce expenses → uw expenses or LAE

Rate adjustments / New products

→ The steps for implementing a rate change are:

- → 1) Select an overall average premium
- → 2) Construct a rating algorithm
- → 3) Select relativities for each rating variable
- → 4) Calculate any applicable expense fees + other additive components
- → 5) Derive the base rate required to reach the selected overall average premium

Expense fees & other additives

- → Total premium = Base premium * relativity + Additive premium (variable premium)
- → Expense fee → $\bar{F}_A = \frac{\bar{L} + \bar{E}_L + \bar{F}_F}{1 - V - Q_T} = \frac{\bar{L} + \bar{E}_L}{1 - V - Q_T} + \frac{\bar{E}_F}{1 - V - Q_T}$ (variable premium; expense fee (adjusted for VER + profit provision)); $= \frac{\text{Fixed expense per exposure}}{\text{VPLR}}$
- → other additive fees work the same way

4.2.2 → Deriving base rates

→ Avg premium = (Base rate) * Avg rating factor + Additive fee
↳ Final step is to derive this
↳ Tricky to derive

⇒ easier method:

→ Let the average premium, base rate, weighted average rating factor, & expense fee w/ $\bar{P}, B, \bar{R}, A$, respectively, & subscripts P to indicate "proposed" & C to indicate "current"

⇒ restating above: $\bar{P}_P = B_P * \bar{R}_P + A_P$; $\bar{P}_C = B_C * \bar{R}_C + A_C$

→ If we take a ratio of the proposed variable premium to the current variable premium, we discover another relationship

$$\frac{B_P * \bar{R}_P}{B_C * \bar{R}_C} = \frac{\bar{P}_P - A_P}{\bar{P}_C - A_C}$$

$$B_P * \bar{R}_P = \frac{\bar{P}_P - A_P}{\bar{P}_C - A_C} * (B_C * \bar{R}_C)$$

$$* \; B_P = \frac{\bar{P}_P - A_P}{\bar{P}_C - A_C} * B_C * \frac{\bar{R}_C}{\bar{R}_P}$$ ⇝ assuming not changing relativities ⇒ = 1

→ Deriving base rates: changing relativities → three methods

→ Approximated average rate differential

→ The method is called approximated average rate differential because it allows us to approximate the proposed average rating factor (a.k.a. proposed rate differential) component in the equation. Specifically, we will approximate the average rating factor as the product of the weighted average rating factors (rate differentials) for each individual rating variable.

→ e.g.) Avg rating factor ≈ Avg Class factor * Avg Territory factor

→ When calculating the weighted average rating factors for each rating variable, there are a few different options for the weighting. The most accurate option would be to weigh by the current variable premium at base level. Variable premium at base level is the total multiplicative premium a level would be charged if it were re-rated as the base level. In other words, if it is the variable premium if the level had a relativity of 1.

→ This is equivalent to weighting relativities by the adjusted exposures (in the pure premium method was used to calculate the proposed

→ Approximated change in average rate differential

→ $OBF = \frac{R_C}{R_P}$ in * equation above (note proposed in denominator for OBF ~ go backwards)

⇒ $\text{Proposed base rate} = \frac{\text{Proposed Avg Premium} - \text{Proposed additive fee}}{\text{Current Avg Premium} - \text{Current additive fee}} * \text{Current base rate} * OBF$

e.g.) Current LC 1.0 m; adjusted LC 1.5 m; OBF 0.667 (↑ current base ← ↓ starting base)

→ $OBF_{overall} = \frac{\text{Current Avg rating factor}}{\text{Proposed Avg rating factor}}$
↓
$= OBF_{var 1} * OBF_{var 2}$

→ When calculating OBF_i, have two equivalent options

- → 1) w/ variable premium at base level or adjusted exposures when weighting
- → 2) $OBF = \frac{1}{\text{Avg relativity change factor}}$ / w/ variable premium not at base level when weighting

→ Extension of exposures (no approximation)

→ $\text{Proposed Base rate} = \text{Seed Base rate} * \frac{\text{Proposed Avg Premium} - \text{Proposed Additive fee}}{\text{Proposed Avg Premium w/ seed base rate} - \text{Proposed Additive fee}}$
↓
can be anything ≠ 0 ⇒ just use 1

① → Current avg premium = $\frac{\Sigma \text{ rate} * \text{Exposure combos}}{\Sigma \text{Exposures}}$

② → Proposed avg premium = (1 + selected overall rate change) * current avg premium

③ → Proposed avg premium w/ base rate = same as ①, except replace base rate w/ seed base rate (typically = 1) + do (2) again

④ ⇒ Proposed avg base rate ⇒ $\text{Seed base rate} * \frac{② - \text{proposed fee}}{③ - \text{proposed fee}}$

(CHECK) repeat ③ w/ ④ (↑ seed base rate; ↑ proposed base rate) & should get ② (except total premium)

4.2.3 → Capping rates

→ Capping helps maintain fairness among insureds by ensuring that rate changes are not excessive or unfairly discriminatory. While capping may deviate from strictly cost-based pricing, it balances equity considerations with practical market realities + regulatory requirements. Additionally, limiting large rate increases can support customer retention + foster regulatory goodwill, aligning w/ the broader goals of sustainable + equitable ratemaking.

→ Because capping generally reduces the total premium collected from the capped classes, this may lead to a premium shortfall relative to the target rate change. To meet the overall rate objectives, actuaries must adjust the base rate & other class relativities so that the non-capped classes contribute enough to make up for the shortfall. Here, we will explore two methods for handling a premium shortfall:

→ Capping a non-base class

→ Method 1 → (formulas) A structured, formula-based adjustment for both capped + non-capped classes.

- → 1) Reduce capped class's relativity: $\text{Initial capped relativity} = \frac{\text{Current relativity} * (1 + \text{cap \%})}{OBF * (1 + \text{target rate change})}$
- → 2) Increase base rate: $\text{Shortfall adjustment factor} = \frac{\text{Premium shortfall}}{\text{Total proposed premium from uncapped classes}}$
- → 3) Re-adjust relativity of capped class: $\text{Final capped relativity} = \frac{\text{Initial capped relativity}}{\text{Shortfall adjustment factor}}$

→ As for the final premium amounts, we've already established that the final premium for class A must be $108,000 in order to comply w/ the cap. The relativities for classes B + C are not touched, but the base rate is scaled by the shortfall adjustment factor. Then the final premium amounts for classes B + C are just their proposed premiums multiplied by the shortfall adjustment factor.

→ Final premium = Proposed premium * shortfall adjustment factor

→ Benefits → Method 1 provides a precise, formula-driven solution, ideal for formal calculations

→ It is effective for structured, standardized scenarios, where accuracy in achieving the cap + target rate is prioritized

→ Drawbacks → Method 1 can feel complex + less intuitive due to its step-by-step recalculations, especially in large or multi-capped portfolios

→ Problem solving → Notice that the % change in premium is not larger than 20% for any one class + that the overall target rate change is achieved. Additionally, the total final premium amount is the same as the total final premium we found before applying the cap. Verifying that these relationships hold true is a good way to check your work.

→ Method 2 → (manually reallocate the shortfall) An intuitive, proportional reallocation approach that simplifies adjustments, especially useful for multi-capped portfolios

→ Example →

Class	Proposed Premium	Shortfall Reallocation	Final Premium
A	$120,778	−$12,778	$108,000
B	$345,081	$12,778 × $345,081 / $517,622 = $8,519	$353,600
C	$172,541	$12,778 × $172,541 / $517,622 = $4,259	$176,800
Total	$638,400	$0	$638,400

→ Reallocating the shortfall in this way effectively alters each of the relativities, not the base rate. We can derive the adjusted relativities by comparing the final premium amounts to the proposed premium amounts.

→ Adjusted relativity = Proposed relativity * $\frac{\text{Final premium}}{\text{Proposed premium}}$

→ Benefits → Method 2 is practical + intuitive, avoiding the need for recalculations + providing a streamlined way to achieve the target rate

→ Especially useful in real-world situations w/ multiple capped classes, as it requires only one reallocation + rebasing step

→ Drawbacks → May feel less structured than Method 1 due to the reallocation process

→ Requires a final re-basing step for consistency, setting the base class relativity to 1.00

→ Capping a base class

→ Applying a cap to the base class inherently lowers the base rate when compared to the uncapped proposed base rate. As a result, there are a few changes to the first approach to handling the premium shortfall. The second approach is essentially unchanged. Nonetheless, we will demonstrate both approaches using a modified version of the example above where the base class is capped.

→ Method 1 (formulas) → Just have to 1) apply an extra factor to the base rate + then 2) adjust the non-base class relativities accordingly

- → 1) $\text{Capped base adjustment factor} = \frac{1 + \text{cap \%}}{1 + \text{Proposed \% change in premium}}$
- → 2) Adjust non-base class relativities → Suppose decrease base rate by x% ⇒ then [Base rate (1 − x)] * [factor/(1 − x)] ≟ Premium (need to balance)

→ Method 2 → (manually reallocating the shortfall) Pretty much the same

4.2.4 → Other considerations

→ Effect of minimum premium = $\frac{\text{Total premium w/ minimum}}{\text{Total premium w/o minimum}} - 1$

→ Minimum premium offset factor = $\frac{1}{1 + \text{Effect}}$