

## AP Notes

### 1.1 → The fundamental insurance equation

- 1.1.1 → Basic insurance terms  $\rightarrow$  1.1.2 → The fundamental insurance equation
- Relationship between EP & EP
- EP > EP  $\Rightarrow$  loss growth
  - EP < EP  $\Rightarrow$  shrinking
- Insured (reported) loss = Paid loss + Loss reserve
- Estimated ultimate loss = Insured loss + Loss reserve + Loss reserve
- LAC = ALAE + ULAE
- Underwriting profit = Income - Expenses (from strictly business on policies)
- Price = Cost + Profit  
↓  
Premiums & Losses, LAC, ULAE, Expenses
- Total profit = UW profit + Investment income

### For problems solving steps 1A

- When aggregating data, manually create indicators to include or not (ie. either)
- Define premium
  - Only a relative estimate of EP when policies are written uniformly (ie. in terms of one or several events throughout year)
- Example with: Impact of rate changes, calculate at different times to see how book is changing

### 1.1.3 → Basic insurance ratios

→ Frequency =  $\frac{\# \text{ claims}}{\# \text{ exposures}}$   $\rightarrow$  Typically reported claims

→ Severity =  $\frac{\text{Losses}}{\# \text{ claims}}$ , Variations  $\rightarrow$  Paid severity =  $\frac{\text{Losses on closed claims}}{\# \text{ closed claims}}$

→ Numerator may include  $\rightarrow$  Reported severity =  $\frac{\text{Reported losses}}{\# \text{ reported claims}}$   
or exclude ALAE

→ Pure premium (or loss cost) =  $\frac{\text{Losses}}{\text{Exposures}}$   $\rightarrow$  Price of business  $\downarrow$  which has cost trends (ie. writing more historic risk policies over time)

$$\begin{aligned} &= \downarrow \times \frac{\# \text{ claims}}{\# \text{ claims}} \\ &= \frac{\# \text{ claims}}{\# \text{ exposures}} \times \frac{\text{Losses}}{\# \text{ claims}} \\ &= \text{Frequency} \times \text{Severity} \end{aligned}$$

→ Average premium =  $\frac{\text{Premium}}{\# \text{ exposures}}$  ( $\#$  of lines owned or risks written)

$$\begin{aligned} \rightarrow \text{Loss ratio} &= \frac{\text{Losses}}{\text{Premium}} \\ &= \downarrow \frac{\# \text{ exposures}}{\# \text{ exposures}} \\ &= \frac{\text{Losses} / \# \text{ exposures}}{\text{Premium} / \# \text{ exposures}} \\ &= \frac{\text{Pure premium}}{\text{Avg Premium}} \end{aligned}$$

→ Loss + LAC ratio =  $\frac{\text{Loss} + \text{LAC}}{\text{Premium}}$

→ LAC ratio =  $\frac{\text{LAC}}{\text{Loss}}$

$$\begin{aligned} \rightarrow \text{Loss ratio} (1 + \text{LAC ratio}) &= \frac{\text{Loss}}{\text{Premium}} (1 + \frac{\text{LAC}}{\text{Loss}}) \\ &= \downarrow \frac{(\text{Loss} + \text{LAC})}{\text{Loss}} \\ &= \frac{\text{Loss} + \text{LAC}}{\text{Premium}} \\ &= \text{Loss} + \text{LAC ratio} \end{aligned}$$

→ UW expense ratio =  $\frac{\text{UW expenses}}{\text{Premium}}$   $\rightarrow$  Insured or incurred ① during policy term ②

$$\begin{array}{c} \text{①} \\ \text{UW expenses, other applications} \\ \text{②} \\ \text{Paid, Unpaid + fees} \end{array} + \frac{\text{General expenses}}{\text{EP}}$$

→ Operating expense ratio (OER) = UW expense ratio +  $\frac{\text{LAC}}{\text{EP}}$   
 $\rightarrow$  measures portion of each premium dollar used towards paying claim related expenses & UW expenses

$$\begin{aligned} \rightarrow \text{Combined ratio} &= \frac{\text{Losses}}{\text{EP}} + \frac{\text{LAC}}{\text{EP}} + \frac{\text{UW expenses}}{\text{EP}} \\ &= \text{Loss ratio} + \text{LAC ratio} + \downarrow \text{Breakdown} \\ &= \text{Loss ratio} + \text{OER} \quad * \text{ If UW expenses are incurred during the policy term} \\ &\qquad\qquad\qquad \Rightarrow \div \text{ by EP instead of UW} \end{aligned}$$

→ Close ratio =  $\frac{\# \text{ accepted quotes}}{\# \text{ quotes}}$

### 1.2 → Policies, coverages & claims

#### 1.2.1 → Exposures

→ Exposure  $\rightarrow$  a basic unit that measures a policy's exposure to loss. It is the basis for the calculation of premium.

→ Criteria for exposure bases

- 1) proportional to expected loss  $\rightarrow$  the factor that is most directly proportional to losses (ie. loss amount or exposure  $\Rightarrow$  loss increase in losses)
- 2) practical  $\rightarrow$  affordable, easy/inexpensive to obtain & verify
- 3) historical precedence  $\rightarrow$  should consider any preexisting exposure base established in the industry. Changes need to be carefully considered

→ Common exposure bases  $\rightarrow$  The table below shows some commonly used exposure bases for different lines of business.

Line of Business	Typical Exposure Bases
Personal Automobile	Earned Car Year
Homeowners	Earned House Year
Workers Compensation	Payroll
Commercial General Liability	Sales Revenue, Payroll, Square Footage, Number of Units
Commercial Property	Amount of Insurance Coverage
Professional Liability	Number of Professionals
Personal Articles Floater	Value of Item

→ Exposure base evaluation example (using value of book instead of book years, for physical damage)

$\rightarrow$  Proportional to expected loss  $\rightarrow$  Yes, directly related to potential losses (exposure book  $\Rightarrow$  exposure to repair/replacement)

$\rightarrow$  Practical  $\rightarrow$  affordable, easy/inexpensive to obtain & verify

$\rightarrow$  Historical precedence  $\rightarrow$  Yes, it clearly defined it would be value already accounted by the insurance company

$\rightarrow$  Consistency  $\rightarrow$  Yes, easily to switch to new base from ST  $\rightarrow$  we'd end up with large premium swings for the insured

$\rightarrow$  Give firm recommendation  $\rightarrow$  If evaluating for multiple accounts, don't recommend split exposure base bc it would require lots of extra work from the company's perspective

### 1.3 → Understanding insurance data

#### 1.3.1 → Aggregating data + 1.3.2 → Measuring exposures & premium & 1.3.3 → Measuring losses

→ Data aggregation goals  $\rightarrow$  1) Accurately match losses & premium

$\rightarrow$  2) Use the most recent data available

$\rightarrow$  3) Minimize the cost associated w/ gathering & maintaining data

→ Four methods of data aggregation:

→ Calendar year aggregation

$\rightarrow$  Advantages  $\rightarrow$  data is readily available once the CY ends

$\rightarrow$  There is no future development (fixed at the end of the CY)

$\rightarrow$  Data is easily accessible

$\rightarrow$  Disadvantages  $\rightarrow$  mismatch between premium & losses (EP + loss can come from policies written in prior years)

$\rightarrow$  Inability to capture major developments due to the fixed nature of data



→ Accident year aggregation

$\rightarrow$  Advantages  $\rightarrow$  easier to assess for premiums, except by allowing for premium credits after the end of the CY

$\rightarrow$  Disadvantages  $\rightarrow$  Easy to achieve & easy to understand

$\rightarrow$  Better match of premiums & losses than CY aggregation (ie. losses year for are assigned to premium calendar year vs)

$\rightarrow$  Useful for identifying the impact of major claim events (eg. a catastrophe)

$\rightarrow$  Disadvantages  $\rightarrow$  requires estimation of future development

$\rightarrow$  Provides a less accurate match of premiums & losses (compared to CY)

$\rightarrow$  May data better for estimating unpaid claims bc it is the industry standard (bc no multiple treatments & data available)

$\rightarrow$  CY has no IBNR  $\Rightarrow$  over year over, can't be many more reported claims in that year, only IBNR

→ Policy year aggregation

$\rightarrow$  Advantages  $\rightarrow$  provides a less match between losses & premiums

$\rightarrow$  useful for identifying the shape of underwriting or pricing changes

$\rightarrow$  Disadvantages  $\rightarrow$  Development on SAVR claims is excluded



→ Report year aggregation

$\rightarrow$  Advantage  $\rightarrow$  provides more stable data than PY aggregation, as the # of claims is fixed at the end of the year

$\rightarrow$  Disadvantage  $\rightarrow$  Development on SAVR claims is excluded



→ Uncertain exposures / premiums

$\rightarrow$  The following relationships hold for an individual policy or a group of policies aggregated using either the CY aggregation method or the PY aggregation method

$$\text{Written} = \text{Earned} + \text{Claims in Unclosed exposure}$$

$\rightarrow$   $\downarrow = \downarrow + (\text{Earned - Old Earned})$  exposure

$$\text{Written} = \text{EP} + \text{Claims in Unclosed premium}$$

$\rightarrow$   $\downarrow = \downarrow + (\text{Old Unclosed - Old Unclosed})$  premium

$\rightarrow$  Rearranging the equations above, we can write the unearned exposure/premium at the end of the year as:

$$\text{EOT Unclosed} = \text{Written} - \text{Earned} + \text{Buy Unclosed exposure (UEB)}$$

$$\text{EOT Unclosed} = \text{EP} - \text{EP} + \text{Buy Unclosed premium (UEP)}$$

$\rightarrow$  Since the starting unearned exposure/premium for a policy year will always be 0, the relationships above can be simplified to the following if policy year aggregation is used:

$$\rightarrow \text{UE} = \text{EP} + \text{UEP}$$

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$\rightarrow$  Add term adjustments

→ Type 1: Cancellations

$\rightarrow$  If a policy (losses written), the unearned portion of the written exposure/premium is shown as negative written exposure/premium in the year of cancellation.

$\rightarrow$  If aggregation is done using the PY method, the original written exposure/premium & written exposure/premium due to cancellation will always be in the same policy year.

→ Type 2: Premium adjustments

$\rightarrow$  Just do term logically, ex. earn at higher/lower rate after the adjustment >

→ Loss data aggregation methods

→ All 4 data aggregation methods apply to loss data.

→ CY aggregation  $\rightarrow$  considers all loss transactions that occur during the CY

$\rightarrow$  Losses are fixed at end of year (ie. no development)

→ PY  $\rightarrow$  considers all loss transactions for claims w/ an accident/occurrence date during the year

$\rightarrow$  Losses develop

$\rightarrow$  premium linearly compared to CY

→ PY  $\rightarrow$  considers all loss transactions for claims w/ a report date during the year

$\rightarrow$  used for claims-made policies

→ First step is always to determine what claims are relevant based on aggregation method & year (ie. older claims)

$\rightarrow$  Then it is straightforward if we generate the pattern first

→ Written = Vertical line (ie. full-term premium)

→ Endorsements & premium audits count towards PY data

→ Endorsements get recorded

→ Premium audits do not

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