Notes

1.1 → The fundamental insurance equation

1.1.1 → Basic insurance terms ⇓ 1.1.2 → The fundamental insurance equation

→ Relationship between UP + EP

→ UP > EP ⇒ high growth

→ UP < EP ⇒ shrinking

→ Incurred (reported) loss = Paid Loss + Loss reserve

→ Estimated ultimate loss = Incurred loss + IBNR reserve + IBNER reserve

→ LAE = ALAE + ULAE

→ Underwriting profit = Income − Expenses (from strictly business on policies)

→ Price = Cost + Profit
- Price ↓ premium
- Cost ↓ {loss}, LAE, UW expenses
- Profit ↓ UW profit

⇒ Total profit = UW profit + investment income

→ When balancing the fundamental insurance equation, need to address two considerations:

→ 1) Rationality in prospective → Goal is to estimate future, unknown costs w/ historical data, factoring in expected costs during the period the premium will be in effect

→ 2) Balance b/t aggregate + individual levels
- ↳ premium should reflect the risk of the specific policyholder
- ↳ total premium should be enough to cover all expected costs from entire book

⇒ If successful, then rates are adequate & equitable

1.1.3 → Basic insurance ratios

→ Frequency = (# claims / # exposures)
- # claims → Typically reported claims
- # exposures → earned exposures

→ Severity = losses / # claims
- variations → paid severity = losses on closed claims / # closed claims
- → reported severity = reported losses / # reported claims

* → Numerator may include or exclude ALAE

→ Pure Premium (or loss cost) = losses / exposures → Mix of business shifts affect loss cost trends (e.g. writing more higher risk policies over time)

= ↓ × (# claims / # claims)

= (# claims / # exposures) × (losses / # claims)

= frequency × severity

→ Average Premium = premium / # exposures (* b/c earned or both written)

→ Loss ratio = losses / premium

= ↓ (# exposures / # exposures)

= (losses / # exposures) / (premium / # exposures)

= Pure Premium / Avg Premium

→ Loss & LAE ratio = (loss + LAE) / premium

→ LAE ratio = LAE / losses

→ Loss Ratio (1 + LAE ratio) = (losses / premium) (1 + LAE / losses)

= ↓ ((losses + LAE) / losses)

= (losses + LAE) / premium

= Loss & LAE ratio

→ UW expense ratio = UW expenses / premium
- UW expenses: Incurred at inception ① / ---- during policy term ②

→ UW expense ratio = ① (commissions, other acquisitions, Taxes, licenses + fees) / WP + ② (general expenses) / EP

→ Operating expense ratio (OER) = UW expense ratio + LAE / EP

→ measures portion of each premium dollar used towards paying claim related expenses & UW expenses

→ Combined ratio = losses / EP + LAE / EP + UW expenses / WP

= Loss & LAE ratio + ↓

= loss ratio + OER

* ★ Benchmark is 100% (breakeven)

* If UW expenses are incurred during the policy term ⇒ ÷ by EP instead of WP

→ Close ratio = # accepted quotes / # quotes

1.2 → Policies, exposures & claims

1.2.2 → Exposures

→ Exposure → 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 → the factor that is most directly proportionate to loss (i.e 10% increase in exposure ⇒ 10% increase in losses)
- → 2) practical → obtainable, easy/inexpensive to obtain & verify
- → 3) historical precedence → should consider any preexisting exposure base established in the industry. Changes need to be carefully considered

→ Common exposure bases → 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 boat instead of boat years, for physical damage)
- → Proportional to expected loss → Yes, directly related to potential losses (expensive boat ⇒ expensive to repair/replace)
- → Practical → No: not easy to obtain & verify; easy to manipulate if left to insured's word; Boat value somewhat subjective due to different definitions, sale price or market value?
- → Yes: Yes, if clearly defined it would be value already on-record by the insurance company
- → Historical precedence → No; costly to switch to new base from BY - no & could result in large premium swings for the insured
- ⇒ Give final recommendation ⇒ If evaluating for multiple coverages, don't recommend split exposure base b/c it would require lots of extra work from the company's perspective

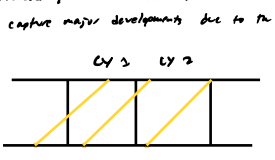
1.3 → Understanding insurance data

1.3.2 → Aggregating data ⇓ 1.3.3 → Measuring exposures & premium ⇓ 1.3.4 → Measuring losses

→ Data aggregation goals → 1) Accurately match losses & premium
- → 2) Use the most recent data available
- → 3) Reduce the cost associated w/ gathering & retrieving data

→ Four methods of data aggregation:

→ Calendar year aggregation
- → Advantages → data is readily available once the CY ends
  - → There is no future development (fixed at the end of the CY)
  - → Data is easily accessible
- → Disadvantages → mismatch between premium & losses (EP & losses can come from policies written in prior year)
  - → Inability to capture major developments due to the fixed nature of data

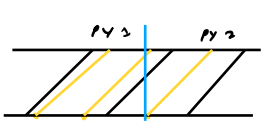


→ Accident Year aggregation
- → Calendar/Accident year are nearly the same for premium, except AY allows for premium written after the end of the CY
- → Advantages → Easy to obtain & easy to understand
  - → Better match of premiums & losses than CY aggregation (i.e losses year for are compared to premium earned year to)
  - → Useful for identifying the impact of major claim events (e.g. a catastrophe)
- → Disadvantages → requires estimation of future development
  - → Provides a less accurate match of premiums & losses (compared to PY)

→ AY data better for estimating unpaid claims b/c it is the industry standard (bc of available benchmarks & data available)

← PY has no IBNR ⇒ once year ends, can't be any more reported claims in that year, only IBNER

→ Policy Year Aggregation
- → Advantage → Provide the best match between losses & premiums
  - → useful for identifying the impact of underwriting or pricing changes
- → Disadvantage → Development on IBNR claims is excluded



→ Report year aggregation
- → Advantage → provides more stable data than AY aggregation, as the # of claims is fixed at the end of the year
- → Disadvantage → Development on IBNR claims is excluded

→ Unearned exposures / premium
- → 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

Written Exposure = Earned Exposure + Change in Unearned exposure (End/Beginning of year)

↓ = ↓ + (EOY Unearned exposure − BOY Unearned Exposure)

Written premium = EP + Change in Unearned Premium

↓ = ↓ + (EOY Unearned premium − BOY Unearned premium)

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

EOY Unearned Exposure = Written Exposure (WE) − Earned exposure (EE) + BOY Unearned Exposure (UEE)

EOY Unearned Premium = WP − EP + BOY Unearned premium (UEP)

→ Since the starting unearned exposures/premium for a policy year will always be 0, the relationships above can be simplified to the following if policy year aggregation is used:
- → UE = EE + UEE
- → UP = EP + UEP

→ Mid term adjustments
- → Type 1: Cancellations
  - → If a policy cancels midterm, the unearned portion of the written exposure/premium is shown as negative written exposure/premium in the year the cancellation happens).
  - → 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
  - (just do these logically, e.g) earn at higher/lower rate after the adjustment)

→ Loss data aggregation methods
- → All 4 data aggregation methods apply to loss data.
  - → CY aggregation → considers all loss transactions that occur during the CY
    - → losses are fixed at end of year (i.e no development)
  - → AY ------ → considers all loss transactions for claims w/ an accident/occurrence date during the year
    - → losses develop
  - → PY ------ → considers all loss transactions on policies that were written during the year
    - → losses develop
    - → takes longer for PY data to be fully developed compared to AY
  - → RY ------ → considers all loss transactions for claims w/ a report date during the year
    - → used for claims-made policies

→ Incurred loss = Paid + Case reserve

→ CY IL = CY Paid + CY Δ in Case Reserve

→ AY IL = Paid + Ending Case reserve (for policies w/ accidents in year X only)

→ PY IL = Paid + Ending Case reserve (for policies written in year X only)

→ Endorsement & premium audits count towards PY data
- → Endorsements get processed
- → Premium audits do not

→ Solvency = vertical line (use full-term premium)

→ Uneven earning pattern ⇒ determine that first = EE / EWB → solve

⇒ then it is straightforward if we generalize the pattern first

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→ first step is always to determine what claims are relevant based on aggregation method & year (i.e filter claims)
⇒ then solve!