Rising Fellow

2026

Exam 5

Study Guide

BASIC RATEMAKING AND RESERVING

Comprehensive study guide
with past CAS practice problems

Exam 5 Study Guide

Spring 2026 Sitting

Rising Fellow

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Published By:

Rising Fellow
United States, TX, 78006
www.RisingFellow.com

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Published in the United States

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Introduction

How to Use This Guide

This guide is intended to **supplement** the Content Outline readings. Although we believe it provides a thorough review of the exam material, the readings provide additional context that is invaluable. Please do NOT skip the Content Outline readings.

Past CAS Exam Problems

Past CAS exam problems & solutions are included for each paper. Note that these questions are solely owned by the CAS. They are included in the online course for student convenience. All past CAS problems are Excel-based and can be downloaded from the online course.

Feedback

We always working to improve the Exam 5 Study Guide and the rest of the Rising Fellow study material. Please send us an email at **exam5@risingfellow.com** if you have feedback about any of the following:

- Sections that are confusing or could be improved
- Errors (ex. formatting, spelling, calculations, grammar, etc.)

Note that errata will be posted on the Rising Fellow website on an as-needed basis.

Blank Pages

Since many students want a printed copy of the study guide, blank pages have been inserted throughout the guide to ensure that all outlines start on odd pages.

W & M Ch. 1 – Introduction

Outline

The basic economic relationship for the price of any product is Price = Cost + Profit. Unlike standard consumer products, the cost of an insurance "product" is unknown at the time the product is sold. Thus, there is additional complexity when setting prices for insurance products. This textbook outlines the fundamentals of setting insurance prices.

I. Basic Insurance Terms

This chapter begins with several definitions and concepts that set the stage for the rest of the textbook:

- **Rating Manual** – a document that contains the information necessary to classify each risk and calculate the premium associated with that risk
- **Exposure** – basic unit of risk that underlies the insurance premium
    - **Written exposures (WE)** – the total exposures arising from policies issued during a specified period of time
    - **Earned exposures (EE)** – the portion of the written exposures for which coverage has already been provided as of a certain point in time
    - **Unearned exposures** – the portion of the written exposures for which coverage has not yet been provided as of a certain point in time
    - **In-force exposures** – the number of insured units that are exposed to loss at a given point in time
- **Premium** – the amount the insured pays for insurance coverage
    - **Written premium (WP)** – the total premium associated with policies issued during a specified period of time
    - **Earned premium (EP)** – the portion of the written premium for which coverage has already been provided as of a certain point in time

    - **Unearned premium** – the portion of the written premium for which coverage has yet to be provided as of a certain point in time
    - **In-force premium** – the full-term premium for policies that are in effect at a given point in time
- **Claim** – a demand made by the insured to the insurer for indemnification under an insurance policy
- **Claimant** – the individual making the demand for indemnification
- **Date of loss (i.e., accident date or occurrence date)** – the date of the event that caused the loss
- **Report date** – the date in which the claimant reports the claim to the insurer
- **Incurred but not reported (IBNR) claims** – claims not currently known by the insurer (ex. an insured has an auto accident on January 1 but does not report the claim until January 15. From January 1 to January 15, this is an IBNR claim)
- **Loss** – the amount of compensation paid or payable to the claimant under the terms of the insurance policy (note that Friedland uses the term "Claim" when referring to the dollar amount of "Losses")
    - **Paid losses** – the amounts that have been paid to claimants
    - **Case reserve** – the amount of additional money required to ultimately settle a claim. When a claim is reported and a payment is expected to be made in the future, the insurer will establish a case reserve. As payments are made on the claim, the case reserve is reduced accordingly since it represents the additional money needed to ultimately settle the claim. Actuaries are not typically involved in the setting of case reserves. Instead, these are usually set by the claims department
    - **Reported losses (i.e., case incurred losses)** – the sum of the paid losses and the current case reserve for a claim. Mathematically, "**Reported Losses = Paid Losses + Case Reserve**"
    - **Incurred but not reported (IBNR) reserve** – the amount estimated to ultimately settle unreported claims

    - **Incurred but not enough reported (IBNER) reserve** – the additional amount above the aggregate reported losses needed to settle reported claims
    - **Ultimate losses** – the amount of money required to close and settle all claims for a defined group of policies. Mathematically, "**Ultimate Losses = Reported Losses + IBNR + IBNER = Paid Losses + Case Reserves + IBNR + IBNER**"
    - At first glance, it may be difficult to distinguish ultimate losses and reported losses. However, they are different for two reasons: 1) ultimate losses include an IBNR reserve for unreported claims whereas reported losses only consider reported claims and 2) ultimate losses include an IBNER reserve to cover loss development on reported claims
    - If you are confused by the various loss definitions above, do not fret! We will look at in-depth examples in later chapters that clarify these differences. In other words, "just roll with it" for now!
- **Loss adjustment expense (LAE)** – the expense dollars incurred by the insurer in the process of settling claims
    - **Allocated loss adjustment expense (ALAE)** – claims-related expenses that are directly attributable to a specific claim (ex. fees associated with outside legal counsel to defend a claim). These may also be referred to as Defense and Cost Containment (DCC)
    - **Unallocated loss adjustment expense (ULAE)** – claim-related expenses that cannot be directly attributed to a specific claim (ex. salaries of claims department personnel that are not readily assignable to a specific claim). These may also be referred to as Adjusting and Other (A&O)
    - LAE = ALAE + ULAE
- **Underwriting expenses** – the expense dollars incurred by the insurer in the acquisition and servicing of policies
    - Commissions and brokerage – amounts paid to insurance agents or brokers as compensation for generating business

    - Other acquisition – expenses other than commissions and brokerage paid to acquire business (ex. insurer media advertisements)
    - Taxes, licenses, and fees – all taxes and miscellaneous fees paid by the insurer excluding federal income taxes (ex. premium taxes)
    - General expenses – any remaining expenses associated with the insurance operations (ex. electricity costs for the home office)
- **Underwriting profit** – the sum of the profits generated from individual policies. In the simplest terms, this is equal to premiums – losses – expenses

II. Fundamental Insurance Equation

As mentioned earlier, basic economics tells us that Price = Cost + Profit. We can translate this to the insurance industry in a form known as the **fundamental insurance equation**:

$$\boxed{Premium = (Losses + LAE + UW\ Expenses) + UW\ Profit}$$

When we set rates for an insurance product, the goal is to determine the premium required to cover all costs and achieve the target underwriting profit.

There are **two key points** to consider in regard to achieving the appropriate balance in the fundamental insurance equation:

1) Ratemaking is prospective
2) Balance should be attained at the aggregate and individual levels

Ratemaking is Prospective

As mentioned earlier, we do not know the cost of an insurance product upon sale. Thus, we must estimate the cost. The ratemaking process involves estimating the components of the fundamental equation to set a rate that is expected to achieve the target profit **during the period the rates will be in effect**. For example, if the rates go into effect six months from now, then we want to set a rate that covers what costs will look like six months from now (i.e., the expected cost) and leaves enough premium left over to achieve the target underwriting profit.

Overall and Individual Balance

During the ratemaking process, we want to ensure that the fundamental equation is in balance at both an overall level, as well as at an individual or segment level.

Equilibrium at the aggregate level ensures that the total premium for all policies written is sufficient to cover the total expected losses and expenses and achieve the target profit.
Equilibrium at the individual level ensures that individual policies with higher risks of loss have higher premiums than policies with lower risks of loss (i.e., minimal levels of subsidization).

III. Basic Insurance Ratios

This section introduces several key insurance ratios:

- $\boldsymbol{Frequency = \frac{Number\ of\ Claims}{Number\ of\ Exposures}}$
    - **Changes in claims frequency** can be used to identify general industry trends associated with the incidence of claims or the utilization of the insurance coverage
- $\boldsymbol{Severity = \frac{Losses}{Number\ of\ Claims}}$
    - In general, **paid severity** is calculated as paid losses on closed claims divided by closed claims
    - In general, **reported severity** is calculated as reported losses on reported claims divided by reported claims
    - ALAE may or may not be included in the numerator
    - **Changes in severity** can provide information about loss trends and highlights the impact of any changes in claims handling procedures
- $\boldsymbol{Pure\ Premium = \frac{Losses}{Number\ of\ Exposures} = Frequency \times Severity}$
    - Pure premium is also known as the **loss cost**
    - Pure premium describes the portion of the risk's expected costs that is purely attributable to loss
    - ALAE may or may not be included in the numerator

- **Changes in pure premium** can highlight industry trends in overall loss costs due to change in both frequency and severity

- $\boldsymbol{Average\ Premium = \frac{Premium}{Number\ of\ Exposures}}$
  - The numerator and denominator need to be on the same basis. For example, to calculate average written premium, written premium and written exposures should be used
  - **Changes in average premium**, if adjusted for rate change activity, can highlight changes in the mix of business written (ex. shift towards higher or lower risk characteristics reflected in rate). We will look at how to adjust premiums for rate change activity in a later chapter
- $\boldsymbol{Loss\ Ratio = \frac{Losses}{Premium} = \frac{Pure\ Premium}{Average\ Premium}}$
  - There are many common variations of a loss ratio. One common variation divides total reported losses by total earned premium
  - Total LAE may or may not be included in the numerator. When included, the ratio is known as the **loss and LAE ratio**
  - **The loss and LAE ratio** is a primary measure of the adequacy of the rates overall and for key segments of the portfolio
- $\boldsymbol{LAE\ Ratio = \frac{LAE}{Losses}}$
  - First and foremost, notice that this definition of LAE ratio has losses in the denominator instead of premium. Thus, the loss and LAE ratio we covered above is equal to (Loss Ratio) x (1 + LAE Ratio)
  - Both paid and reported figures are used by companies when defining the LAE ratio
  - **The LAE ratio** is used to determine if costs associated with claim settlement procedures are stable or not. An LAE ratio the changes drastically from year to year is not stable

- $\boldsymbol{Underwriting\ (UW)\ Expense\ Ratio} = \frac{\boldsymbol{UW\ Expenses}}{\boldsymbol{Premium}}$
    - This ratio is typically split into two ratios: 1) expenses that are generally incurred at the onset of the policy (commissions and brokerage, other acquisition, and taxes, licenses, and fees) and 2) expenses that are incurred throughout the policy (general expense)
    - The expenses incurred at the onset are divided by written premium and the expected incurred throughout the policy are divided by earned premium. This is done to **better match the expense payments to the premium associated with the expense**
    - Based on the two bullet above, we can re-write the UW Expense Ratio as $UW\ Expense\ Ratio = \frac{C\&B\ + OA + TLF}{Written\ Premium} + \frac{GE}{Earned\ Premium}$
    - **Analysis of the UW ratio** involves comparing actual changes in the ratio to expected changes based on general inflation
- $\boldsymbol{Operating\ Expense\ Ratio\ (OER) = UW\ Expense\ Ratio} + \frac{\boldsymbol{LAE}}{\boldsymbol{Earned\ Premium}}$
    - The OER represents the portion of each premium dollar used to pay for LAE and UW expenses
    - **The OER** is used to monitor operational expenditures and is key to understanding the overall profitability of the insurer
- $\boldsymbol{Combined\ Ratio = Loss\ Ratio} + \frac{\boldsymbol{LAE}}{\boldsymbol{Earned\ Premium}} + \frac{\boldsymbol{UW\ Expenses}}{\boldsymbol{Written\ Premium}}$
    - Notice that LAE is considered separately in the formula above. If the insurer uses a loss and LAE ratio instead of a loss ratio, then the second component above would be excluded. The point is just to make sure that LAE is not double counted
    - Notice that the total UW expenses are being divided by written premium. If we wanted to use the "more accurate" version where UW expenses incurred through the policy are divided by earned premium, then the formula would be re-written as $Combined\ Ratio = Loss\ Ratio + OER$

- **The combined ratio** is the primary measure of the profitability of the book of business since UW Profit = 1.00 – Combined Ratio

- $\boldsymbol{Retention\ Ratio = \frac{Number\ of\ Policies\ Renewed}{Number\ of\ Potential\ Renewal\ Policies}}$
  - There are many variations of the retention ratio. For example, some companies exclude policies that cancel due to death
  - **Retention rates and changes in retention ratios** are used to gauge the competitiveness of rates. Retention rates are also central to lifetime customer value and/or projecting future premium values

- $\boldsymbol{Close\ Ratio = \frac{Number\ of\ Accepted\ Quotes}{Number\ of\ Quotes}}$
  - There are variations of the close ratio. For example, suppose a prospective insured receives multiple quotes. Some companies may count that as one quote, while others may count each quote separately
  - **Close rates and changes in retention ratios** are used to gauge the competitiveness of rate for new business

W & M Ch. 3 – Ratemaking Data

Outline

This chapter discusses various types of ratemaking data, along with data aggregation methods.

I. Internal Data

There are **two types** of internal data involved in a ratemaking analysis:

1) Risk information – includes exposures, premiums, claim counts, losses, and explanatory characteristics about the policy or the claim
2) Accounting information – includes underwriting expenses and ULAE (both are typically only available at the aggregate level)

Risk Information

When analyzing risk information, we want to link exposure and premium data with the corresponding claim and loss data. In general, companies record this information in **two separate databases**: 1) a policy database and 2) a claim database.

Policy Database

The policy database is defined according to records (i.e., individual policies or some further subdivision of the policy) and fields (i.e., explanatory information about the record). Records are defined differently based on the line of business. For example:

- Homeowners – a record may be a home for an annual policy period
- Workers' Compensation – a record may be the relevant industry classification

In addition to the record definitions above, records are also subdivided according to any changes in the risk(s) during the policy period. For example, if a policy is amended during the policy term, then separate records are created for the partial policy periods before and after the change. We will explore an example later to illustrate this.

Fields for each record on the policy database may include the following:

- Policy identifier – a key that identifies each policy
- Risk identifier – a key that identifies each risk if there are multiple risks on a single policy (ex. multiple operators on a single auto policy)
- Relevant dates – policy start date, policy amendment date, etc.
- Premium – typically written premium (by coverage, if applicable)
- Exposure – typically written exposure (by coverage, if applicable)
- Characteristics – rating variables, underwriting variables, etc.; the characteristics should reflect what was present on the policy during that specific period

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Example: Policy Database

Given the following homeowners policies:

- Policy A
    - Written date: January 1, 2010
    - Annual premium: $1,100
    - Territory: 1
    - Deductible: $250
    - Policy remains unchanged for the full term of the policy
- Policy B
    - Written date: April 1, 2010
    - Annual premium: $600 at policy issue
    - Territory: 2
    - Deductible: $250 at policy issue
    - Policy is canceled on December 31, 2010
- Policy C
    - Written date: July 1, 2010

- Annual premium: $1,000 at policy issue; increased to $1,200 after deductible change described below
- Territory: 3
- Deductible: $500 at policy issue; decreases to $250 on January 1, 2011

The policy database is shown below, where each row represents a "record:"

Policy	Orig. Effect. Date	Orig. Term. Date	Trans. Effect. Date	Ded.	Terr.	Other Chars.	Written Exposure	Written Premium
A	01/01/10	12/31/10	01/01/10	$250	1	…	1.00	$1,100
B	04/01/10	03/31/11	04/01/10	$250	2	…	1.00	$600
B	04/01/10	03/31/11	12/31/10	$250	2	…	-0.25	-$150
C	07/01/10	06/30/11	07/01/10	$500	3	…	1.00	$1,000
C	07/01/10	06/30/11	01/01/11	$500	3	…	-0.50	-$500
C	07/01/10	06/30/11	01/01/11	$250	3	…	0.50	$600

How did we build the table above?

- Policy A – This is straight-forward. Since there were no changes during the policy period, we have a single record and a written exposure of 1.00
- Policy B – The only policy change was the cancellation. Thus, we have two records. The first record shows the information known at policy issue. The second record shows the cancellation adjustment. Since the policy was cancelled 75% of the way through the policy period, the second record shows a written exposure of -0.25 and a written premium of -$150. In doing so, the "net" result after aggregating the two records is a net written exposure of 0.75 = 1.00 – 0.25 and a net written premium of $450 = $600 – $150
- Policy C – The only policy change is a mid-term adjustment to decrease the deductible. Since the policy was not cancelled, we have three records. The first record shows the information at policy issue. The second record negates the portion of the original policy that was unearned at the time of the amendment. Since half of the record was unearned, the written exposure is -0.50 and the written premium is -$500. The third record shows the information for the amended portion of the policy. Since half of the policy remains,

the written exposure is 0.50. Since the annual premium associated with the amendment is $1,200, the written premium associated with the amendment is $600 = (0.50)($1,200)

Claims Database

In a claims database, each record represents a transaction tied to a specific claim. Examples of transactions include claim payments and changes in case reserves. Each record also includes dates or other explanatory information relevant to each claim.

Fields included for each record on the claims database include the following:

- Policy identifier
- Risk identifier
- Claim identifier – a key that identifies each claim. If a claim has multiple claimants, each claimant will have the same claim identifier
- Claimant identifier – a key that identifies each claimant on a particular claim
- Relevant loss dates – loss date, report date, etc.
- Claim status – shows whether the claim is open, closed, re-opened, etc.
- Claim count – identifies the number of claims by coverage associated with the loss occurrence
- Paid loss – payments made for each claim record
- Case reserve – the case reserve or change in the case reserve at the time the transaction is recorded
- ALAE – the ALAE for each claim record
- Salvage/subrogation – companies can often recoup some claim payments in the form of salvage or subrogation. When damaged property is sold by the insurer, this is known as salvage and can be used to offset claim payments. When a company pays for an insured's loss, the company reserves the right to recover any damages from a third party who was at fault. This is known as subrogation and can be used to offset claim payments
- Claim characteristics – type of injury, loss location, age of injured party, etc.

Example: Claims Database

Given the following claim information for three policies:

- Policy A
    - Loss date: January 10, 2010
    - Report date: January 15, 2010
    - Initial case reserve: $10,000
    - Payment #1: $1,000 made on March 1, 2010, with a corresponding $1,000 reduction in the case reserve
    - Payment #2: $9,000 made on May 1, 2010, and the claim is closed
- Policy B: No claims
- Policy C
    - Loss date: October 1, 2010
    - Report date: October 15, 2010
    - Initial case reserve: $18,000
    - Payment #1: $2,000 made on December 15, 2010, with a $1,000 reduction in the case reserve. Notice that the change in the case reserve is not always a direct offset to the claim payment. This happens when the claims adjuster feels that additional payments beyond the initial case reserve will be required. Remember that we referred to this as development on a known claim in Chapter 1 (IBNER)
    - Payment #2: $7,000 made on March 1, 2011, with a $2,000 reduction in the case reserve
    - Payment #3: $15,000 made on March 1, 2012, and the claim is closed. The insurer receives a $1,000 salvage recovery by selling damaged property

The claims database is shown below, where each row represents a "record:"

Policy	Claim Number	Loss Date	Report Date	Trans. Date	Claim Status	Claim Chars.	Loss Pmt.	Case Res.	Sal/Sub
A	1	01/10/10	01/15/10	01/15/10	Open	…	$ -	$10,000	$ -
A	1	01/10/10	01/15/10	03/01/10	Open	…	$1,000	$9,000	$ -
A	1	01/10/10	01/15/10	05/01/10	Closed	…	$9,000	$ -	$ -
C	2	10/01/10	10/15/10	10/15/10	Open	…	$ -	$18,000	$ -
C	2	10/01/10	10/15/10	12/15/10	Open	…	$2,000	$17,000	$ -
C	2	10/01/10	10/15/10	03/01/11	Open	…	$7,000	$15,000	$ -
C	2	10/01/10	10/15/10	03/01/12	Closed	…	$15,000	$ -	$1,000

How did we build the table above?

- Policy A – There are three records: one when the claim is reported; one when the first payment is made; and one when the last payment is made and the claim is closed
- Policy B – There are no claims and thus, no records
- Policy C – There are four records: one when the claim is reported; one when the first payment is made; one when the second payment is made; and one when the last payment is made, salvage/subrogation is received, and the claim is closed
- At any given point in time for a single claim, we can sum up all payments and add on the latest case reserve to obtain the reported loss gross of sal/sub. If we subtract off all sal/sub received from the reported loss gross of sal/sub, we obtain the reported loss net of sal/sub. We can do the same thing across all claims to obtain the aggregate reported loss net of sal/sub

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Accounting Information

Accounting information refers to financial information not specific to any one claim (ex. UW expenses and ULAE). Thus, accounting information is usually tracked at the aggregate level. Companies typically track accounting information by calendar year.

II. Data Aggregation

When aggregating data for ratemaking purposes, three general objectives apply:

1) Accurately match losses and premium for the policy
2) Use the most recent data available
3) Minimize the cost of data collection and retrieval

We will explore **four methods of data aggregations**: calendar year (CY), accident year (AY), policy year (PY), and report year (RY).

CY Aggregation

CY aggregation **considers all premium and loss transactions** that occur during the twelve-month calendar **without regard to the date** of policy issuance, the accident date, or the report date of the claim. Regarding earned premium, earned exposures, paid losses, and reported losses:

- CY Earned Premium – all premium earned during the twelve-month period
- CY Earned Exposures – all exposures earned during the twelve-month period
- CY Paid Losses – all loss payments made during the twelve-month period
- CY Reported Losses – equal to CY Paid Losses + Change in Case Reserves during the twelve-month period

An **advantage** of CY aggregation is that data is available quickly. Once a CY ends, all premium, exposure, and loss information is fixed and never changes.

A **disadvantage** of CY aggregation is the mismatch between premiums and losses. The premiums earned during the CY come from policies in-force during the year. For annual policies, those premiums come from policies written in the previous CY or the current CY. The losses could come from any open claims. For example, CY 2010 can include loss payments made on claims that occurred in 1985. Complicated claims can remain open for decades. If a loss payment on a 1985 claim occurs in CY 2010, then the CY 2010 paid losses will include that payment.

CY aggregation **is most appropriate** for lines of business in which **losses are reported quickly and settled quickly** (ex. homeowners).

AY Aggregation

Under AY aggregation, premiums and exposures are aggregated in the same manner as CY aggregation. However, AY aggregation of losses only **considers losses for accidents that have occurred during that twelve-month period**, regardless of when the policy was issued or when the claim was reported. Given that premiums and exposures follow CY aggregation whereas losses follow AY aggregation, this is sometimes known as CY/AY aggregation. Regarding earned premium, earned exposures, paid losses, and reported losses:

- CY/AY Earned Premium – all premium earned during the twelve-month period
- CY/AY Earned Exposures – all exposures earned during the twelve-month period
- AY Paid Losses – all loss payments made on claims that occurred during the twelve-month period
- AY Reported Losses – all loss payments and the current case reserve on claims that occurred during the twelve-month period

An **advantage** of AY aggregation is that it provides a better match of premium and losses than CY aggregation. Since it only considers claims that occurred during the twelve-month period, any losses will come from policies issued in the previous CY or the current CY.

A **disadvantage** of AY aggregation is that the AY is not fixed at the end of the twelve-month period. As mentioned in Chapter 1, we often have development on known claims (IBNER). We also have to consider pure IBNR claims that occurred in the AY but have yet to reported. It can take several years for all claims that occurred in a specific AY to be settled. Thus, AY losses change (i.e., develop) over time.

PY Aggregation

Also known as underwriting year (UY) aggregation, PY aggregation considers **all premiums and loss transaction on policies that were written during a twelve-month period**, regardless of when

the claim occurred or when it was reported. Regarding earned premium, earned exposures, paid losses, and reported losses:

- PY Earned Premium – all premium earned on policies written during the twelve-month period
- PY Earned Exposures – all exposures earned on policies written during the twelve-month period
- PY Paid Losses – all loss payments made on claims from policies written during the twelve-month period
- PY Reported Losses – all loss payments and the current case reserve on claims from policies written during the twelve-month period

An **advantage** of PY aggregation is that it represents an exact match of premiums and losses. The premium comes from policies written during the twelve-month period. The losses come from those exact same policies that were written during the twelve-month period.

A **disadvantage** of PY aggregation is that data takes longer to develop than both calendar year and accident year. For example, PY 2010 includes premium and losses from policies written between January 1, 2010 and December 31, 2010. An annual policy written on December 31, 2010 will earn nearly all of its premium in 2011. In addition, a loss on this policy could occur as late as December 30, 2011. Thus, when dealing with policies with annual policy terms, it takes 24 months for all exposures to fully earn out and for all losses on those policies to occur. Similar to AY aggregation, PY losses develop over time as more information is gathered on known claims and as unreported claims are gradually reported.

RY Aggregation

This method is like CY/AY except that the losses are aggregated according to when the claim was reported, as opposed to when the claim occurred. This method **is typically used for claims-made policies (ex. medical malpractice policies)**.

We will show detailed examples of each of the aggregation methods above in a later chapter.

Overall vs. Classification Analysis

When the goal of the ratemaking analysis is to review the adequacy of the overall rate level, the data can be highly summarized (i.e., aggregated at a broad level like year and location). When the goal is classification analysis, more granular data is needed. For example, if the aim is to revise a rating plan's territory relativities, then detailed data is needed by territory. If the aim is to perform multivariate analysis via a predictive model, then detailed data is needed by policy or risk.

III. External Data

External data is useful when internal data is limited (ex. entering a new line of business). External data includes the following:

- Statistical plans
- Other aggregated industry data
- Competitor rate filings or competitor manuals
- Other third-party data

Statistical Plans

Statistical plan data is summarized data required by state regulators. To comply with state requirements for aggregated industry data, industry service organizations such as NCCI and ISO have been formed to collect and aggregate data from participating insurers. This data can be used to supplement internal data when performing actuarial analyses.

Other Aggregated Industry Data

Many insurers voluntarily report data to other various industry organizations so that it can be aggregated and used by the insurance industry. Examples include the following:

- Fast Track Reports used by insurers and state regulators to analyze loss trends

- Loss data from the Highway Loss Data Institute (HLDI) that provides detailed loss information by type of car for use by insurers and consumers in the form of safety recommendations

Competitor Rate Filings or Competitor Manuals

In certain states, rate filings are publicly available. Since rate filings typically include actuarial justification, they often include detailed premium, loss, and expense information. Insurers can use this to compare themselves to competitors.

Companies may be required to include manual pages as well. Rating manuals include the rules, rating structures, and rating algorithms in use by the company. Insurers can review competitor rating manuals to see how they stack up in terms of rating features. When reviewing rating manuals, insures should **keep in mind that underwriting tiers** are often not included. Since underwriting tiers can be a large component of the final premium charged, insurers should be cautious when comparing their premiums to competitor premiums.

Other Third-Party Data

Insurers also make use of non-insurance information sourced from third parties. This includes economic data (ex. Consumer Price Index), geo-demographic data (ex. average characteristics of a particular location) and credit data. Note that there are many other types of third-party data as well.

The Consumer Price Index can assist companies in projecting trends in expenses, premium, or losses. Geo-demographic data and credit data can be included in predictive models used for predicting frequency and severity.

W & M Ch. 4 – Exposures

Outline

I. Criteria for Exposure Bases

An **exposure** is the basic unit that measures a policy's exposure to loss. A good exposure base should meet the following **three criteria**:

1) It should be directly proportional to expected loss
2) It should be practical
3) It should consider any pre-existing exposure base established within the industry (i.e., historical precedence)

Directly Proportional to Expected Loss

All else being equal, the expected loss of a policy with two exposures should be twice the expected loss of a policy with one exposure. Notice that words "all else being equal." In addition to the number of exposures, the expected loss of a policy varies by several other factors, including rating or underwriting variables.

As an example of this "directly proportional" concept, consider workers' compensation (WC) insurance. The most used exposure base for WC insurance is payroll. As the number of workers increases (or decreases) or the average number of hours worked increases (or decreases), both payroll and risk of loss increases (or decreases). Thus, payroll moves in proportion to expected losses.

Practical

By practical, we mean that the exposure base should be objective and relatively easy and inexpensive to obtain and verify. The exposure base should also be selected so that policyholders (or agents) cannot manipulate exposure information for their own gain (i.e., moral hazard).

As an example, on the surface, annual mileage appears to be a reasonable exposure base for auto policies. However, this information is typically provided by the policyholder and not verified by the insurer. In this case, it's very easy for the policyholder to provide a lower annual mileage figure resulting in a lower premium. Thus, car-years is often used instead to measure exposure.

Another **example** concerns product liability. An intuitive exposure base is the number of products currently in use. Since it is difficult for insurers to track how many of their products are actually being used during the coverage period, gross sales is used instead.

Historical Precedence

Insurer should be cautious before changing an exposure base for a line of business for the following reasons:

- Any change in exposure base can lead to large premium swings for individual insureds
- Any change in exposure base will require a change in the rating algorithm, which could require a lot of time and expense
- Any change in exposure may require significant data adjustments since ratemaking analyses require several years of historical data

Here is a table of exposure bases by LOB:

LOB	Exposure Bases
Personal Auto	Earned Car Year
Homeowners	Earned House Year
WC	Payroll
Commercial General Liability	Sales Revenue, Square Footage
Commercial Business Property	Amount of Insurance Coverage
Physician's Professional Liability	Number of Physician Years
Professional Liability	Number of Professionals
Personal Articles Floater	Value of Item

II. Exposures for Large Commercial Risks

Given the unique nature of large commercial risks, they do not follow traditional exposure base conventions. Instead, **composite rating and loss-rated composite rating** is often used for these risks.

Under **composite rating**, different exposure measures are used for each "sub-coverage." For example, a commercial multi-peril policy might use sales revenue for general liability and amount of insurance value for commercial business property. These exposure bases are combined with the rating algorithms for each "sub-coverage" to calculate the initial premium. Obviously, these exposure bases can change over time. Instead of regularly auditing each exposure base and re-doing the premium calculation, a **proxy measure** is used to measure the overall change in exposure to loss. Using the same commercial multi-peril policy above, the insurer might choose the property value as the proxy measure. If the property value increases by 20%, then the total policy premium will also increase by 20%.

Under **loss-rated composite rating**, there is no rating algorithm. Instead, the premium is calculated solely using the individual risk's historical loss experience.

III. Aggregation of Exposures

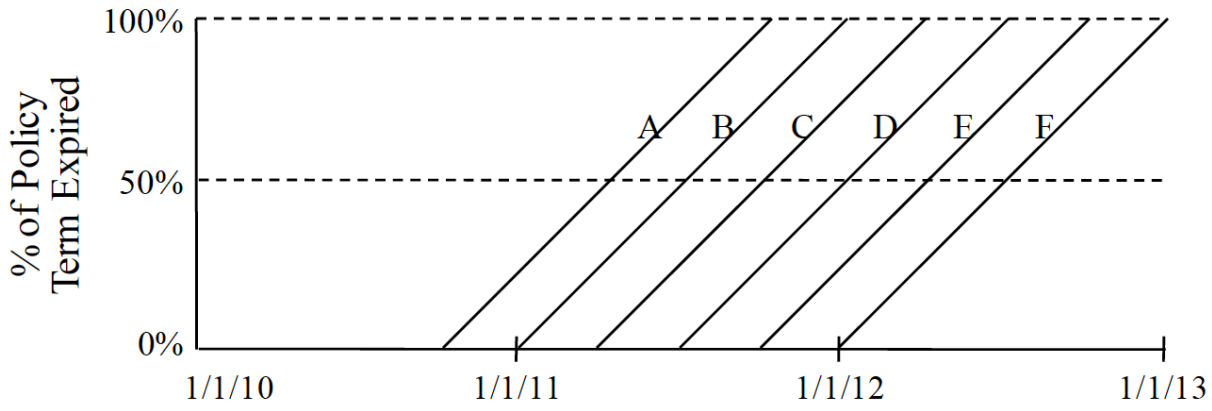
In Chapter 3, we covered four methods of aggregation: CY, AY, PY, and RY. However, for exposures, there are only two aggregation methods: CY and PY. As mentioned in Chapter 3, AY aggregation is identical to CY aggregation for exposures and premiums. RY aggregation is a loss concept and doesn't apply to exposures and premiums. In this section, we will apply these concepts to a set of homeowners' policies.

Example: Exposure Aggregation – Annual Policies

Given the following homeowners policies with annual terms as of December 31, 2012:

Policy	Effective Date	Expiration Date	Exposure
A	10/01/10	09/30/11	1.00
B	01/01/11	12/31/11	1.00
C	04/01/11	03/31/12	1.00
D	07/01/11	06/30/12	1.00
E	10/01/11	09/30/12	1.00
F	01/01/12	12/31/12	1.00

We can also represent the policies pictorially:



How do we interpret the picture above?

- Each diagonal line represents a single policy (A through F)
- The x-axis represents the effective date or the expiration date. The y-axis represents the % of the policy term that has expired. Thus, each policy starts at 0% (at the policy effective date) and ends at 100% (at the policy expiration date)
- A single point on each diagonal line represents the "current date during the policy term" and the associated "expiration percentage." Using Policy A as example, the policy term is half-way complete on 03/31/11. Thus, if we were to draw a vertical line at 03/31/11, it would intersect policy A's diagonal line at the 50% mark