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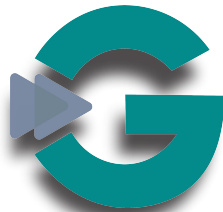
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Study Manual for CAS Exam 5 1st Edition

by

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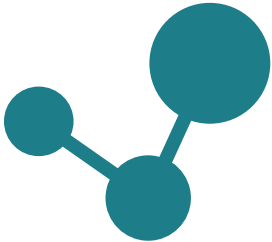
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4. Here is an example of the topic **Pareto Distribution**:

 Pareto Distribution ×

The (Type II) **Pareto distribution** with parameters $\alpha, \beta > 0$ has pdf

$$f(x) = \frac{\alpha\beta^\alpha}{(x + \beta)^{\alpha+1}}, \quad x > 0$$

and cdf

$$F_P(x) = 1 - \left(\frac{\beta}{x + \beta}\right)^\alpha, \quad x > 0.$$

If X is Type II Pareto with parameters α, β , then

$$E[X] = \frac{\beta}{\alpha - 1} \text{ if } \alpha > 1,$$

and

$$Var[X] = \frac{\alpha\beta^2}{\alpha - 2} - \left(\frac{\alpha\beta}{\alpha - 1}\right)^2 \text{ if } \alpha > 2.$$

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INTRODUCTORY COMMENTS

CAS Exam 5 is typically the first upper-level exam actuarial students will take on the property and casualty side of the actuarial track. This exam is unlike any of the other exams you have previously taken in that it introduces concepts much more specifically tailored to the property and casualty area. The syllabus of material is robust and diverse enough to make this into two smaller exams, one on Ratemaking and one on Reserving, but where would be the fun in that 😊? You can expect each of those two topics to make up roughly half of the exam.

The first half of the exam relies mainly on a well-written and well-sequenced text by Geoff Werner and Claudine Modlin on ratemaking. It starts with the foundational information on insurance terms and data before getting into the high-level topic areas specific to ratemaking, premiums, losses, and expenses. The text walks through each area with several examples scattered throughout each topic. The writings also vary between lines of business keeping it engaging for students in any p&c line of business. After going through the areas of ratemaking in the first portion of the text, the second half brings it all together and walks through implementation and considerations in ratemaking. The remainder of the ratemaking source material is much smaller and supplements elements covered in the ratemaking text.

The second half of the exam is focused on reserving and heavily relies on a text authored by Jacqueline Friedland. This text is also the main text for the reserving portion of the exam with some additional readings included in the syllabus to supplement portions of the main reserving text. This reading introduces basic terminology and claims information before delving into the various claims-reserving techniques presented.

The authorship and contribution to the materials on this exam by Werner, Modlin, and Friedland can't be highlighted enough. More veteran p&c actuaries will recall when the material on these two texts was scattered throughout several source materials. These authors bring those topics together into one text for ratemaking and one on reserving have made studying much easier for actuarial students.

I suggest that you work through the study guide by studying a section of notes and then attempting the exercises in the problem set that follows that section. The ordering of the study guide follows the sequencing of the readings in the syllabus. I have intended to make this study guide self-contained and comprehensive for the CAS 5 Exam topics, however, it is important to be familiar with original reference material on all topics. As mentioned before, the amount of material in the course readings for CAS Exam 5 is robust, but to be expected for a 4-hour upper-level exam. This study guide provides a summary of the topics presented but is absolutely not a substitute for thoroughly reading the source material as that is the best way to familiarize any student with these topics.

If you have any questions, comments, or concerns regarding this study guide, please contact the ACTEX as we want this study guide to be as helpful to all current and future actuarial candidates as possible. A good deal of effort has gone into addressing any errors, but in the event you come across one, I humbly apologize in advance and would appreciate it if you would bring them to my attention. ACTEX will be maintaining a website for errata that can be accessed from www.actexlearning.com.

It is my sincere hope that you find this study guide helpful and useful in your preparation for the exam. I wish you the best of luck on the exam.

-DD

**** New October/November 2023 Content Outline ****

In early 2023, the CAS released a new exam content outline starting with the fall exams. This update left the syllabus of readings unchanged. The topics covered were rearranged slightly in terms of how the CAS presented them in the syllabus, but for all intents and purposes, no text/materials were changed. There was also a cognitive structure listed in the syllabus, which in my opinion, really just restates what has been underlying the exam all along and isn't a change to be concerned with at all.

The biggest (and only) change really introduced with the fall 2023 sitting is the format of the questions on the exam. Previously, all questions were free response. With this being the first upper-level exam, many candidates often fell into the partial-credit trap, pondering, "Did I put enough down to get credit?" Oftentimes, several paragraphs were written by a candidate only for them to see that a simple 2- or 3-sentence explanation of how their solution was derived would have sufficed. Make sure to key in on the way a question is phrased, picking up on terms like "briefly describe", "list", "explain", etc. Typically, the intended responses aren't long and wordy but should be enough to display your understanding of what is being asked in the question.

The new question format brings back multiple choice questions, which had been on the exam many years ago, with one or multiple answers being correct. It also introduces fill-in-the-blank responses. The usual constructed response questions are still on the exam as well. There's been no indication from the CAS as to what the expected distribution of question type will be on the exam, but you can likely expect the exam to still have you working through a bulk of the 4-hour exam allotment.

Geoff Werner and Claudine Modlin, Chapter 3: “Ratemaking Data,”
in *Basic Ratemaking*, 2016, pp. 36–48.

INTRODUCTION:

This chapter covers the various data types, data elements, and data sources typically used in ratemaking.

KEY CONCEPTS:

1) Overall

a. **Data is vital to the ratemaking process and drives the quality of the final rates.**

- i. Ratemaking involves analyzing rate adequacy using internal or external/industry historical data.
- ii. Pricing new products requires data with some relationship to the products being priced.
- iii. The granularity of the data required is dictated by the level of analysis being performed.
- iv. Ratemaking uses historical data to project future profitability.
- v. The actuary is responsible for the appropriateness and reasonableness of the data being used in ratemaking.

2) Internal Data

a. Types of internal data:

- i. **Risk/Policy level information** (risk specific characteristics, exposures, premiums, losses, claim counts, etc.)
- ii. **Financial/accounting information** generally only available at an aggregate level (underwriting expenses, ULAE, general expenses, etc.)

b. *Policy Database*

i. Defined & organized by **records** and **fields**

1. **Records** are typically at the policy level or some further segmentation (e.g.: coverage level where there may be multiple coverages on a policy).

- a. Records defined and established based on typical company and industry practice.
- b. Changes in risk profile are also recorded as new records (e.g.: a deductible change or a coverage change).

ii. **Fields** contain descriptive information about the policy.

1. Fields use the information that is current on the policy as of that given time.
2. Typical fields in a record:

- a. **Policy identifier / number** – A unique number assigned to the policy
- b. **Risk identifier** (e.g. vehicle # and operator #) - Keeps the record at a singular/granular risk level
- c. **Relevant dates** (effective, termination)
- d. **Premium** associated with that record at the appropriate segment level
- e. **Exposure** associated with that record at the appropriate segment level
- f. **Risk Characteristics** – Descriptive of the policy and the risk (e.g.: selected coverage limits and deductibles)

iii. Data Storage

1. Data may be stored in multiple databases within a company.
2. It's best to store the data in a stable fashion with stable data elements (e.g.: use year of construction for home insurance rather than age of home which will change from one policy term to the next)

c. *Claims Database*

- i. Typically separate from policy database and stored on a per claim transaction basis (e.g.: claim payment or reserve change).
- ii. Data may also be stored on a per feature basis rather than per claim (e.g.: an auto claim may have multiple features such as a bodily injury record as well as a property damage record).
- iii. Record & Field Definitions
 1. **Policy identifier / number**
 2. **Risk identifier at a singular risk level** (e.g.: vehicle # and operator # on a policy)
 3. **Claim identifier / number**
 4. **Claimant identifier** – Distinguishes on claims with multiple impacted parties
 5. **Relevant loss dates** – Date of loss, reported date, loss transaction date, etc.
 6. **Claim status** – Open/active or closed/settled
 7. **Claim count** – Used if multiple claims are stored on a record (depending on how the data is stored)
 8. **Paid loss** – Amount of money actually paid out by the insurer at a given point in time on the loss record
 9. **Event identifier** – Catastrophe indicator or other extraordinary event noted in the claims database
 10. **Case reserve** – The amount of the case reserve or the change in case reserve as of the date of the record. Case reserve is the amount of funds set aside by the insurer on the portion of the claim that the insured is aware of but has not yet paid out
 11. **Allocated loss adjustment expense (ALAE)** – Portion of the claims handling expense that can be directly tied to a claim (i.e.: claims adjuster expense)
 12. **Salvage/subrogation** – Any recoupment the company receives from salvage (e.g.: value of an automobile the company assumed ownership for after paying out on a total loss used to offset the loss payment) or subrogation (e.g.: any recovery from a third party who contributed to the loss)
 13. **Claim characteristics** – Any additional descriptive information available to the company that they can capture in their database (e.g.: type of injury, description of loss event, etc.)

d. *Accounting Information* used in ratemaking

- i. Typically tracked by calendar year and is not specific to any one policy or claim
 - ii. Underwriting Expense – expenses associates with the acquisition and servicing of a policy. Some can be specifically allocated to a policy (e.g.: commissions), but most cannot (e.g.: cost associates with the company's building)
 1. Loss adjustment expenses (LAE) - Some can be allocated (ALAE) while others cannot (ULAE) -> (as discussed in chapter 1)
- e. By keeping data at a detailed/segmented level, aggregation to the appropriate levels for ratemaking can be achieved.
- f. Data should be aggregated to the appropriate level of the analysis being performed (i.e.: state level, territory level, risk classification level, etc.).
- g. **General objectives when aggregating data for ratemaking purposes:**
- i. *Be able to accurately match premium and loss by policy/segment*
 - ii. *Use the most recent evaluation of data*
 - iii. *Keep the data costs minimized*

h. Common data aggregation methods:

i. Calendar Year

1. All premium and loss transactions that occur during a twelve-month period with no regard to the dates of the events (policy issuance, claims date, etc.) which generated those transactions.
2. Advantages
 - a. All values (earned, paid, etc.) are recorded during the calendar year which results in them being fixed at year-end.
 - b. Aggregation of data is available as soon as the calendar year ends.
 - c. This data also ties into financial statements.
3. Disadvantages
 - a. Mismatch in timing of premium and losses since data is only recorded based on calendar occurrence and not necessarily tied to a policy.
 - b. Only appropriate to use in ratemaking for lines of business that close relatively quickly (e.g.: homeowners).
 - c. Least accurate method for ratemaking.

ii. Accident Year

1. Premium and exposure is the same as the calendar year basis (sometimes referred to as “calendar-accident year method) while losses only consider losses for accidents that occur during that time period.
2. Advantage
 - a. Better match of exposure and premium earned with losses than calendar year data.
 - b. More quickly available than policy year data.
3. Disadvantage
 - a. Loss amounts (paid and reserved) on an accident year basis can change at the end of a calendar year.
 - b. Future development of losses needs to be estimated.

iii. Policy Year / Underwriting Year

1. Uses all premium and losses on policies written during the year.
2. Losses are like accident year in that loss’s values (paid and reserved) will potentially continue to change into the future.
3. Advantage
 - a. Best match to policies of premium and losses.
4. Disadvantage
 - a. Premiums and exposures aren’t fixed until the expiration of all policies associated with that policy year.
 - b. It takes longer for this data to develop.

iv. Report Year

1. Like claims-accident year except losses are grouped based on when they are reported not when the claim occurred.
2. Typically used for claims-made policies (e.g.: medical malpractice insurance).

3) External data

- a. External data is sometimes used when historical data is unavailable (e.g.: a new line of business), not credible (e.g.: a line of business with few inforce policies) or as a benchmark.
- b. The actuary is responsible to pick the reasonableness of the external data used given the situation.
- c. *Types of external data:*

i. Statistical plans

1. Regulators require companies to submit statistical data to them while regulating the companies.
2. This data is collected (either by the government or by an industry service organization).
 - a. Examples:
 - i. National Council for Compensation Insurance (NCCI)
 - ii. Insurance Services Office, Inc. (ISO)
3. Companies can request this data to provide additional information in their ratemaking work.
4. Regulators may also make ad hoc data calls from which data can be made available for companies to use.

ii. Other Aggregated Industry Data

1. Voluntarily reported information to third parties which is then aggregated for use by regulators, public policy makers of the general public.
2. Examples:
 - a. Fast Track Monitoring System
 - b. Highway Loss Data Institute (HLDI)

iii. Competitor Filings / Manuals

1. Companies are typically required to submit changes to their rates or rating structure to regulators for review.
2. Many of these submissions contain information that can supplement the ratemaking process.

iv. Other Third-Party Data

1. Ratemaking can use data not specific to insurance (where appropriate).
2. Economic data
 - a. Consumer Price Index (CPI) components
3. Geo-demographic data
 - a. US Census data
 - b. Weather indices
 - c. Theft indices
 - d. Average annual miles driven

KEY FORMULAS:

$$\text{Incurred Losses} = \text{Paid Losses} + \text{Case Reserves}$$

$$\text{Case Reserves} = \text{Ending Loss Reserve} - \text{Beginning Loss Reserve}$$

(These formulas will be explored in more depth in later chapters.)

SUMMARY:

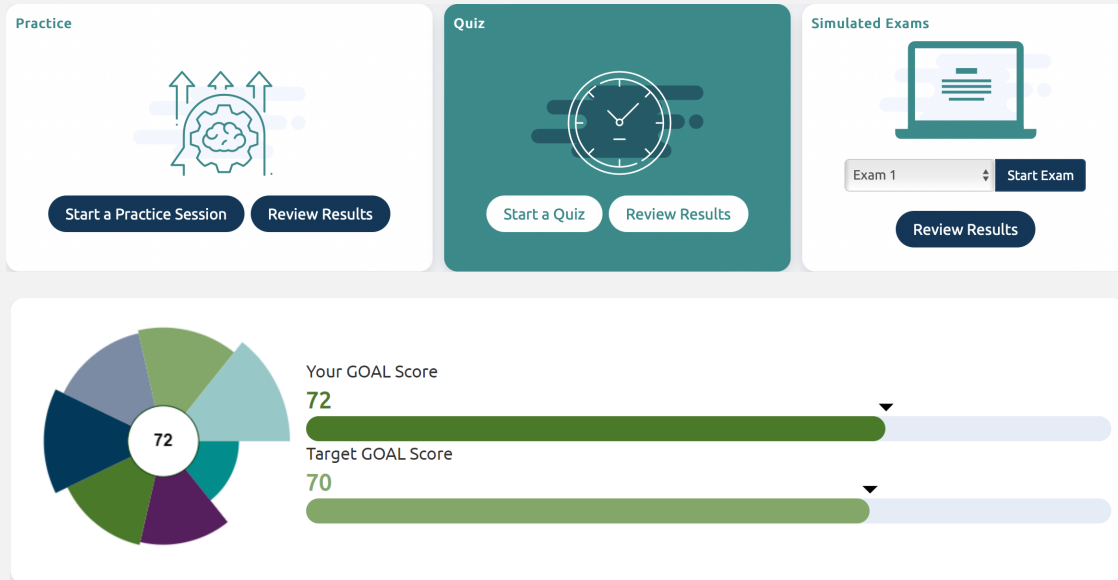
Ratemaking requires enough data to estimate the future cost of providing insurance protection. The data used in ratemaking must be aggregated to an appropriate level for the analysis being performed. Data used in ratemaking can come from various sources all with the goal of making a better-informed decision on rates.

PAST CAS EXAMINATION QUESTIONS (MODIFIED)

1. Discuss the advantages and disadvantages (with respect to ratemaking) of the calendar year and accident year measures of loss experience relative to each other.
2. A loss ratio, on which basis, most accurately match the losses with the premiums intended to fund those losses?
3. What are the advantages and disadvantages associated with the use of calendar year and policy year data for ratemaking?
4. Modify the wording below to make each statement true.
 1. Policy year premium statistics can be distorted by significant audit premiums.
 2. Compared to policy year ones, calendar year statistics for the same year take longer to develop.
 3. Calendar year data and calendar-accident year data differ primarily in calculating premium.
5. Which method of gathering statistics provides an exact matching of losses and premiums to a specific group of insured entities?
6. Give three properties of ratemaking using the calendar year method.
7. Of the three methods for gathering ratemaking statistics described by Werner and Modlin, which method is the only method that provides an exact match between premium and losses for a specific group of insured entities?
8. What is the formula for incurred losses?
9. Can calendar year statistics can have parts of a single claim being included in several years?
10. Which method provides the best match of losses to premiums?
11. Which method is the least accurate method?
12. What is a disadvantage of the policy year method of compiling ratemaking statistics versus the accident year method is that the policy year method?
13. The only method for gathering ratemaking statistics that provides an exact matching of losses and premiums to a specific group of insureds is which method?
14. Under the policy year method, are incurred losses are affected by changes in reserves for events that occurred in earlier periods?
15. The accident year method uses what kind of earned premiums?

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