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ACTEX Study Manual for

CAS Exam 5

Fall 2018 Edition

Volume I

David H. Deacon, Jr., ACAS, MAAA

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INTRODUCTION

Speaking from experience, balancing exam taking with family, job, outside interests, etc. is an arduous, unenviable task on the road to becoming a stronger actuary. It's my hope that this study manual provides benefit and relief in the exam taking challenge presented in our careers. While this study manual (and associated note cards) provide a valuable source of information in exam preparation, they are by no means a substitute for the source material from which the exam questions are directly drawn from. Every effort has been made to ensure unintended mistakes and incorrect answers. With a manual of this size, some may still remain and I'd encourage anyone finding any issues to please bring them to my attention for correction.

Questions and parts of some solutions have been taken from material copyrighted by the Casualty Actuarial Society. They are reproduced in this study manual with the permission of the CAS solely to aid students studying for the actuarial exams. Some editing of questions has been done. Students may also request past exams directly from the society. I am very grateful to this organization for its cooperation and permission to use this material. It is, of course, in no way responsible for the structure or accuracy of the manual.

I would like to recognize the tremendous work of Peter Murdza, FCAS, ASA on past versions of this manual. It's my hope that I'm able to build upon his efforts and make this an even more valuable study aid for CAS exam students. I would also like to thank Stephen Camilli, FSA and the folks at ACTEX Learning for this opportunity to aid in the learning of students outside of my industry and classroom role.

Last but not least, I'd like to thank my family (Kerri, Jake and Maddy) who endured my seemingly countless hours of being holed up nights and weekends on my computer working on this project. I couldn't have endured through this process without your love and support.

-DD

Geoff Werner and Claudine Modlin, Chapter 1: "Introduction,"
in *Basic Ratemaking*, 2016, pp. 1–12

INTRODUCTION:

This is a basic chapter introducing definitions and overarching formulas. All topics covered in this chapter are covered in much more depth in later chapters.

KEY CONCEPTS:

1) **Exposure** – A means of quantifying risk in an insurance transaction which can vary by line of business.
   a. **Written exposure** – Risk units associated with the issuance of a policy.
   b. **Earned exposure** – Risk units associated with the portion of insurance coverage that has been provided up to a certain point in time.
   c. **Unearned exposure** – The portion of the risk unit associated with the coverage not yet provided under the insurance contract as of a certain point in time.
   d. **In-force exposure** – The amount of risk units exposed to loss at a particular point in time.

Example 1: Ten 1-year single vehicle auto policies are issued. A sample exposure unit for this risk is number of vehicles (which is 10 Exposures in this case). As soon as they are issued (and throughout the entire year), there are 10 written exposures.

Three months into the contract year, there are:
2.5 earned exposures = 10 exposures x time coverage has been in effect
7.5 unearned exposures = 10 exposures x time coverage has not yet been provided

At any point during the year (barring any of these 10 policies cancelling), there are 10 in-force exposures as well.

2) **Premium** – The consideration paid from an insured to an insurer for insurance protection.
   a. **Written Premium** – Total premium associated with the issuance of an insurance contract.
   b. **Earned Premium** – Premium amount associated with the portion of insurance coverage that has been provided up to a certain point in time.
   c. **Unearned Premium** – The portion of premium associated with the portion of coverage not yet provided under the insurance contract as of a certain point in time.
   d. **In-Force Premium** – The total amount of premium for all policies that are in-effect as of a certain point in time.

Example 1 (continued): Each of the ten auto policies have a premium of $500. As soon as they are issued (and throughout the entire year), the written premium for this block of policies is $5,000.

Three months into the contract year:
Earned premium is 1,250 = 5,000 of premium x time coverage has been in effect
Unearned premium is 3,750 = 5,000 of premium x time coverage has not been provided

At any point during the year (barring any of these 10 policies cancelling), there is 5,000 of in-force premium as well.

3) **Claim** – The demand by an insured to an insurer for indemnification under an insurance contract. The claimant is the person making the demand for payment from the insurer and is not necessarily the insured.
    a. Dates
        i. **Accident Date** (aka Date of Loss aka Occurrence Date) is the day the loss event takes place.
        ii. **Report Date** is the day the insurer is notified of the loss event taking place.
    b. **Unreported Claims** – Claims not yet reported to the insurer by the insured [aka Incurred But Not Reported (IBNR) Claims].
    c. **Reported Claims** – Once a claim is known by the insurer, it is considered reported.
        i. **Open Claims** are reported claims that have not been completely settled.
        ii. **Closed Claims** are reported claims that have been completely settled and are no longer considered open.
        iii. Closed Claims may be re-opened if there is subsequent claims activity on a loss

4) **Loss** – The amount of money payable under the terms of an insurance contract arising from an insurable event.
    a. **Paid Loss** – The amount of money that's been paid out on an insurable event as of a certain date.
    b. **Case Reserve** – The insurer's best estimate of the claim amount remaining beyond the amount already paid. This value changes over time as more amounts are paid and/or a better estimate of the remaining payments is calculated.
    c. **Reported Loss** (aka **Case Incurred Loss**) = Paid Loss + Case Reserve
    d. **Ultimate Loss** – The amount of money paid out over time until the claim is closed. This value varies from reported losses due to the following:
        i. **Incurred But Not Reported (IBNR) Reserve** – The estimated amount of money to resolve unreported claims.
        ii. **Incurred But Not Enough Reported (IBNER) Reserve** – This is development on known claims which is the difference between the amount to ultimately close the claims and the reported loss at a given point in time.
        iii. Ultimate Losses = Reported Losses + IBNR Reserve + IBNER Reserve

Example 2 – A claim is reported on January 1, 2016. The insurer estimates the claim will cost $50,000 and pays out $10,000 on January 2, 2016 to the insured.

As of January 2nd, 2016:
Paid Loss is $10,000
Case reserve is $40,000
Reported loss amount is $50,000 = $10,000 + $40,000

5) **Loss Adjustment Expense (LAE)** – The expenses incurred in the course of closing a claim.
    a. **Allocated Loss Adjustment Expenses (ALAE)** – Claim settlement expenses that can be directly assigned to a specific claim (e.g.: attorney fees from litigating a lawsuit resulting from a claim).
    b. **Unallocated Loss Adjustment Expenses (ULAE)** – Claim settlement expenses that cannot be directly assigned to a specific claim (e.g.: claims department staff salaries).
    c. LAE = ALAE + ULAE

6) **Underwriting Expenses** – Costs associated with acquiring and servicing insurance contracts.
   a. **Commissions & Brokerage** Fees – Amounts paid to those responsible for bringing the business to the insurer.
   b. **Other Acquisition Costs** – Costs outside of Commissions and Brokerage Fees that are realized in the course of acquiring the business (e.g.: marketing and advertising).
   c. **General Expenses** – Costs associated with the operation of the insurance company (e.g.: salaries of the insurer's underwriting department).
   d. **Taxes, Licenses, and Fees** – The costs paid by the insurer to regulatory bodies in the course of business (excluding federal income taxes).

7) **Underwriting Profit** (aka **Operating Income**) – The profit of an insurance company for taking on the risk that the premium paid by the insured may be insufficient to cover claims. This is one of the two main sources of profit for an insurer (the other being investment income on the monies held by the insurer).

8) **Ratemaking Process**
   a. Prospective process to determine future cost of an insurance contract with the ultimate cost not known, potentially, for a long time.
   b. A rate should provide for all of the costs associated with the transfer of risk (per CAS principles).
   c. Historical data is used, as applicable, as a predictor of the future loss costs.
   d. Adjustments to historical data should be made for the following:
      1. Rate changes
      2. Operational changes
      3. Inflationary pressures
      4. Mix of business changes
      5. Law changes
   e. Expectation is that premiums will cover future expected losses, costs and a reasonable profit.

KEY FORMULAS:

1) Price = Cost + Profit

   This formula can be modified for insurance to be:

   $$\text{Premium} = \text{Losses} + \text{LAE} + \text{UW Expenses} + \text{UW Profit}$$

2) Frequency – The rate at which claims occur on a book of business. Trends and impacts of underwriting actions can be observed from measuring frequency over time.

   $$\text{Frequency} = \frac{\text{Number of Claims}}{\text{Number of Exposures}}$$

3) Severity – The average value of a claim given that a claim has occurred. Changes in severity can help to identify changes in claims practices or overall loss cost trends.

$$\text{Severity} = \frac{\text{Losses}}{\text{Number of Claims}}$$

This formula can be adapted to different loss amounts as follows:

$$\text{Paid Severity} = \frac{\text{Paid Losses on Closed Claims}}{\text{Closed Claims}}$$

$$\text{Reported Severity} = \frac{\text{Reported Losses}}{\text{Reported Claims}}$$

4) Pure Premium (aka Loss Cost aka Burning Cost) – The average loss per exposure unit or the portion of the premium "purely" attributed to loss.

$$\text{Pure Premium} = \frac{\text{Losses}}{\text{Number of Exposures}} = \text{Frequency x Severity}$$

5) Average Premium – The average amount paid for insurance coverage with the premium and exposures used in this calculation expressed on the same basis (e.g.: written, earned, or inforce). Any observed trends (when adjusted for rate changes) could signify shifts in business mix.

$$\text{Average Premium} = \frac{\text{Premium}}{\text{Number of Exposures}}$$

6) Loss Ratio – This measures the portion of premium that goes towards paying losses. This is a commonly used metric to evaluate overall rate adequacy.

$$\text{Loss Ratio} = \frac{\text{Losses}}{\text{Premium}} = \frac{\text{Pure Premium}}{\text{Average Premium}}$$

7) Loss Adjustment Expense Ratio – This measures the portion of *losses* that goes towards paying expenses associated with settling claims. With this being a percentage of losses, it is multiplied by the loss ratio to obtain the Loss & LAE Ratio (rather than being added). This is helpful in monitoring the stability of claims settlement costs.

$$\text{LAE Ratio} = \frac{\text{Loss Adjustment Expenses}}{\text{Losses}}$$

8) Underwriting Expense Ratio – This measures the portion of premium that goes towards paying for underwriting expenses.

$$\text{UW Expense Ratio} = \frac{\text{UW Expenses}}{\text{Premium}}$$

The UW Expense Ratio is usually the sum of two separate expense ratios.

1) Expenses incurred at the inception of the policy (e.g.: commissions) are divided by written premium
2) Expenses incurred during the policy period (e.g.: general expenses) are divided by earned premium
3) The result of parts 1 and 2 above are added together to get the overall UW Expense Ratio
4) Trends in this resulting ratio are reviewed to evaluate expected changes and benchmark against other insurers.

9) Operating Expense Ratio (OER) – This measures the portion of premium used to pay for LAE and UW Expenses to monitor overall profitability.

$$\text{OER} = \text{UW Expense Ratio} + \frac{\text{LAE}}{\text{Earned Premium}}$$

10) 10) Combined Ratio – This is the primary profitability measure of a company.

$$\text{Combined Ratio} = \text{Loss Ratio} + \frac{\text{LAE}}{\text{Earned Premium}} + \frac{\text{Underwriting Expenses}}{\text{Written Premium}}$$

$$\text{Combined Ratio} = \text{Loss Ratio} + \text{OER}$$

11) Retention Ratio – This is a measure of the rate at which existing insureds renew their policies to the next policy term. This provides a means to gauge rate competitiveness and a metric to aid in projecting future premium volume.

$$\text{Retention Ratio} = \frac{\text{Number of Policies Renewed}}{\text{Number of Potential Policies}}$$

12) Close Ratio (aka Hit Ratio aka Conversion Rate aka Quote-to-Close Ratio) – This is a measure of the rate at which customers accept a policy from the insurer and is used to measure competitiveness.

$$\text{Close Ratio} = \frac{\text{Number of Accepted Quotes}}{\text{Number of Quotes}}$$

SUMMARY:

This chapter simply presents key terms, definitions, and formulas which will be built upon in subsequent chapters. A thorough understanding of the basic information in this chapter is critical as these concepts are explored in much more depth in subsequent chapters of this text. An important conceptual take-away to this chapter is that there are several diagnostic calculations that can be used to evaluate various aspects of the insurance company's financial position and operations.

PAST CAS EXAMINATION QUESTIONS (MODIFIED)

1. Using the following data, calculate the company's combined ratio.

Incurred losses and loss expense	$20,000,000	Investment income	$3,000,000
Incurred underwriting expense	6.000,000	Earned premium	25,000,000
Written premium	32,000,000		

2. Given the following information, calculate the combined ratio:

Incurred underwriting expenses	$2,500,000	Incurred loss adjustment expenses	3,650,000
Incurred losses	11,150,000	Written premiums	14,150,000
Earned premiums	19,000,000		

3. Given the following information, calculate the combined ratio.

2008 earned premium	$200,000	2008 incurred losses	$125,000
Loss adjustment expense ratio	.14	Underwriting expense ratio	.25

4. a. Explain how the standard economic formula, Price = Cost + Profit, relates to the fundamental insurance equation.
   b. Company ABC replaced inexperienced adjusters with experienced adjusters who have a greater knowledge of the product. Explain the impact of this change on each component of the fundamental insurance equation.

5. Given the following information:

Calendar Year 2010	
Written premium	$280.00
Earned premium	$308.00
Commissions	$33.60
Taxes, licenses and fees	$9.80
General expenses	$36.96
LAE ratio (to loss)	8.2%
Combined ratio	100%

Calculate the 2010 operating expense ratio.

6. Given the following information:

Calendar Year 2014	
Written premium	$560.00
Earned premium	$616.00
Commissions	$67.20
Taxes, licenses and fees	$19.60
General expenses	$73.92
LAE ratio (to loss)	8.2%
Combined ratio	100%

Calculate the 2010 operating expense ratio.

PAST CAS EXAMINATION SOLUTIONS

1. $$\text{Combined Ratio} = \frac{\text{Incurred Losses + LAE}}{\text{Earned Premium}} + \frac{\text{Underwriting Expenses Incurred}}{\text{Written Premium}}$$

   CR = 20$\overline{M}$/25$\overline{M}$ + 6$\overline{M}$/32$\overline{M}$ = 98.8%

2. $$\text{Combined Ratio} = \frac{\text{Incurred Losses + LAE}}{\text{Earned Premium}} + \frac{\text{Underwriting Expenses Incurred}}{\text{Written Premium}}$$

   CR = (11.15$\overline{M}$ + 3.65$\overline{M}$)/19$\overline{M}$ + 2.5$\overline{M}$/14.15$\overline{M}$ = 95.6%

3. $$\text{Combined Ratio} = \frac{\text{(Incurred Losses)(1 + LAE Ratio)}}{\text{Earned Premium}} + \frac{\text{Underwriting Expenses Incurred}}{\text{Written Premium}}$$

   CR = ([(125,000(1 + .14)]/200,000 + .25 = 96.3%

4. a. "The general economic formula can be tailored to the insurance industry using the basic insurance terminology outlined in the preceding section. Premium is the 'price' of an insurance product. The 'cost' of an insurance product is the sum of the losses, claim-related expenses, and other expenses incurred in the acquisition and servicing of policies. Underwriting profit is the difference between income and outgo from underwriting policies, and this is analogous to the 'profit' earned in most other industries. . . . Making those substitutions, the prior formula is transformed into the fundamental insurance equation:

   Premium = Losses + LAE + UW Expenses + UW Profit,"

   b. The overall effect on future premium is uncertain. The effect on losses is uncertain. More experienced adjusters may detect more fraudulent claims, reducing losses, but they could also pay out more under policy provisions with which inexperienced adjusters are unfamiliar, increasing losses. The effect on LAE is uncertain. Experienced adjusters may work efficiently, reducing LAE, but will earn higher salaries, increasing LAE. UW expenses should be unaffected. The overall effect on UW profit is uncertain.

5. $$\text{Underwriting Expense Ratio} = \frac{\text{Commissions + Taxes, Licenses, and Fees}}{\text{Written Premium}} + \frac{\text{General Expenses}}{\text{Earned Premium}}$$

   UER = (33.60 + 9.80)/280 + 36.96/308 = .275

   Operating Expense Ratio = 1 – (1 – UER)/(1 + LAE/Losses) = 1 – (1 – .275)/(1 + .082) = 33.0%

6. $$\text{Underwriting Expense Ratio} = \frac{\text{Commissions + Taxes, Licenses, and Fees}}{\text{Written Premium}} + \frac{\text{General Expenses}}{\text{Earned Premium}}$$

   UER = (67.20 + 19.60)/560 + 73.92/616 = .275

   Operating Expense Ratio = 1 – (1 – UER)/(1 + LAE/Losses) = 1 – (1 – .275)/(1 + .082) = 33.0%

CONCEPTUAL EXAMINATION QUESTIONS – These problems look to test your understanding of the concepts from the chapter and are less about the rote memorization and application of formulas.

1. Given the following information, evaluate whether the Expense Provision calculated below is appropriate:

	Calendar Year ($000)		
	2013	2014	2015
General Expense	4,525	4,175	3,875
Other Acquisition	5,220	6,000	6,750
Commissions/Brokerage	8,700	8,000	7,500
Taxes, Licenses and Fees	3,480	3,200	3,000
Total Expenses	21,925	21,375	21,125

	Calendar Year ($000)		
	2013	2014	2015
Written Premium	87,000	80,000	75,000
Earned Premium	90,500	83,500	77,500

Expense provision = (21,925 + 21,375 + 21,125) / (90,500 + 83,500 + 77,500) = 25.6%

2. Determine an appropriate exposure measure for the following lines of business and justify your answer:
   a. Workers Compensation Insurance
   b. Personal Auto Insurance

CONCEPTUAL PAST CAS EXAMINATION SOLUTIONS

1. This approach (dividing all expenses by earned premium) is flawed as it assumes all costs are incurred over the duration of the contract. Combining costs incurred when the policy is initially written divided by written premium (e.g.: commissions) with cost incurred during the contract period divided by earned premium (e.g.: general expenses) would more appropriately reflect the cost allocation. The decline in premium volume in recent years lends itself to further adjustments/weightings which is covered in future chapters.

2. a. An appropriate exposure base for workers compensation insurance would be payroll. It is an easily verifiable metric and directly relates to the loss amount paid as insurance payouts are typically based on an employee's compensation
   b. An exposure base for personal auto could be number of vehicles. This is easily verifiable and is a commonly used metric in the industry.

   This topic is explored further in Chapter 4.

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

INTRODUCTION:

This chapter covers the various types of data, 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 by **records** and **fields**
            1. **Records** are at the policy level or some further segmentation (e.g.: coverage level where there may be multiple coverages on a particular 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).
        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
                b. **Risk identifier** (e.g. vehicle # and operator #) - Keeps the record at a singular 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 particular 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 are able to 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 (ie: 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 particular 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 similar to accident year in that losses 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. Similar to 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 in the course of 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:

Incurred Losses = Paid Losses + Case Reserves
Case Reserves = Ending Loss Reserve – Beginning Loss Reserve
(These formulas will be explored in more depth in later chapters.)

SUMMARY:

Ratemaking requires a sufficient amount of data in order 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 briefly 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 advantages and disadvantages are 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. According to Werner and Modlin, which of the following is false regarding ratemaking using the calendar year method?

    A. The method can result in a single claim affecting several years of loss experience.
    B. The method is generally less accurate than the accident year method.
    C. The method estimates earned premium in the same manner as the accident year method.
    D. None of these statements are false.
    E. All of these statements are false.

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. True or False: A disadvantage of the policy year method of compiling ratemaking statistics versus the accident year method is that the policy year method involves more delays in gathering statistics.

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. True or False: The accident year method uses policy year earned premiums.

16. Werner and Modlin, in "Basic Ratemaking," describe three different types of experience periods by which insurance data is compiled.
    a. Describe how premiums and losses are compiled under each of the three experience periods:
        i) Policy year
        ii) Calendar year
        iii) Calendar-accident year

    b. State one advantage and one disadvantage associated with each type of experience period.

17. For purposes of ratemaking, which method in a. is most responsive and which method is least responsive?

18. Discuss the appropriateness of applying each of the following data aggregation methods to the given line of business:
    a. Calendar year aggregation for auto physical damage
    b. Policy year aggregation for homeowners
    c. Report year aggregation for medical professional liability.

19. Given the following information:

Claim	Policy Effective Date	Accident Date	Report Date	Transaction Date	Claim Status	Loss Payment	Case Reserve Change
1	10/1/2013	12/15/2014	1/5/2014	1/7/2014	Open	-	+5,000
				3/1/2014	Open	4,000	-4,000
				1/5/2015	Closed	500	-1,000
2	11/1/2013	2/1/2014	2/10/2014	3/1/2014	Open	-	+6,000
				3/15/2014	Closed	6,000	-6,000
3	1/1/2014	6/1/2014	6/5/2014	6/10/2014	Open	-	-10,000
				9/1/2014	Open	1,000	+10,000
				1/3/2015	Open	4,000	-5,000
				7/20/2015	Open	500	+5,000
4	6/1/2014	8/15/2014	7/15/2015	3/1/2016	Open	-	+5,000
				6/1/2016	Open	5,000	+7,000

Calendar Year 2014 earned premium = 50,000
Calendar Year 2015 earned premium = 60,000

a. Calculate the calendar year 2015 case incurred loss.
b. Calculate the policy year 2014 case incurred loss evaluated at 12/31/2014.
c. Calculate the accident year 2014 case incurred loss ratio evaluated at 12/31/2015.

20. Given the following automobile policies issued during calendar years 2013 through 2015:

Effective Date	Expiration Date	Number of Policies
4/1/2013	9/30/2013	100
10/1/2013	3/31/2014	110
4/1/2014	9/30/2014	105
10/1/2014	3/31/2015	100
4/1/2015	9/30/2015	110
10/1/2015	3/31/2016	105

All policies have a 6-month term.

a. Calculate the written car-years for calendar year 2014.
b. Calculate the in-force car-years as of 12/31/2014.
c. Calculate the earned car-years for calendar year 2015.

21. Given the following information:

- 1,000 two-year policies with an effective date of 4/1/15
- 1,000 one-year policies with an effective date of 7/1/15

a. Calculate the calendar year 2015 written exposures.
b. Calculate the calendar year 2015 earned exposures.
c. Calculate the calendar year 2016 earned exposures.

22. Given the following information about two claims:

Claim #	Accident Date	Transaction Date	Incremental Payment	Ending Case Reserves
1	1/1/2015	1/1/2015	$0	$20,000
1	1/1/2015	1/1/2016	$25,000	$0
2	4/1/2015	7/1/2015	$0	$50,000
2	4/1/2015	10/1/2015	$25,000	$75,000
2	4/1/2015	4/1/2016	$100,000	$20,000

a. Calculate the incurred losses for accident year 2015 as of 5/1/2016.
b. Calculate the incurred losses for calendar year 2015 and calendar year 2016.
c. Briefly describe one advantage and one disadvantage of calendar year aggregation.

PAST CAS EXAMINATION SOLUTIONS

1. 1) Calendar year data does not require development factors, whereas accident year data requires such factors to reflect changes in loss valuation called loss development.
   2) Calendar year losses and premiums do not have a close relationship as losses are affected by reserve changes, whereas accident year losses and calendar year premiums are more closely related.

2. A fully developed policy year loss ratio

3. Calendar year data is available promptly but lacks accuracy in its estimation of incurred losses because of distortions caused by reserving inaccuracies. Policy year data provides a more accurate matching of losses and premiums but is not available promptly since the data stretch over two calendar years and is more costly since a separate system must be maintained.

4. 1. Substitute "calendar" for "policy."

   2. Switch "calendar" and "policy."

   3. The difference is in the calculation of losses.

5. Accident Year

6. D.

7. Policy Year

8. Incurred Losses = Loss reserves at end of year plus losses paid during the year less loss reserves at beginning of year.

9. Yes, they can.

10. Policy Year.

11. Calendar Year.

12. True.

13. Policy Year.

14. No. Incurred losses are only affected by changes in the reserves for the particular policy year.

15. False – Substitute "calendar" for "policy."

16. a. Policy year experience uses earned premiums and incurred losses arising from policies issued in a particular twelve-year period. Calendar year experience uses financial data for a particular calendar year. Calendar year earned premium equals premiums written during that year plus the beginning unearned premium reserve less the ending unearned premium reserve. Calendar year incurred losses equals paid calendar year losses plus the ending loss reserve less the beginning loss reserve. Calendar-accident year experience uses calendar year earned premium and losses arising from accidents that occur during the particular calendar year.

    b. Policy year experience provides an exact match of premiums and losses as it arises from a defined set of policies. It is less mature than the other experience. Calendar year is fully mature at the end of the year but provides the least exact match of premiums and losses. Accident year experience is a compromise between policy year and calendar year experience. It provides a more exact match of premiums and losses than calendar year experience but a less exact match than policy year experience. On the other hand, it is more mature than policy year experience but less mature than calendar year experience.

17. Responsiveness reflects maturity. Thus calendar year data is most responsive and policy year data the least responsive.

18. a. It is appropriate because auto physical damage "losses are reported and settled relatively quickly."

    b. Like automobile physical damage coverage, homeowners "losses are reported and settled relatively quickly" and thus calendar year aggregation is appropriate.

    c. Report year is appropriate if claims-made policies are used. If occurrence policies are used, calendar-accident year aggregation is more appropriate.

19. a. 500 – 1,000 + 4,000 – 5,000 + 500 + 5,000 = 4,000
    (use only loss information with a 2015 transaction date)

    b. 10,000 + 1,000 + 10,000 = 21,000
    (use loss information with a 2014 policy effective date with a transaction date prior to 12/31/2014)

    c. Incurred Losses = 6,000 + 6,000 – 6,000 + 10,000 + 1,000 + 10,000 + 4,000 – 5,000 + 5,500) = 31,500
    (use only loss information with a 2014 accident date with a transaction date prior to 12/31/2015)
    Earned Premium = 50,000
    (use calendar year 2014 earned premium)
    Loss Ratio = Incurred Losses / Earned Premium = 63%

20. a. Written car-years for CY 2014 = (105 + 100) x ½ = 102.5 (remember, these are 6 month policies)

    b. Inforce car-years as of 12/31/2014 = 100 x ½ = 50
    The policy written on 10/1/2014 is the only one inforce as of 12/31/2014

    c. Earned car-years for CY 2015 = (100 x ½ + 110 + 105 x ½) = 106.25

21. a. Written exposures = 1,000 x 2 + 1,000 = 3,000

b. Earned exposures = 1,000 x 0.75 + 1,000 x 0.5 = 1,250

c. Earned exposures = 1,000 x 1.0 + 1,000 x 0.5 = 1,500

22. a. Paid = 25,000 + 25,000 + 100,000 = 150,000
Ending Case Reserve = 0 + 20,000 = 20,000
Incurred = Paid + Ending Case Reserve = 150,000 + 20,000 = 170,000

b. CY 2015: [0 + (20,000 – 0)] + [0 + (50,000 – 0)] + [25,000 + (75,000 – 50,000)] = 120,000
CY 2016: [25,000 + (0 – 20,000)] + [100,000 + (20,000 – 75,000)] = 50,000

c. Advantage: There is no development after the calendar year is over.
Disadvantage: Does not match premium to losses

CONCEPTUAL EXAMINATION QUESTIONS

1. An insurance company writes both 6-month and 12-month automobile policies. Given the following information:

Policy	Original Effective Date	Original Expiration Date	Transaction Effective Date	Full-Term Written Premium	Notes
A	1/1/2015	12/31/15	1/1/15	1,000	Start of New Policy
A	1/1/2015	12/31/15	7/1/15	n.a.	Policy Cancelled
B	7/1/2015	6/30/16	7/1/15	500	Start of New Policy
B	7/1/2015	6/30/16	9/30/15	400	Changed Policy
C	10/1/2015	3/31/16	10/1/15	1,000	Start of New Policy

Full-term written premium represents the policy premium if policy characteristics shown were in place from the original effective date to the original expiration date.

a. Calculate the 2015 calendar year written premium as of 12/31/15.

b. Calculate the 2015 calendar year earned premium as of 12/31/15.

c. Calculate the 2015 policy year written premium as of 12/31/2015.

2. Using the information provided, answer the questions below:

Policy Number	Policy Written	Incurred Loss as of 12/31/15	Incurred Loss as of 12/31/16	Incurred Loss as of 12/31/17
1001	1/1/2015	1,000	1,200	1,400
1002	7/1/2015	0	5,000	6,200

a. What is the calendar year 2015 incurred loss as of 12/31/2015?
b. What is the calendar year 2015 incurred loss as of 12/31/2016?
c. What is the policy year 2015 incurred loss evaluated as of 12/31/2015?
d. What is the policy year 2015 incurred loss evaluated as of 12/31/2016?
e. Why are the answers to part b and c different?

CONCEPTUAL EXAMINATION SOLUTIONS

1. a. Written Premium on Policy A = (½) x 1,000 = 500 (since it was cancelled mid-year)
Written Premium on Policy B = 500 x (¼) + 400 x (¾) = 425 (since the premium changes after ¼ year)
Written Premium on Policy C = 1,000
Total CY 2015 WP = 1,925

b. Earned Premium on Policy A = 500 (only inforce for half of the year)
Earned Premium on Policy B = 500 x (¼) + 400 x (¼) = 225 (only interested in CY 2015)
Earned Premium on Policy C = 1,000 x ½ = 500 (only interested in CY 2015)
Total CY 2015 EP = 1,225

c. Policy Year 2015 WP = Calendar Year 2015 WP since all policies written in 2015 = 1,925

2. a. The CY 2015 incurred loss as of 12/31/2015 is 1,000.

b. Since calendar year data is "frozen" at the end of the calendar year, no matter what future evaluation point is used, after 12/31/2015, the calendar year incurred losses remain unchanged at 1,000.

c. The PY 2015 incurred loss as of 12/31/2015 is 1,000.

d. The PY 2015 incurred loss as of 12/31/2016 is 6,200.

e. Since all losses are tied back to when the policy was written, the loss amounts on a policy year basis can continue to develop into the future until all losses on policies written in that policy term are closed.