ACTEX Learning

ILA 101
Pricing And Introduction To Valuation And Risk Management Course Study Manual

1st Edition

John Aprill, FSA, MAAA

An SOA Exam

Actuarial & Financial Risk Resource Materials
Since 1972

Printed in the United States of America.

NOTES

This study guide is designed to assist candidates preparing for the SOA Exam **ILA101: Pricing and Introduction to Valuation and Risk Management**. It summarizes, in outline form, all the required books, study notes, and articles listed in the official syllabus. Within each topic, outlines are organized according to syllabus order.

The major topic areas covered include:

- Individual Life and Annuity Product Design and Pricing
- Assumption Development and Experience Studies
- Product Management
- Introduction to Life and Annuity Valuation Concepts
- Introduction to Assets and Risk Management

To help candidates assess their understanding and prepare for the actual exam, a full-length practice exam is included. This mock exam mirrors the structure of the official exam (3 hours, 50 points). Both the questions and their assigned point values are representative of what candidates can expect. Complete solutions are provided for all questions to support self-assessment.

While every effort has been made to ensure the accuracy of the material, errors may remain. If you notice any issues or have suggestions for improvement, please contact us at **support@actexlearning.com**.

Best of luck in your studies and on exam day!

TABLE OF CONTENTS

Section A: Individual Life and Annuity Product Design and Pricing

ILA101-100-25, Life Products and Features A-1 to A-54

ILA101-101-25, Annuity Products and Features A-55 to A-98

Structured Settlement Annuities, SOA Research Institute, Mar 2022 A-99 to A-104

Pension Risk Transfers in Canada and the U.S, SOA Research Institute, Mar 2022 A-105 to A-108

Registered Index-Linked Annuities, SOA Research Institute, Aug 2022 A-109 to A-118

Life Insurance Acceleration Riders, SOA Reinsurance News, Jul 2013, pp. 15-38 A-119 to A-120

ILA101-102-25, Understanding Profitability in Life Insurance A-121 to A-130

ILA101-103-25, Life Insurance Products and Fonance, Chapter 9 A-131 to A-136

ILA101-104-25, Life Insurance Products and Fonance, Chapter 11 A-137 to A-142

ILA101-105-25, Life Insurance and Annuity Nonforfeiture Practices A-143 to A-154

Section B: Assumption Development and Experience Studies

ILA101-106-25, Experience Assumptions for Individual Life Insurance and Annuities B- 1 to B-22

ILA101-107-25, Lapse Supported Insurance Analysis B-23 to B-28

CIA Educational Note: Selective Lapsation for Renewable Term Insurnce Products, Feb 2017 B-29 to B-38

Report on Premium Persistency Assumptions Study of Flexible Premium Universal Life Products, May 2012, (pp. 9-15) B-39 to B-42

Variable Annuity Guaranteed Living Benefits Utilization, SOA LIMRA Research, 2018, Executive Summary only, pp. 19-32 B-43 to B-50

Term Conversions: Pricing and Reserving, Product Matters, Mar 2017 B-51 to B-52
Predictive Models on Conversion Studies for the Level Term Premium Plans, SOA, Mar 2017 B-53 to B-60

Credibility Methods Applied to Life, Health and Pensions, SOA, Feb 2019 pp. 1-25 B-61 to B-74
Table Development, Feb 2018, (exclude appendices C, D, F, G, H) B-75 to B-94

Experience Study Calculations, SOA, 2016 (sections 2, 3, 4, 11, 12, 15, 17, 18) B-95 to B-126

Section C: Product Management

Life Insurance for the Digital Age: An End-to-End View, Product Matters, Nov. 2017 C-1 to C-6

The Art and Science of Life Insurance Distribution,
Chapter 3, Primary Life Distribution Channels C-7 to C-12
Chapter 4, Functions of Distribution in the Life Insurance Business C-13 to C-16
Chapter 6, Distribution Compensation C-17 to C-20
Chapter 7, Economics of Life Insurance Distribution C-21 to C-24
Chapter 10, Future of Life Insurance Distribution C-25 to C-26

ILA101-108-25, Chapter 1 of Life insurance and Modified Endowments Under IRC 7702 and 7702a, Desrochers, 2nd Edition C-27 to C-40

ILA101-108-25, Chapter 2 of Life insurance and Modified Endowments Under IRC 7702 and 7702a, Desrochers, 2nd Edition C-41 to C-64

ILA101-116-25, Ch. 10, The Taxation of Insurance Policies, Canadian Insurance Taxation, Swales, et. Al. C-65 to C-80

Overview of Nonguaranteed Elements (NGEs), SOA Research Institute, Nov. 2022 C-81 to C-94

Market Trends and Product Designs: Considerations When Interest Rates Are Rising, Product Matters, Nov. 2021 C-95 to C-98

Section D: Introduction to Life and Annuity Valuation Concepts

U.S. GAAP, Chapter 1, U.S. GAAP Objectives D-1 to D-18
U.S. GAAP, Chapter 5, Nonparticipating Traditional Life Insurance D-19 to D-48

Statutory Valuation, Chapter 1, Overview of Valuation Requirements D-49 to D-52
Statutory Valuation, Chapter 11, Valuation Methodologies D-53 to D-60

ILA101-110-25, Fundamentals of the Principles Based Approach to Statutory Reserves for Life Insurance, Jul 2019 D-61 to D-76

ILA101-111-25, Insurance Contracts First Impressions:
2020 Edition IFRS17, KPMG, July 2020 D-77 to D-96

Regulatory Capital Adequacy for Life Insurance Companies:
A Comparison of Four Jurisdictions, SOA Research Institute, Jul 2023 D-97 to D-122

Section E: Introduction to Assets and Risk Management

Introduction to Computational Risk Management of Equity Linked Insurance,
Feng Runhaun, 2018, Chapter 1, Modeling of Equity Linked Insurance E-1 to E-8

Introduction to Computational Risk Management of Equity Linked Insurance,
Feng Runhaun, 2018, Chapter 4, Pricing and Valuation E-9 to E-26

Handbook of Fixed Income Securities, Ch. 10, Corporate Bonds E-27 to E-40
Handbook of Fixed Income Securities, Ch. 21, Mortgages E-41 to E-52

Life, Health and Annuity Reinsurance, Tiller 4th Edition, Tiller, 2015
Chapter 1, Basic Concepts E-53 to E-66
Chapter 4, Basic Reinsurance Concepts E-67 to E-78
Chapter 5, Advanced Reinsurance Concepts and Structures E-79 to E-86

ILA101-112-25, Revisiting the Role of Insurance Company ALM
w/in a RM Framework E-87 to E-90

ILA101-113-25, Ch. 7 (sections 7.2-7.5 & 7A) of Derivatives Markets,
McDonald, 3rd E-91 to E-98

ILA101-114-25, Ch. 16 of ALM Management of Financial Institutions,
Tilman, 2003 E-99 to E-104

ILA101-115-25, Simulation of a Guaranteed Minimum Annuity Benefit,
Freedman, 2019; Excel Model-- Stochastic Simulation of a GMAB Option E-105 to E-108

Practice Exam 1 Questions PEQ-1 to PEQ-10

Practice Exam 1 Solutions PES-11 to PES-18

SECTION B

ASSUMPTION DEVELOPMENT AND EXPERIENCE STUDIES

ILA101-106-25

EXPERIENCE ASSUMPTIONS FOR INDIVIDUAL LIFE INSURANCE AND ANNUITIES

I. The experience assumption process

A. Introduction

1. Actuaries must use professional judgment to develop appropriate assumptions for use in a model

2. Models may differ within a company due to different purposes for the models or due to a lack of coordination and understanding among users

3. Models are used in pricing and product design studies, reserve adequacy and valuation, financial reporting, and actuarial appraisals

B. Categories of experience assumptions

1. Cash value view: three broad categories of assumptions are

a. Obligation or liability assumptions: assumptions are used to project future obligation cash flows, including assumptions for mortality and lapse rates, administrative expenses and taxes, dividend policy and crediting rate strategies

b. Asset assumptions: This includes assumptions about actual or hypothetical assets, such as earnings rates, default, investment expenses as well as reinvestment and borrowing policy

c. Scenario assumptions

i. This is the scenario where scenarios which will be analyzed
ii. They may include stochastically generated interest rate scenarios or simple sensitivity testing of a few key assumptions

2. Degree of conservatism

a. Assumptions are categorized as to whether they are a best estimate assumption or whether it includes a provision for adverse deviation (PAD)

b. Whether an assumption includes a PAD depends on how it will be used

i. Accounting rules for financial reporting use best estimate or best estimate with the PAD for certain purposes

ii. Accounting for regulatory rules may prescribe a particular assumption which may or may not be conservative

c. A best estimate assumption represents the actuary's judgment as to the most likely outcome; if two outcomes are equally likely the more conservative choice is generally chosen

d. For financial reporting, conservatism means a higher liability or a smaller asset; in pricing conservatism means a lower benefit or higher charge to the customer

e. When adjusting the best estimate assumption with a PAD, the PAD should consider the degree the assumption is subject to risk in total and by duration

i. Assumptions with wide swings have a larger PAD than stable assumptions

ii. If the risk charge increases with duration, a larger PAD is appropriate at later durations

f. Adjusting an assumption for a PAD should make it more conservative; this can mean increasing the assumption, decreasing the assumption, or a change that is not immediately obvious

g. Prescribed assumptions generally contain an implicit PAD which is intended to create conservative results; if the prescribed assumption is not clearly conservative, the actuary should consider how the result differs if more realistic assumptions were used

C. Establishing experience assumptions

1. The steps required to develop assumptions are

a. Identify the assumptions required
b. Determine the structure of each assumption
c. Analyze experience and trends in experience for each assumption
d. Review and adjust the set of assumptions for reasonableness, consistency, and appropriateness
e. Document assumptions
f. Monitor experience and update assumptions

2. Identify the assumptions required

a. No model takes into account all uncertainties and interdependencies affecting the insurer's cash flows; different models make different simplifying assumptions

b. Common assumptions used in different models are

i. Obligation assumptions: mortality and morbidity rates, lapse rates, expense rates, tax rates, incidence and level of premium payments, reinsurance results

ii. Asset assumptions: investment earnings rate, capital gains rate, default rates, investment expenses

iii. Scenario assumptions

a) Set of specified deterministic interest rates
b) Stochastically generated interest rate scenarios generated interest rate scenarios
c) Set of possible economic scenarios
d) Set of sensitivity tests

3. Determine the structure of each assumption

a. Depending on the model and its purpose and the materiality of an assumption, the structure can be quite simple or very complex; for example, statutory reserves use a single number as the interest rate, while option pricing may involve hundreds of scenarios

b. Experience assumptions are determined for particular risk class

i. An experience class consists of all contracts the company groups together for the experience assumption

ii. Its purpose is to establish homogenous groups for analysis that are expected to generate similar experience in the future

c. Experience class will consist of all contracts that

i. Are a similar type
ii. Have the same structure of charges or benefits
iii. Are issued over a continuous time
iv. Have similar marketing objectives

d. Different experience classes may be classified differently

i. An experience class used for pricing, once it is closed, will remain intact until all contracts included in the class have matured

ii. However, as a class of policies ages and the number of policies in the class declines, it may be appropriate to combine classes

iii. Within an experience class the experience assumption may consist of more than one number

e. Risk classification is an important aspect in establishing the structure of an experience assumption; the key principles to decide the complexity of the assumption structure are

i. Differences in experience assumptions should reflect differences in experience

a) It is appropriate to vary mortality rates by issue age, duration, sex, and smoking status because these are shown to have significant mortality variations

b) Lapse rates should vary by frequency of premium payment because annual premiums lapse at different rates than policies with monthly premiums

c) Establishing different classes can be based on actual historical data or other sources such as expert opinion

d) If there is no difference in actual or expected experience, policies should be grouped in the same class and use the same assumption

ii. The number of risk classes should be objective and easily understood

iii. The number of classes should be practical and cost effective

a) It is important to balance precision and the expense of a complex assumption structure
b) If added precision is not material to the model, a simplified assumption structure is preferred
c) Models should be explainable as well as accurate

4. Analyze experience and trends in experience for each assumption

a. Evaluate credibility of data

i. Evaluating credibility of experience data requires informed actuarial judgment and is not a precise mathematical process

ii. Considerations in evaluating credibility of data are

a) The homogeneity of data
b) Reasonableness of methods and results; results should not be biased in any material way

b. Evaluate quality of data

i. Completely accurate appropriate and comprehensive data is seldom available

ii. The actuary should understand the data itself and how it will be used; the extent of review depends on its intended use

iii. The evaluation of the quality of data involves consideration of

a) Possible sources of data, balanced with cost, quality, timing

b) Appropriateness of data—is it recent, biased or limited

c) Reasonableness and comprehensiveness of data—is size sufficient, is data consistent

iv. An actuary may rely on data supplied by others

a) The accuracy and comprehensiveness of the data is the responsibility of those who supplied the data

b) The actuary should review the data for reasonableness and consistency with the intended purpose; this involves identifying questionable data values or relationships that are materially inconsistent

c. Use actual or similar experience to reflect trends and experience

i. Experience for a class of business should be determinable, available, and statistically credible

ii. If the actual experience for a class of business does not meet these criteria, the assumption could be based on similar experience using the following order of preference

a) Experience from a similar business in the same company
b) Experience from a similar business in other companies
c) Other sources

iii. Adjustments may need to be made to this experience

d. Reflect trends in experience assumptions

i. Trends in experience need to be evaluated over time, and judgment is required to determine whether trends will continue

ii. Trends should always be considered, but may be appropriate to ignore them if doing so is conservative or is required by regulation

e. Reflect company and external factors

i. It is important to review company business practices and reflect them in setting assumptions, especially when company practices have changed or if data is from another company with different business practices

ii. Underwriting rules are an important business practice to consider; mortality rates should reflect the selection criteria for each rating class, the frequency with which underwriters make exceptions to the underwriting rules, the requirements for reinstatements, etc.

iii. Expense assumptions can be affected if the underwriting requirements differ significantly by issue age or face amount

iv. Investment policy--investment assumptions should be consistent with a limits by asset type, asset quality, duration, or convexity; different assumptions would be appropriate for general account segments

v. Changes in business practices should be considered, such as changes in policy provisions, premiums, or benefit levels and changes in administrative systems and procedures

vi. In addition to company factors, medical, economic, social, or technological developments could have an impact on experience

f. Sensitivity test assumptions

i. Actual experience may emerge significantly differently than experience assumptions project

ii. It is important to understand the financial impact of likely deviations using sensitivity tests

iii. Standard statistical tests or historical experience can be used to establish a range of likely deviation

5. Review and adjust the set of assumptions for reasonableness, consistency, and appropriateness

a. Every assumption has a range that is consistent with the underlying data

b. All assumptions should be reviewed for reasonableness, consistency and appropriateness

c. Assumptions should be comprehensive and internally consistent

d. The model should also reasonably produce actual results when using a set of assumptions

6. Document assumptions

a. What the assumption is

i. The numerical value of the assumption
ii. The class of policies or contracts the assumption applies
iii. How these functions compare with other similar assumptions

b. Data underlying the assumption

i. The source of the data
ii. The numerical values of the data
iii. The materiality of any biases about the data
iv. Adjustments made to the data and reason for it
v. The extent of reliance on data supplied by others

c. How the assumption was developed

i. Methods and assumptions used to develop the assumption
ii. The credibility methods used
iii. Material changes from prior studies

d. How to use the assumption

i. The appropriate purpose for the assumption
ii. The results of sensitivity testing
iii. Applicable regulatory requirements

7. Monitor experience and update assumptions

a. Experience assumptions need to be reviewed and updated on a regular basis

b. The frequency varies by the type of assumption, purpose of model, volatility of assumption, and credibility of the data

c. Regular analysis is necessary to evaluate trends and experience; interest rates on annuities might be reviewed weekly, mortality might be annual

d. Assumptions need to be reviewed, but do not need to be updated each time they are reviewed; if experience is not credible or materially different, it is appropriate to maintain the assumption

II. Mortality assumptions

A. Structure

1. Mortality assumptions generally take the form of a table of rates that vary by issue age and duration since issue

2. Unlike population data which varies only by attained age, insured experience usually has a select and ultimate structure, reflecting the selection effect of underwriting in life insurance and self-selection in annuities

3. Notation

x: issue age

t: duration

$q(x,t)$: mortality rate for issue age x, duration t

n: select period, usually 15 to 25 years

4. Relationships

$$q(x,t) = q(y,s) \text{ if } x+t = y+s,\ t > n,\ s > n$$

$$q(x,t) \leq q(y,s) \text{ if } x+t = y+s\ \ t < s,\ t \leq n$$

5. Two approaches for issue age: age last birthday and age nearest birthday

    a. Issue age is determined on the date the policy is issued
    b. If age nearest birthday is used, x corresponds to exact ages x - ½ to x + ½
    c. If age last birthday is used, x corresponds to exact ages x to x + 1

6. There are separate mortality tables for males and females, smokers and nonsmokers because the pattern of mortality is significantly different by issue age and duration for each risk class

7. Relationships between ALB and ANB

$$q^{ALB}(x) = [q^{ANB}(x) + q^{ANB}(x+1)] / 2$$

$$q^{ANB}(x) = [q^{ALB}(x-1) + q^{ALB}(x)] / 2$$

8. Male and female mortality exhibit different mortality improvement over time

9. Other distinctions in mortality classes are expressed as a table multiple or table modification for life or a limited period of time

10. Common variations in mortality class

    a. Risk selection class: preferred classes may be available with stricter underwriting; substandard classes with higher mortality assumptions for customers in poor health

    b. Selection process: simplified underwriting or guaranteed issue basis use less than normal underwriting but have higher mortality rates

    c. Sizes of policy: larger policies have lower mortality due to greater underwriting and socio-economic factors

    d. Miscellaneous: marketing method, plan type, policy provisions (term or whole life)

11. The trend is for more refined mortality assumptions as a result of competition and technology improvements

12. Mortality improvement is generally expressed as an annual percentage rate applied to the table

    a. This is an important assumption for annuities

    b. The assumption is not as important for life insurance and is generally ignored because it is conservative

    c. The rate of improvement varies by male/female, issue age, and the number of years projected

B. Analyzing experience

1. Credibility

a. Credibility of data is important because mortality rates at most ages are very low

b. If actual data is not credible, industry or reinsurer data are commonly used

c. Confidence intervals are a way to judge the credibility of a company's data

i. Estimated mortality rate q

ii. Expected claims for n policies, $E = nq$

iii. Variance of expected claims for n policies, $E = nq(1 - q)$

iv. 95% confidence interval of expected claims, E+/- $1.96\sqrt{var}$

v. 95% confidence interval of mortality rate, (E+/- $1.96\sqrt{var}$) / n

2. Risks covered

a. Mortality studies consist of standard risks and exclude the following

i. Policies not subject to normal underwriting standards, such as simplified or guaranteed issue, group or term conversions, or under a guaranteed insurability option

ii. Substandard policies

iii. Policies in force as extended term or reduced paid up

iv. Multiple life policies

b. Separate studies are performed on excluded policies, and the mortality assumption is a simple multiple of the standard mortality table

c. Multiple lives derived from a single life table

i. Theoretical mortality rates are calculated assuming lives are independent

ii. For second to die insurance, early duration mortality is very small

iii. This result is adjusted to reflect that lives are not independent, such as joint accident, by adding a flat amount per thousand or setting a minimum rate per thousand

3. Mortality studies

   a. Two types of mortality studies: anniversary to anniversary and calendar year

      i. Anniversary to anniversary studies look at policies from one policy year, from the anniversary in one calendar year to the anniversary in the next policy year; this is conceptually easy because each policy contributes experience in one cell

      ii. Calendar year studies look at experience over one calendar year which means that each policy may contribute experience in two different cells

   b. Each policy contributes an amount of exposure and amount of claims in each cell; the mortality rate for each cell is the sum of the amount of claims divided by the sum of the exposure for that cell

   c. Notation

      i. A = the number of lives observed who attain exact age x during the study period

      ii. N = new entrants: the number of lives at exact age $x+r$, $0 < r < 1$ at the beginning of the study period

      iii. W = withdrawals: the number of lives that leave the study at exact age $x+s$, $0 < s < 1$

      iv. D = the number of deaths observed among persons between age x during the study period

      v. B = the number of lives observed who attain exact age x+1 during the study period

   d. The only way into the study equals the only ways to leave the study

      $$A + N = W + D + B$$

   e. Using the Balducci hypothesis, a simple formula for mortality rate is

      $$q(x) = D / [A + (1 - r) N - (1 - s) W]$$

      i. The denominator is the exposure

      ii. Exposure can be calculated on a policy-by-policy basis or summed up in the aggregate using a midyear assumption

f. Six ways to contribute exposure

Situation	Exposure	Notes
(A, W)	S	Contributes exposure from age x to age $x+s$
(A, D)	1	Contributes exposure from age x to age $x+1$regardless of when death occurs
(A, B)	1	Contributes exposure from age x to age $x+1$
(N,W)	$s-r$	Contributes exposure from age $x+r$ to age $x+s$
(N, D)	$1-r$	Contributes exposure from age $x+r$ to age $x+1$; no deduction from exposure for dearhs
(N, B)	$1-r$	Contributes exposure from age $x+r$ to age $x+1$

4. Other aspects of mortality studies

   a. Due to credibility concerns, look at experience over several years; five years is typical for a new mortality table

   b. Annual experience studies are used to monitor trends over time

   c. Mortality studies are performed on a policy or amount of insurance basis, but each has unique issues that need to be considered

      i. Mortality studies based on policy can be distorted if an individual has multiple policies; however, it may not be an issue if the study is large and the mortality experience for individuals with multiple policies is the same as other insureds

      ii. Mortality studies based on amount of insurance are preferred because they reflect the economic impact on the insurance company

         a) Credibility is not as high as a study based on policies

         b) Variation in amounts of insurance by policy introduces a source of variability in year-to-year results

         c) A study based on amounts tends to produce lower mortality rates than a study based on policies and amounts, reflecting the lower mortality for policies of high amounts

5. Enhancing credibility

   a. To improve credibility, it is common to combine multiple years of issue, issue ages and durations; groups are smoothed to produce final rates

   b. Another technique is actual to expected analysis

      i. For each cell, the total exposure is multiplied by the mortality rate of the expected table
      ii. The actual deaths from the overall study is compared to the sum of the expected deaths from each cell to develop a ratio
      iii. This ratio can track trends over time and adjust experience without creating a new mortality table

6. Credibility of actual to expected ratios

    a. Confidence intervals can be developed for actual to expected ratios and in addition to individual mortality rates

        i. Expected mortality rate for life i = $q(i)$

        ii. Expected number of claims, E = sum of $q(i)$

        iii. Variance of expected number of claims, var = sum of $q(i)\ (1 - q(i))$

        iv. 95% confidence interval of claims, CIC = E +/- 1.96 $\sqrt{var}$

        v. 95% confidence interval of mortality ratio, CIC / E

    b. The analysis can be extended to a study based on amounts of insurance

        i. Amount of insurance on life i = $A(i)$

        ii. Expected amount of claims, sum all $E = A(i)\ q(i)$

        iii. Variance of amount of claims, sum of all $A(i)^2\ q(i)\ (1 - q(i))$

        iv. 95% confidence interval of amount of claims, E +/- 1.96 $\sqrt{var}$

        v. 95% confidence interval of mortality ratio, (E +/- 1.96 $\sqrt{var}$) / E

    c. The variation in policy size can increase the size of the confidence interval

7. Adjusting mortality tables for special situations

    a. Some mortality solutions are not developed by a study but are derived from mortality tables used for other purposes

    b. This includes multiple life mortality, substandard mortality, term conversions, antiselection, and blended tables

8. Term conversions

    a. Term policies generally have a conversion privilege that allows the customer to purchase permanent insurance at standard rates without underwriting

    b. The expected mortality rate on these policies is higher than on regularly underwritten policies and the extreme mortality needs to be accounted for in pricing and other models

        i. One option: include term conversions in the regular mortality study and have all permanent customers share in the extra mortality cost

        ii. Another option: include a charge in the term pricing for the present value of the cost of the extra anticipated mortality on the permanent policy for a term policy issued at age x and converted after t years

c. The cost of the extra anticipated mortality in year after conversion is

$$(q^{c}_{[x]+t+s} - q^{s}_{[x+t]+s}) * NAR_s$$

$q^{c}_{[x]+t+s}$ is the mortality rate for the converted policies originally issued at age x converted at duration t of the term policy in force at duration s of the permanent policy

$q^{s}_{[x+t]+s}$ is the standard pricing mortality rate for a permanent policy issued at age x + t at duration s

NAR_s is the net amount at risk at duration s for the permanent policy

d. The present value is calculated using the pricing interest rate, mortality rate and lapse rate for the permanent policy

e. The mortality rate on converted policies can be calculated using

i. A separate mortality study conducted on converted policies if data is adequate

ii. Mortality is worse on converted policies than simple issue age and duration on the term policy because unhealthy individuals convert; they do not qualify for a new underwritten policy

iii. The mortality rate on converted policies can be estimated by making an antiselection assumption

9. Antiselection

a. Healthy lives qualify for lower rates after the level term period rather than continue with higher term rates

b. Using the principle of conservation of deaths, higher mortality rates can be derived from a given level of selective lapsation

$$q^{AS}(x,t) = [q(x,t) - \text{sum of } A(s)\, q(x+s,t-s)] / (1 - \text{sum of } A(s))$$

$q(x,t)$ = the mortality rate at duration t for a policy underwritten at age x in the absence of selective lapsation

A = the portion of policies that lapse at duration r to buy a newly underwritten policy at duration $x+r$

$q^{AS}(x,t)$ = the mortality rate at duration t reflecting the effect of antiselection

$A(s)$ = the portion of policies that lapse at duration s to buy a newly underwritten policy at age $x+s$

10. Blending tables

    a. Two mortality tables may be combined into a single blended table

    b. The most common example is blending male and female mortality tables to develop a unisex table

    c. If mortality rates in the two tables being blended are significantly different, it may not be appropriate to simply average the mortality rates

    d. For example, male mortality rates are generally higher than female rates and the proportion of males the blended table will decline at higher attained ages

    e. If the blend of males and females are assumed to be constant throughout the mortality table, then the mortality rates produced in the blended table are significantly lower

11. Adjusting similar experience

    a. If actual experience is not credible and similar experience is relied on, factors to be considered in determining the mortality assumption are

        i. Quality of company underwriting relative to experience underlying the industry table or other experience being used

        ii. Distribution channels: more antiselection may be expected on brokerage business than career agency business

        iii. Market: more affluent markets will generally have better mortality than small face mount markets

        iv. Antiselection from excessive lapses, a concern with term products

        v. Underwriting requirements for preferred or substandard risk classes: reinsurers can add valuable insight into value of various underwriting requirements when developing a new risk class

        vi. Reinsurance quotes on the business

    b. To develop a mortality table for a country where no study of insured lives exists, additional factors should be considered including

        i. Quality of the data: how table is constructed, what data it represents

        ii. Cause of death information can be useful to compare between population data and insured lives for underwritten risks

        iii. Ability to do medical underwriting; medical histories may be limited

        iv. Ability to contest claims

        v. Likelihood of wars, epidemics, or natural disasters

III. Lapse assumptions

A. Structure

1. Lapse assumptions generally take the form of a table of rates varying by duration since policy issue and may vary by one or more of the following: age at issue, frequency of premium payment, policy size, policy type, marketing method, and market

2. For permanent insurance, first year lapse rates are higher than renewal lapse rates

3. Term policies and annuities have a shock lapse rate tied to product design

    a. Term policies at the end of a level premium period
    b. Annuities at the end of the surrender charge period

4. Lapse rates generally vary by scenario

5. The lapse rate assumption is expressed as a formula that modifies the base lapse rates to reflect

    a. The difference between a market interest rate and a rate credited to the customer and
    b. The size of any surrender charge

6. Lapses are generally assumed to occur on premium due dates; a person paying an annual premium has no advantage to lapse the policy before the end of the year

    a. For fixed premium products, the distribution is related to the expected mix of premium modes

    b. For flexible premium contracts, a uniform distribution of lapses by month is common

B. Analyzing experience

1. Credibility

    a. Credibility of data is less of an issue for lapse than mortality

    b. Lapse assumptions are generally less refined and generally higher than mortality rates (except that the advanced ages)

    c. These factors make measurement of lapse rates more credible

    d. It is common to base lapse assumptions on a company's actual experience rather than using industry experience

2. Lapse studies

    a. A lapse study is similar to a mortality study; the only difference is that lapses and deaths switch places in the calculation of exposure and claim amounts

    b. Lapses are treated as claims; and, in the exposure calculation, deaths are treated as withdrawals from the study and lapsed policies get a full year of exposure

3. Factors affecting lapse rates

    a. Product design—lapse rates are higher when term premiums increase, or annuity surrender charges expire

    b. Distribution channel—brokers have higher lapse than agent sold business; agent quality also impacts persistency

    c. Policy size—smaller policies have high early year lapse rates; laager policies have high later duration lapse rates

    d. Effectiveness of company conservation program

4. When lapse rate assumptions are expressed as a formula that varies by interest rate, scenario judgment is required to set the parameters to determine how sensitive the lapse rates are to surrender charges and the spread between market and credited rates

5. Sensitivity of lapse rates to interest rate scenarios generally vary by

    a. Product type—deferred annuities are more sensitive than life insurance

    b. Distribution channel—broker sold business is more sensitive than agent sold

6. Types of lapse

    a. Lapse studies define a lapse as

        i. Termination without value for nonpayment of premium
        ii. Cash surrenders
        iii. Transfer to extended term or reduced paid up

b. Other situations that may be included in a lapse study

i. Term conversions

a) May be a separate assumption or included in the lapse rate

b) The term policy ends on conversion, but the converted policy has an extra mortality cost

1) If the cost is attributed to the term policy, a separate term conversion assumption is required

2) If mortality cost less underwriting savings are attributed to the new policy, the term conversion is treated as a lapse

ii. Partial withdrawals are included in the lapse rate unless a portion of the contract value can be withdrawn without a surrender charge

iii. Premium persistency—for flexible premium policies, measure the ratio of actual payments by duration relative to target or billed premiums

iv. Termination without value when the policy loan exceeds cash value

IV. Interest assumptions

A. Structure

1. Deterministic models of interest rates use one of these approaches

a. Portfolio average: this approach averages the investment income over all policies in a specific group or all policies supported by a specific portfolio of investments

b. Investment generation: this approach recognizes, for each group of policies or portions of policies, the amount, timing, and rollover of investable cash flows

i. For fixed premium policies using an investment generation approach, policies can be grouped by year of issue

ii. For flexible premium policies premiums in a month or year may be grouped together for purposes of investment generation

2. Investment income assumptions are generally after investment expense and expected defaults; although separate assumptions can be used for the gross interest rate, investment expenses and defaults

3. Policy loans may be treated as an asset cash flow or a liability cash flow

    a. For deterministic models, policy loans are generally aggregated with other investments to determine the interest rate

    b. To do this, additional assumptions are needed regarding

        i. Policy loan interest rate (fixed or variable) which may vary by plan
        ii. Policy loan expenses
        iii. Policy loan utilization rate which may vary by loan rate plan and policy size

    c. For models with multiple interest rate scenarios, policy loans are modeled as a liability cash flow with utilization rates that vary with the interest scenario

    d. The number of scenarios necessary depends on the importance of the asset risk and practical considerations for the model; however, there should be sufficient scenarios to reflect the range of conditions consistent with the model's purpose

4. For each scenario, the interest rates can vary by one or more factors such as time, asset quality, and credit risk

5. Investment returns may be measured on a book value basis or a market value basis

6. In addition to interest rate assumptions, additional assumptions are needed for

    a. The mix of existing investments by asset class and maturity
    b. The reinvestment and disinvestment strategy

B. Analyzing experience

1. When calculating a deterministic interest rate using recent experience on assets supporting the block of business, the rate is determined as the investment income from the block of assets divided by the average amount of assets in the block

2. The formula is

    $2I / (A + B – I)$

    i = interest rate

    I = investment income

    A = assets at beginning of the year

    B = assets at the end of the year

3. Capital gains and losses can be smoothed over a number of years to reduce year-to-year volatility of results

4. When determining a new money rate, the interest rate can be based on a benchmark return on bonds in the market plus a spread; the spread relates to the investment mix or investment policy for the assets supporting the business

5. When analyzing returns on a market value basis, a different formula is used since the return includes not only investment income but also realized and unrealized capital gains

6. The formula is

   $r = (B – A – C) / (A + C/2)$

   A = market value of assets at the beginning of the period

   B = market value of assets at the end of the period

   C = net cash flows

   All cash flows occur in the middle of the year

7. The formula can be applied to any period of time

   a. For mutual funds where rates of return are calculated on a daily basis the formula can be simplified to

      $r = (B – A) / A$

   b. The formula can also be applied over any period of time with no cash inflows or outflows

   c. In evaluating reach of return over time, two different approaches combine multiple rates of return

      i. The time weighted return which is the geometric mean of the rates of return

      ii. The dollar weighted return which is the level rate of return earned considering the timing of cash flows

8. The dollar weighted rate of return can be significantly more or less than the time weighted return on the investment

V. Expense assumptions

A. Structure

1. Expenses are split between direct (marginal) and indirect expenses

    a. Direct expenses vary directly with a policy
    b. Indirect expenses are associated with a group of policies

2. Common direct expenses

    a. Agent commissions are typically a percentage of premium or account value that varies with duration; other compensation is expressed as a percentage of premium

    b. Taxes are a function of premium, income, surplus or assets depending on the tax law

    c. Underwriting costs vary by age and policy size

3. Expenses may be considered direct or indirect depending on the model used and the purpose of the model

4. Indirect expenses are expressed in terms of a convenient driver

5. Overhead expenses are included or excluded depending on the purpose of the model

6. Expense assumptions are split between acquisition expenses, maintenance expenses, and overhead; acquisition and maintenance expenses both have direct and indirect components

B. Analyzing experience

1. Units

    a. The formula to determine a unit expense assumption is to divide the appropriate expense by the appropriate count of units

    b. The number of units must be consistent with the model in which the assumption is used

    c. An expense study is performed on a calendar year basis while a pricing model is done on a policy year basis

d. Policy counts are the number of policies in force at the beginning and end of the calendar year and the number of policies issued during the calendar year; pricing models usually charge expenses at either the beginning or middle of each policy year

A = beginning of calendar year policies in force and

N = number of new policies issued in calendar year

W = the number of withdrawing policies in a calendar year by death or surrender

B = the end of calendar year policies in force

$B = A + N - W$

$W = A + N - B$

e. If the pricing model charges expenses at the beginning of each policy year, then the appropriate count is the number of policy years that begin in the calendar year of study

i. This includes all new policies plus those policies in force at the beginning of the year that do not withdraw before their policy anniversary

ii. If half the withdrawals occur before the policy anniversary and half occur after the policy anniversary the appropriate count is

$N + A - W/2 = (A + B + N) / 2$

f. If the pricing model charges expenses in the middle of each policy year and assuming that half the new issues are sold in the first half of the year and half in the second half of the year, the appropriate count is

$N / 2 + A - W/2 = (A + B) / 2$

g. In summary

i. When expenses are charged at the beginning of the policy year, the count is $(A + B + N) / 2$

ii. When expenses are charged in the middle of the policy year, the count is $(A + B) / 2$

2. Expense allocation

a. Annual statement expenses need to be allocated to line of business

i. Some expenses are associated with a particular product line
ii. Other expenses are allocated
iii. Expenses are categorized into major components

b. Expenses can be allocated by

i. Transaction or item counts

ii. Transfer cost: Centralized expenses are allocated on a fee basis

iii. Employee time allocation

a) These are used where tasks are not uniform in effort and simple transaction counts are not appropriate

b) Employee surveys that time spent by product can be used instead

iv. Indexed based allocations

a) Overhead expenses do not vary with a specific driver

b) These expenses are allocated to products based on indices such as policy council or premium

c. Expenses are further allocated by first year expenses and ongoing expenses

3. Projecting expenses

a. Future unit expenses depend on estimates of the total level of expenses and the count on which the units are based

b. Projections should reflect historical expense trends, expected future volumes of business, expected inflation rates, how various types of expenses vary with changes in business volume, and the impact on the company's business that is anticipated

ILA101-107-25

LAPSE SUPPORTED INSURANCE ANALYSIS

I. Lapse supported policies

A. Every product has a persistency assumption

1. If lapses are less than assumed, profitability improves because the present value of the income stream increases more than the present value of future benefits plus acquisition cost

2. However, this depends on the lapse assumptions and how far off it is

B. A product is lapse supported when there is a possible lower lapse rate that will create a problem for the company; if the profit margin built into the pricing is adequate, a lower lapse will keep the product profitable

1. In the usual situation, policyholders that stay are subsidizing those who lapse

2. Lapse support shifts the benefit pattern in favor of those that stay rather than lapse; lapse moves profits in the opposite direction than expected

C. With a stated profit target and interest rate assumption, then with a lapse supported product

1. The higher the lapse rate assumed, the lower the premium and the lower the tendency to lapse

2. Lower the lapse assumption and the premium rate goes up

II. To determine whether a product is lapse supported

A. Request a profitability test using a zero-lapse rate

B. Use the results of the life illustration rules to determine disqualifying lapse support showing actual lapse experience for the first five years and zero thereafter

C. If either test is profitable, then the policy is not lapse supported

D. Reserves do not determine lapse support; however, they determine when the issue will arise because reserves control the incidence of profit

III. The degree a lapse supported policy is sensitive to the lapse rate is a function of when most benefits will be paid

A. With a level premium policy and benefits late in policy duration, then the lapse rate defines the number of people paying premium but do not last long enough to collect benefits

B. Cash values eliminate the problem of lapse support; term policies have limited cash values at older ages and longer durations

C. Low lapses become a problem when products are designed to work around the nonforfeiture laws

D. Most A&H policies are lapse supported to some extent since morbidity increases over time; most policies provide early benefits that reduces sensitivity to lower lapse; however, long term care has no early year benefits

E. Products can become lapse supported if they have a return of premium benefit because it eliminates lapse at some point

IV. The higher the lapse assumed, the lower the product price and the greater perceived value and therefore a lower lapse rate

A. Since the goal is to have the cheapest premium that can be justified with established product goals, both actuarial and marketing become pessimistic about lapse and set the lapse rate at the highest level justifiable

B. Since it takes several years for lapse statistics to become credible, the company can build a reserve shortfall that will come due all at once

V. Timing is critical in lapse support

A. Management information on lapse comes from the agency system which only reports 13 to 24 months; after that it is assumed that the ultimate lapse rate applies

B. Lapse is more relevant after acquisition costs have been recovered

1. Prior to acquisition cost recovery, the company and policyholders lose regardless of the ultimate lapse rate

2. After this, there is some profitability until the claims accelerate

3. It is not fair to change policies and procedures in later years; however, canceling a block or raising premiums in later years are effectively doing that

VI. Lapse supported policies are likely to create adverse results, especially term to 100 which has lower premium than whole life and no nonforfeiture values

A. Term to 100 was priced at 6% lapse, but actual lapse was 2%

B. On most of these policies the insurer can raise premium because the current rate is below the guaranteed rate; the policyholder bears this risk

C. Consequences to the company depend on whether premiums can be increased high enough, how soon premiums can be raised, and policyholder reaction to a premium increase

VII. Lapse supported policies can be created by structure or normal structures with inadequate pricing assumptions

A. Long term care and term to 100 are lapse supported created by pricing assumptions; conservative assumptions on long term policies cannot easily be defined

B. Less obvious are universal life where charges do not immediately impact premium and whole life with low cash values or a term policy with another benefit supposed to be increasing

VIII. Mid Continent Life Insolvency

A. Their product was level premium for life at half the whole life premium due to a very high lapse assumptions and high dividends

B. Reserves were based on high lapse and were insufficient when the lapses did not materialize

C. The product was sold as level premium suggesting the policy cost would not change even though it was term insurance that decreased each year with dividends used to purchase paid up additions paid u additions

IX. Lapse supported policies that perform as projected must be reserved carefully to ensure that lifetime profit is not reported in the early durations

A. The nature of level premium is that policyholders pay early excess premiums to support later deficient premiums; reserves hold the excess

B. Management must ensure that the product is lapsing at the rate designed and reserve assumptions match product design assumptions

C. Earnings that are either too high or too low than expected warrant attention

X. Illustrations of lapse supported life products are forbidden by regulation

A. ASOP 24 defines lapse support as a product that is not self-supporting given persistency assumptions in the first 5 years and 100%persistency thereafter

B. The model regulation does not prohibit lapse supported policies; they only prohibit illustrating values that are not guaranteed

C. This is an important consideration if the field force is accustomed to using illustrations

D. A given premium at guaranteed internal rates and interest rates may only stay inforce several years whereas current rates make appears to be maintained it for life

XI. Companies in high income markets are more likely to run into lapse support problems

A. High cash values and high lapse rates appears to be the only way to get low premiums that are competitive

B. However, the market lapse rate is low in the absence of agent promoted replacements

C. High lapse rates are agent driven replacements which continue until the lowest market premium is reached and then the lapse rates decline substantially

XII. Return of premium (ROP) riders are popular with agents because they look cheap or free; on a net cost basis, the time value of money is ignored

A. Return of premium has the highest amount of lapse support because the benefit only goes to persisters at the end of the specified period and profitability is highly sensitive to the lapse rate

B. For disability

1. ROP is a percentage of premiums less claims paid every 10 years
2. ROP demographics tend to be blue collar and gray collar markets

C. The CSV rider has a different impact on lapse support

1. It returns a percent of premium grading from 0 to 100% at maturity when the base plan is surrendered
2. The early benefit effect reduces sensitivity to lapse

XIII. The ROP rider is a tontine modified by the deduction for claims paid out at the end of the specified period

A. The return can be 8% for persisting policyholders, but the risk of lapse makes it a bad investment

B. The relevance of claim offset varies by product

1. Disability policies have a significant offset and claims deterrence as a result
2. Cancer policies have a low incidence high value claims, so the offset is less important

C. The purest form of tontine is a term policy with an ROP since risk of reduction by claim is minor

XIV. ROP can be profitable if the lapse rate is correct or have a product design rate lower than actual experience

A. If competition permits higher premiums from a lower lapse rate, the excess goes to the insurer's bottom line

B. Some market niches have pricing advantages

1. If the lapse rate is influenced by independent events rather than individual choice, the contrary effect on price on lapse can be significantly less and easier to forecast

2. For example, work site marketing lapse rates are determined by employee turnover

XV. Some ROP riders do not take the lapse rate into pricing consideration

A. If the earned rate equals the premium accrual rate, then the excess lapse is profit to the company

B. The same effect occurs when the lapse rate is low

C. If a product is sensitive to lapse and the actual lapse rate is different, either the company receives a lower profit, or the policyholder paid a higher premium than necessary

D. Overpricing in a competitive market is bad for the company

E. For some products, lapse support is inevitable, such as ROP

F. The tendency to move away from any reasonable projection gives lapse support a bad reputation; without early benefits, all that can be done is to monitor lapse

XVI. If a company has poor early year persistency, it should emphasize ROP

A. Poor early duration persistency undercuts profitability of the base plan, but ROP can make it profitable due to additional early year premium that will lapse without the policyholder receiving benefits

B. ROP pricing favors companies with average persistency

C. ROP rates are uniformly high and remain high to keep them adequate for the more persistent markets

D. There is no incentive for companies with poor persistency to lower premiums

XVII. Many states now require ROP to comply with the standard nonforfeiture law; the profit to the company in a lapse is reduced by the cash value

A. Cash values are now becoming universal

B. However, ROP is still a loser until the end of the specified period

C. ROP cash values are not as high as a stand-alone product because

1. ROP products are filed as annuities and exempt from nonforfeiture laws
2. The base plan and the ROP are considered together

XVIII. All limited pay policies have some degree of lapse support, but most are technical and do not cause problems for the company because the reserve accumulated in the premium paying period covers the subsequent mortality

A. If an ROP is added to the policy, the payout is backloaded and converted to a lapse support policy

B. The present value of the reserve needs to be accumulated during the premium paying period; otherwise, profits are front loaded

C. If profit emerges during the premium paying period even small losses can become a problem, especially on a closed block

D. Higher early reserves reduce ROI even though profitability is not impacted

E. Adding an ROP rider exacerbates ROI

CIA EDUCATIONAL NOTE

SELECTIVE LAPSATION FOR RENEWABLE TERM INSURANCE

I. Summary

A. This note reflects a review of the impact on selective lapsation at renewal for renewable term
B. It presents alternative methods for determining renewal mortality assumptions taking selective lapsation into account
C. Results are compared to available experience
D. Issues to consider are also discussed
E. Since there is little available data, no strong conclusions can be drawn about the predictive ability of different methods

II. Background

A. In 2002, an educational note was published on setting expected mortality assumptions for individual life insurance policies

1. It focused on general principles and processes

2. An appendix focused on selective lapsation and the mortality assumption after the renewal date for term products to reflect mortality deterioration from the higher lapse of healthy lives versus unhealthy lives

B. Since 2002, experience of lapse and mortality assumptions at renewal of renewable term policies has become available

C. Since 2002, there has been an evolution of premium design (jump premium) and ongoing discussions of studies on this topic

III. Objectives

A. Review relevant topics to support a narrow range of practice
B. Summarize findings of SOA publications
C. Analyze Canadian experience
D. Identify different methods to identify deteriorating experience
E. Assess the appropriateness of these methods considering product design
F. Clarify the implementation of these methods to ensure they are appropriately applied

IV. The 2002 educational note

A. Selective lapses are lapses whose mortality experience would be identical to newly selected lives

B. Lapse rates on renewable term products can show a temporary increase when premium rates rise at the renewal date

C. Healthy lives are more likely to lapse their policies at renewal than unhealthy lives, resulting in a deterioration in mortality for the remaining lives

D. The following factors are considered when determining the selective lapse rate assumption

1. Size of premium rate increase
2. Period between premium increases
3. Duration
4. Policy size
5. Distribution system used
6. Heaped renewal commissions
7. External market conditions
8. Proportion of healthy lives remaining
9. Conversion activity

E. Other considerations

1. Selective lapse may occur at times other than renewal

2. Some effects of selective lapsation may be included in mortality experience data

3. Lapsation assumes the underlying lapses are comparable to those experienced in the exposure underlying the select mortality table

4. If mortality data fully reflects the effects of selective lapsation, it can be used as the base for expected mortality assumption without adjustment, if the same level of selective lapse are experienced in the future

V. Summary of SOA publications and key findings

A. SOA publications are based on US design products which differ from Canadian products

1. In Canada, a new level premium period after the renewal period is the common practice

2. In the US, the common design is annually increasing guaranteed premium rates based on conservative mortality rates

B. Report on the survey of post premium period lapse and mortality assumptions for level premium term plans (2013)

1. The survey covered mortality and lapse assumptions used by actuaries for pricing and modeling level premium term products

a. 71% of respondents assumed a lapse assumption less than 100% at the end of the level term period for at least one level term product

b. A 100% lapse assumption was more common for 20 and 30 year term compared to 10 or 15 year term

2. Among those that did not use a 100% lapse assumption

    a. The median lapse rate at the end of the level premium period increased with the term length (80% for term 10 and 95% for term 30). Including the year following the renewal date, the cumulative lapse rate was 88% for term 10 and 96% for term 30

    b. The median mortality deterioration assumed for the year after the renewal date was between 232% and 300% where 100% represents no deterioration

    c. Mortality deterioration assumptions begin grading down in the third year after the renewal date

    d. A variety of methods were used for the mortality deterioration assumptions

    e. There is a strong correlation between the level of the lapse assumption at the end of the level premium period and the mortality deterioration assumed in the year after the renewal date

    f. The median premium jump multiple at renewal was between 3.2 and 25.5 depending on issue age, gender, term period, and risk class; the premium jump multiple for a lapsing policy holder that purchases another policy is between 1.9 and 6.0

C. Report on the lapse and mortality experience of post level term period plans (2014)

1. This study considers both lapse and mortality experience

2. An adjustment was made to set the lapse date at the beginning of the grace period to replicate the true effective date of termination

3. Key findings: Lapse experience

    a. Premium jump ratio

        i. Policies with higher premium jumps have higher lapse rates
        ii. Term 15 experience is similar to term 10 experience, although lapses are slightly lower at the higher premium jumps

    b. Premium jump ratio and post level period premium structure

        i. Premium jumps
            i. Premium jump to annual renewable term
            ii. Premium grade to ART
            iii. Premium jump to new level period
            iv. Premium jump to other

    c. Premium jump to other had lower apse rates at renewal than premium jump to ART below a 6 time jump

    d. Patterns observed for term 15 are similar to term 10

e. Premium jump by company--The general trend holds for all companies; lapse rates increase quickly at lowest premium jumps, begin to level off as jumps increase, and level off at the highest premium levels

f. Issue age and premium jump ratio—lapse rates increase by issue age within a premium band

g. Face amount and premium jump—lapse rates increase by issue age even within a premium jump band

h. Lapse skewness

i. Lapses in the year before renewal are skewed towards the end of the policy year
ii. Lapses on the first year following the renewal date are heavily skewed toward the beginning of the policy year

4. Key findings; Mortality deterioration experience

a. Premium jump ratio—mortality rates increase significantly as the premium jump ratio increases

b. Grace period

i. The grace period is the time after an insurance premium is due and the policy is still in force; the grace period provides increased mortality by providing free life insurance to all policyholders, including those intending to lapse

ii. Excess mortality during the grace period is more evident when lapse rates are elevated

c. Lapse rate vs. mortality deterioration—mortality rates are increasing more quickly at the highest lapse rates

VI. Canadian experience

A. This information is not publicly available

B. There is very little credibility in durations 11 – 15

C. Mortality experience following the renewal date is worse using the face amount rather than the number of claims; this may suggest that higher selective lapsation occurs for higher face amounts

VII. Methods to reflect deteriorated mortality

A. Three methods

1. Dukes MacDonald
2. Becker Kitsos method
3. VTP2

B. Different versions of the Dukes MacDonald model have been developed using a similar approach, but with different mechanics and produce different results. Thes methods

1. Are based on underlying base tables that do not contain experience from products with high lapses resulting from an increase in premium
2. Are based on knowing the underlying lapse rates
3. Keep track of notional cohorts that lapse and persist
4. Further segment the cohorts that lapse into those with select or average mortality
5. Decrement the cohorts at their respective mortality rates and the underlying lapse rates
6. Assume all lapses (other than the underlying lapses) occur just prior to the end of the year
7. Apply the principle of conservation of deaths to the cohorts to solve for the mortality of the of deaths of the residual persisting cohort
8. Result in excess mortality that grades off to zero after the select period of the grace period
9. Assume no grace period

C. The three methods summarized

1. Dukes MacDonald (DM)

a. Assumes that 100% of the lapse other than underlying lapse are selective; mortality follows the select mortality of a newly underwritten group

b. Later variations use the concept of effectiveness where some additional lapses are not select

2. Becker Kitsos method

a. Refines Dukes MacDonald by adding an effectiveness factor

b. Additional lapses are assumed to be fully select

c. Additional lapses have fully select mortality plus extra mortality equal to a portion of the initial difference between the select and persisting groups

d. The extra mortality is graded off over the select period

3. VTP2

    a. Similar concepts and parameters to DM1

    b. The most important difference is in the occurrence of underlying lapses

    c. The formulas assume

        i. The average and selective lapse rates are applied to the persisting portion prior to the anniversary and acted on instantaneously at the anniversary

        ii. The underlying lapse rate and mortality rate are assumed to be continuous

    d. Note that DM1 assumes that underlying lapses occur prior to selective lapses

D. Differences between the methods

1. The total cohort T is divided into four groups

    a. Additional lapses that die with select mortality, S
    b. Additional lapses that die with average mortality, A
    c. Lapse with underlying mortality, U (lapses used in the mortality table)
    d. Those who do not lapse, P

2. The goal is to determine the mortality of the persisters

3. Comparison of methods

	Cohort				
Method	T = 100%	S	A	U	P = 1 – S – A- U
BK*	$q'_{[x]+t}$	See below	Ignored	$q'_{[x]+t}$	$q''_{[x]+t}$
DM1	$q'_{[x]+t}$	$q'_{[x]+t}$	$q'_{[x]+t}$	$q'_{[x]+t}$	$q''_{[x]+t}$
DM2	$q'_{[x]+t}$	$q'_{[x]+t}$	Ignored	$q'_{[x]+t}$	$q''_{[x]+t}$
VTP2	$q'_{[x]+t}$	$q'_{[x]+t}$	$q'_{[x]+t}$	Ignored	$q''_{[x]+t}$

The BK* formula for S is

$$q_{[x+t]} * [1 + R^{*}G(t)] * q_{[x]+t} - q_{[x+t]} / q_{[x]+t}$$

R is the parameter that controls the level of mortality; smaller R implies higher mortality for persisters

G(t) is the grading function over the select period

E. All methods apply the conservation od deaths principle to solve for the residual mortality

F. For VTP2

1. The mortality in the first year following the renewal date is

$$q''_{[x]+t} = [(1 - A) * q'_{[x]+t} - S^{*} q_{[x+t]}] / (1 - S - A)$$

2. Expressed as an increment to the base rate

$$q''_{[x]+t} = q'_{[x]+t} + S^{*}(q_{[x]+t} - q'_{[x]+t}) / (1 - S - A)$$

3. Note that all methods other than DM1 have persisters that are larger than the true persisters; this results in persister mortality to be lower than DM1

G. Common problems or issues

1. Skewness of lapses

   a. Lapse is assumed to occur at the end of a year

   b. However, lapses are concentrated at the beginning of the year, especially in a year following a renewal date

   c. The result is that projected mortality is understated in the year following the renewal date

2. Shape of the underlying mortality table

   a. The level and runoff pattern of excess mortality depends on the shape of the mortality table
   b. Unusual runoff patterns may occur if there are discontinuities in the mortality table
   c. The base table must be appropriately selected

3. Grace period

   a. This is not a flaw, but an insurance cash flow model item

   b. Deaths during the grace period following a renewal date will be supported by a much lower group of persisters

   c. If lapse rates are low, model deaths during the grace period are not significant

   d. If total lapses are T = S + A + U, then the approximate mortality rate for deaths during the grace period, allocated to the persisters under DM1 is

      $[S^{*} q_{[x]+t} + (A + U) * q'_{[x]+t}] * \text{Grace Period} / 365 / (1 - T)$

      i. This amount is added to the persisters' mortality rate in the year following the renewal date
      ii. The U term is ignored under VTP2 because underlying deaths are assumed to occur on the renewal date

VIII. Appropriateness of methods—all methods are based on knowing the underlying lapse rates

A. US experience

1. Relative mortality experience in year 10 was 87.5%, but jumped to 400% in year 11

2. The selective proportion parameter must be estimated to fit mortality deterioration based on observed mortality and lapse experience

3. VPT2 does not reproduce the observed mortality rate of 400%

4. Models do not account for deaths in the grace period; grace period deaths decrease as the selective proportion increases since a higher proportion of lapse are assumed to be select sand have lower mortality

5. Adding the grace period deaths to the VPT2 model, the model produces the higher observed mortality

B. Canadian experience

1. Since CIA mortality studies do not provide the corresponding lapse experience; an assumption must be determined

2. The educational note considers only simple, high-level analysis using broad assumptions and disparate sources for mortality and lapse data

3. The underlying rate is assumed to be 5% which is consistent with other data

4. The excess lapse rate is applied at the end of the level term period and includes model deaths during the 30-day grace period

5. Similar to US experience, VTP2 comes close but does not reproduce the lapse rate in the year following term renewal; DM1 comes closer

IX. Application of VTP2

A. While the experience is not credible, the VPT2 model is unable to reproduce current levels of mortality observed in CIA experience studies

B. VTP2 uses selective lapse rates, underlying lapse rates, additional lapse rates and an underlying mortality table for level term experience consistent with underlying lapse rates; it is free from mortality for additional lapse

C. All methods ignore deaths during the grace period

D. Average and selective lapses are applied just prior to the anniversary, underlying lapse is applied continuously; therefore, the total lapse rate is not the sum of these lapse rates

E. Question: what is the size of the block immediately prior to the renewal date

1. For 10-year term paid monthly, additional lapses occur in the first few months of duration 11; while important for cash flows, it is not important for mortality deterioration because additional lapses occurred at the end of year 10

2. The assumption for underlying lapse rates is that they all occur by the end of the policy year; this is reasonable for monthly premium policies, but not annual premium policies; the inforce block just prior to the excess lapse should be net of the underlying lapse rate since they occur throughout the year

3. This is not how VPT2 is applied; selective and average lapse rates need to be grossed up. When the total lapse rate exceeds 70%, the difference is material

4. If all additional lapses occur at the end of a policy year, it does not matter whether lapse occurred during the year or at the end of a year

5. Revised VPT2 parameters result in higher residual mortality and, with grace period adjustments, come close to replicating observed residual mortality rates

F. If the projected attained age is prior to the renewal date, the mortality rate after the renewal date need not take deteriorated mortality experience into account after the renewal date for calculating life expectancy at the projected attained age

X. Conclusions

A. Objectives supplement

1. Review relevant topics to support a narrow range of practice
2. Summarize findings of SOA publications
3. Analyze Canadian experience
4. Identify different methods to identify deteriorating experience
5. Assess the appropriateness of these methods considering product design
6. Clarify the implementation of these methods to ensure they are appropriately applied

B. The base mortality assumption reflects the same experience as used to determine the underlying lapse rate assumption

C. The selective proportion is the key unobservable parameter

D. Renewable term products issued today will have much higher lapse rates than products renewing because the premium jumps on current products are significantly higher

E. The methods used are theoretically sound, but some aspects require additional consideration

1. Deaths during the grace period—impact is low when lapse rates are low, but what happens when lapse rates are high

2. Skewness of lapse—if the skewness of lapses is in the year following renewal is not considered in the model, mortality may be understated in the year following the renewal date

3. Underlying lapses—not reflecting the underlying lapse timing has an insignificant impact on mortality deterioration when lapse rates are low, but what happens when lapse rates are high

F. Since there is little data available, no strong conclusion can be drawn about the predictive ability of different methods, but some evidence suggests that VPT2 understates mortality deterioration, but the revised version better replicates limited observed experience

SECTION PEQ

Practice Exam Questions

Introductory Note

This section of the study manual contains an array of review questions covering the entire syllabus. These questions were written to serve as an aid in assessing your understanding of the material after you have completely covered it through your studies. It is unlikely that you would see questions of this type on the actual exam, since those questions are developed with an eye toward application of multiple parts of the syllabus in actual job situations.

While these questions were not developed as possible exam questions by themselves, it is entirely possible that you could see some of these questions as parts of actual exam questions.

START OF EXAM

50 Points -- 6 Questions

Question 1 (8 points)

Discuss the actions a life insurer can take in the digital age to

- Improve customer satisfaction
- Speed up the risk classification and underwriting process

GO TO NEXT PAGE

Question 2 (8 points)

Briefly describe the table development process with respect to

(a) Graduation
(b) Modeling

GO TO NEXT PAGE

Question 3 (8 points)

Your company is considering its first line of participating products. The company isocnsidereing the following options for a dividend formula

- The three-factor method
- The experience premium method
- The fund value method

a) Outline a presentation to the Board outlining the dividend scale options

b) Demonstrate the formulas to the actuarial department for each of these dividend options

GO TO NEXT PAGE

SECTION PES

Solutions to Practice Exam Solutions

Question 1 Solution

Source: **Life Insurance in the Digital Age**

Step 1: User interaction

Millennials are comfortable with online interactions

They expect to make their own decisions with occasional online help
Online is not a dominant channel for life insurers, but can be leveraged with other distribution channels

Insurers seek answers to many application questions to assess mortality risk, but

This can be a deal breaker due to the time commitment to complete
Not all questions have the same predictive power
Machine learning can help reduce the number of questions
The application can be pre-filled from internal and external sources

Steps in the accelerated underwriting process

Behavioral economics design (application process)
Fluid-less risk score prediction
Smoker propensity prediction
Triage rules
    If fail, full underwriting
    If pass, continue to risk score
Risk score to risk class conversion
External rules engine
Mortality based pricing (using actuarial data base)

Step 2: Risk score prediction

To avoid long applications and paramedic exams, insurers are moving to a more customer centric experience without these items

To accomplish this, nontraditional data sources and predictive models can be used

Data elements to build mortality risk predictive model

Third party data

MIB, prescription, and motor vehicle records
To validate medical and prescription history

Public data

Properties, professional licenses, criminal history
To validate data and add missing information

Financial

Who We Are

A Benefit Corporation Experienced at Teaching Actuaries!

Experienced

More than 50 years experience helping students prepare and pass actuarial exams! We are an eLearning technology and education company leveraging experts in the field to constantly update our learning content in a format that works for you.

Trustworthy

ACTEX Learning is a leading US based provider of study materials for actuarial exams. Our authors and content contributors are renowned academics and Actuaries that are proud to have their names on the cover of our manuals and textbooks!

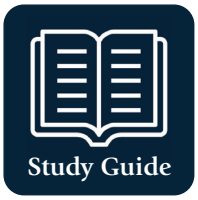
Mission Focused

We are a Benefit Corporation focusing on the mission of accessible high quality actuarial education. We're dedicated to empowering actuarial students by offering test prep materials that are not just effective and efficient but also tailored to suit every type of student.

Become an ACTEX Champion

Join our Global ACTEX Champion Program and bring the benefits to your Actuarial Club. To learn more about the program, scan the QR code on the right. If you have any questions or would like to speak to a Champion Coordinator, please do not hesitate to reach out to us at champions@actexlearning.com.

ACTEX Has the Solutions to Help You with Exam Prep



Our study guides offer the most recommended actuarial prep program. Search our interactive manuals for different topics and toggle easily between concepts and study materials.

Available for P, FM, FAM, ALTAM, ASTAM, PA. ATPA, MAS-I, MAS-II, CAS 5, CAS 6 US & CAN, CAS 7, CAS 8, CAS 9

Want to know you're prepared for your exam? Practice efficiently with our robust database of questions and solutions and predict your success through GOAL's innovative scoring system. GOAL also features dedicated instructor support so you can get help where you need it and pass the exam with confidence!

Available for P, FM, FAM, ALTAM, ASTAM, MAS-I, MAS-II, CAS 5, CAS 6 US & CAN

Master key topics and formulas with our flashcards, which allow you to filter by topic. To help you direct your focus, each card is rated to indicate its importance on the exam.

Available for P, FM, FAM, ALTAM, ASTAM, PA. ATPA, MAS-I, MAS-II, CAS 5, CAS 6 US & CAN, CAS 7, CAS 8, CAS 9

Studies have shown video learning can lead to better retention. We offer hours of video instruction to aid you in your studies. They're a great way to deepen your learning on challenging topics and gain a variety of perspectives from our expert instructors.

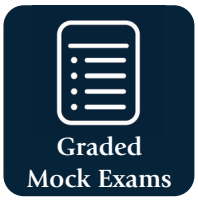
Available for P, FM, FAM, ALTAM, ASTAM, PA. ATPA, MAS-I, MAS-II, CAS 5, CAS 6 US & CAN, CAS 7, CAS 8, CAS 9

ACTEX offers convenient online courses approved for CAS VEE credits. All courses are available on-demand. Students complete the courses at their own pace and take the final exams on the date of their choosing.

Available for Accounting & Finance, Mathematical Statistics, and Economics

Study Materials are Available for the Following:

SOA: P, FM, FAM, ALTAM, ASTAM, SRM, PA, ATPA, CFE, GI, GH, ILA, RET
CAS: MAS-I, MAS-II, CAS 5, CAS 6C, CAS 6US, CAS 7, CAS 8, CAS 9



The ACTEX Graded Mock Exam is a great way to predict your exam outcome! Before you take the official exam - take the new ACTEX Graded Mock Exam and get feedback from an expert. The ACTEX Graded Mock Exam has all the typical elements your SOA exam will have. This can help you evaluate your progress. The questions and format are set up just like the SOA exam.

Available for ALTAM, ASTAM, PA

ACTEX Bootcamps provide a more individualized approach, allow you to ask questions in real time, and boost your last-minute learning. You'll review the harder topics on the exam, as well as common errors and exam strategy. All classes are recorded for future on-demand viewing.

Available for P, FM, FAM, SRM

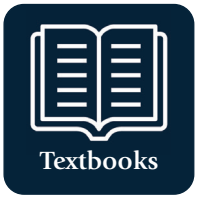
Alongside our P & FM study guide, this course is comparable to a one-semester college class. This course offers SOA Exam practice problems, video solutions, timed practice tests, sample questions, and more. You'll also have 1:1 email support from an instructor for 180 days after purchase.

The Advanced topics in Predictive Analytics video course is designed to help you more easily climb the steep ATPA learning curve. This module-focused video course for Topic 3 in the syllabus, includes videos, end of module assessments and lecture slides. This video course is a deep dive into the three modules. Access to an instructor during the duration of the course as well as participation in a discussion forum.

Available for P, FM, and ATPA

This at-a-glance tool helps you memorize and recall key formulas and information. It covers important formulas needed to prepare your exam. Also, it's an easy-to-print format you can study with, no matter where you are.

Available for P, FM, FAM, ALTAM, ASTAM, PA. ATPA, MAS-I, MAS-II, CAS 5



Looking for Extra Preparation?

Explore our range of textbooks designed to support your studies. From recommended to required readings, ACTEX offers exceptional materials to help you succeed.

ACTEX Learning

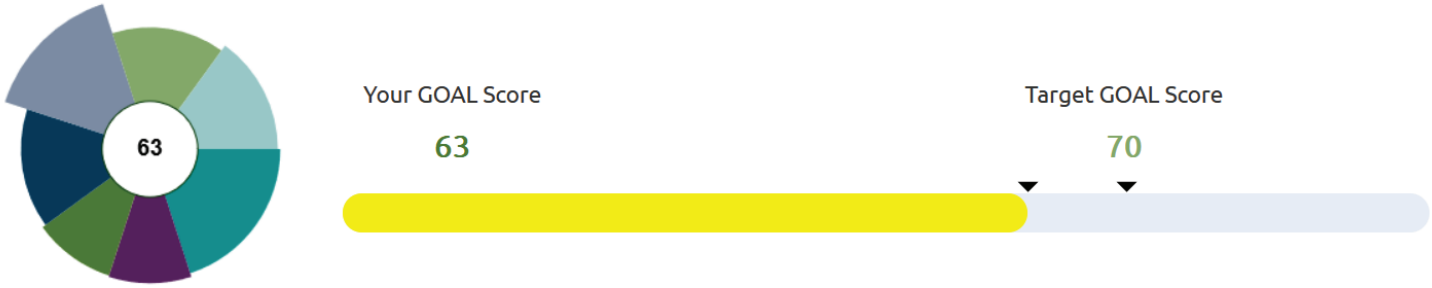
Use GOAL to Practice What You've Learned

- Over 22,000 exam-style problems with detailed solutions
- 3 learning modes (Practice, Quiz, Simulated Exams)
- 3 levels of difficulty (Core, Advanced and Mastery)
- You control your topics and sub-topics
- Dedicated instructor support

GOAL is currently available for the following SOA & CAS Exams:

Exam P 1,050+ Questions	Exam FM 1,500+ Questions	Exam FAM-L 1,300+ Questions	Exam FAM-S 900+ Questions	Exam FAM 2,300+ Questions
Exam ALTAM 1,400+ Questions	Exam ASTAM 1,300+ Questions	Exam SRM 1,150+ Questions	Exam MAS-I 1,050+ Questions	
Exam MAS-II 850+ Questions	Exam CAS 5C 500+ Questions	Exam CAS 6US 550+ Questions	Exam CAS 6CA 650+ Questions	

Use GOAL Score to Gauge Your Exam Readiness



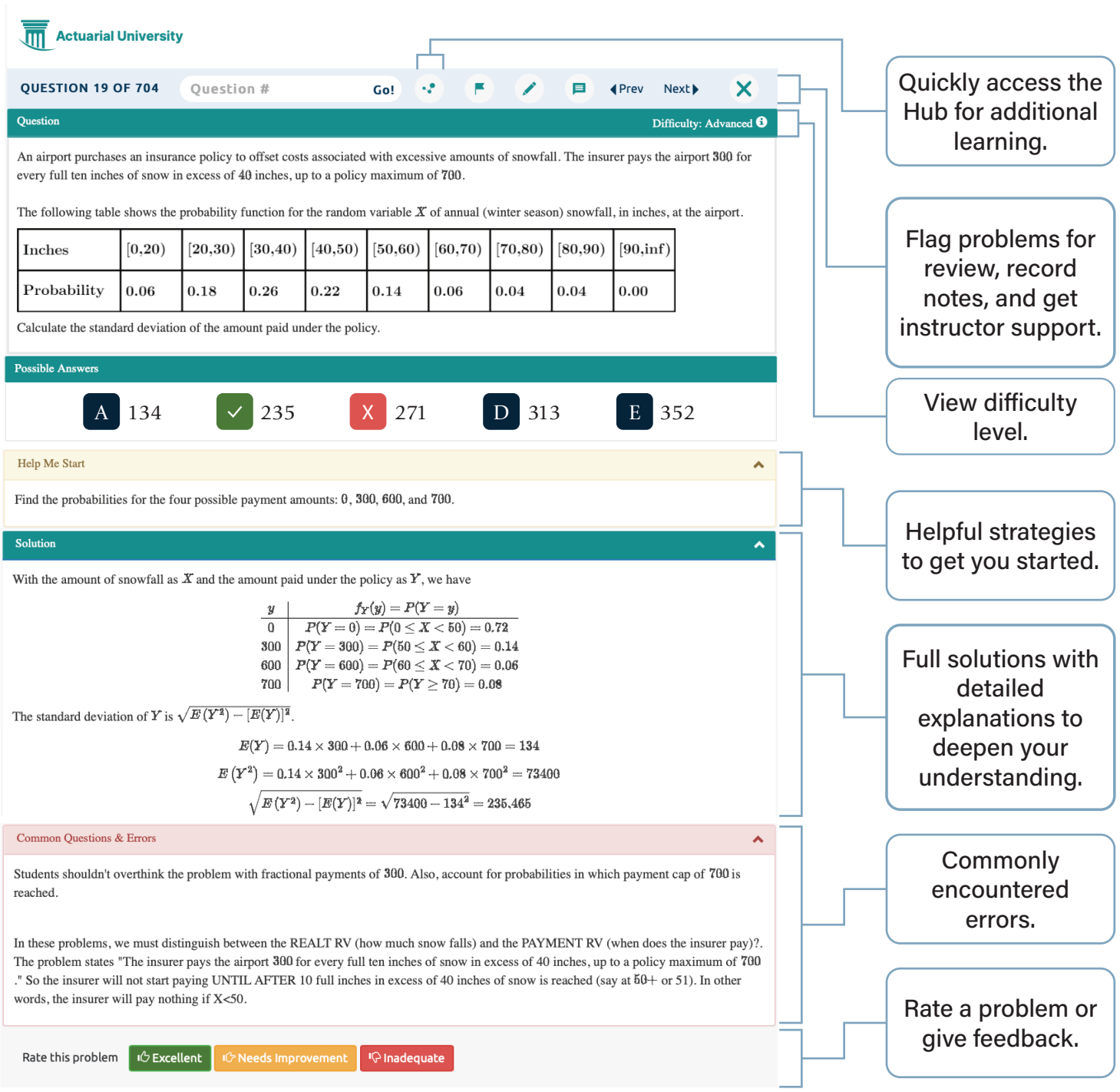
Measure how prepared you are to pass your exam with a tool that suits any study approach. A GOAL Score of 70 or above indicates readiness.

Your score is broken into categories, allowing you to study efficiently by concentrating on problem areas. GOAL Score quantifies your exam readiness by measuring both your performance and the consistency of your performance. Your GOAL Score also analyzes your strengths and weaknesses by category, topic, and level of difficulty.

Scan to Learn More

GOAL Improves Your Studies

How you can prepare for your exam confidently with GOAL custom Practice Sessions, Quizzes, & Simulated Exams:



Actuarial University

QUESTION 19 OF 704 | Question # | Go! | Prev | Next

Question — Difficulty: Advanced

An airport purchases an insurance policy to offset costs associated with excessive amounts of snowfall. The insurer pays the airport 300 for every full ten inches of snow in excess of 40 inches, up to a policy maximum of 700.

The following table shows the probability function for the random variable X of annual (winter season) snowfall, in inches, at the airport.

Inches	[0,20)	[20,30)	[30,40)	[40,50)	[50,60)	[60,70)	[70,80)	[80,90)	[90,inf)
Probability	0.06	0.18	0.26	0.22	0.14	0.06	0.04	0.04	0.00

Calculate the standard deviation of the amount paid under the policy.

Possible Answers

A 134 ✓ 235 X 271 D 313 E 352

Help Me Start

Find the probabilities for the four possible payment amounts: 0, 300, 600, and 700.

Solution

With the amount of snowfall as X and the amount paid under the policy as Y, we have

y	$f_Y(y) = P(Y = y)$
0	$P(Y = 0) = P(0 \le X < 50) = 0.72$
300	$P(Y = 300) = P(50 \le X < 60) = 0.14$
600	$P(Y = 600) = P(60 \le X < 70) = 0.06$
700	$P(Y = 700) = P(Y \ge 70) = 0.08$

The standard deviation of Y is $\sqrt{E(Y^2) - [E(Y)]^2}$.

$$E(Y) = 0.14 \times 300 + 0.06 \times 600 + 0.08 \times 700 = 134$$

$$E(Y^2) = 0.14 \times 300^2 + 0.06 \times 600^2 + 0.08 \times 700^2 = 73400$$

$$\sqrt{E(Y^2) - [E(Y)]^2} = \sqrt{73400 - 134^2} = 235.465$$

Common Questions & Errors

Students shouldn't overthink the problem with fractional payments of 300. Also, account for probabilities in which payment cap of 700 is reached.

In these problems, we must distinguish between the REALT RV (how much snow falls) and the PAYMENT RV (when does the insurer pay)?. The problem states "The insurer pays the airport 300 for every full ten inches of snow in excess of 40 inches, up to a policy maximum of 700 ." So the insurer will not start paying UNTIL AFTER 10 full inches in excess of 40 inches of snow is reached (say at 50+ or 51). In other words, the insurer will pay nothing if X<50.

Rate this problem | Excellent | Needs Improvement | Inadequate

Quickly access the Hub for additional learning.

Flag problems for review, record notes, and get instructor support.

View difficulty level.

Helpful strategies to get you started.

Full solutions with detailed explanations to deepen your understanding.

Commonly encountered errors.

Rate a problem or give feedback.

Thank You for Choosing ACTEX Learning!

We're committed to helping you succeed on your actuarial journey.

For the latest study guides, textbooks, free Formula Sheets, and more resources for SOA, CAS, IFoA, and IAI exams, visit:

ACTEX Learning https://actexlearning.com/

Your destination for comprehensive actuarial exam preparation and professional development.

Looking for additional study material or other actuarial books?

THE ACTUARIAL BOOKSTORE https://www.actuarialbookstore.com/

The #1 online source for actuarial books and study guides.

Scan to Learn More