

 ACTEX Academic Series

INTRODUCTION TO RATEMAKING AND LOSS RESERVING FOR PROPERTY AND CASUALTY INSURANCE

FIFTH EDITION

Robert L. Brown
PhD, FSA, FCIA, ACAS

W. Scott Lennox
FSA, FCIA, FCAS



5th



Robert L. Brown, PhD, FSA, FCIA, ACAS
W. Scott Lennox, FSA, FCIA, FCAS

Introduction to
Ratemaking and Loss Reserving
for Property and Casualty Insurance

ACTEX Learning • Greenland, New Hampshire

Copyright © 2022 ACTEX Learning, a division of ArchiMedia Advantage Inc.

All rights reserved. No portion of this book may be reproduced in any form or by any means without the prior written permission of the copyright owner.

Request for permission should be addressed to:
ACTEX Learning
PO Box 69
Greenland, NH 03840
support@actexmadriverr.com

Manufactured in the United States of America

Cover Design by Rachel Maragnano

ISBN: 978-1-64756-787-3

Table of Contents

<i>ACKNOWLEDGEMENTS</i>	vii
<i>PREFACE TO THE FIFTH EDITION</i>	viii
<i>1 WHY INSURANCE?</i>	1
1.1 THE EVOLUTION OF INSURANCE	1
1.2 HOW INSURANCE WORKS	3
1.3 INSURANCE AND UTILITY	6
1.4 WHAT MAKES A RISK INSURABLE	11
1.5 WHAT INSURANCE IS AND IS NOT	12
1.6 RISK, PERIL, AND HAZARD	14
1.7 PURCHASE OF INSURANCE: OTHER REASONS	14
1.8 EXERCISES	16
<i>2 PROPERTY/CASUALTY COVERAGES</i>	20
2.1 THE EVOLUTION OF INSURANCE	20
2.2 AUTOMOBILE INSURANCE	21
2.2.1 LIABILITY INSURANCE (SECTION A)	23
2.2.2 MEDICAL BENEFITS (SECTION B)	24
2.2.3 UNINSURED AND UNDERINSURED MOTORIST COVERAGES	25
2.2.4 COLLISION AND OTHER THAN COLLISION (SECTION C)	25
2.3 HOMEOWNERS INSURANCE	27
2.4 TENANTS PACKAGE	34
2.5 WORKERS COMPENSATION	34
2.6 COMMERCIAL PROPERTY INSURANCE	37

2.7	MARINE INSURANCE	38
2.8	LIABILITY INSURANCE	39
2.9	LIMITS TO COVERAGE	40
2.9.1	DEDUCTIBLES	40
2.9.2	POLICY LIMITS	41
2.10	CONCLUSION	42
2.11	EXERCISES	43
3	LOSS RESERVING	45
3.1	INTRODUCTION	45
3.2	HOW OUTSTANDING CLAIM PAYMENTS ARISE	46
3.3	DEFINITION OF TERMS	48
3.3.1	BASIC ELEMENTS	48
3.3.2	INDIVIDUAL CLAIM FILE ESTIMATES	49
3.3.3	REPORTED LOSSES	50
3.3.4	TOTAL IBNR	50
3.3.5	TOTAL UNPAID LOSS RESERVES	51
3.3.6	SALVAGE AND SUBROGATION	51
3.3.7	LOSS ADJUSTMENT EXPENSES	52
3.3.8	FAST TRACK RESERVES	53
3.3.9	LOSS DEVELOPMENT	53
3.4	PROFESSIONAL CONSIDERATIONS	54
3.5	DATA FOR RESERVING	55
3.5.1	ACCIDENT YEAR	55
3.5.2	POLICY YEAR	56
3.5.3	CALENDAR YEAR	57
3.5.4	CHECKING THE DATA	57
3.6	LOSS RESERVING METHODS	58
3.6.1	CASE RESERVES PLUS	58

3.6.2	<i>THE EXPECTED LOSS RATIO METHOD</i>	59
3.6.3	<i>THE CHAIN-LADDER OR LOSS DEVELOPMENT TRIANGLE METHOD</i>	60
3.6.4	<i>THE BORNHUETTER FERGUSON METHOD</i>	72
3.6.5	<i>ESTIMATES SPLIT INTO FREQUENCY AND SEVERITY</i>	77
3.6.6	<i>SUMMARY</i>	83
3.7	<i>DISCOUNTING LOSS RESERVES</i>	84
3.8	<i>STATISTICAL METHODS</i>	87
3.9	<i>EXERCISES</i>	91
4	<i>RATEMAKING</i>	99
4.1	<i>INTRODUCTION</i>	99
4.2	<i>OBJECTIVES OF RATEMAKING</i>	100
4.2.1	<i>ESSENTIAL OBJECTIVES</i>	100
4.2.2	<i>NON-ESSENTIAL BUT DESIRABLE OBJECTIVES</i>	102
4.3	<i>DATA FOR RATEMAKING</i>	103
4.4	<i>PREMIUM DATA</i>	103
4.5	<i>THE EXPOSURE UNIT</i>	103
4.6	<i>THE EXPECTED EFFECTIVE PERIOD</i>	104
4.7	<i>INGREDIENTS OF RATEMAKING</i>	106
4.7.1	<i>LOSS-DEVELOPMENT FACTORS</i>	106
4.7.2	<i>TREND FACTORS</i>	108
4.7.3	<i>EXPENSES</i>	112
4.7.4	<i>LOADING FOR PROFIT AND CONTINGENCIES</i>	114
4.7.5	<i>CREDIBILITY FACTORS</i>	115
4.7.6	<i>INVESTMENT INCOME</i>	116
4.8	<i>RATE CHANGES</i>	117
4.8.1	<i>OVERALL AVERAGE RATE CHANGE</i>	117
4.8.2	<i>CHANGING RATING VARIABLE DIFFERENTIALS</i>	124

4.8.3	BALANCING BACK	129
4.8.4	SUMMARY OF THE RATE CHANGE PROCEDURE	131
4.9	EXERCISES	140
5	INTERMEDIATE TOPICS	150
5.1	INTRODUCTION	150
5.2	INDIVIDUAL RISK RATING PLANS	150
5.2.1	PROSPECTIVE RATING PLANS	151
5.2.2	RETROSPECTIVE RATING PLANS	153
5.3	INCREASED LIMITS FACTORS	153
5.3.1	DATA CONSIDERATIONS	156
5.3.2	LOSS DEVELOPMENT	157
5.3.3	LOSS TREND	157
5.3.4	RISK LOAD	159
5.3.5	EXPENSES	160
5.3.6	LOSS DISTRIBUTIONS	160
5.4	DEDUCTIBLE PRICING	161
5.4.1	LOSS ELIMINATION RATIOS	161
5.4.2	DATA CONSIDERATIONS	163
5.4.3	LOSS DEVELOPMENT AND TREND	164
5.4.4	LOSS DISTRIBUTIONS	164
5.5	REINSURANCE	165
5.5.1	FUNCTIONS OF REINSURANCE	166
5.5.2	TYPES OF REINSURANCE	166
5.5.3	REINSURANCE RESERVING	168
5.5.4	REINSURANCE PRICING	169
5.6	EXERCISES	174
Appendix		178
Answers to Text Exercises		181

ACKNOWLEDGEMENTS

The evolution of this textbook began with a set of class notes used to teach an introductory property/casualty insurance course at University of Waterloo. The original manuscript was prepared by Linda Lingard, and reviewed by several groups of students and other instructors, most notably Andrew R. Cartmell, FCAS. Their contributions to this project are greatly appreciated.

In the course of developing the five editions of the text, many significant contributions have been made. The authors would like to thank Susan Gozzo Andrews, FCAS, of Connecticut Insurance Department, H. Elizabeth Mitchell, FCAS, of Platinum Underwriters Reinsurance Inc, David F. Mohrmann, FCAS, of Towers Watson in Simsbury, Susan J. Patschak, FCAS, of Canopius Underwriting Bermuda Limited, Dr. Thomas N. Herzog, ASA, Dr. Gerald R. Hartman, FCAS, of Temple University, Mary Hardy, FIA, FSA, of University of Waterloo, Frank Bensics, FSA, Joel Kleinman, FCAS, Retired, Anna Marie Beaton, FCAS, ASA, of the Co-operators General Insurance Company, and Leon R. Gottlieb, FCAS, MAAA, of Oliver Wyman. Thanks also to Janet Duncan, FSA, MAAA, FCAS, of UCSB Santa Barbara, for her significant additions and improvements to the fifth edition of this text.

This edition of the text received final editorial and presentation polishing by the staff at ACTEX Publications. Our thanks go to Kim Neuffer, Director, Product Management and Marketing Strategy for her help and patience.

The authors express their thanks and appreciation to everyone who contributed to the completion and continuing improvement of this text.

W. Scott Lennox, FSA, FCIA, FCAS
Robert L. Brown, Ph.D., FSA, FCIA, ACAS

PREFACE TO THE FIFTH EDITION

This text is designed for use in teaching an introductory course in property/casualty insurance topics. The material can be covered comfortably in a twelve-week teaching semester with time for review and problem classes. The material also represents the basic foundation of knowledge needed to gain an introductory appreciation of the building blocks of the property/casualty actuarial discipline.

Although the material presented here is purely property/casualty in its origins, the application of the knowledge gained is much broader. The methods presented here have potential application not only in the property/casualty practice area, but also in accident and sickness insurance, group life and health insurance, and many other related areas.

Students of this introductory material should not, however, presume to have gained a working knowledge in the property/casualty practice area. This book is designed to provide an overview of the core principles and methodologies, incorporating examples as an educational tool. To achieve a proper working knowledge in this field, the interested reader is advised and encouraged to pursue the broader base of material available through a more advanced actuarial syllabus.

Some time ago, I was approached by Gail Hall from Actex and Rob and asked to be involved in updating this text to the fourth edition. Having reviewed the third edition of this text and taught a fourth-year property and casualty university course since 2009, I was only too happy to get involved in this project. I know many actuaries who have found this text useful as an introduction for students new to the property and casualty actuarial profession. With that in mind, my intention was to keep this material at the introductory level, while leaving the more advanced concepts and methods to a more robust actuarial curriculum.

The fifth edition incorporates the supplemental material to the fourth edition on the statistical foundations of the reserving methods. Also, the terminology has been updated to reflect common use. In particular, this edition uses the term reported losses to avoid confusion with the accounting terminology of incurred losses.

Finally, the fifth edition has also been updated to reflect industry changes over the past seven years and includes some additional exercises.

June, 2022

W. Scott Lennox, FSA, FCIA, FCAS

1

WHY INSURANCE?

1.1 THE EVOLUTION OF INSURANCE

Humans have strived for security since the beginning of their existence. At its earliest point, security existed if there was an assurance of food, warmth, and shelter. The Bible relates the story of how, in ancient Egypt, Joseph set aside part of the crop in good years to cover the expected shortfall in years of drought.

The World Bank has recently identified casualty (or general) insurance as a critical element for the development of emerging economies.

This is only the latest recognition of the importance of casualty insurance to economic development. The roots of [insurance](#) can be traced back to Babylonia, over four thousand years ago, when traders developed markets to insure the goods on their caravans against loss on the hazardous trade routes. Without this form of property insurance, traders would have been reluctant, or financially unable, to engage in the trade that led to this nascent western civilization. Recognized as the oldest branch of insurance, marine insurance was developed in ancient Greece and enabled trade to occur and civilization to flourish. Again, forms of casualty insurance were the essential ingredients to economic development. The lack of life insurance on the captain, or a pension system for the sailors, did not stop ships from sailing. But without insurance on the ships and cargo, trade stopped¹.

As society developed and the roles of individuals within the economic framework became more specialized, the need for economic security increased.

¹From Steve D’Arcy, CAS President, *The Actuarial Review*, Nov 2005, p. 7.

Economic security is the opposite of *economic risk*, which we will refer to simply as *risk*. Risk derives from variation from the expected, not from probability. For example, on a cloudy morning we may be told there is a risk of rain. What is meant, more correctly, is that there is a high probability of rain. The variation associated with the weather forecast could be just as high or higher on a sunny morning.

A modern industrial society provides many examples of risk. A homeowner faces a large variation associated with the potential economic loss caused by a house fire. A driver faces a similar, though less variable, potential economic loss if his or her car is damaged. A larger possible economic loss would be associated with the injury of a third party in a car accident for which you are responsible.

Examples of early informal insurance arrangements can be found in the cooperatives and fraternal organizations that existed in Europe over 400 years ago. For example, the farmers in a certain area would agree, usually informally, that if one farmer's barn was destroyed, the community would see that it was rebuilt. If the breadwinner in a family unit died, the community would "pass the hat" to establish a fund for the surviving dependents. In this informal arrangement, each person's economic risk was shared or pooled among the members of the community.

These informal systems proved to be adequate for several hundred years. At the time of the industrial revolution, however, the need for a more formal system arose. Because of the rapid urbanization of the population, it became true that one's neighbor could be a stranger with whom one had no interests in common. Hence, it was no longer sufficient to expect a communal or cooperative response when one family unit met with an economic reversal.

It was perfectly natural that the "pooling" concept of the existing cooperatives and fraternal organizations became formalized in the new insurance industry. Under the new formal arrangement, each policyholder still implicitly pooled his or her risk with all other policyholders. However, it was no longer necessary for any individual policyholder to know or have any connection with any other policyholder.

1.2 HOW INSURANCE WORKS

If we look at the risk profile of an individual, we see that there is an extremely large variation of possible outcomes, each with a specific economic consequence. Thus, any individual is exposed to a significant amount of risk associated with perils like death, fire, disability, and so on.

By purchasing an insurance policy, an individual (the *insured*) can transfer this risk, or variability of possible outcomes, to an insurance company (the *insurer*) in exchange for a set payment (the *premium*). We might conclude, therefore, that if an insurer sells n policies to n individuals, it assumes the total risk of the n individuals. In fact, the insurer, through careful underwriting and selection will end up with an average risk that is relatively smaller compared to the original risk to individual policyholders.

The explanation of this surprising result is a principle called *the law of large numbers*, which states that as the number of observations increases, the difference between the observed relative frequency of an event and the true underlying probability tends to zero. Similarly, the difference between the observed average severity of an event (the average size of a loss) and the expected severity tends to zero as the number of observations increases. So, accurate prediction of outcomes is much easier with many separate (independent) risks than with only one or two.

Here is another way to see the reduced variability of outcomes based on larger samples. At a certain age, the probability of death within one year is 0.001, or 10 in 10,000. If we have a sample of 10,000 lives, we can predict with 95% probability that the number of deaths will be between 4 and 16, a range of ± 6 away from the mean of 10. If we have a sample of 1,000,000 lives, the 95% confidence interval is (938,1062), a range of ± 62 away from the mean of 1000. But we observe that the variability is 60% of the mean in the first case, but only 6.2% of the mean in the case with the larger sample.

As long as the individuals being insured are *independent* risks (i.e., a claim from one policyholder does not increase the probability of a claim from any other policyholder), then the larger the sample size, the smaller the variance of the average claim, and, hence, the smaller the risk. Thus, through the insurance mechanism, individuals can transfer their risks to an insurer without having the insurer taking on an unmanageable level of risk in total.

In life insurance, the risk is associated with the variability in the number of death claims, which is modeled by a probability [frequency distribution](#). In most property/casualty lines of insurance (e.g., auto), not only is there a frequency distribution for number of claims, but there is also a [severity \(or loss\) distribution](#) for size of claim, from which variability also arises. That is, given that a claim has occurred, the size of the loss payment is still highly variable.

By buying insurance, the individual policyholder transfers his or her risk to the insurer, but, because of the law of large numbers, the insurer ends up with a total risk that is manageable. This is illustrated in Figures 1.1a and 1.1b, showing the risk profiles for the individual and the insurer, respectively.

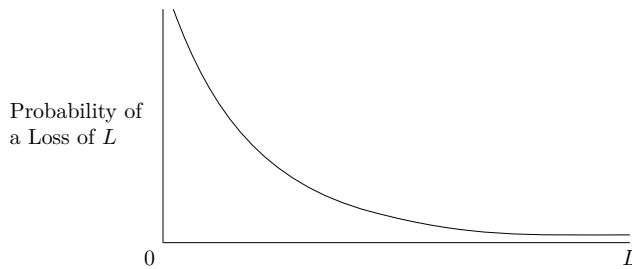


Figure 1.1a

For the individual, the probability is very high that there will be no loss at all from the defined event, but there is a non-zero probability of a significant loss. We denote the [expected value](#) of the loss to the policyholder by μ_{ph} , and the [variance](#) of the loss to the policyholder by σ_{ph}^2 .

If the insurer selects n identical and independent policyholders, each with the same risk profile as that illustrated in Figure 1.1a, then the loss distribution for the insurer can be illustrated by Figure 1.1b.

For the insurer, the probability of no loss at all, given n policyholders, will be virtually zero if n is large, and the range of possible losses per policy is much smaller than for the individual policyholder.

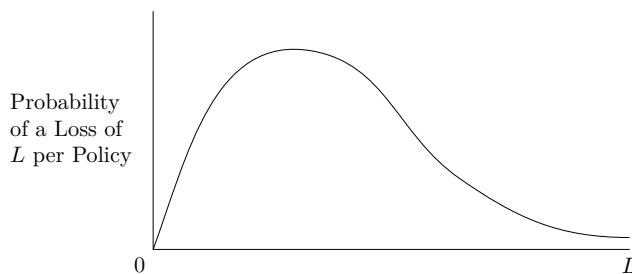


Figure 1.1b


If the insurer selects n identical and independent policyholders, the expected value of the average loss per policy is μ_{ph} , the same as for the individual policyholder, but the **variance of the average loss** per policy is

$$\frac{\sigma_{ph}^2}{n},$$

or, equivalently, a standard deviation of

$$\frac{\sigma_{ph}}{\sqrt{n}}.$$

These results are derived in the following example.

Example 1.1.  Given n independent policyholders with individual loss random variables X_1, X_2, \dots, X_n , such that the expected value of any policyholder's loss is μ_{ph} and the variance is σ_{ph}^2 , show that for the insurer providing these n policyholders with insurance, the expected value of the insurer's average loss per policy is μ_{ph} , and the variance of the average loss per policy is $\frac{\sigma_{ph}^2}{n}$.

Solution. Let $S_n = X_1 + X_2 + \dots + X_n$. Let

$$\bar{X} = \frac{1}{n} \cdot S_n = \frac{1}{n} (X_1 + X_2 + \dots + X_n).$$

Then

$$E[\bar{X}] = \frac{1}{n} \cdot E[S_n] = \frac{1}{n} \cdot n\mu_{ph} = \mu_{ph},$$

and

$$\text{Var}(S_n) = \text{Var}(X_1 + X_2 + \dots + X_n) = n \cdot \sigma_{ph}^2.$$

But

$$\begin{aligned} \text{Var}(\bar{X}) &= \text{Var}\left(\frac{1}{n} \cdot S_n\right) \\ &= \frac{1}{n^2} \cdot \text{Var}(S_n) \\ &= \frac{1}{n^2} \cdot n\sigma_{ph}^2 \\ &= \frac{\sigma_{ph}^2}{n}. \end{aligned}$$

Hence we can see that the risk to the insurer, measured by the variance of the average loss, is only $\frac{1}{n}$ th of the risk to the individual policyholder.

□

1.3 INSURANCE AND UTILITY

It should be clear that the existence of a private insurance industry, of and by itself, will not decrease claim frequencies or loss severities. Viewed another way, merely by entering an insurance contract a person's expectation of loss does not change. Thus, with perfect information, the net premium for any policyholder would have to be the expected value of loss. But the policyholder would have to pay a **gross premium** in excess of the net premium so as to cover the expenses of selling and servicing the contract.

Why would someone pay a gross premium for an insurance contract that must exceed the expected value of the loss? The answer lies in a principle called the **decreasing marginal utility of money**. According to this principle, as extra units of wealth or income are added, the **utility** derived from such units decreases. This is displayed in the graphs that follow.

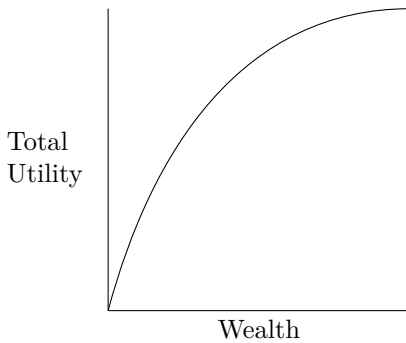


Figure 1.2a

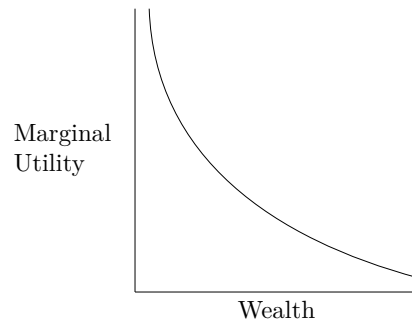


Figure 1.2b

As an example, with early dollars of income we buy food, clothing, and shelter, which represent high utility. With later dollars of income, we buy items such as a stereo for the jacuzzi, which is of lower utility.

The principle of decreasing marginal utility of money applies to anyone who is a **risk averse**, which is the case for most people. There are some people who are **risk seekers**, for whom the principle of decreasing marginal utility does not apply. Such a person, for example, could be expected to forgo basic needs, such as food or shelter, to gamble on a chance for large wealth. The examples that follow assume that the purchaser of insurance is a risk avoider.

Example 1.2. A prospective purchaser of insurance has 100 units of wealth. He faces a situation whereby he could incur a loss of Y units, where Y is a random loss with a uniform distribution between 0 and 36. This person has a personal utility curve given by $u(x) = \sqrt{x}$. What maximum gross premium would this person be willing to pay for insurance?

Solution. Note that for this individual $u'(x) > 0$, so that u increases with x , and $u''(x) < 0$, so that each additional unit of x brings less than one additional unit of utility, u . Hence this prospective policyholder is a risk avoider, since the law of decreasing marginal utility applies. (A risk seeker would have an increasing marginal utility curve.)

Further, noting that the p.d.f. for the random loss is $f(y) = \frac{1}{36}$, we can find

$$\begin{aligned} E[Y] &= \int y \cdot f(y) dy \\ &= \int_0^{36} \frac{y}{36} dy \\ &= \frac{y^2}{72} \Big|_0^{36} \\ &= 18. \end{aligned}$$

so the expected value of the loss is 18. The insurer must therefore charge a gross premium in excess of 18 to cover sales commissions and administration costs.

Why would a policyholder pay more than 18 to buy insurance whose expected value is 18? The answer lies in the marginal utility curve for this policyholder illustrated in the following figure.

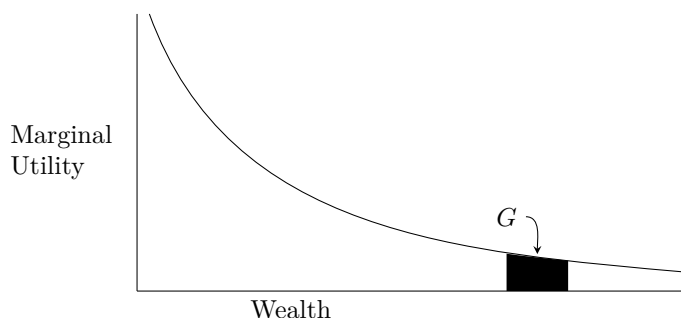


Figure 1.3


The policyholder will pay a gross premium of G for the insurance, so he loses G whether or not the loss occurs, leaving him with $100 - G$ units of wealth. Without insurance, however, the policyholder faces a possible loss of 36 units of wealth, which is 36% of his total wealth.

If the policyholder buys insurance, the resulting wealth position is certain; it will be $100 - G$, with utility value $\sqrt{100 - G}$. If he does not buy insurance, the resulting wealth position is probabilistic, given by $100 - Y$, and the expected utility value of the resulting wealth position can be calculated as

$$\begin{aligned} E[U] &= \int_0^{36} u(100 - y) \cdot f(y) dy \\ &= \int_0^{36} \sqrt{100 - y} \cdot \frac{1}{36} dy \\ &= \frac{1}{36} \left\{ -\frac{2}{3} (100 - y)^{3/2} \right\} \Big|_0^{36} \\ &= \frac{244}{27}. \end{aligned}$$

The policyholder should be willing to pay a premium G that equates the expected utility values of the resulting wealth positions with or without insurance. Thus we find G such that $\sqrt{100 - G} = \frac{244}{27}$, which results in $G = 18.33$. Thus the policyholder will pay up to 18.33 for this insurance, which exceeds its expected value of 18, and if the insurer can charge a premium less than 18.33, the insurance purchase will be made. \square

Given this or a similar **utility function**, we can see why it may not make sense to insure against small losses (e.g., theft of goods worth less than \$200). In this case, the utility value of the **gross premium** will exceed the expected utility value, because we have not moved far enough in the decreasing marginal utility curve to overcome the expense element inherent in the gross premium.

Example 1.3.  You are trying to decide whether to invest in Company A or B. For this investment, the utility profile can be measured by the function

$$u(P) = \sqrt{P - 100}, P > 100,$$

where P represents profit.

- Show that this is the utility function of a risk avoider.
- Given the following information, determine your investment strategy based on (i) expected monetary value, and (ii) expected utility value.

	Probability	Profit	
		Company A	Company B
Economy Advances	0.40	4000	2800
Economy Stagnates	0.60	200	400

Solution.

(a) Given that

$$u(P) = \sqrt{P - 100},$$

then

$$u'(P) = \frac{1}{2}(P - 100)^{-1/2}$$

and

$$u''(P) = -\frac{1}{4}(P - 100)^{-3/2}.$$

This shows that

$$u'(P) > 0, \text{ for } P > 100,$$

and

$$u''(P) < 0, \text{ for } P > 100,$$

so the investor is risk averse.

(b) The following table shows the monetary payoffs and their associated utilities.

	Probability	Profit	
		Company A	Company B
Economy Advances	0.40	4000(62.45)	2800(51.96)
Economy Stagnates	0.60	200(10.00)	400(17.32)

(i) Expected monetary value:

$$E(\text{Company A}) = (0.40)(4000) + (0.60)(200) = 1720$$

$$E(\text{Company B}) = (0.40)(2800) + (0.60)(400) = 1360$$

Invest in Company A.


(ii) Expected utility value:

$$E(\text{Company A}) = (0.40)(62.45) + (0.60)(10.00) = 30.98$$

$$E(\text{Company B}) = (0.40)(51.96) + (0.60)(17.32) = 31.18$$

Invest in Company B.

□

Example 1.4.  An individual faces the following possible losses:

Loss Size	Probability
\$1000	0.001
100	0.100
0	0.899

If the utility function of a potential purchaser of insurance is:

$$u(x) = x^{0.6}$$

- Show that this person is risk averse.
- Calculate the maximum premium this individual would pay for insurance given the above loss distribution and initial wealth of \$2000.

Solution.

- $$u(x) = x^{0.6} > 0 \text{ if } x > 0$$

$$u'(x) = 0.6x^{-0.4} > 0 \text{ if } x > 0$$

$$u''(x) = -0.24x^{-1.4} < 0$$

So we have decreasing marginal utility, which indicates the individual is risk averse.

- With insurance that costs \$ G , the outcome is known and equals $2000 - G$ with utility $(2000 - G)^{0.6}$.

Without insurance, we have a loss distribution with three possible outcomes and resulting expected utility.

$$\begin{aligned} & (0.001)(\$1000)^{0.6} + (0.100)(\$1900)^{0.6} + (0.899)(\$2000)^{0.6} \\ & = 0.63095734 + 9.273681167 + 85.97608973 \\ & = 95.31286663 \end{aligned}$$

$$\text{So set } (2000 - G)^{0.6} = 95.3128663$$

$$G = \$11.22$$

$$\text{Note: } E[L] = (0.001)(\$1000) + (0.100)(100) = \$11.00$$

So $G > E[L]$.

□

1.4 WHAT MAKES A RISK INSURABLE

We have shown in the previous sections that an individual will see the purchase of insurance as economically advantageous if the principle of decreasing marginal utility applies (i.e., the individual is a risk avoider). On the other hand, the insurer will agree to insure a prospective policyholder if the [law of large numbers](#) can be applied to the risk pool to which the prospective policyholder wishes to belong. With these principles in mind, what makes a risk [insurable](#)?

- (1) ***It should be economically feasible.*** If we do not move far enough on the utility function, then the utility gained by insuring will not be enough to cover the utility of the cost of the insurance mechanism (e.g., sales commissions and head office expenses).
- (2) ***The economic value of the insurance should be calculable.*** An example of where this criterion holds is auto collision insurance. Here a large number of small losses are experienced. We can get a lot of data on collision experience and, through the law of large numbers, can calculate an expected premium with a high degree of confidence. Insuring a nuclear reactor against meltdown is an example of where this criterion does not hold. Such a policy can be issued by using a risk-sharing arrangement among many insurers so that the exposure to risk for any one company is manageable.
- (3) ***The loss must be definite.*** This criterion is meant to guard against policyholder manipulation and moral hazard. Moral hazard occurs when the insured is able to increase the value of the insurance beyond that expected in the price or premium. A car accident with police documentation is definite. Death is definite. What is not so definite, but still insured, is disability. When is an insured well enough to return to work? How do you guard against malingering?
- (4) ***The loss must be random in nature.*** Again, we wish to have the insured event beyond the control of the policyholder. The presence of criteria three and four allow the actuary to assume random sampling in the projections of future claim activity. That is, there is no statistical bias in the selection of one insurance unit versus another.
- (5) ***The [exposures](#) in any rate class must be homogeneous.*** This means that, before the fact, the loss expectation for any unit in a class must be similar to the loss expectation to any other unit in the class. In terms of random sampling, this is analogous to each elementary unit having a similar probability of being drawn. Through anti-selection by policyholders, this criterion might not be satisfied. **Anti-selection** occurs when the policyholder has more information than the insurer, and the policyholder uses that extra information to gain a price/rate loss advantage.

- (6) *Exposure units should be spatially and temporally independent.* In terms of random sampling, this implies that selection of one elementary unit does not affect the probability of drawing any other elementary unit. In more practical terms, we wish to avoid any catastrophic exposure to risk. We would not, for example, insure all the stores in one retail area, since one fire or one riot could result in a huge loss. In insurance terms, the fact that one insured has a claim should not affect whether another insured has a claim.

These criteria, if fully satisfied, mean that the risk is definitely insurable. On the other hand, the fact that a potential risk exposure does not fully satisfy the criteria does not necessarily mean that insurance will not be issued. Some special care or risk sharing in these circumstances (e.g., reinsurance) may be necessary. In property/casualty insurance, rarely does an insurable risk meet all of the listed criteria. The questions of risk classification and price still follow.

1.5 WHAT INSURANCE IS AND IS NOT

There is often confusion in the minds of consumers and regulators as to the purposes and intent of insurance.

The insurance mechanism is used to transfer risk from the individual policyholder to the pooled group of policyholders represented by the insurance corporation. If the insured pool is a large collection of independent policyholders then the per-unit risk will be greatly reduced and will be manageable for the insurance company. The insurance company administers the plan, invests all funds, pays all claims, and so on. The insurance company can only pay out money that comes from the pooled funds. If claims rise, so too must premiums.

From the policyholders' viewpoint, *insurance* is available only for pure risks; that is, where the outcome is either loss or no loss. The policyholder cannot profit from buying insurance. In property/casualty insurance, we often refer to the insurance payment as *indemnification* (or reimbursement) vs. benefit used in life insurance. This is because the payment is limited to the amount of the loss rather than a policy face value, hence you don't really benefit from buying the policy.

In *speculation*, there is also a transfer of risk, in that an individual can transfer an unwanted risk to a speculator. The motive for the speculator is the chance to make a profit.

A good example of how speculation can be used to transfer risk is the futures market. Suppose a farmer plants a field of winter wheat in October. He will deliver this wheat in July. This farmer is risk averse and does not wish to speculate on what the price of grain might be in July. The farmer goes to the futures exchange and sees that it is possible to sell the grain in October to a speculator for \$4 a bushel with delivery in July. In July, grain is actually selling for \$3.50 a bushel. The farmer delivers the grain as agreed and is paid \$4 a bushel. The speculator must now realize the loss of \$0.50 a bushel. Had grain prices risen to \$4.75 a bushel (e.g., in a dry summer) the speculator would have made a profit of \$0.75 a bushel.

By taking on this risk, the speculator does two positive things. First, the risk of fluctuating prices is removed from the risk averse farmer and assumed by the speculator (who hopes to make a profit). To the extent that the speculator is correct in his/her projections, prices are stabilized. Note, however, that the risk has only been transferred; it has not been reduced or removed.

There are two key differences between speculation and insurance. The first is the profit motive behind speculation. There is no profit motive on the part of the policyholder in entering an insurance agreement (the insurer, however, hopes to make a profit). Second, the insurance process significantly reduces total risk through the Law of Large Numbers. Speculation transfers risk but does not reduce it.

In *gambling*, risk is created where none existed, and none needed to exist. In terms of utility, gambling works in a fashion opposite of insurance.

People spend early and high utility dollars in the hopes of gaining large wealth that has lower utility value. Overall, gambling decreases societal utility by redistributing income in a non-optimal fashion. Some theorize that gamblers have utility curves that explain their actions, i.e., both $u'(x)$ and $u''(x)$ would be positive.

If the profits from the gambling process (e.g., a state or provincial lottery) are spent on high utility needs (e.g., a hospital), then it is possible for the final result of this process to increase total societal utility. Otherwise gambling decreases total utility and is a waste of human resources.

1.6 RISK, PERIL, AND HAZARD

Risk is a measure of possible variation of economic outcomes. It is measured by the variation between the actual outcome and the expected outcome.

Peril is used as an identifier of a cause of risk. Examples include fire, collision, theft, earthquake, wind, illness, and so on.

The various contributing factors to the peril are called *hazards*. There are physical hazards such as location, structure, and poor wiring, and there are moral hazards such as dishonesty, negligence, carelessness, indifference, and so on. Hazards can be natural or man-made.

An example might help. Mr. Rich owns a cabin cruiser. Hazards when sailing are negligence on the part of the captain, rocks, shoals, and so on. These are contributing factors. Perils would be things like fire or collision (i.e., cause of risk) which may or may not cause a financial loss, which is risk.

In conclusion, an insurance contract will reimburse the policyholder for economic loss caused by a peril covered in the policy. Thus, the policyholder transfers this risk to the insurance company.

1.7 PURCHASE OF INSURANCE: OTHER REASONS


While utility theory provides an underlying economic rationale for the decision to purchase insurance, quite often some other practical reasons are present:

- (1) Legal requirements. Most jurisdictions have financial responsibility laws that apply to all licensed motor vehicles. The licensee must show that he or she can satisfy judgments rendered as a result of accidents resulting from operation of the vehicle. The most popular way of satisfying this requirement is through insurance. There are other laws and regulations that require insurance before a license to engage in certain businesses is issued.
- (2) Lenders' requirements. When an individual takes out a mortgage on property or takes out a loan to purchase a vehicle, the lender almost always requires insurance on the property or vehicle up to the amount of the loan (this to protect the lender's insurable interest in the property). This is also common for commercial loans, which are secured by property.



- (3) Commercial requirements. In the course of business transactions, one party will often obligate itself in some measure to perform a service, to deliver a product, etc. It is common that insurance is purchased to compensate the injured party if the service is not performed or the goods are not delivered. Such business arrangements are often contingent on the performing party obtaining insurance.
- (4) Special expertise. The insurance company may provide a service on a more cost-effective basis than the insured can do on its own. The most obvious example is adjustment of claims. Insurers have large, experienced, claim departments. An example of this would be using an insurance company to administer the paperwork of a large dental insurance program. Some companies also see value in having a “third party,” the insurer, handle claims made by its customers. Other services include boiler inspections, and loss control audits.
- (5) Taxation. If a company in the United States or Canada self-insures its exposures, it can only claim a tax deduction for losses as they are paid. In contrast, the cost of insurance is expensed immediately since the premium is paid up front. Thus in “long-tailed” lines such as product liability, the deduction for income tax purposes can be accelerated by many years and provide a real economic benefit.

1.8 EXERCISES

Section 1.2

1.  (a) State the law of large numbers.
 (b) Explain the importance of the law of large numbers to the insurance mechanism.

Section 1.3

2.  Confirm that the utility function log, for $u(x) = k \cdot \log x$, and $k > 0$ $x > 0$, is the utility function of a decision maker who is risk averse.
3.  Which of the following two proposals in the table below would a risk avoider choose?

Outcome	Proposal A		Proba- bility	Proposal B		Proba- bility
	Payoff	Utility		Payoff	Utility	
O_1	80,000	1.0	.6	50,000	.9	.5
O_2	10,000	0.5	.1	30,000	.8	.3
O_3	-30,000	0.0	.3	-10,000	.2	.2

4.  Two businessmen view the following proposals.


	X		Y	
	Success	Failure	Success	Failure
Profit	50,000	-20,000	5,000	-5,000
Probability	.35	.65	.55	.45

Their respective utility schedules for the project are as follows.

x	Businessman	
	A	B
-20,000	.300	.550
-5,000	.450	.709
+5,000	.550	.770
+50,000	1.000	1.000

What decisions would they make based on:


- (a) expected monetary value, and
- (b) expected utility value?

5.  Assume the management of an investment firm has utility function, for any project, $U(P) = \sqrt{P - 1000}$, where P represents profit.
- (a) Confirm that management is risk averse.
 - (b) Consider the following two proposals, below:

Proposal A	
Profit	Probability
3000	.10
3500	.20
4000	.40
4500	.20
5000	.10

Proposal B	
Profit	Probability
2000	.10
3000	.25
4000	.30
5000	.25
6000	.10

Which proposal would management choose based on:


- (i) expected monetary value, and
 - (ii) expected utility value?
6.  A market gardener faces the possibility of an early frost that would destroy part of his crop. He can buy crop insurance. This creates four possible outcomes, which are presented, in the following table.

	Profit	
	Freeze	No Freeze
No Insurance	10,000	30,000
Insurance	20,000	25,000

- (a) Based on expected monetary value, what probability must the farmer attach to early frost to make buying insurance a wise decision?
- (b) Given his existing wealth, the farmer has the following utility profile.

Profit	Utility
10,000	71
20,000	123
25,000	141
30,000	158

Based on expected utility value, what probability must the farmer attach to an early frost to make buying insurance a wise decision?

7.  You are subject to the utility function $u(x) = \left(\frac{x}{10,000}\right)^9$, where x is wealth. Your current wealth is 50,000. What is the maximum premium you would pay to insure against a loss that is uniformly distributed between 0 and 30,000?

8. You follow the utility function $u(x) = 1 - \exp\left(\frac{-x}{100,000}\right)$, where x is wealth. Your current wealth is 20,000. What is the maximum amount you would pay to take part in a fair coin toss where you have .5 probability of winning 10,000? If you win you do not receive a return of your wager.
9. A person has a utility function, over the relevant range, given by $u(x) = 10,000x - x^2$, where x is wealth. Her current wealth is 3000. What is the maximum wager she would make in a game where there is a 30% chance of winning 2000 plus the return of her wager?
10. You are given the following information.
- (i) The gross premium for insurance is 4500.
 - (ii) The individual knows he will have 1, 2, or 3 losses with equal probability.
 - (iii) Each loss will cost 2000.
 - (iv) $u = \mu + \sigma/6$ measures the loss of utility for the individual, where u is a measure of utility, μ is the expected value of loss, and σ is the standard deviation of loss.

Under these conditions, determine whether the prospective policyholder will buy insurance. Why?



11. Mr. Smith has a total wealth of 525,000 and his utility of wealth is $u(x) = \ln(x)$. He owns a sports car worth 50,000. The insurance on his sports car is due for renewal. Based on Mr. Smith's driving record, the risk of damage to his car in the next year is as follows.

Amount of Damage	Probability
0	.80
10,000	.15
20,000	.04
50,000	.01

Mr. Smith's insurance company charges premiums for all its policies equal to the expected value of its claim payments under the policy plus 10% of this expected value as a loading.

- (a) Should Mr. Smith fully insure his car at the insurance company's premium? Explain why or why not.
- (b) As an alternative to its full coverage policy, the insurance company is offering a new policy that will pay 50% of all damage amounts for accidents greater than or equal to 20,000. All other damage amounts are paid by the insured. Should Mr. Smith insure his car with this new policy?


Section 1.4

12.  It is common for successful race horses to be sold for stud (breeding purposes) at the end of their racing careers. Not all such horses are “successful.” Should it be possible to buy insurance to indemnify you for loss if a race horse you buy is not a successful breeder?
13.  The XYZ Insurance Company has been asked to issue a 2-year term insurance policy on a specially trained dog that is going to star in a movie. If the dog dies in year one, 8000 will be paid at the end of year one. If the dog dies in year two, 5000 will be paid at the end of year two. If the dog lives to the start of year three, no payment is made and the contract ends. The dog is now age x , and the insurance company develops the following survivorship data based on known mortality experience of dogs of the given age and breed.


$$\begin{aligned}l_x &= 7000 \\l_{x+1} &= 6000 \\l_{x+2} &= 4500 \\l_{x+3} &= 2500 \\l_{x+4} &= 0\end{aligned}$$

- (a) Is this an insurable risk?
- (b) If $i = 10\%$, determine the net single premium for the contract.
- (c) Calculate the associated variance.

Section 1.5

14.  From an economic viewpoint, compare and contrast gambling and insurance. Briefly explain why insurance is more acceptable.

Section 1.6

15.  (a) Differentiate among risk, peril, and hazard.
- (b) Give an example of each.

2

PROPERTY/CASUALTY COVERAGES²

2.1 THE EVOLUTION OF INSURANCE

Chapter *One* outlined the reasons that consumers buy insurance. In Chapter Two we will review some of the most widely sold coverages available from property/casualty insurance companies and the areas of economic insecurity for which the property/casualty insurance industry provides insurance. We will describe these coverages in a very general and generic way. That is, it is not the purpose of this chapter to outline any particular contract used by any particular insurer. Rather, we will attempt to describe property/casualty coverages that exist around the world and the general level of security that they provide. Property/casualty coverages are often segmented into personal lines of business vs. commercial lines of business. Personal lines are policies sold to individuals (e.g., auto and homeowners insurance), whereas commercial lines are insurance policies sold to businesses (e.g., workers compensation, commercial auto, commercial property, marine, general liability).

Readers are invited to review their own insurance coverage at this time. Most of you will have some property/casualty insurance contract, be it an automobile insurance policy or insurance for a homeowner or tenant. It will prove advantageous to look at your particular coverage when you are reading the generic description of that coverage in this chapter.

²Often referred to as Property/Liability insurance.

2.2 AUTOMOBILE INSURANCE

Important coverages normally available in an [automobile insurance](#) policy include:

- *liability insurance*
- *medical benefits*
- *uninsured and underinsured motorist coverage*
- *collision insurance*
- *other than collision (OTC) insurance*

In many jurisdictions, the first two coverages are compulsory in that the law requires each auto owner to purchase insurance that meets the *financial responsibility limits*, whereas the others are usually purchased at the option of the policyholder. If you require a loan to finance the purchase of your car, then the financial institution may require collision and comprehensive coverage.

The insured parties are the named policyholder and immediate family. The policy coverage applies when the policyholder or family member is driving one of the vehicles listed in the policy declarations (your covered auto). Coverage also applies if the covered auto is being driven by an “invited driver” and coverage usually extends to a utility trailer attached to the vehicle. The policy does not cover normal operating expenses such as wear and tear, depreciation, rust, and so on. Coverage normally ceases if the vehicle is being used for commercial purposes. *Commercial auto policies* exist for this purpose, but with a different price structure. They will not be discussed further in this text.

Legislative reforms over the past decade have significantly changed the importance of Liability Insurance (Section A of the policy) versus Medical Benefits (Section B of the policy).

We now generally have two types of legislation defining how the auto insurance benefits will be determined: at fault and no-fault. In the United States, 38 states require that the injured party prove that the insured was *at fault* in the accident and is therefore liable for the payment of claim to the injured party.

Benefits under the liability section of the auto policy are available only if the liability insurer believes its insured was at fault in the accident or the injured party sues the insured and proves that the insured was at fault in the accident. This may require a lengthy court case, although the majority of cases are settled out of court. This at-fault system of settlement is also called the *tort*³ system. Evidence exists that in the tort system small claims are highly overcompensated, usually through out-of-court settlements, whereas larger claims are compensated for as little as 30% of their costs. Further, only about 25% of the premium dollar ends up in the hands of the injured party. The other 75% is consumed by legal fees, court costs, and insurer administration expenses. Because of this, many jurisdictions have implemented no-fault auto insurance systems.

Under a *no-fault* system, the injured party does not have to sue for compensation or even prove that the driver of the other car was at fault for the accident. Instead, the benefits that would normally be paid by an at-fault party's liability insurance become payable under the insured's personal injury protection. Thus, instead of the injured party suing for damages because of bodily injury or property damage, the injured party gets the level of benefits defined in the policy's personal injury protection policy (accident benefits in Canada). Thus the benefits are not paid by the insurer of the at-fault driver; the benefits are paid by the injured party's own insurer. The tort system liability premium is significantly decreased while the personal injury protection premium is significantly increased under a no-fault system. In theory, the total premium under the no-fault system should be lower than the total premium under the tort system because many legal and court expenses are reduced or eliminated. On the other hand, the flexibility of the tort system is lost to the defined benefits of the no-fault system.

At the time of writing, all provinces in Canada and twelve states in the United States had some kind of no-fault legislation. There are virtually as many no-fault insurance systems as there are jurisdictions with these systems. For example, some jurisdictions use a system called *threshold no-fault*, under which you look first to your own insurer for defined no-fault benefits for any minor accident, but if your injuries exceed a defined threshold (e.g., death, total and permanent disability, disfigurement, or medical expenses which exceed a specified amount), you can then pursue a tort settlement. In this case, the court may have to make a two-part decision. First, does your injury exceed the defined threshold? Second, if it does, what is the appropriate tort settlement given that fault has been established?

³A tort is a civil wrong where the at-fault party has caused personal injury or property damage to another party making them legally responsible.

In three other provinces in Canada, the provincial government runs the auto insurance system through a **government monopoly**. In these provinces, there is no issue as to who is at fault since there is only one insurer/payor. Government monopolies for auto insurance are rare around the world. Government *regulation* of coverage and/or rates is, however, fairly common. Even in a pure no-fault environment, the police will still be asked which driver was at fault or the degrees to which the drivers shared in the fault, because, in most jurisdictions, at-fault events cause the premium to rise at the next policy renewal, and remain elevated for several years.

Virtually all auto policies provide coverage for out-of-state or out-of-province accidents, up to the amounts required in the jurisdiction where the accident occurs. Most policies issued in Canada or the United States limit liability coverage to just Canada and the United States.

2.2.1 LIABILITY INSURANCE (SECTION A)

This coverage is commonly referred to as Third Party Liability, or Section A, or BI/PD (which stands for Bodily-Injury/Property Damage).

The **liability** section of the auto policy provides coverage to the policyholder if, as the driver of a covered vehicle, the policyholder injures a third party or damages a third party's property. The policyholder's property is not covered by the auto liability insurance but would normally be covered under the policyholder's homeowners policy. Although most liability incidents are settled without going to court, in a **tort jurisdiction** (i.e., at-fault), if the policyholder is sued with respect to negligence for such bodily injury or property damage, the insurer will provide legal defense for the policyholder and, if the policyholder is found to be liable, the insurer will also pay, on behalf of the policyholder, damages assessed against the policyholder up to the limits of coverage defined in the policy. Note that the total cost of legal defense and payment of damages can exceed the policy limits because only the payment for damages is subject to the **policy limits**. The insurer is allowed, however, to cease its legal defense when the amount it has paid for damages reaches the policy limits. A person who intentionally causes a loss is not covered. There is also no coverage if **workers compensation** is supposed to provide the benefits.

Third-party liability coverage is compulsory in virtually all jurisdictions before you can legally drive your car (although many drivers drive illegally without such insurance). Virtually all jurisdictions specify some minimum level of liability coverage, such as \$25,000 in most states and \$200,000 in most provinces in Canada. Higher limits are available for an extra premium. There may be separate (called *split*) limits for the bodily injury and the property damage coverages (the latter limit is normally smaller). Further, the bodily injury coverage may specify a limit per person injured per occurrence and a second overall total limit per occurrence (e.g., \$50,000 per person and \$100,000 per occurrence). Because bodily injuries can result in claims of millions of dollars and the courts can attach your personal assets if the assessed damages exceed your insurance coverage, you are well advised to buy increased limits of liability coverage.

Premiums for the liability coverage vary by the limits chosen, the territory in which the vehicle is garaged, the use of the automobile (e.g., pleasure or business), the accident claims and moving vehicle convictions record of the policyholder, and often the age, sex and marital status of the policyholder if not precluded by human rights legislation or regulatory rules. These variables used to determine premium are called *rating factors* or *risk classification* factors. More recently, auto premium sometimes considers telematics data, which can include GPS and behavior based data collected through a special tracking device.

2.2.2 MEDICAL BENEFITS (SECTION B)

Generally, the second policy coverage ([Section B](#)) is called *medical payments* (in a [tort jurisdiction](#)), *personal injury protection* (in a [no-fault jurisdiction](#)), or *accident benefits* (in Canada). This coverage provides protection to the policyholder and family in the case of injury in an accident for which the policyholder would be liable (you cannot sue yourself for coverage under third party liability, so this is the alternative), or for any accident in a no-fault jurisdiction. Again, this coverage is usually compulsory.

Personal injury protection provides defined levels of benefits to the injured policyholder or family member for income replacement, medical care, rehabilitation, home care, survivor's benefits, and so on. This is an example of *first-party* coverage since the policyholder receives the claim payments. Generally there is no coverage if [workers compensation](#) is supposed to provide the benefits.

In a tort (at-fault) jurisdiction, the importance of Section A coverage (and its limits and costs) exceed the importance of Section B. In a no-fault jurisdiction, the reverse is true.

2.2.3 UNINSURED AND UNDERINSURED MOTORIST COVERAGE

A third section of the policy usually provides protection for the policyholder and family if injured by either an *unidentified, uninsured, or underinsured* motorist (i.e., someone who is insured but at lower liability limits than purchased by the policyholder or required by law). This coverage is used in tort jurisdictions. Under this coverage, the policyholder has coverage from his or her own insurer equivalent to what would have existed had the motorist causing the accident been identifiable or fully insured. In this respect, this coverage is similar to no-fault where your insurer covers your injuries and damages (even if the uninsured or underinsured driver was at fault). Note that this benefit provides an incentive for the policyholder to buy larger liability limits of coverage for himself or herself.

2.2.4 COLLISION AND OTHER THAN COLLISION (SECTION C)

A fourth section of a typical auto insurance policy provides coverage for damage to the policyholder's own vehicle, under two subsections: one covering *collision* and another covering *other than collision* (OTC). The policyholder has the option to purchase one or the other, or both, of these coverages.

Under collision insurance, if your vehicle is damaged in an accident, the insurer will pay the cost of its repair or replacement as defined in the policy, normally subject to a *deductible* such as \$500. This means that the policyholder is responsible for the first \$500 of the repair or replacement cost. This tends to eliminate the filing of small claims for which the cost of administration and settlement would likely exceed the benefit. It also provides an economic incentive for the policyholder to prevent accidents, since the policyholder now carries some risk.

The *collision limit* is the lesser of the actual cash value of the damaged property or the amount necessary to repair or replace it. The insurer reserves the right to pay for the loss in money or repair or replace the damaged property. As an aside, on some new cars the depreciated value of the car (which is the policy limit) may be less than the outstanding balance of the car loan, which can create potential problems in the case of a serious accident. Special provisions exist for such instances.

If another driver is at fault for the accident in a tort jurisdiction, the insurer that paid the policyholder the defined collision benefits can sue the at-fault driver and recover its costs and the deductible from the at-fault driver or his or her insurer. If the suit is successful, the amount of the deductible (now recovered) will be paid to the policyholder. If the insurer decides not to sue, the policyholder can try to recover the deductible from the alleged at-fault driver or insurer, but at the policyholder's risk and expense.

The ability of the insurer to sue the at-fault driver in a tort jurisdiction and recover its costs is called *subrogation*. Technically, subrogation means that the insurer, once it has indemnified the policyholder, automatically assumes the legal rights of the policyholder to sue. As a result of the subrogation process, premiums for collision insurance tend to be lower, whereas premiums for liability insurance tend to be higher than without subrogation. However, the resulting liability and collision premiums are more appropriate and equitable because the resultant premiums reflect the true costs that are brought to the insurance pool by the policyholder. Also the at-fault party, rather than an innocent victim, bears the cost. Subrogation is also important because the liability coverage is normally compulsory whereas the collision coverage is not.

Another legal right of the insurer under an auto insurance policy is called *salvage*. If a collision claim requires paying the full value of the vehicle (known colloquially as a write-off or total loss), the ownership rights to any remaining value in the vehicle accrue to the insurer. Thus, the insurer has the right to take the vehicle to a wrecker and retain any salvage value that may remain. If the salvage value exceeds the amount the insurer originally paid to the policyholder, the payment to the policyholder must be increased to at least the salvage value payment. That is, the insurer cannot profit from the salvage provision. The salvage provision ultimately decreases the premium required for the collision coverage.

Collision premiums typically vary according to the following rating or risk classification factors: type of vehicle (based on its value plus an index of damageability and cost to repair), its use (e.g., business or pleasure), and normally also the territory in which the vehicle is garaged. Almost all jurisdictions allow premiums to vary according to the accident history of the driver. Finally, most jurisdictions allow premiums to vary based on the policyholder's age, gender and (sometimes) marital status. The use of these parameters has become a human rights issue in some jurisdictions. Statistics do exist that clearly show correlation between each of these risk classification factors and the expected costs brought to the risk class by the policyholder.

The final optional subsection of a typical auto insurance policy covers perils other than collision (OTC), such as hail, fire, vandalism, stone chips, theft, and so on. Excluded perils include war, acts of terrorism, damage due to wear and tear, road damage to tires, radioactive contamination, damage due to the discharge of a nuclear weapon, and, of course, collision.

If coverage is provided for all perils except those specifically excluded, such as those just listed above, then it is referred to as *comprehensive* coverage. If, however, the policy only covers perils that are specifically listed (as opposed to all perils except those specifically excluded), then the coverage is referred to as *specified perils*. OTC premiums usually vary only by the type of vehicle (its value and expectation as to ease of damage and cost to repair), and the territory where the vehicle is garaged. Personal attributes of the policyholder (e.g., age, sex, marital status, claims history) are not normally deemed to be relevant in pricing this coverage.

Policyholders often choose to lower their collision and OTC coverage as the vehicles age because the value of the vehicles decrease. Antique car owners are an exception to this as the vehicles increase in value with age. Insurers offer antique car coverage usually for an ‘agreed-upon value’ for the car.

2.3 HOMEOWNERS INSURANCE

As with auto insurance, the typical *homeowners insurance* policy has different sections that specify different insurance coverages. Section I of the policy is normally subdivided into four subsections often called Coverages A, B, C, and D.

Coverage A provides protection against damage to your house (dwelling) on a named perils or an all-risks basis up to a set limit. Earthquake and flood are generally excluded from standard coverage. These exclusions and limits are designed to make rates more affordable and equitable, given the expected costs that are brought to the insurance pool by the policyholders.

Loss or damage occurring after the dwelling has been vacant for more than thirty consecutive days and damage caused by nuclear accidents or acts of war or terrorism are not covered, nor are buildings used for business or farming purposes. Finally, loss or damage resulting from intentional or criminal acts of the insured is not covered.


The fact that not all perils are covered brings up the matter of determining exactly which peril did, in fact, cause the loss. Under an important principle called the *doctrine of proximate cause*, a loss is covered only if a **covered peril** is the proximate cause of a **covered consequence** (note the need for both a covered cause and a covered consequence). A **peril** is covered if it is a named peril in a specified perils policy or it is not an excluded peril in a all-risks policy. A covered peril is the proximate cause if it initiates an unbroken sequence of events leading to a covered consequence. If, for example, a windstorm causes a power outage, and as a result of the power outage all of the food in your freezer goes bad, then this loss is covered if you are covered for wind (a covered peril) and for reimbursement of food spoilage (a covered consequence). Wind is the proximate cause.

Homeowners dwelling coverage comes with a deductible to preclude small claims which are both administratively expensive and, given the utility concepts of Chapter One, uneconomical to the insured. It also puts the policyholder at risk (for the deductible) which should result in more responsible actions by the insured.

In the previous section on auto insurance, we described *subrogation*, which also exists in any homeowners policy. To show how subrogation might work with homeowners dwelling insurance, consider the following scenario.

A homeowner experiences a \$50,000 fire in the home. It is established that the cause of the fire is faulty wiring in a kitchen appliance. When the insurer pays the homeowner the \$50,000 necessary to rebuild the kitchen, it acquires the legal rights of the homeowner to sue the appliance manufacturer for negligence. If successful, the insurer can recover its \$50,000 of costs. (If it recovers more, the extra amount would be paid to the homeowner.) In this instance, the \$50,000 was initially considered a homeowner's loss, but after it is recovered from the manufacturer's insurer it will be viewed instead as a product liability loss.

This scenario alludes to another feature that may exist within a homeowners policy. We noted earlier that there is a deductible within the homeowners policy to avoid the expense of small claims. This deductible may be defined so as to disappear after the loss reaches a certain size, i.e., a *disappearing deductible*. This is illustrated more fully in the example that follows.

Example 2.1.  A homeowners dwelling policy has a deductible of 250 for claims up to 1000. Between 1000 and 2000, the deductible disappears linearly so that for claims of 2000 or more, there is no deductible. Determine the payment that would be made to the policyholder on a claim of 1300.

Solution. Set up a diagram to show the linear disappearance of the deductible.

Claim	1000	1300	2000
	----- ----- -----		
Deductible	250	X	0
Loss Payment	750	$1300 - X$	2000

Using linear interpolation, $X = \left(\frac{2000-1300}{2000-1000} \right) (250) = 175$, so the resulting loss payment is $1300 - 175 = 1125$. \square

Homeowners can purchase dwelling coverage on a replacement cost basis. An interesting feature in the dwelling insurance coverage on a replacement cost basis is a provision called a *coinsurance clause*. Most homes experience little or no damage year after year (at least nothing in excess of the deductible). Even if there is a claim, it is usually far less than the full value of the home or the amount of insurance purchased on it. Thus, most property losses are partial, not total, and are relatively small. For homeowners insurance, the loss distribution is heavily weighted toward the smaller claim amounts.

The coinsurance clause under a homeowners policy is unique, and works quite differently than coinsurance in other policies. Coinsurance for other policies, such as health benefits coverages, often specifies a specific percentage of the payment that the policyholder covers. For a homeowners policy, the coinsurance clause is only triggered if the coinsurance requirement is not met, as illustrated in Example 2.2.

What would happen, however, if a policyholder only purchased partial coverage? For example, what benefit or premium adjustment would be fair if a policyholder bought \$200,000 of insurance on a \$300,000 home, and then suffered a \$40,000 loss? Clearly the premium for \$200,000 of coverage should be more than two-thirds the premium for \$300,000 of coverage on the same house. To avoid this problem, insurers require that policyholders insure their homes to near full value in order to get full coverage; otherwise the coinsurance clause is activated.

Normally, if the insurance equals at least 80% of the value of the house *at the time of the loss*, it is deemed to be insured for the full value. Demanding 100% coverage would be difficult as the approach that is often used to determine the full value changes from year to year due to inflationary influences (e.g., if the cost to rebuild the home is the basis used, the cost of labor and building materials will change with inflation). That is if:

$$I(X) = \text{Insurance for Loss } X$$

The coinsurance requirement is not met if:

$$SI < 0.80 \cdot FV$$


Then:

$$I(X) = \min \left\{ SI, \frac{SI}{0.80 \cdot FV} \times X \right\}$$

where $SI =$ Sum Insured

$FV =$ Full Value

An example of how this clause works may be helpful.

Example 2.2.  A homeowner has a house valued at 300,000 at the time of a loss event, but has insured it for 200,000 with an insurer that requires 80% of full coverage before it reimburses losses in full. If coverage is less than 80% of full coverage, then any loss is reimbursed on a pro-rata basis of what would have been paid had the 80% requirement been met. The homeowner has a kitchen fire estimated at 40,000 on a replacement cost basis. How much will the insurer pay toward reimbursing the homeowner for this loss?

Solution. For full coverage, the homeowner needed insurance equal to at least 240,000 (80% of 300,000) as measured at the time of loss. In this case the homeowner only had 200,000 of coverage. Thus, the coinsurance requirement is not met, and on the 40,000 kitchen fire, the insurer would pay

$$\frac{200,000}{(.80)(300,000)} \times 40,000 = 33,333.$$

The amount of reimbursement paid by the insurer is further limited by the policy limit of the policy (200,000 in this case).

Note: The value of the home used in the coinsurance clause is the value at the time of loss. □

An insurance policy will describe how deductibles are applied when interacting with coinsurance. The coinsurance penalty can either be applied before or after the deductible. For example, if the coinsurance penalty is applied before the deductible, the formula for determining the amount the insurance company will pay for a covered loss can be determined as:

$$I(X) = \min \left\{ SI, \frac{SI}{(\text{coinsurance \%}) \cdot FV} \times X \right\} - \text{deductible}$$

In determining compliance with the coinsurance requirement, the insured is permitted to deduct the cost of excavations and pipes, wiring or foundations that are below the basement (or below the ground if there is no basement), from the replacement cost of the home.

There are several arguments in favor of the coinsurance clause, including the following:

- (1) It encourages insurance to full value by penalizing under-insurance.
- (2) The use of the coinsurance clause results in greater premium equity among insureds. If losses are skewed to smaller claims, but the premium on any given home is a linear function of the amount of insurance purchased, then, without a coinsurance clause, persons who purchased small amounts of insurance would bring more risk to the pool than would be commensurate with the premium they paid, whereas those who bought full coverage would be paying more than their fair share based on the risk they were contributing. The coinsurance clause provides a simple mechanism to adjust for the skewed loss distribution.
- (3) The overall rate level can be lower but still adequate. This is really a corollary to the second point. By making everyone pay a premium equal to the risk for which they will be compensated, it allows for a lower average rate per thousand of coverage since it removes the possibility of anti-selection (i.e., a case where someone knowingly buys a small amount of insurance, but still expects full coverage on claims less than the policy limit).

There are also some disadvantages of this coinsurance arrangement, which include the following:

- (1) The clause is not well understood by many policyholders.
- (2) Because of the misunderstanding of the coinsurance clause, some costly disputes arise over its use and meaning.
- (3) A policyholder who buys less than full coverage is only penalized if there is a claim, since he or she can pay a lower premium and get away with it. For example, a restaurateur may have to prove the existence of insurance coverage before being granted a license or a mortgage.
- (4) The 80% coinsurance percentage (or any other percentage less than one hundred) discriminates against those who carry higher levels of insurance (which should be encouraged).
- (5) With high rates of inflation in house construction costs (a recent problem), a homeowner may unwittingly fall below the coinsurance percentage requirement. (Note that this is why the 80% requirement is used; housing costs seldom rise in value by more than 25% in one year.)
- (6) The use of a coinsurance percentage less than 100% may imply a recommendation to the policyholder to buy less than full coverage.

In order to make sure that the policy limit keeps up with inflation, most insurers offer an option whereby the limit is increased automatically each year, in accordance with an appropriate inflation index. If the homeowner selects this option, the coinsurance penalty is waived if the insured value falls below 80% of full coverage (and there were no unreported improvements to the property.)

Coverage B of Section I provides a specific amount of insurance on a garage and other structures on the premises, which are separate from the primary dwelling, normally equal to 10% of the dwelling coverage amount. This insurance may be increased above the standard 10% by paying an extra premium. Separate structures used for business purposes or held for rental are not covered.

The coverage on the dwelling and other buildings under the normal homeowners policy provides replacement cost coverage if the coinsurance clause has been satisfied. Otherwise coverage is for the actual cash value specified in the policy and the coinsurance provision does not apply.

Coverage C of Section I of the homeowners policy will insure the actual cash value of the policyholder's personal property and contents of the house up to a defined policy limit which is usually a percentage of the insured value of the house. The actual percentage varies among insurers but is normally either 40% or 50%. Thus, if the home is covered for \$400,000, the contents would be covered up to a policy limit of \$200,000 for the covered perils, if the Coverage C percentage is 50%. Many insurers also offer replacement cost coverage on contents, for an additional premium. Coverage C extends to borrowed property in the possession of the insured.

Inside limits apply to certain losses. There will be, for example, a defined limit on how much will be reimbursed in the case of loss or theft of cash (e.g., \$1000). Also, there will be inside limits on the coverage for jewelry, silverware and art. If the homeowner wants full insurance on these last three items, then a **schedule** of the items to be insured, with their appraised values, will be attached to the policy and an extra premium will be charged for these scheduled items. In the case of loss or theft of such items, the amount paid out by the insurer will be exactly the amount set in the schedule, not the current market value of the items. This benefit is referred to as a **valued** benefit (since there is no loss distribution associated with this part of the policy), similar to life insurance.

The coverage for the contents of the home also applies when personal items are outside of the home. If, for example, you are traveling and lose some personal assets, your homeowners policy will provide coverage for such a loss, normally anywhere in the world. Coverage on property at any other insured residence besides the main resident dwelling (e.g., a vacation home) is normally limited to 10% of the amount of Coverage C.

Coverage D of Section I provides coverage for additional living expense and loss of rental income. This coverage will pay the fair rental value for alternative accommodation while your dwelling is being repaired because of damage caused by a covered peril. It will also compensate you for loss of rental income from a part of the house which is lost while the damage is being repaired. The limit of coverage for Coverage D is normally 20% of the coverage on the dwelling.

Section II of the homeowners policy provides **liability coverage** to the policyholder. Liability could arise if a third party is injured or if the property of a third party is damaged while on your property or in certain other circumstances. (Dog bites are one of the most common bodily injury liability claims under a homeowners policy). Before any payment is made, however, the injured party is technically required to establish negligence on the part of the homeowner, and show that there were injuries or damage that require compensation. Although this might require a full court hearing, most claims are settled out of court.

As with auto insurance, the insurer will defend the homeowner in court and pay the costs of defense. As with auto insurance, however, the insurer has the right to settle out-of-court without the insured's permission. Payments to the third party for injury or property damages are limited by the liability limits of the homeowners policy (this will be a specified limit such as \$2 million), but the cost of the defense is paid over and above the payment for damages. The insurer can break off the defense of the case once it has paid costs for damages which equal the liability limits defined in the policy.

Finally, the homeowners policy will normally provide very limited medical coverage for any third party injured on your property without the need to sue to recover (i.e., on a no-fault basis).

The homeowners insurance policy is not meant to cover buildings used for commercial purposes and will so stipulate. We will not specifically discuss such commercial coverage here.

Rates for homeowners insurance vary by the home's geographic location, its construction, and its value. The geographic location parameter reflects such risk classification factors as distance to the nearest fire station, the probability of perils such as earthquake, floods, windstorms, and so on. If the probability of a defined event is very high, and would create unaffordable rates, one alternative is to exclude the named peril and offer coverage for this named peril at an extra premium. This is common practice for flood and earthquake.

Rates will also vary depending on the construction materials used in the house. Homes with untreated cedar shake shingles as roofing, for example, may have higher rates. Discounts on rates may be offered if there is a security or sprinkler system in the home, and so on.

2.4 TENANTS PACKAGE

For people who rent rather than own their own homes, coverage is available in a *tenants package policy*. This policy typically combines personal contents coverage and liability coverage (similar to a homeowners policy), but excludes dwelling coverage since the property is owned by a landlord rather than the tenant. Premium under a tenants package is modified to reflect the tenants lower exposure to risk. The chance of a liability claim, for example, is far less in an apartment than on the land, or in and around the home, of a homeowner. Much of the total liability risk inherent in an apartment complex will be covered by the liability coverage carried by the owner of the apartment building. Also, if the apartment building is damaged by wind, fire or other insured peril, it is not of concern to the tenants except as to their personal possessions and some rights of tenancy. Therefore, the coverage within a tenant's package is mostly coverage for personal possessions in one's apartment or storage area. This policy will not be discussed further here.

There is also a special policy form for condominium owners that reflects their ownership interest in the dwelling (which is more than a tenant, but less than a homeowner), as well as personal contents and liability coverages.

2.5 WORKERS COMPENSATION

Workers compensation is an example of an early introduction of no-fault insurance whereby workers gave up their rights to sue their employers in cases of occupational accident or sickness in return for no-fault benefits on a pre-defined or scheduled basis. Workers compensation requirements are defined by legislated statutes in each state or province.

Prior to 1895, it was normally very difficult for a worker to get compensation in case of injury or illness. The worker was forced to sue the employer and prove negligence on the part of the employer. It was normally the case that the worker could not collect compensation if the worker contributed in any way to the injury or sickness (the *doctrine of contributory negligence*), or even if the injury or sickness resulted from the negligence of a fellow worker (the *fellow-servant doctrine*), because it was necessary to show that the employer was at fault. Further, the ability to sue was often restricted if it could be shown that the worker had advance knowledge of the inherent dangers of the job (the *assumption-of-risk doctrine*).

Under current workers compensation laws, which exist in all states and provinces, the employer is deemed to be absolutely liable for the occupational injuries suffered by the worker, regardless of who might be at fault in the eyes of a court of law. In return, the compensation paid to the injured or sick worker is normally limited to the benefit defined in the workers compensation legislation.

Objectives of workers compensation include the following:

- (1) Broad coverage of workers for occupational injury and disease.
- (2) Substantial protection against loss of income.
- (3) Sufficient medical care and rehabilitation services.
- (4) Encouragement of safety. (Most state workers compensation plans, for example, allow experience rating whereby employers with superior claims records pay relatively lower premiums, and vice versa.)
- (5) An efficient and effective delivery system for benefits and services.

In Canada, workers compensation is normally administered by a Workers Compensation Board controlled by the provincial government. In the United States, an employer can satisfy the compulsory workers compensation law by obtaining private insurance (the most common method), by self-insurance, or by use of the state workers compensation fund. Five states offer only a monopolistic state fund.

About 87% of *salaried* workers in the United States are covered by some form of workers compensation. Depending on the state, those not covered include farm labor, domestic servants, casual employment, and employees of some very small firms. Some states also exempt nonprofit educational, charitable, or religious organizations. In two states, employers can “opt-out” of workers compensation. If they do so, they may be subject to litigation by injured employees. Railroad workers in interstate commerce and seamen in the U.S. Merchant Marine are covered under the Federal Employees’ Liability Act with very similar provisions and benefits.

For an injury or sickness to be covered by workers compensation, the injured worker must work in a covered occupation and have experienced an accident or disease that arose out of *and* in the course of employment. Occupational diseases are conditions that develop over an extended period of time due to exposure to some condition related to employment. The definition of disease encompasses a variety of ailments, including hearing loss, carpal tunnel syndrome, and asbestosis. These tend to be more costly on average than traumatic (sudden) injuries,

such as a fall that causes a broken leg, and are often the subject of disagreement concerning the extent to which they are work related and thus are compensable. Examples of injuries that are not covered are those arising out of driving to and from work, employee intoxication, and intentional self-inflicted injuries.

A worker can usually expect the following workers compensation benefits:

- (1) Medical care benefits, which represent about 55% of the workers compensation claims by amount. Workers compensation normally provides unlimited medical care (i.e., there are normally no dollar or time limits).
- (2) Disability income benefits payable to the worker after a waiting period of from 3 to 7 days. If the worker is disabled long enough, then benefits are normally paid retroactively to the date of injury. The weekly benefit is based on a percentage of the worker's average weekly wage (e.g., $66\frac{2}{3}\%$) and the degree of disability. Disability Income benefits are normally non-taxable income. Most states have minimum and maximum weekly benefits, which normally adjust with the state's average industrial wage. The degree of disability is usually classified as one of (a) temporary but total (e.g., two broken arms), (b) permanent and total (e.g., paralysis, for which most states pay lifetime benefits), (c) temporary and partial, (e.g., one broken arm), or (d) permanent but partial. Examples of the latter include the loss of a limb or an eye (for which a set scheduled benefit would be paid), and a back injury (a non-scheduled injury for which some benefit, which is a function of the wages lost, would be paid).
- (3) Death benefits including a burial allowance plus cash-income payments to any eligible surviving dependents.
- (4) Vocational rehabilitation services and benefits. This may include vocational evaluation and training.

In the United States, workers compensation benefits are paid either by insurers or by employers who are "qualified self-insurers." Many large employers are insured, but maintain a large deductible or use retrospective rated plans, which are discussed in Chapter [Five](#). The premium is normally a function of the payroll of the employer, the industry class of the occupation being covered (e.g., lumberjacks are charged a higher rate than bank tellers are), and so on. For small employers, all companies within a defined industry classification are charged the same rate (this is called *class rating*). In some states, the administrative costs of the workers compensation system are paid by the state. Normally, however, in the United States virtually all costs are borne by the employers.

The benefits and eligibility requirements for workers compensation in Canada are almost the same. The primary difference between workers compensation in the United States and Canada is the common use of private insurance in the United States. In most of the rest of the world, workers compensation is almost always administered by a government agency, which also sets the rules for coverage, the rates to be paid, and the level of benefits.

2.6 COMMERCIAL PROPERTY INSURANCE

Homeowners and tenants package policies provide property and liability insurance to individual homeowners and tenants. Businesses also need [property and liability insurance](#). Standard coverages that provide such protection are reviewed in this and the following two sections.

Property insurance is designed to indemnify the insured for loss of, or damage to, buildings and personal property by fire, lightning, windstorm, hail, explosion, and other perils. Coverage may be provided for both the direct loss (i.e., the actual loss represented by the destruction of the property), and the indirect loss (the loss of income and/or extra expenses due to the loss of use of the protected property). Originally only fire was an insured peril, but the number of perils insured against has gradually been expanded until it has reached the present status where even all-risks coverage can be provided, albeit with some exclusions, as previously mentioned.

The [standard fire policy](#) (SFP) is the starting point for all fire insurance coverages. The SFP covers only direct loss from fire and lightning, and at least one additional form must be attached to have a valid policy. Forms used to complete the coverage under the SFP include the following:

- (1) Those that provide personal coverage (dwelling building and contents forms).
- (2) Those that provide commercial coverages (general property, multiple location, and reporting forms).
- (3) Those that increase the covered perils, such as the extended coverage perils of vandalism or malicious mischief, and the optional perils policy.
- (4) Those that increase the covered losses, such as additional living expenses, rental value, rental income, leasehold interests, demolition expenses, consequential loss or damage, replacement costs, business interruption losses, profits and commission losses, and extra expenses.

Types of coverages written by fire insurers on separate policies, rather than by forms attached to the SFP, are called *allied lines*. Principal allied lines include earthquake insurance, rain insurance, sprinkler leakage insurance, water damage insurance, and crop hail insurance. Risk managers of large corporations may design their own forms to meet their own specific needs.

2.7 MARINE INSURANCE

There are two types of *marine insurance*, ocean marine and inland marine insurance. Many *ocean marine insurance* policies are closely related in wording to those originally written at Lloyd's Tea House more than 200 years ago. Similarly, when insurance forms and policies were needed for the trucking industry, modifications of marine insurance forms were used. Thus developed the name *inland marine insurance* for the trucking industry.

Marine insurance, like other property insurance, is designed to protect against financial loss resulting from damage to, or destruction of, owned property, except that here the covered perils are primarily those connected with transportation.

Ocean marine insurance policies provide coverage on all types of oceangoing vessels and their cargoes. Policies are also written to cover the ship-owners liability. The coverage of the basic policy applies to cargo only after it has been loaded onto the ship, but policies are frequently endorsed to provide coverage from "warehouse to warehouse," thus protecting against overland transportation hazards as well as those of the ocean.

Risks eligible for coverage under inland marine forms include the following:

- (1) Domestic shipments including goods being transported by railroads, motor vehicles, or ships and barges on the inland waterways and in coastal trade. In addition, provision is made for insuring goods transported by air, mail, parcel post, express, armored car, or messenger.
- (2) Instrumentalities of transportation and communication such as bridges, tunnels, piers, wharves, docks, communication equipment, and movable property.
- (3) Personal property floater risks used for coverage of construction equipment, personal jewelry and furs, agricultural equipment, and animals.

2.8 LIABILITY INSURANCE

In Sections 2.2 and 2.3, we pointed out that liability is an important coverage within both auto and homeowners insurance, and it provides two levels of security for the policyholder. First, in the case of injury to a third party or in the case of damage to the property of a third party, where negligence was alleged against the policyholder, the insurer will defend the policyholder in court, if necessary, but the insurer can stop the defense when the amounts paid for damages equal the limits of the policy. Further, if the policyholder were found to be negligent and at fault, and damages were assessed to be paid to the third party for injury or property damage, then the insurer would pay these damages within the policy limits. Note that payment of damages plus the cost to defend can, and often do, exceed the stated policy limits. As stated earlier, most cases are settled out of court.

Examples of **liability insurance** sold as a separate coverage include *product liability insurance*, *errors and omissions insurance*, *medical malpractice insurance*, *professional liability insurance*, *directors and officers liability*, *employment practices liability*, *cyberliability*, and others of a similar nature.

These coverages are characterized by low claim frequency but high value claims that often are reported many years after occurrence and take many years to settle once they are reported. In order to make these coverages more predictable by reducing the time delays, some are insured on a claims-made policy form. Under **claims-made**, only claims that occurred after a specific date and are reported during the policy period are covered. **Tail coverage** is sold for claims occurring during the period, but which are reported after the final policy period provided by the insurer.

A second characteristic of these claims is the potential for high litigation cost. In order to reduce their risk, insurers sometimes include defense within the policy limit. Therefore if there is a \$2 million limit, that amount covers both defense cost and indemnity payment. If the limit is exhausted by defense costs, the insurer can withdraw.

2.9 LIMITS TO COVERAGE

In all of the types of insurance outlined in this chapter there have been limits to coverage. More specifically, these limits included deductibles as well as policy limits (both overall and some inside limits). We now discuss the reasons for such limits, and some of the problems associated with them.

2.9.1 DEDUCTIBLES

Reasons for **deductibles** include the following:

- (1) Small losses do not create a claim, thus saving the associated expenses.
- (2) For larger losses, the average claim payment is reduced by the amount of the deductible which is translated into premium savings.
- (3) The fact that the deductible puts the policyholder at risk provides an economic incentive for the policyholder to prevent a claim.
- (4) The policyholder can optimize the use of limited premium dollars by using the deductible to save money where the value of the coverage is not as great (i.e., in terms of its utility).

Problems associated with deductibles include the following:

- (1) The insured may be disappointed that losses are not paid in full. Certainly, deductibles increase the risk for which the insured remains responsible.
- (2) Deductibles can lead to misunderstandings and bad public relations.
- (3) Deductibles may make the marketing of the coverage more difficult.
- (4) The insured may inflate the claim to recover the deductible, which is unfair to the honest policyholders who will pay the resulting higher premium.

There are several types of deductibles, including the following:

- (1) **Fixed dollar deductibles**, which apply to each claim.
- (2) **Fixed percentage deductibles**, which may be a percentage of either the loss or the policy limit, that apply to each claim. A fixed percentage deductible is usually combined with a minimum dollar deductible so the insurer does not need to handle small claims.

- (3) A *disappearing deductible*, as explained in Section 2.3 on homeowners insurance. If the loss is less than a dollars, the insurer pays nothing. If the loss exceeds b dollars, then the insurer pays the loss in full. If the loss is between a and b , then the deductible is reduced pro rata or linearly between a and b (see Example 2.1). The complexity of the disappearing deductible and the difficulty in making it understandable has resulted in its decreasing use.
- (4) A *franchise deductible*, whereby if the loss is less than n dollars the insurer pays nothing, but if the loss equals or exceeds n the claim is paid in full. This is just a *cliff disappearing deductible*. This type of deductible used to be common in ocean marine insurance, but is seldom used today.
- (5) Health insurance policies or medical expense insurance policies (not discussed in this book) often use a *fixed dollar deductible per calendar year* (as opposed to a per loss deductible). Often the policyholder is able to choose among a variety of deductibles with the premium going down as the deductible goes up. This deductible can sometimes be a dollars for an individual policyholder, but b dollars for a family under family coverage. This type of deductible is not widely used outside of health insurance.
- (6) Disability income and sickness insurance benefits often have an *elimination period*, which is the period from the time of the disablement to the date that disability benefits begin. This is common in *workers compensation*. Sometimes the elimination period differs depending upon whether the cause of the disability is an accident or a sickness. If so, it is common to have a shorter elimination period for accidents than for sicknesses. As noted in Section 2.5 on workers compensation, if the disability continues beyond a defined period of time, benefits will then be paid retroactively to the first day of disability. If the retroactive qualification period equals the elimination period, this arrangement is equivalent to a franchise deductible.

2.9.2 POLICY LIMITS

An insurer can have a variety of reasons for placing a *limit* on the coverage provided in a policy, including the following:

- (1) The limit clarifies the insurer's obligation. (Note that workers compensation medical coverage is unlimited.)
- (2) In the context of risk, setting a policy limit provides an upper bound to the loss distribution for the insurer and lessens the risk assumed by the insurer. This, in turn, decreases the probability of insurer insolvency. Having policy limits also decreases the premium that must be charged for the basic coverage.

- (3) Having policy limits allows the policyholder to choose appropriate coverage at an appropriate price (the premium will be lower for lower policy limits).

As has been discussed throughout this chapter, a policy can have more than one limit, and, overall, there is more than one way to provide for policy limits. In a homeowners policy, for example, there will be a defined limit for the liability coverage. The **dwelling coverage** will be limited by the value of the dwelling determined by the policyholder and the agent. The **contents coverage** limit is a percentage of the dwelling limit. There will be scheduled limits on the coverage provided for jewelry, silverware, and so on. There can also be inside limits for other coverages, such as a limit on the insurance for stolen cash.

Remember that the total of all loss adjustment expenses (e.g., legal costs) and the payment of damages can exceed the policy limit. For most policies, only the payment of damages is subject to the policy limits. However, some commercial liability policies are now written with defense inside the policy limits; this is used for coverages with exceptionally high litigation rates, e.g., products liability coverage.

2.10 CONCLUSION

This chapter has provided a generic description of several of the most important insurance coverages provided by property/casualty insurers. The descriptions were very general, and should apply to these coverages worldwide. The coverages described are only a sample of coverages available. Other coverages include ***boiler and machinery insurance***, ***contract surety insurance***, ***business interruption insurance***, and many others. Each coverage has its own particular policy legal requirements and limits, and, as a result, each has its own unique ratemaking methodology.

Readers of this textbook are encouraged to review their own auto and homeowners (or tenants package) policies carefully to understand the legal restrictions that exist within their own coverages.