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Chapter 2
Insurance and Risk

■ Teaching Note

Risk was defined in Chapter 1. This chapter opens with a definition of insurance. You may want to stress the essential elements included in the definition: pooling, fortuitous loss, transfer, and indemnification. Pooling naturally leads to a discussion of the law of large numbers, which you can discuss in relation to objective risk, which was covered in Chapter 1. Of course certain perils are difficult to insure privately. Comparing a readily insurable peril (fire, for example) with a peril that's difficult to insure (flood, for example) while citing the discussing the characteristics of an ideally insurable risk is effective.

Adverse selection is often misunderstood by students. It's not "high risk people buying insurance"—that happens all the time. If they are identified and properly rated, there's no adverse selection. Adverse selection occurs when higher-than-average risks attempt to purchase insurance at the average cost. Undetected, the insurer's losses will be higher than expected. Insurers use underwriting and contractual provisions to address this problem.

You may want to spend some time comparing gambling and insurance, again citing concepts from Chapter 1. Gambling creates a new speculative risk, while insurance addresses a pure risk that is already present. Gambling does have a similarity to insurance in one respect, application of the law of large numbers. Most casino gambling is done through repetitive small wagers rather than a few large wagers. The casino's actual results should approach its expected results through the application of the law of large numbers.

The chapter closes with an overview of the types of insurance and the costs and benefits of insurance to society. The benefits of insurance should be discussed, including the enhancement of credit. Try to borrow money to purchase a house without having physical damage insurance on the home, which serves as collateral for the loan. You may want to include some examples from the "Hall of Shame" when you discuss fraudulent claims, a cost of insurance to society. You may want to note that the benefits of insurance to society far outweigh the costs.

■ Outline

I. Definition of Insurance

II. Basic Characteristics of Insurance

A. Pooling of losses

B. Payment of fortuitous losses

C. Risk transfer

D. Indemnification

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III. Characteristics of an Ideally Insurable Risk

A. General Requirements
   1. Large number of exposure units
   2. Accidental and unintentional loss
   3. Determinable and measurable loss
   4. No catastrophic loss
   5. Calculable chance of loss
   6. Economically feasible premium

B. Application of the Characteristics
   1. The risk of fire to a private dwelling satisfies the requirements.
   2. The risk of unemployment does not completely meet all requirements.

C. Adverse Selection and Insurance
   1. Nature of adverse selection
   2. Consequences of adverse selection

IV. Insurance and Gambling Compared

A. Insurance addresses an existing pure risk, while gambling creates a new speculative risk.

B. Insurance is socially productive, while gambling is socially unproductive.

V. Insurance and Hedging Compared

A. Insurance transfers a pure risk, while hedging involves the transfer of a speculative risk.

B. Moral hazard and adverse selection are more severe problems for insurers than for speculators who buy or sell futures contracts.

VI. Types of Insurance

A. Private Insurance
   1. Life insurance
   2. Health insurance
   3. Property and liability insurance

B. Government Insurance
   1. Social insurance
   2. Other government insurance programs

VI. Social Benefits and Costs of Insurance

A. Benefits of Insurance to Society
   1. Indemnification for loss
   2. Reduction of worry and fear
   3. Source of investment funds
   4. Loss prevention
   5. Enhancement of credit

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B. Costs of Insurance to Society
   1. Cost of doing business
   2. Fraudulent claims
   3. Inflated claims

■ Answers to Case Application

a. This is not insurance. Although the risk of a defective television set is transferred to the manufacturer, there is no pooling of losses.

b. This is not insurance. Although the risk of defective tires for the first 50,000 miles is transferred to the manufacturer, there is no pooling of losses.

c. This guarantee is not insurance. Although the risk of a defective home is transferred to the builder, there is no pooling of losses, which is the essence of insurance. Any losses would fall directly on the builder.

d. This is not insurance. The risk of default has been transferred to the cosigner. If the debtor defaults, the cosigner must make the payments. The loss would fall directly on the cosigner, and there is no pooling of losses.

e. The elements of insurance are present here. First, risk transfer is present; the homeowner transfers the risk of fire to the group. Second, pooling of losses is also present. Pooling is the essence of insurance. Fire losses would be pooled over the entire group, and average loss is substituted for actual loss. Third, fire losses generally are fortuitous. Finally, the homeowner would be indemnified for any loss.

■ Answers to Review Questions

1. Insurance plans have four distinct characteristics:
   (a) *Pooling.* Losses incurred by the few are spread over the entire group so that in the process, average loss is substituted for actual loss.
   (b) *Fortuitous loss.* Insurance plans provide for the payment of fortuitous losses. A fortuitous loss is one that is unforeseen and unexpected, and occurs as a result of chance.
   (c) *Risk transfer.* In private insurance, a pure risk is transferred from the insured to the insurer, which is typically in a better financial position to pay the loss than the insured.
   (d) *Indemnification.* Compensation is given to the victim of a loss, in whole or in part, by payment, repair, or replacement.

2. The law of large numbers states that the greater the number of exposures, the more closely the actual results will approach the probable results expected from an infinite number of exposures. As the number of exposures increases, the relative variation of actual loss from expected loss will decline. Thus, the insurer can predict future losses with a greater degree of accuracy as the number of exposures increases. This is important, since an actuary must charge a premium that is adequate for paying all losses and expenses during the policy period. The lower the degree of objective risk, the more confidence an insurer has that the actual premium charged will be sufficient to pay all claims and expenses and leave a margin for profit.

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3. There are several requirements of an ideally insurable risk:
   (a) There must be a large number of exposure units.
   (b) The loss must be accidental and unintentional.
   (c) The loss must be determinable and measurable.
   (d) The loss should not be catastrophic.
   (e) The chance of loss must be calculable.
   (f) The premium must be economically feasible.

4. Insurers can deal with the problem of a catastrophe loss by (1) reinsurance, (2) avoiding the concentration of risk by dispersing coverage over a large geographical area, and (3) use of certain financial instruments in the capital markets, such as catastrophe bonds.

5. These risks are generally uninsurable for several reasons. First, many of these risks are speculative risks, which are difficult to insure privately. Second, the potential for a catastrophic loss is great; this is particularly true for political risks, such as the risk of war. Finally, calculation of the correct premium may be difficult because the chance of loss cannot be accurately estimated.

6. (a) Adverse selection is the tendency for persons with a higher-than-average chance of loss to seek insurance at standard (average) rates, which, if not controlled by underwriting, results in higher-than-expected loss levels.
   (b) Adverse selection can be controlled by careful underwriting, by charging higher premiums to substandard applicants for insurance, and by certain policy provisions.

7. Insurance differs from gambling in two ways. First, gambling creates a new speculative risk that did not exist before, while insurance is a technique for handling an already existing pure risk. Second, gambling is socially unproductive, since the winner's gain comes at the expense of the loser. Insurance is always socially productive, since both the insured and insurer win if the loss does not occur.
8. Insurance differs from hedging. An insurance transaction usually involves the transfer of risks that are insurable, since the requirements of an insurable risk can generally be met. Hedging is a technique for handling risks that are typically uninsurable, such as protection against a substantial decline in the price of commodities. A second difference is that moral hazard and adverse selection are more severe problems for insurers than for speculators who buy or sell futures contracts.

9. (a) The major fields of private insurance are life insurance, health insurance, and property and liability insurance (also called property and casualty insurance).
   (b) Property and casualty coverages can be divided into personal lines and commercial lines. Personal lines include private passenger auto insurance, homeowners insurance, personal umbrella liability insurance, earthquake insurance, and flood insurance.

   Commercial lines include fire and allied lines insurance, commercial multiple peril insurance, general liability insurance, products liability insurance, workers compensation insurance, commercial auto insurance, accident and health insurance, inland marine and ocean marine insurance, professional liability insurance, directors and officers liability insurance, boiler and machinery insurance (also known as equipment breakdown insurance), fidelity and surety bonds, and crime insurance.

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10. (a) Social insurance programs are government insurance programs with certain characteristics. The programs are enacted into law to deal with social and economic problems. The programs generally are compulsory and financed by contributions from covered employers and employees; benefits are paid from specifically earmarked funds; benefits are skewed or weighted in favor of lower income groups; benefit amounts generally are related to the covered individual's earnings; and eligibility requirements and benefit rights are prescribed by statute.

    (b) Major social insurance programs are the following:

    - Old-age, survivors, and disability insurance (Social Security)
    - Medicare
    - Unemployment insurance
    - Workers compensation
    - Compulsory temporary disability insurance
    - Railroad Retirement Act

■ Answers to Application Questions

1. (i) Risk of fire
    (a) *Large number of exposure units.* This is generally met, since there are millions of homes that are insured.
    (b) *Accidental and unintentional loss.* This requirement is generally met, since most insureds do not deliberately start a fire.
    (c) *Determinable and measurable loss.* A fire loss can be determined and measured. In case of disagreement, a property insurance policy has a provision for resolving disputes.
    (d) *No catastrophic loss.* This requirement is met, since most homes do not burn at the same time.
    (e) *Calculable chance of loss.* Insurers can estimate within ranges the probability of a fire loss.
    (f) *Economically feasible premium.* For most insureds, this requirement is fulfilled.

    (ii) Risk of war
    (a) *Large number of exposure units.* This requirement is not fulfilled. Based on the law of large numbers, it is difficult to estimate accurately the number of wars that will occur.
    (b) *Accidental and unintentional loss.* This requirement is not met. Most wars are not accidental, and losses are intentional.
    (c) *Determinable and measurable loss.* Although a war loss can be determined, the measurement of loss would be difficult.
    (d) *No catastrophic loss.* This requirement is not fulfilled, since large numbers of exposure units would simultaneously incur losses.
    (e) *Calculable chance of loss.* This requirement cannot be easily met.
    (f) *Economically feasible premium.* Because of the catastrophic potential of war, the premiums would not be economically feasible.

2. (a) (1) Indemnification means that insureds are restored to their former financial position after a loss occurs, either partly or wholly. As a result, individuals and families can maintain their economic security and are less likely to apply for public assistance or welfare, or seek financial assistance from relatives and friends.

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(2) Insurance makes a borrower a better credit risk because it guarantees the value of the borrower's collateral, or gives greater assurance that the loan will be repaid. For example, life insurance can be used to pay off a bank loan if the creditor dies prematurely, and so makes the creditor a better credit risk. Property insurance secures the collateral for a loan. If money is borrowed for the purchase of a home, the lender commonly requires property insurance on the home in case the home is damaged or destroyed.

(3) Premiums are collected in advance, and funds not needed to pay immediate losses and expenses can be invested in financial securities issued by business firms and government units. These funds typically are invested in capital goods, such as housing developments, shopping centers, new plants, machinery and equipment, and local government projects, such as water treatment plants. Since the stock of capital goods is increased, economic growth and full employment are promoted. In addition, since the supply of loanable funds is increased, the cost of capital to business firms is lower than it would be in the absence of insurance.

(b) The major social and economic costs of insurance are the following:

- Cost of doing business
- Fraudulent claims
- Inflated claims

3. (a) Ideal requirements of a privately insurable risk:

- Large number of exposure units
- Accidental and unintentional loss
- Determinable and measurable loss
- No catastrophic losses
- Calculable chance of loss
- Economically feasible premium

(b) The requirement of not having a catastrophic loss is not met because large numbers of exposure units in a flood zone would be incurring losses at the same time. Also, the requirement of an economically feasible premium generally is not met. Without a government backup, premiums for flood insurance in major flood zones generally would be unaffordable for many insureds.

4. (a) Life insurance can provide the needed funds for a college education.

(b) Auto liability insurance will protect the parents if Danielle negligently injures someone while driving a family car.

(c) An individual or group disability income policy will provide periodic income payments if Jacob becomes totally disabled.

(d) A homeowners policy will provide the desired protection. Windstorm and hurricanes are covered perils.

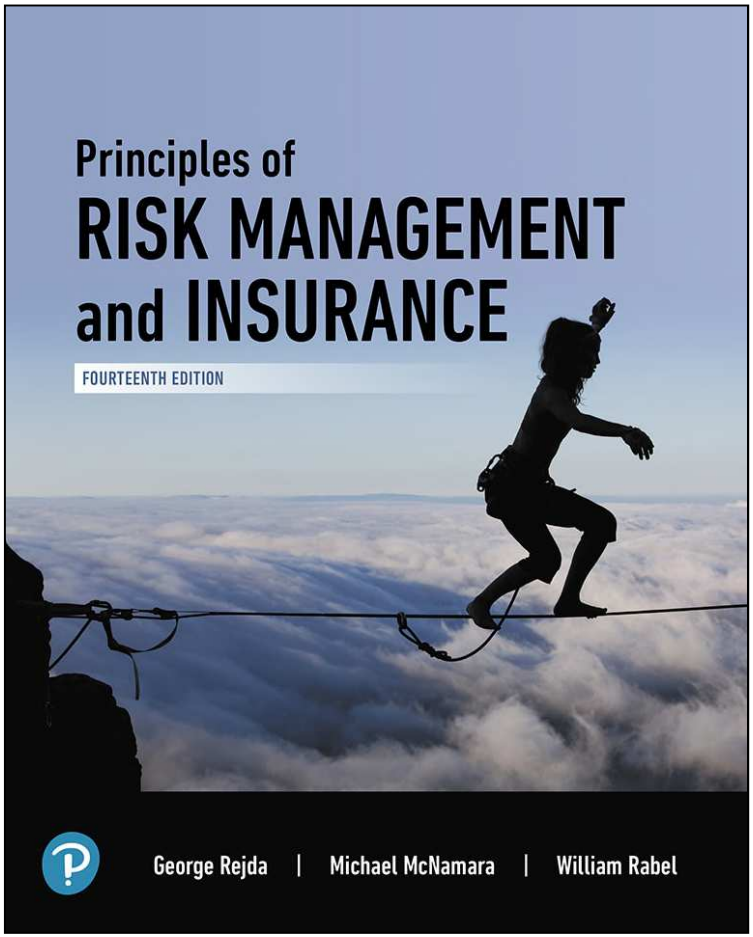
(e) A commercial general liability insurance policy will cover Nathan if a customer is injured in his store.

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Chapter 2 Appendix

Basic Statistics and the Law of Large Numbers

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Probability and Statistics (1 of 4)

- The **probability** of an event is the long-run relative frequency of the event, given an infinite number of trials with no changes in the underlying conditions.
- Probabilities can be summarized through a probability distribution
  - Distributions may be discrete or continuous
- A probability distribution is characterized by:
  - A mean, or measure of central tendency
  - A variance, or measure of dispersion

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Probability and Statistics (2 of 4)

- The mean (μ) or expected value = $\sum X_i P_i$
- For example,

Amount of Loss (X_i)		Probability of Loss (P_i)		$X_i P_i$
\$0	×	0.30	=	\$0
\$360	×	0.50	=	\$180
\$600	×	0.20	=	\$120
		$\sum X_i P_i$	=	\$300

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Probability and Statistics (3 of 4)

- The variance of a probability distribution is:

$$\sigma^2 = \sum P_i \left(X_i - EV \right)^2$$

- For the previous loss distribution,

$$\begin{aligned}\sigma^2 &= 0.30(0-300)^2 + 0.50(360-300)^2 + 0.20(600-300)^2 \\ &= 27{,}000 + 1{,}800 + 1{,}800 \\ &= 46{,}800\end{aligned}$$

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Probability and Statistics (4 of 4)

- The standard deviation = $\sqrt{\sigma^2} = \sigma = 216.33$
- Higher standard deviations, relative to the mean, are associated with greater uncertainty of loss; therefore, the risk is greater

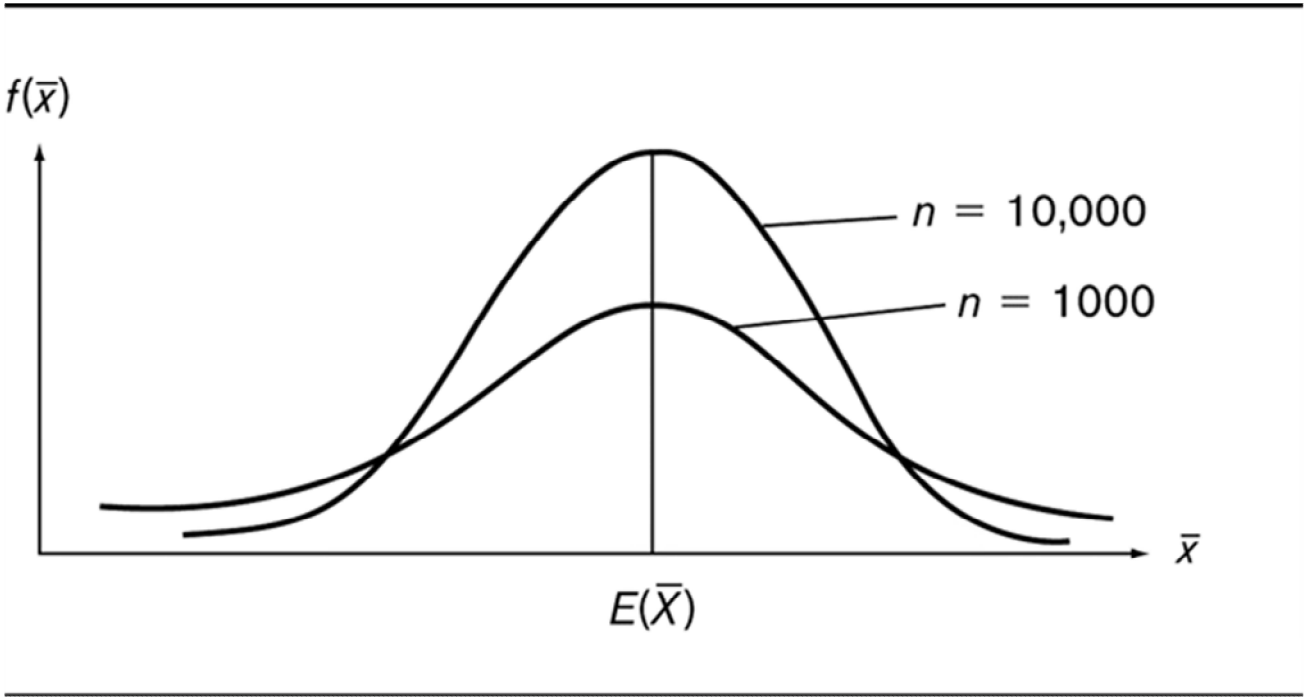
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Law of Large Numbers (1 of 2)

- The **law of large numbers** is the mathematical foundation of insurance.
- Average losses for a random sample of *n* exposure units will follow a normal distribution because of the Central Limit Theorem.
  - Regardless of the population distribution, the distribution of sample means will approach the normal distribution as the sample size increases.
  - The standard error of the sampling distribution can be reduced by increasing the sample size

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Exhibit A2.1 Sampling Distribution Versus Sample Size

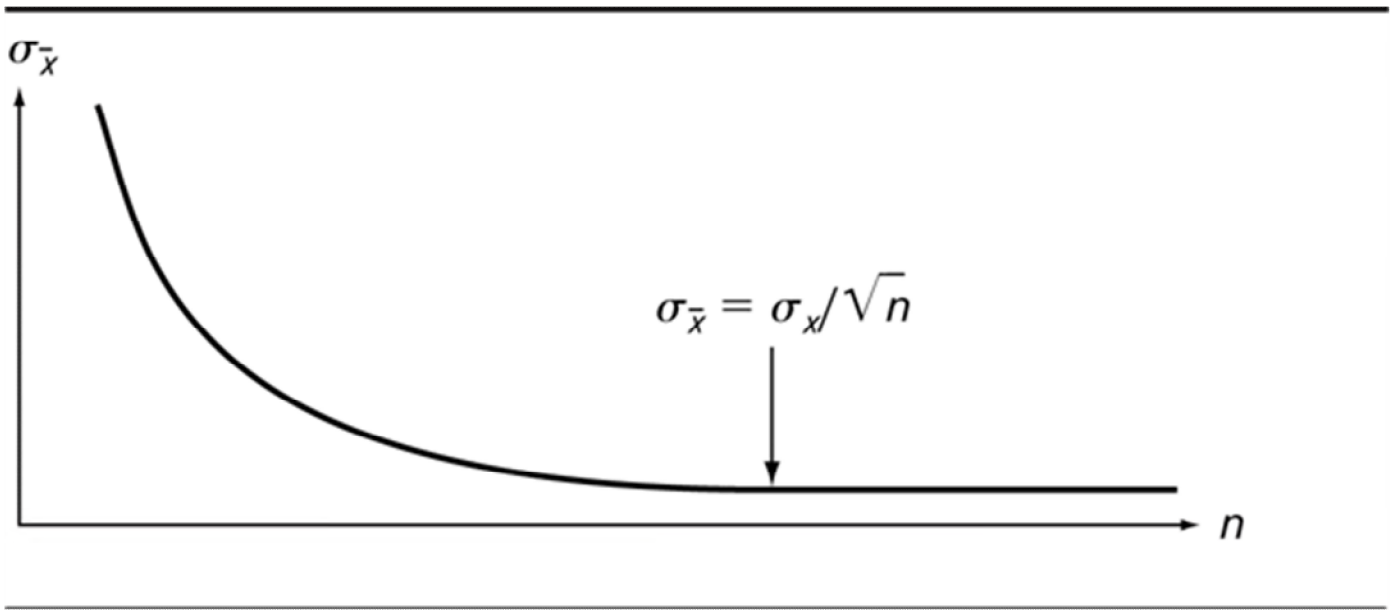


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Exhibit A2.2 Standard Error of the Sampling Distribution Versus Sample Size



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Law of Large Numbers (2 of 2)

- When an insurer increases the size of the sample of insureds:
  - Underwriting risk increases, because more insured units could suffer a loss.
  - But, underwriting risk does not increase proportionately. It increases by the square root of the increase in the sample size.
  - There is “safety in numbers” for insurers!

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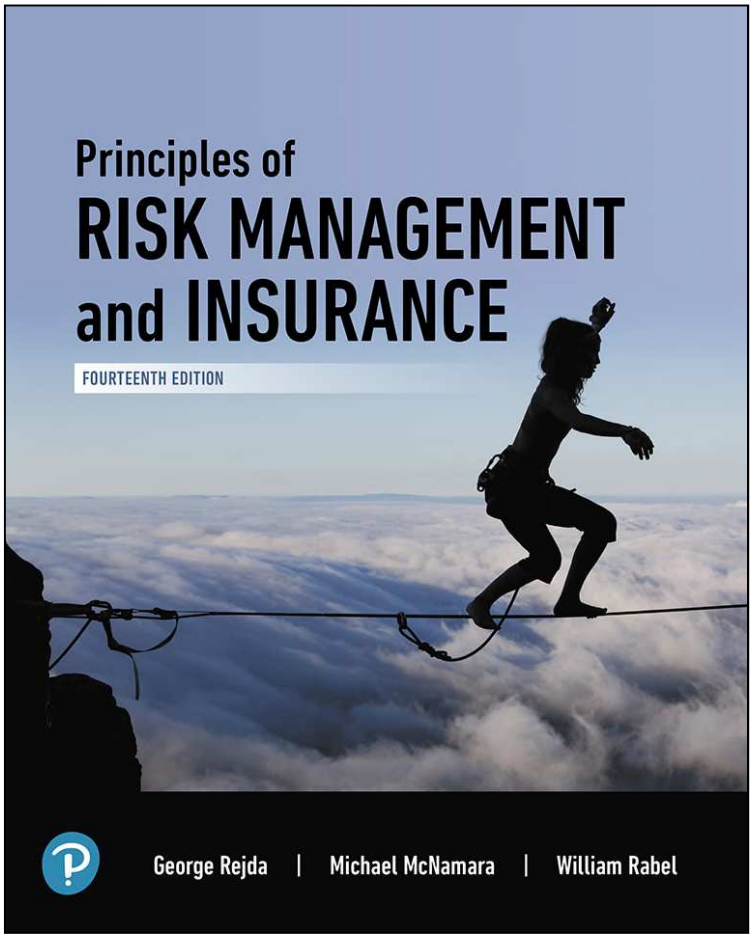
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Chapter 2

Insurance and Risk

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Learning Objectives (1 of 3)

2.1 a. Define insurance based on the definition drafted by the Commission on Insurance Terminology.

b. Explain the basic characteristics of insurance based on the aforementioned definition.

2.2 Explain the law of large numbers.

2.3 a. Describe the characteristics of an ideally insurable risk from the viewpoint of a private insurer.

b. Explain whether fire and unemployment meet the requirements of an insurable risk.

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Learning Objectives (2 of 3)

2.4 a. Understand how adverse selection can lead to higher-than-expected losses and unprofitable business for insurers.

b. Explain the methods insurers use to control adverse selection.

2.5 a. Show how insurance is not the same thing as gambling.

b. Understand how insurance differs from hedging as a technique for treating risk.

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Learning Objectives (3 of 3)

2.6 a. Identify the major types of private insurance companies operating in the United States today.

b. Identify important social insurance programs in the United States.

c. Identify other government insurance programs in the United States at the federal and state levels.

2.7 a. Explain the social and economic benefits of insurance to society.

b. Explain the costs of insurance to society.

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Definition of Insurance

- **Insurance** is the **pooling** of **fortuitous losses** by transfer of such risks to insurers, who agree to **indemnify** insureds for such losses, to provide other pecuniary benefits on their occurrence, or to render services connected with the risk

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Basic Characteristics of Insurance (1 of 4)

- An insurance plan or arrangement typically includes the following characteristics:
  - Pooling of losses
  - Payment of fortuitous losses
  - Risk transfer
  - indemnification
- Pooling involves spreading losses incurred by the few over the entire group

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Basic Characteristics of Insurance (2 of 4)

- Example of Pooling:
  - Two business owners own identical buildings valued at $50,000
  - There is a 10 percent chance each building will be destroyed by a peril in any year
  - Loss to either building is an independent event
  - Expected value and standard deviation of the loss for each owner is:

$$\textbf{Expected loss} = 0.90 \times \$0 + 0.10 \times \$50{,}000 = \$5{,}000$$

$$\textbf{Standard deviation} = \sqrt{0.90(0 - \$5{,}000)^2 + 0.10(\$50{,}000 - \$5{,}000)^2}$$

$$= \$15{,}000$$

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Basic Characteristics of Insurance (3 of 4)

- Example, continued:
  - If the owners instead pool (combine) their loss exposures, and each agrees to pay an equal share of any loss that might occur:

$$\text{Expected loss} = 0.81 \times \$0 + 0.09 \times \$25{,}000 + 0.09 \times \$25{,}000 + 0.01 \times \$50{,}000$$
$$= \$5{,}000$$

$$\text{Standard deviation} = \sqrt{0.81(0 - \$5{,}000)^2 + (2)(0.09)(\$25{,}000 - \$5{,}000)^2 + 0.01(\$50{,}000 - \$5{,}000)^2}$$
$$= \$10{,}607$$

  - As additional individuals are added to the pool, the standard deviation continues to decline while the expected value of the loss remains unchanged

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Law of Large Numbers

- Risk reduction is based on the **Law of Large Numbers**
- According to the Law of Large Numbers, the greater the number of exposures, the more closely will the actual results approach the probable results that are expected from an infinite number of exposures.

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Basic Characteristics of Insurance (4 of 4)

- Payment of fortuitous losses
  - A **fortuitous loss** is one that is unforeseen, unexpected, and occur as a result of chance
- **Risk transfer**
  - A pure risk is transferred from the insured to the insurer, who typically is in a stronger financial position
- **Indemnification**
  - The insured is restored to his or her approximate financial position prior to the occurrence of the loss

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Characteristics of an Ideally Insurable Risk (1 of 3)

- Large number of exposure units
  - to predict average loss based on the law of large numbers
- Accidental and unintentional loss
  - to assure random occurrence of events
- Determinable and measurable loss
  - to determine how much should be paid

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Characteristics of an Ideally Insurable Risk (2 of 3)

- No catastrophic loss
  - to allow the pooling technique to work
  - exposures to catastrophic loss can be managed by using **reinsurance**, dispersing coverage over a large geographic area, or using financial instruments, such as catastrophe bonds
- Calculable chance of loss
  - to establish a premium that is sufficient to pay all claims and expenses and yields a profit during the policy period

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Characteristics of an Ideally Insurable Risk (3 of 3)

- Economically feasible premium
  - so people can afford to purchase the policy
  - For insurance to be an attractive purchase, the premiums paid must be substantially less than the face value, or amount, of the policy
- Based on these requirements:
  - Most personal, property and liability risks can be insured
  - Market risks, financial risks, production risks and political risks are difficult to insure

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Exhibit 2.1 Fire as an Insurable Risk

Requirements	Does the risk of fire satisfy the requirements?
1. Large number of exposure units	Yes. Numerous exposure units are present.
2. Accidental and unintentional loss	Yes. With the exception of arson, most fire losses are accidental and unintentional.
3. Determinable and measurable loss	Yes. If there is disagreement over the amount paid, a property insurance policy has provisions for resolving disputes.
4. No catastrophic loss	Yes. Although catastrophic fires have occurred, all exposure units normally do not burn at the same time.
5. Calculable chance of loss	Yes. Chance of fire can be calculated, and the average severity of a fire loss can be estimated in advance.
6. Economically feasible premium	Yes. Premium rate per $100 of fire insurance is relatively low.

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Exhibit 2.2 Unemployment as an Insurable Risk

Requirements	Does the risk of unemployment satisfy the requirements?
1. Large number of exposure units	Not completely. Although there are a large number of employees, predicting unemployment is often difficult because of the different types of unemployment and different types of labor.
2. Accidental and unintentional loss	Not always. Some unemployment is due to individuals who voluntarily quit their jobs.
3. Determinable and measurable loss	Not completely. The level of unemployment can be determined, but the measurement of loss may be difficult. Most unemployment is involuntary because of layoffs or because workers have completed temporary jobs. However, some unemployment is voluntary; workers voluntarily change jobs because of higher wages, a change in careers, family obligations, relocation to another state, or other reasons.
4. No catastrophic loss	No. A severe national recession or depressed local business conditions in a town or city could result in a catastrophic loss.
5. Calculable chance of loss	Not completely. The different types of unemployment in specific occupations can make it difficult for actuaries to estimate the chance of loss accurately.
6. Economically feasible premium	Not completely. Adverse selection, moral hazard, policy design, and the potential for a catastrophic loss could make the insurance too expensive to purchase. Some plans, however, will pay unemployment benefits in certain cases where the unemployment is involuntary, and the loss payments are relatively small, such as waiver of life insurance premiums for six months, or payment of credit card minimum payments for a limited period.

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Adverse Selection and Insurance

- **Adverse selection** is the tendency of persons with a higher-than-average chance of loss to seek insurance at standard rates
- If not controlled by underwriting, adverse selection results in higher-than-expected loss levels
- Adverse selection can be controlled by:
  - careful **underwriting** (selection and classification of applicants for insurance)
  - policy provisions (e.g., suicide clause in life insurance)

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Insurance and Gambling Compared

Insurance

- Handles an already existing pure risk
- Is always socially productive:
  - both parties have a common interest in the prevention of a loss

Gambling

- Creates a new speculative risk
- Is not socially productive
  - The winner's gain comes at the expense of the loser

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Insurance and Hedging Compared

Insurance

- Risk is transferred by a contract
- Involves the transfer of pure (insurable) risks
- Moral hazard and adverse selection are more severe problems for insurers

Hedging

- Risk is transferred by a contract
- Involves risks that are typically uninsurable
- Fewer problems of moral hazard and adverse selection for entities who buy or sell futures contracts

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Types of Insurance (1 of 5)

- Insurance can be classified as either private or government insurance
  - Private insurance includes life and health insurance as well as property and liability insurance
  - Government insurance includes social insurance programs and other government insurance plans

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Types of Insurance (2 of 5)

- Life and Health
  - **Life insurance** pays death benefits to beneficiaries when the insured dies
  - **Health insurance** covers medical expenses because of sickness or injury

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Types of Insurance (3 of 5)

- Property and Liability
  - **Property insurance** indemnifies property owners against the loss or damage of real or personal property
  - **Liability insurance** covers the insured's legal liability arising out of property damage or bodily injury to others
  - **Casualty insurance** refers to insurance that covers whatever is not covered by fire, marine, and life insurance

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Types of Insurance (4 of 5)

- Private insurance coverages can be grouped into two major categories
  - Personal lines: coverages that insure the real estate and personal property of individuals and families or provide protection against legal liability
  - Commercial lines: coverages for business firms, nonprofit organizations, and government agencies

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Types of Insurance (5 of 5)

- Social Insurance Programs
  - Financed entirely or in large part by contributions from employers and/or employees
  - Benefits are heavily weighted in favor of low-income groups
  - Eligibility and benefits are prescribed by statute
  - Examples: Social Security, Unemployment, Workers Comp
- Other Government Insurance Programs
  - Found at both the federal and state level
  - Examples: Federal flood insurance, state health insurance pools

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Benefits of Insurance to Society

- Indemnification for Loss
- Reduction of Worry and Fear
- Source of Investment Funds
- Loss Prevention
- Enhancement of Credit

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Costs of Insurance to Society (1 of 2)

- The major social costs of insurance include:
  - Cost of Doing Business
    - An **expense loading** is the amount needed to pay all expenses, including commissions, general administrative expenses, state premium taxes, acquisition expenses, and an allowance for contingencies and profit
  - Fraudulent Claims
  - Inflated Claims

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Costs of Insurance to Society (2 of 2)

- Higher premiums to cover additional losses reduce disposable income and consumption of other goods and services

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