Chapter One

Risk and Related Topics

Definition of Risk

There is no single definition of risk. Economists, behavioral scientists, risk theorists, statisticians, actuaries, and historians each have their own concept of risk.

Traditional Definition of Risk

Risk traditionally has been defined in terms of uncertainty. Based on this concept, risk is defined as uncertainty concerning the occurrence of a loss. *For example*, the risk of being killed in an auto accident is present because uncertainty is present. The risk of lung cancer for smokers is present because uncertainty is present. The risk of flunking a required college course is present because uncertainty is present.

Employees in the insurance industry often use the term risk in a different manner to identify the property or life that is being considered for insurance. For example, in the insurance industry, it is common to hear statements such as *"That driver is a poor risk"* or *"That building is an unacceptable risk."*

Risk Distinguished from Uncertainty

In the economics and finance literature, authors and actuaries often make a distinction between risk and uncertainty. According to the American Academy of Actuaries, the term **risk** is used in situations where the probabilities of possible outcomes are known or can be estimated with some degree of accuracy, whereas **uncertainty** is used in situations where such probabilities cannot be estimated. For example, the probability of dying at each attained age can be estimated with considerable accuracy. In contrast,

the probability of destruction of your home by a meteorite from outer space is only a guess and generally cannot be accurately estimated. As such, many authors have developed their own concept of risk, and numerous definitions of risk exist in the professional literature.

Loss Exposure

Because risk is an ambiguous term and has different meanings, many authors and corporate risk managers use the term loss exposure to identify potential losses. A loss exposure is any situation or circumstance in which a loss is possible, regardless of whether a loss actually occurs. Examples of loss exposures include manufacturing plants that may be damaged by an earthquake or flood, defective products that may result in lawsuits against the manufacturer, possible theft of company property because of inadequate security, and potential injury to employees because of unsafe working conditions.

Finally, when the definition of risk includes the concept of uncertainty, some authors make a careful distinction between objective risk and subjective risk.

Objective Risk

Objective risk (also called ***degree of risk***) is defined as the relative variation of actual loss from expected loss.

For example, assume that a property insurer has 10,000 houses insured over a long period and, on

average, 1 percent, or 100 houses, burn each year. However, it would be rare for exactly 100 houses to burn each year. In some years, as few as 90

houses may burn; in other years, as many as 110 houses may burn. Thus, there is a variation of 10 houses from the expected number of 100, or a variation of 10 percent.

This ***relative variation*** of actual loss from expected loss is known as objective risk. Objective risk declines as the number of exposures increases. More specifically, objective risk varies inversely with the square root of the number of cases under observation. In the previous example, 10,000 houses were insured, and objective risk was 10/100, or 10 percent. Now assume that 1 million houses are insured. The expected number of houses that will burn is now 10,000, but the variation of actual loss from expected loss is only 100. Objective risk is now 100/10,000, or 1 percent. Thus, as the square root of the number of houses increased from 100 in the first example to 1,000 in the second example (10 times), objective risk declined to one-tenth of its former level.

Objective risk can be statistically calculated by some measure of dispersion, such as the standard deviation or the coefficient of variation. Because objective risk can be measured, it is an extremely useful concept for an insurer or a corporate risk manager. As the number of exposures increases, an insurer can predict its future loss experience more accurately because it can rely on the law of large numbers.

The law of large numbers states that as the number of exposure units increases, the more closely the actual loss experience will approach the expected loss experience. For example, as the number of homes under observation increases, the greater is the degree of accuracy in predicting the proportion of homes that will burn. The law of large numbers is discussed in greater detail in Chapter 3.

Subjective Risk (Perceived Risk)

Subjective risk (perceived risk) is defined as uncertainty based on a person's mental condition or state of mind. Another name for subjective risk is perceived risk; some authors use the term in their discussion of the perception of risk by individuals.

For example, assume that a driver with several convictions for drunk driving is drinking heavily in a neighborhood bar and foolishly attempts to drive home. The driver may be uncertain whether he will arrive home safely without being arrested by the police for drunk driving. This mental uncertainty or perception is called subjective risk.

The impact of subjective risk varies depending on the individual. Two persons in the same situation can have a different perception of risk, and their behavior may be altered accordingly. If an individual experiences great mental uncertainty concerning the occurrence of a loss, that person's behavior may be affected. High subjective risk often results in conservative and prudent behavior, whereas low subjective risk may result in less conservative behavior.

For example, assume that a motorist previously arrested for drunk driving is aware that he has consumed too much alcohol. The driver may then compensate for the mental uncertainty by getting someone else to drive the car home or by taking a cab. Another driver in the same situation may perceive the risk of being arrested as slight. This second driver might drive in a more careless and reckless manner; a low subjective risk results in less conservative driving behavior.

Chance of loss

Chance of loss is closely related to the concept of risk. Chance of loss is defined as the probability that anevent will occur. Like risk, probability has both objective and subjective aspects.

Objective Probability

Objective probability refers to the *long-run relative frequency* of an event based on the assumptions of an infinite number of observations and of no change in the underlying conditions. Objective probabilities can be determined in two ways.

First, they can be determined by deductive reasoning. These probabilities are called a priori probabilities. For example, the probability of getting a head from the toss of a perfectly balanced coin is 1/2 because there are two sides, and only one is a head. Likewise, the probability of rolling a 6 with a single die is 1/6, since there are six sides and only one side has six dots.

Second, objective probabilities can be determined by inductive reasoning rather than by deduction. ***For example***, the probability that a person age 21 will die before age 26 cannot be logically deduced. However, by a careful analysis of past mortality experience, life insurers can estimate the probability of death and sell a five-year term life insurance policy issued at age 21.

Subjective Probability

Subjective probability is the individual's personal estimate of the chance of loss. Subjective probability need not coincide with objective probability. For example, people who buy a lottery ticket on their birthday may believe it is their lucky day and overestimate the small chance of winning. A wide variety of factors can influence subjective probability, including a person's age, gender, intelligence, education, and the use of alcohol or drugs.

In addition, a person's estimate of a loss may differ from objective probability because there may be ambiguity in the way in which the probability is perceived.

For example, assume that a slot machine in a casino requires a display of three lemons to win. The person playing the machine may perceive the probability of winning to be quite high. But if there are 10 symbols on each

reel and only one is a lemon, the objective probability of hitting the jackpot with three lemons is quite small. Assuming that each reel spins independently of the others, the probability that all three will simultaneously show a lemon is the product of their individual probabilities (**1/10 * 1/10 * 1/10 = 1/1,000**). This knowledge is advantageous to casino owners, who know that most gamblers are not trained statisticians and are therefore likely to overestimate the objective probabilities of winning.

Chance of Loss versus Objective Risk

Chance of loss can be distinguished from objective risk. Chance of loss is the probability that an event that causes a loss will occur. Objective risk is the relative variation of actual loss from expected loss. The chance of loss may be identical for two different groups, but objective risk may be quite different.

For example, assume that a property insurer has 10,000 homes insured in Los Angeles and 10,000 homes insured in Philadelphia and that the chance of a fire in each city is 1 percent. Thus, on average, 100 homes should burn annually in each city. However, if the annual variation in losses ranges from 75 to 125 in Philadelphia, but only from 90 to 110 in Los Angeles, objective risk is greater in Philadelphia even though the chance of loss in both cities is the same.

Peril and Hazard

The terms peril and hazard should not be confused with the concept of risk discussed earlier.

Peril

Peril is defined as *the cause of loss*. If your house burns because of a fire, the peril, or cause of loss, is the fire. If your car is damaged in a collision with another car, collision is the peril, or cause of loss.

Common perils that cause loss to property include fire, lightning, windstorm, hail, tornado, earthquake, flood, burglary, and theft.

Hazard

A hazard is a condition that creates or increases the frequency or severity of loss. There are four major types of hazards:

- Physical hazard
- Moral hazard
- Attitudinal hazard (morale hazard)
- Legal hazard

1. Physical Hazard: A physical hazard is a physical condition that increases the frequency or severity of loss.

Examples of physical hazards include icy roads that increase the chance of an auto accident, defective wiring in a building that increases the chance of fire, and a defective lock on a door that increases the chance of theft.

2. Moral Hazard: Moral hazard is dishonesty or character defects in an individual that increase the frequency or severity of loss. Examples of moral hazard in insurance include faking an accident to collect benefits from an insurer, submitting a fraudulent claim, inflating the amount of a claim, and intentionally burning unsold merchandise that is insured. Murdering the insured to collect the life insurance proceeds is another important example of moral hazard.

Moral hazard is present in all forms of insurance, and it is difficult to control. Dishonest individuals often rationalize their actions on the grounds that *"the insurer has plenty of money."* This view is incorrect because the insurer can pay claims only by collecting premiums from other insureds. Because of moral hazard, insurance premiums are higher for everyone.

Insurers attempt to control moral hazard by the careful underwriting of applicants for insurance and by various policy provisions, such as deductibles, waiting periods, exclusions, and riders.

3. Morale Hazard (Attitudinal Hazard): Attitudinal hazard is carelessness or indifference to a loss, which increases the frequency or severity of a loss. Examples of attitudinal hazard include leaving car keys in an unlocked car, which increases the chance of theft; leaving a door unlocked, which allows a burglar to enter; and changing lanes suddenly on a congested expressway without signaling, which increases the chance of an accident. Careless acts like these increase the frequency and severity of loss.

The term morale hazard has the same meaning as attitudinal hazard. However, the term attitudinal hazard is more widely used today and is less confusing to students and more descriptive of the concept being discussed.

4. Legal Hazard: Legal hazard refers to characteristics of the legal system or regulatory environment that increase the frequency or severity of losses. Examples include adverse jury verdicts or large damage awards in liability lawsuits; statutes that require insurers to include coverage for certain benefits in health insurance plans, such as coverage for alcoholism; and regulatory action by state insurance departments that prevents insurers from withdrawing from a state because of poor underwriting results.

Classification of Risk

Risk can be classified into several distinct classes. The most important include the following:

- Pure and speculative risk
- Diversifiable risk and non-diversifiable risk
- Enterprise risk

■ Systemic risk

1. Pure Risk and Speculative Risk

Pure risk is defined as a situation in which there are only the *possibilities of loss or no loss*. The only possible outcomes are adverse (loss) and neutral (no loss). Examples of pure risks include premature death, job related accidents, catastrophic medical expenses, and damage to property from fire, lightning, flood, or earthquake.

In contrast, speculative risk is defined as a situation in which *either profit or loss is possible*. For example, if you purchase 100 shares of common stock, you would profit if the price of the stock increases but would lose if the price declines. Other examples of speculative risks include betting on a horse race, investing in real estate, and going into business for yourself. In these situations, both profit and loss are possible.

It is important to distinguish between pure and speculative risks for three reasons.

First, private insurers generally concentrate on pure risks and do not emphasize the insurance of speculative risks. However, there are exceptions. Some insurers will insure institutional portfolio investments and municipal bonds against loss. Also, enterprise risk management (discussed later) is another important exception where certain speculative risks can be insured.

Second, the law of large numbers can be applied more easily to pure risks than to speculative risks. The law of large numbers is important because it enables insurers to predict future loss experience. In contrast, it is generally more difficult to apply the law of large numbers to speculative risks to predict future loss experience. An exception is the speculative risk of gambling, where casino operators can apply the law of large numbers in a most efficient manner.

Finally, society may benefit from a speculative risk even though a loss occurs, but is harmed if a pure risk is present and a loss occurs.

For example, a firm may develop new technology for producing inexpensive computers. As a result, some competitors may be forced into bankruptcy. Despite the bankruptcy, society benefits because the computers are produced at a lower cost. However, society normally does not benefit when a loss from a pure risk occurs, such as a flood or earthquake that destroys a town or area.

2. Diversifiable Risk and Non-diversifiable Risk

Diversifiable risk is a risk that *affects only individuals or small groups* and not the entire economy. It is a risk that can be reduced or eliminated by diversification.

For example, a diversified portfolio of stocks, bonds, and certificates of deposit (CDs) is less risky than a portfolio that is 100 percent invested in common stocks. Losses on one type of investment, say stocks, may be offset by gains from bonds and CDs. Likewise, there is less risk to a property and liability insurer if different lines of insurance are underwritten rather than only one line. Losses on one line can be offset by profits on other lines. Because diversifiable risk affects only specific individuals or small groups, it is also called **nonsystematic risk** or **particular risk**. Examples include car thefts, robberies, and dwelling fires. Only individuals and business firms that experience such losses are affected, not the entire economy.

In contrast, **non-diversifiable risk** is a risk that affects the entire economy or large numbers of persons or groups within the economy. It is a risk that cannot be eliminated or reduced by diversification.

Examples include rapid inflation, cyclical unemployment, war, hurricanes, floods, and earthquakes because large numbers of individuals or groups are

affected. Because non-diversifiable risk affects the entire economy or large numbers of persons in the economy, it is also called as fundamental risk.

The distinction between a diversifiable and non-diversifiable (**fundamental**) risk is important because government assistance may be necessary to insure non-diversifiable risks. Social insurance and government insurance programs, as well as government guarantees or subsidies, may be necessary to insure certain non-diversifiable risks.

For example, the risks of widespread unemployment and flood are difficult to insure privately because the characteristics of an ideal insurable risk (discussed in Chapter 3) are not easily met. As a result, state unemployment compensation programs are necessary to provide weekly income to workers who become involuntarily unemployed. Likewise, the federal flood insurance program makes property insurance available to individuals and business firms in flood zones.

3. Enterprise Risk

Enterprise risk is a term that encompasses all major risks faced by a business firm. Such risks include pure risk, speculative risk, strategic risk, operational risk, and financial risk. We have already explained the meaning of pure and speculative risk.

Strategic risk refers to uncertainty regarding the firm's financial goals and objectives; for example, if a firm enters a new line of business, the line may be unprofitable.

Operational risk results from the firm's business operations. For example, a bank that offers online banking services may incur losses if "hackers" break into the bank's computer.

Enterprise risk also includes *financial risk*, which is becoming more important in a commercial risk management program. Financial risk refers to the uncertainty of loss because of adverse changes in Credit risk,

Liquidity risk and Market risk (share price, commodity prices, interest rates, foreign exchange rates, and the value of money).

For example, a food company that agrees to deliver cereal at a fixed price to a supermarket chain in 6 months may lose money if grain prices rise. A bank with a large portfolio of Treasury bonds may incur losses if interest rates rise. Likewise, an American corporation doing business in Japan may lose money when Japanese yen are exchanged for American dollars.

Enterprise risk is becoming more important in commercial risk management, which is a process that organizations use to identify and treat major and minor risks. In the evolution of commercial risk management, some risk managers are now considering all types of risk in one program. **Enterprise Risk Management (ERM)** combines into a single unified treatment program all major risks faced by the firm.

As explained earlier, these risks include pure risk, speculative risk, strategic risk, operational risk, and financial risk. By packaging major risks into a single program, the firm can offset one risk against another. As a result, overall risk can be reduced. As long as all risks are not perfectly correlated, the combination of risks can reduce the firm's overall risk. In particular, if some risks are negatively correlated, overall risk can be significantly reduced. Treatment of financial risks typically requires the use of complex hedging techniques, financial derivatives, futures contracts, options, and other financial instruments. Some firms appoint a chief risk officer (CRO), such as the treasurer, to manage the firm's financial risks.

4. Systemic Risk

Systemic risk is an economic risk that is extremely important in the monetary policy of the Federal Reserve, fiscal policies of the federal government, and government regulation of the economy. Systemic risk is especially important with respect to large commercial banks and other

financial institutions that are considered too large to fail without doing major financial harm to a large part of any economy.

Systemic risk is the risk of collapse of an entire system or entire market due to the failure of a single entity or group of entities that can result in the breakdown of the entire financial system. The severe 2008– 2009 *business recession* in the United States was the second-worst economic downswing in U.S. history, which was caused largely by systemic risk. The economy experienced a massive *financial meltdown* and a *brutal stock market crash* that wiped out the life savings of many Americans; the national unemployment rate soared to historically high levels; the housing market collapsed and foreclosures increased; more than 100 commercial banks and financial institutions failed or merged with other entities, which produced a *credit crunch* and *a freezing of credit markets*; commercial banks and some insurers sold billions of complex derivatives that were largely unregulated and resulted in massive losses to investors worldwide; and state and federal regulation of the financial services industry, including insurance companies, proved inadequate and broken.

Major personal risks and Commercial Risks

This section discusses (1) important personal risks that affect individuals and families and (2) major commercial risks that affect business firms.

Personal Risks

Personal risks are risks that directly affect an individual or family. They involve the *possibility of the loss or reduction of earned income, extra expenses, and the depletion of financial assets*. Major personal risks that can cause great economic insecurity include the following:

- Premature death
- Inadequate retirement income

- Poor health
- Unemployment

Premature Death: is defined as the death of a family head with unfulfilled financial obligations. These obligations include dependents to support, a mortgage to be paid off, children to educate, and credit cards or installment loans to be repaid. If the surviving family members have insufficient replacement income or past savings to replace the lost income, they will be exposed to considerable economic insecurity.

Inadequate Retirement Income: The major risk during retirement is inadequate income. The majority of workers in many countries retire before age 65. When they retire, they lose their earned income. Unless they have sufficient financial assets on which to draw, or have access to other sources of retirement income—such as Social Security or a private pension, a plan, or an individual retirement account (IRA)—they will be exposed to considerable economic insecurity.

Poor Health: Poor health is another major personal risk that can cause great economic insecurity. The risk of poor health includes both the payment of catastrophic medical bills and the loss of earned income. The costs of hospitalization, major surgery, diagnostic tests, and prescription drugs have increased substantially in recent years.

Today, an open-heart operation can cost more than $300,000, a kidney or heart transplant can cost more than $500,000, and the costs of a crippling accident requiring several major operations, plastic surgery, and rehabilitation can exceed $600,000. In addition, long-term care in a nursing home can cost $100,000 or more each year. Expensive prescription drugs taken daily present additional financial problems to many people.

Unemployment: Unemployment is a major cause of economic insecurity in the United States. Unemployment can result from business cycle

downswings, technological and structural changes in the economy, seasonal factors, imperfections in the labor market, and other causes as well.

Property Risks: Persons owning property are exposed to property risks—the risk of having property damaged or destroyed from numerous causes. Homes and other real estate and personal property can be damaged or destroyed because of fire, lightning, tornado, windstorm, and numerous other causes. There are two major types of loss associated with the destruction or theft of property: direct loss and indirect or consequential loss.

> **Direct Loss:** A direct loss is defined as a financial loss that results from the physical damage, destruction, or theft of the property. For example, if you own a home that is damaged or destroyed by a fire, the physical damage to the home is a direct loss.
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> **Indirect or Consequential Loss** An indirect loss is a financial loss that results indirectly from the occurrence of a direct physical damage or theft loss. For example, as a result of the fire to your home, you may incur additional living expenses to maintain your normal standard of living. You may have to get a motel room or rent an apartment while the home is being repaired. You may have to eat some or all of your meals at local restaurants. You may also lose rental income if a room is rented and the house is not habitable. These additional expenses that resulted from the fire would be a consequential loss.

Liability Risks: Liability risks are another important type of pure risk that most persons face. Under the legal system, you can be held legally liable if you do something that results in bodily injury or property damage to someone else. A court of law may order you to pay substantial damages to the person you have injured. Liability risks are of great importance for several reasons.

First, there is no maximum upper limit with respect to the amount of the loss.

Second, a lien can be placed on your income and financial assets to satisfy a legal judgment.

Finally, legal defense costs can be enormous.

Commercial Risks

Business firms also face a wide variety of pure risks that can financially cripple or bankrupt the firm if a loss occurs. These risks include

(1) property risks,
(2) liability risks,
(3) loss of business income,
(4) cybersecurity and identity theft, and
(5) other risks.

Property Risks: Business firms own valuable business property that can be damaged or destroyed by numerous perils, including fires, windstorms, tornadoes, hurricanes, earthquakes, and other perils. Business property includes plants and other buildings; furniture, office equipment, and supplies; computers and computer software and data; inventories of raw materials and finished products; company cars, boats, and planes; and machinery and mobile equipment. The firm also has accounts receivable records and may have other valuable business records that could be damaged or destroyed and expensive to replace.

Liability Risks: Business firms often operate in highly competitive markets where lawsuits for bodily injury and property damage are common. The

lawsuits range from small nuisance claims to multimillion-dollar demands. Firms are sued for numerous reasons, including defective products that harm or injure others, pollution of the environment, damage to the property of others, injuries to customers, discrimination against employees and sexual harassment, violation of copyrights and intellectual property, and numerous other reasons. In addition, directors and officers may be sued by stockholders and other parties because of financial losses and mismanagement of the company. Finally, commercial banks, other financial institutions, and other business firms are exposed to enormous potential liability because of cyber security and identify theft crimes that have occurred in recent years.

Loss of Business Income: Another important risk is the potential loss of business income when a covered physical damage loss occurs. The firm may be shut down for several months because of a physical damage loss to business property due to a fire, tornado, hurricane, earthquake, or other perils. During the shutdown period, the firm would lose business income, which includes the loss of profits, the loss of rents if business property is rented to others, and the loss of local markets.

In addition, during the shutdown period, certain expenses may still continue, such as rent, utilities, leases, interest, taxes, some salaries, insurance premiums, and other overhead costs. Fixed costs and continuing expenses that are not offset by revenues can be sizeable if the shutdown period is lengthy.

Finally, the firm may incur extra expenses during the period of restoration that would not have been incurred if the loss had not taken place. Examples include the cost of relocating temporarily to another location, increased rent at another location, and the rental of substitute equipment.

Cybersecurity and Identity Theft: Cybersecurity and identity theft by thieves breaking into a firm’s computer system and database are major

problems for many firms. Computer hackers have been able to steal hundreds of thousands of consumer credit records, which have exposed individuals to identity theft and violation of privacy. As a result, commercial banks, financial institutions, and other business firms are exposed to enormous legal liabilities. Other crime exposures include robbery and burglary; shoplifting; employee theft and dishonesty; fraud and embezzlement; piracy and theft of intellectual property, and computer crimes.

Other Risks: Business firms must cope with a wide variety of additional risks, summarized as follows:

■ **Human resources exposures**. These include job related injuries and disease of workers; death or disability of key employees; group life and health and retirement plan exposures; and violation of federal and state laws and regulations.

■ **Foreign loss exposures**. These include acts of terrorism, political risks, kidnapping of key personnel, damage to foreign plants and property, and foreign currency risks.

■ **Intangible property exposures**. These include damage to the market reputation and public image of the company, the loss of goodwill, and loss of intellectual property. For many companies, the value of intangible property is greater than the value of tangible property.

■ **Government exposures**. Federal and state governments may pass laws and regulations that have a significant financial impact on the company. Examples include laws that increase safety standards, laws that require reduction in plant emissions and contamination, and new laws to protect the environment that increase the cost of doing business.

Burden of Risk on Society

The presence of risk results in certain undesirable social and economic effects. Risk entails three major burdens on society:

- The size of an emergency fund must be increased.
- Society is deprived of certain goods and services.
- Worry and fear are present.

1. Larger Emergency Fund

It is prudent to set aside funds for an emergency. However, in the absence of insurance, individuals and business firms would have to increase substantially the size of their emergency fund to pay for unexpected losses.

2. Loss of Certain goods and Services

A second burden of risk is that society is deprived of important goods and services. For example, because of the risk of a liability lawsuit, many corporations have discontinued manufacturing certain products. Numerous examples can be given. Some 250 companies in the world once manufactured childhood vaccines; today, only a small number of firms manufacture vaccines, due in part to the threat of liability suits.

Other firms have discontinued the manufacture of specific products, including asbestos products, football helmets, silicone-gel breast implants, and certain birth-control devices, because of fear of legal liability.

In addition, as a result of the September 11, 2001, terrorist attacks, Congress feared that companies manufacturing anti-terrorism technologies (such as airport security devices) would not manufacture their products for fear of being sued if the technology failed.

3. Worry and Fear

The final burden of risk is that of worry and fear. Numerous examples illustrate the mental unrest and fear caused by risk. Parents may be fearful if a teenage son or daughter departs on a ski trip during a blinding snowstorm because the risk of being killed on an icy road is present. Some passengers in a commercial jet may become extremely nervous and fearful if the jet encounters severe turbulence during the flight. A college student who needs a grade of C in a course to graduate may enter the final examination room with a feeling of apprehension and fear