CHAPTER 1

Risk, Finance, Corporate Management, and Society

OVERVIEW

Financial engineering is a profession that bridges theoretical finance and financial practice. It spans the many occupations prevalent in financial services. This chapter provides a nonquantitative introduction to financial management and risk engineering. Terms such as *risk*, *uncertainty*, *securities*, *bonds*, *derivatives, options*, and the like are defined and their applications to a broad number of financial concerns outlined. Terms such as *trading*, *investing*, *speculating*, *credit*, *leverage*, *environmental finance, securitization*, and others are defined and applications considered. Real-life financial problems, including safety, reliability, claims, insurance, your pension, and so forth, are highlighted to emphasize the relevance of financial analysis and management to everyday life. Finally, outstanding financial issues, a growing concern for financial ethics, and regulation are also discussed. This chapter may be covered singly or together with the next chapter in one or two lectures with students reading and commenting on the issues the chapter raises.

RISKS EVERYWHERE—A CONSEQUENCE OF UNCERTAINTY

Uncertainty is part of our lives. Its presence underlies our attitudes, our search for information, and the efforts we expend to mitigate and manage its positive and adverse consequences. To do so, we seek definitions, measurements, and the quantification of uncertainty in order to analyze the risks, protect ourselves from the losses uncertainty may lead to, and profit from the opportunities it can provide. In theory and in practice, uncertainty is latent in everything we do. It remains a shadow that never departs, always challenging, for better or for worse.

Risk may be specific or have broad connotations to various persons or groups. For some, it is a threat; for others it is an opportunity to be sought and to revel in. In all cases, risk results from uncertain events and their consequences: whether positive or negative; whether direct or indirect; whether they are accounted for or not; whether of external origin or internally induced; whether predictable or not; and whether of concern to individuals, firms, or the society at large. Uncertain

events may be due to failures of persons or machines, a misjudgment by investors or speculators, accidental hazards, or macroeconomic and environmental factors over which we have partial or no control. To mitigate or profit from risk (also known as *risk management*), preventive means, controls, insurance, hedging, trades in optional markets, and other actions are taken *ex ante* (before the fact) and *ex post* (after the fact, seeking to recover from adverse consequences). These activities broadly summarize the function of financial and risk management.

Risk mitigation is common to many professions, each of which has an approach and uses techniques based on the needs and the accrued experience specific to that profession and acquired over long periods of time. For example, a machine operator maintains a machine to prevent failure or nonconforming operations. Careful diet and exercise, medicines, and planned visits to a doctor for a checkup are used preventively to maintain one's health and avoid disease. By the same token, an airplane has numerous built-in fail-safe mechanisms to counter predictable (albeit extremely rare) potential components or system failures.

Risk finance is focused in particular on money: how to invest it and manage it; how to price assets, contracts, options, and so on; and how to use it for the many real ends for which individuals and corporate, social, or other entities may need it. Pricing assets and the risks of mispricing are particularly important. When an asset is priced properly it allows an efficient exchange between the many parties that consume and supply such an asset. When it is mispriced, exchanges may be severely curtailed, contributing to a lack of liquidity. Financial pricing of an asset allows one to unlock the values embedded in the asset, whether real or virtual values, and render such an asset tradable.

For example, to price a corporate firm engaged in a real economic activity (such as producing cars, making movies, selling a service, performing high-tech or medical research and development, etc.), its value is unlocked by trading current and future returns and risks in units called *securities* or shares of *stock*. A security then translates the firm value into money by letting a buyer and a seller exchange money in a financial market for the right to own part of the firm's future monetary potential. Such an exchange defines, then, both the price of the security and the monetary value that buyers and sellers of the security ascribe to the firm being traded. Real firms and assets and their prospects are thus *securitized* and exchanged in denominated price contracts (in this case, a unit of stock ascribing to its owner some rights over the firm). Predicting the price of a security can be quite complex, however, based on all available real and financial data, future predictions regarding the economic environment, competitive forces, technology, management, and other factors that contribute to enhancing or decreasing the value of firms and their price. A common belief is that such prices cannot be predicted with absolute certainty but may be guessed at best by using the information we can assemble, interpret, and understand, based on insights and an understanding of the market mechanism.

To meet the many challenges of finance and its application in real life, financial institutions and financial markets have defined and commercialized standard financial instruments that are traded, including, among many others, securities, insurance contracts, bonds, options, credit contracts, and the like. In addition, a plethora of financial institutions—banks, insurance firms, brokers, credit providers, and so forth—have conspired to provide the means for investors, speculators, firms, and persons to improve their financial well-being while managing the risks of financial

transactions. In other words, investors willing to assume more risks will do so, and those who seek to assume less risk will do so as well.

This is possible, of course, if markets are liquid. In some cases, a price results from contractual negotiations between specific parties. These contracts assume many forms, such as insurance contracts, over-the-counter (OTC) trades, and so on. In other cases, prices are set arbitrarily to a price level or allowed to fluctuate between two specific levels (for example, in some countries the prices of certain commodities are set by political decisions while in others they are set by exchanges and allowed to fluctuate between upper and lower limits). When markets are not liquid, we can expect firms and persons to cling to their money, each uncertain of the market price. In these conditions, a lack of business and a lack of needed funds to function may cause firms to falter. For this reason, financial institutions seek to provide liquidity for businesses to remain active, both for their own good and for the public good. The potential for financial institutions to make money in such processes is both immense and varied.

For example, insurance firms set a price that insured parties pay, while at the same time seeking a market price for the risks they aggregate in portfolios. They do so both to profit from a spread between insurance cost and the portfolio price and to maintain the capacity to meet claims when they occur. To mitigate insurance risks, insurers can also buy and sell these risks to other parties (to reinsurers who share payments if claims are made, in return for a portion of the premium paid by the insured) or use securitization—that is, selling standardized revenues and their associated claims in an insurance portfolio to financial markets. The same approach is used by mortgage lenders that *aggregate* mortgage contracts into a portfolio, which is sold through intermediaries to financial markets (as is discussed in Chapters 9 and 10). By the same token, a municipality seeking to build a subway by issuing a debt obligation will float a proposal to be priced by buyers (the banks) or financial intermediaries seeking to finance such a transaction through financial markets. Throughout, financial engineering contributes by financial innovations that unlock value that can be traded and priced viably and sustainably by an exchange of buyers and sellers.

On the environmental front, financial markets are assuming a growing responsibility to price and allocate, economically and efficiently, environmental risks. In particular, in the matter of global warming, standardized units of carbon dioxide emission rights are traded. Current beliefs are that carbon emissions would be better controlled by money equivalents and thus would contribute to global and sustainable emission levels (at the same time, carbon taxes may be used to raise additional taxes for needed government revenues). Discussions at the World Economic Forum in Davos, Switzerland, and the U.S. policy of 2009 have emphasized the need to use financial markets for greater environmental and social (economic) efficiency. For some, the concern about global warming has become an opportunity to profit. For example, for countries or firms owning rights that they do not use, it becomes a bounty they never had (which of course leads detractors of such a scheme to assert that carbon trades contribute only to an important transfer of financial resources from developed to undeveloped countries). Nonetheless, there are a growing number of financial markets specializing in such trades, such as the Chicago Climate Exchange and Amsterdam markets. Research and applications are needed, however, to develop this potential further and to understand the mechanism for the market making of

environmentally friendly products, priced sustainably. Our concern is to define these problems and use finance to manage the risks and the opportunities they imply.

Globalization and financial technology have also provided an extraordinary boost to global finance and financial markets and at the same time have contributed to appreciable investment opportunities and risks. However, whether globalization contributes to an increase in risk dependence and risk contagion (see Chapters 4 and 10) across financial markets remains an issue that has no simple or clear-cut answer. Networking, the density of human settlements and their consequences (both good and bad), and other factors have contributed to a far greater awareness that risks are dependent and have many sources. Further, identity thefts, cyber-crimes, virtual enterprises that operate globally, and the breakdown of traditionally secured pension funds and the like are colluding to highlight that risk is no longer an abstract financial issue but a real one—felt by each one of us, wherever we may be. In a global world, risks are global, and risks are thus assumed, exchanged, shared, traded, valued, and priced globally. They are also implied in corporate strategies, whether financial or not. In such an environment, finance and the risk business are necessarily far greater than ever before.

There are many risks that are not easily defined in monetary terms, however, and cannot be exchanged to produce an agreed-on price. For example, rare events (with an extremely small probability of occurring) and catastrophic risks are notoriously difficult to price as only very few financial parties may have the capacity to bear the implied risks. Such risks are a financial engineering challenge—to better manage, define, value, and price these risks, either uniquely or approximately, and unlock the value or financial consequences embedded in them.

RISK AND FINANCE: BASIC CONCEPTS

Risk and finance are defined by a complex set of factors, each determining the others. It has been claimed that a risk with no financial consequence is not a risk. This statement, of course, cannot be true since one's accidental death might not have any financial consequence. For our purposes here, risk and finance are defined implicitly and explicitly by factors that have an underlying financial value. Monetizing this value is a financial engineering challenge. Seven essential factors are used to define the value and price of risk:

1. Events and their probabilities (whether common or rare).
2. Predictability and timing of these events and their recurrence.
3. Uncertain financial consequences (whether adverse or beneficial).
4. Individuals' tolerance for risk bearing, implied in their preferences.
5. Individuals' information and ability to measure and to assess risks.
6. Risk sharing and exchange (contractual or not).
7. Market pricing, arising from the interaction of many buyers and sellers in a fair and efficient manner with common and shared information.

The first two factors, events and their probabilities and their predictability and timing, need not have financial relevance if they have no financial consequence. An individual's rationality and personal information expressing a latent preference

for uncertain outcomes (see Chapters 5 and 6) are relevant to personal finance but might or might not be relevant to financial markets pricing. Finally, risk sharing and exchange as well as financial markets pricing imply the value of a trade, product, or rights conferred by an exchange, reached at an agreed-on price. Each of these factors underlies the concerns of investors, traders, speculators, and financial engineers. For example, the value of an asset or returns derived from an asset held by an investor will depend on the returns or the obligations of the asset and the timing of those returns—whether uncertain or not. The market price of an asset, however, is defined by the buyers and the sellers trading in this asset. When a price is not set by a market, it may be defined by a contractual agreement between a buyer and a seller or by a collective entity (such as by a government that regulates prices, or by a private agreement between an insured and an insurer).

An individual's rationality (or that of a corporate entity) expresses the subjective predisposition of an investor to bear risks and to choose and pay for an investment as a function of its risk/reward characteristics. These factors, combined with macroeconomic effects (such as interest rates, employment statistics, etc.) contribute to a pricing of all valuable assets, with prices based on the attitudes of all parties to a trade.

Risk may be more or less accepted or abhorred by individuals and firms. History offers examples where risk is accepted and even sought out: Egyptians knew of the floods of the river Nile, but knew also that floods would irrigate their agricultural fields near the banks of the river. Thus, Egyptian farmers intentionally settled next to the river with the prospect of growing abundant crops. It was impossible to predict the *amount* of the flooding from year to year, but over many centuries the ancient Egyptians were able to anticipate *when* the flooding would occur (it occurs at about the same time every year). By the same token, many hedge funds nurture their funds with risky bets in expectation of extremely large returns. Individual investors, corporations, and societies relate differently to the risks they assess, assume, or are willing to bear. *Risk behavior*, as well as the *attitudes* it implies, is therefore a fundamental concept (expanded on further in Chapters 5 and 6). It characterizes the degree to which an investor accepts *probabilities* of adverse consequences. Similarly, it underlies the investor's need to hedge and tailor the risks assumed to a tolerable level, where the risk and its rewards are balanced (in the investor's view and interest, of course).

Risk events, their timing, and their consequences have both direct and indirect effects. The former are usually well defined and accounted for, while the latter are harder to assess and might be neglected. It is therefore useful to categorize risks to better appreciate their origins and their consequences. For brevity, we can summarize the categories of risk as follows:

- *External-hazard risks* (such as weather risks, macroeconomic risks to a firm, or risks over which we have little or no control).
- *Endogenous risks* (such as some operational risks arising from human, organizational, mechanical, or process dysfunctions; *endogenous* indicates that these risks are inherent to the process in place).
- *Strategic or counterparty risks* (originating in exchanges between multiple parties, each with different agendas and risk attitudes; for example, counterparty and contractual risks, information and power asymmetries are such risks and are considered in Chapters 9 and 10).

- *Risk externalities* or risks with consequences and origins that are disparate (e.g., when risk consequences are not assumed by the perpetrator—as is sometimes the case in environmental pollution). These risks can have both an adverse and a positive consequence.

Examples of strategic and risk externalities abound. The pollution perpetrated by a chemical firm spilling its wastes in nature is a risk externality. By the same token, a large bank that assumes exuberant risks in the pursuit of short-term profits and huge bonuses because it believes that it is too big to fail is another form of a polluter that puts at risk the financial system. When the parties to business or financial transactions have different objectives, whether these are conflicting or not, a counterparty or strategic risk arises. Similar risks recur in contractual risk exchanges or risk sharing between parties that have different objectives and use their information to take advantage of contract clauses. In this vein, OTC contracts as well as insurance contracts may have a strategic risk (more on this in Chapters 9 and 10).

The definition and measurement of these risks is difficult, however, compounded by the use of risk as a panacea for the many ills, real, potential, or imaginary, that individuals and corporate firms face (either internally or externally). In an era of globalization, some of these risks may become intractable and therefore nontransparent. For example, securitization (the process by which many risks are compounded, confounded, marketed, and traded as a package—in whole or in parts) in global financial markets and transferring risk from one entity to another (from investors, debtors, etc.) through multiple intermediaries have contributed to increased disparities between real and perceived risks. Risks have thus become less transparent, less specific, and more complex. As a result, many financial risks are ill understood, poorly measured, and may potentially contribute to an incentive to assume ever-greater risks (referred to by Robert Shiller as *irrational exuberance*). The measurement of risk is therefore both important and challenging and is addressed in greater detail in Chapters 3 and 4.

Finance and Risks

Financial institutions are motivated by five essential purposes:

1. Provide liquidity (the intent of bank charters and therefore their legal responsibility).
2. Price and manage financial risks—whether these risks are or are not predictable.
3. Allocate wealth to financial and other assets to meet investors' objectives. To do so, finance seeks to define and explain investors' risk attitudes, meet their risk/reward expectations, and prevent or counteract the effects of risk, regulation, and taxes.
4. Provide a decision framework to guide and justify individuals' and firms' financial decisions.
5. Innovate and design financial instruments that meet the needs of investors, individuals, firms, and society for profit, risk bearing, and liquidity.

Financial economic theory, based on specific assumptions of rational behavior, has provided a strong anchor to financial modeling and decision making to support

these needs. The *efficient market hypothesis* (EMH), which claims that under specific assumptions financial markets are rational, is such an example. While the EMH is a powerful and useful theoretical framework, it is also violated in practice, leading to some competing theories—albeit none as general as the EMH. Behavioral finance (BH) in particular seeks to integrate human and behavioral processes into financial decision-making processes. Financial practice, in contrast, seeks the best it can do for financial principals, intermediaries, or agents in a given situation. It is not constrained by theory but by its financial performance, with the stance that its proof is in its results.

FINANCIAL INSTRUMENTS

Financial instruments are varied, including essentially securities, bonds, options, and portfolios on these assets, as well as a large variety of agreements for credit risk and credit derivatives. These instruments and their variants are used for specific financial purposes.

Securities or Stocks

Factories, retail firms, banks, film companies, soft-drink bottlers, utilities, and so on are economic entities transforming assets, production, and services into returns. Stocks are obligations to share in the equity of a firm, and they give the owner of the equity the right to vote for governing board members and to share in the firm's residual profits. These rights confer a value, priced by the security market price. Financial markets have, then, an important role in *liquefying* (or securitizing) the firm's real functions into a financial product that is bought and sold and shared with investors. The ownership of securities publicly traded is thus a common ownership of obligations and returns derived from these stocks.

In 1938, John Burr Williams postulated that the value of *any* financial asset (a stock) equals the present value of all of its future cash flows. For example, if a firm provides its shareholders a periodic cash distribution—the stock dividend—then the stock price equals the present value of these planned disbursements by the firm. The price of a stock and its prediction includes many more considerations, however, expressing the firm's current and future macroeconomic environment, its management, the firm's returns and growth, investors' motives summarized by their risk attitudes and the information they possess, and so forth. In this sense, a stock price expresses more than just current and expected cash flows. The manner in which we calculate the price of securities is critically important, complex, and useful, and is the topic of several chapters where different approaches are used—both subjective estimation using utility-based approaches and by financial market EMH-based theories.

EXAMPLE: AN IBM DAY-TRADES RECORD

Consider the IBM security price recorded daily as shown in Table 1.1. Such information is available daily in the great majority of financial markets and for all products traded. *Open* defines the day's opening price; *high*, *low*, and *close* prices define the

TABLE 1.1 IBM Stock Price over Five Years

Date	Open	High	Low	Close	Volume	Adj Close
01/02/2003	78.8	80.57	78.19	80.57	7,864,500	74.38
01/03/2003	80.7	81.65	80.21	81.65	5,962,300	75.38
01/06/2003	81.9	84.8	81.81	83.59	7,921,300	77.17
01/07/2003	83.95	86.18	83.75	86	11,906,900	79.39
01/08/2003	85.55	85.69	84.07	84.19	9,508,800	77.72
01/09/2003	84.75	87.02	84.75	87	10,711,600	80.32
01/10/2003	85.85	88.04	85.7	87.68	9,955,400	80.94
01/13/2003	88.31	88.95	87.35	87.51	10,499,000	80.79
01/14/2003	87.23	88.59	87.22	88.58	7,569,100	81.78
...	...	...	...	...	...	...
...	...	...	...	...	...	...
12/18/2008	85.77	86.64	82.96	84	8,029,500	83.11
12/19/2008	85.22	85.22	82.97	83.52	13,098,600	82.64
12/22/2008	83.27	83.45	80.32	81.99	7,083,300	81.12
12/23/2008	82.35	82.81	80.13	80.6	6,374,400	79.75
12/24/2008	80.55	81.22	79.92	80.52	2,415,200	79.67
12/26/2008	80.93	81.8	80.55	81.33	3,101,300	80.47
12/29/2008	81.72	81.72	79.68	81.25	6,062,600	80.39
12/30/2008	81.83	83.64	81.52	83.55	5,774,400	82.67
12/31/2008	83.5	85	83.5	84.16	6,667,700	83.27

prices statistics for that day; *volume* denotes the number of trades effected during that day. Such data may be used to predict trends in IBM's stock price, although predicting IBM's price from one day to the next may be tricky. The study of a historical stock price can provide ex post a technically acceptable explanation of price movements. An ex ante prediction of prices is much more difficult. However, Chapter 3 provides a number of statistical approaches to characterize security price processes, asking questions such as whether a security price change is due to macroeconomic factors, statements by corporate leaders or leading analysts, a perceived future profit potential for the security, or other factors. These questions are, of course, difficult to analyze quantitatively, but numerous attempts to do so are made nonetheless.

Pricing a firm's security based only on its daily price record might not reflect the true value of the firm. Macroeconomic factors (such as the gross national product, interest rates, exchanges rates, etc.) as well as industry- and firm-specific factors (such as the industry market structure, technology, management, regulation, government support, etc.) are also important. Some firms are cost-driven, augmenting their profits by increasing their costs (for example, public transportation, health care, etc.), while others are value-driven, based on consumers' ability to pay the value they extract by buying a product or service (in particular, luxury and consumer-branded goods). In general, both costs and values interact in a push-pull process that causes certain firms to have prospective profits or losses (and thereby to have a greater or a lesser value). Prices set in financial markets are then derived from firms' cost and value push-pull processes with a large number of financial parties (including investors, speculators, pension funds, insurance firms, etc.) expressing their needs and choices by buying

and selling firms' securities. In this sense, a financial price, unlike a product market price, is a value imputed to a firm's security by the exchange of financial parties.

Bonds

A bond is an obligation that pays a defined amount of money (a coupon paid periodically and/or its nominal price at the bond maturity) at a given future date T—the bond maturity. Unlike securities, bond payments are assumed to be risk-free, are able to meet their future commitments, and are predictable. Such certainty is based on the belief of a trusting bondholder that the bond issuer will meet all its obligations.

When corporate firms issue bonds (or raise their debt), they expect that in the future they will be able to repay this debt or at least be able to refinance it. When they can do so abundantly, they do not default and are able to meet their financing needs. In such an environment, debt increases and firms become more leveraged. However, when there is no liquidity and firms are unable to repay or renew their debt (either from cash flow or access to credit), such firms default. For this reason, bonds and credit contracts are two instruments, each entailing specific obligations. While bonds have been used for a long time and traded in extremely large quantities (far more than securities), credit products (such as credit default swaps [CDSs], credit derivatives [CDs], etc.) have only recently come into their own as independent financial products based on portfolios of various assets such as mortgage-backed securities (MBSs) and, generally, collateralized debt obligations (CDOs). These products are considered in Chapter 10.

Let's take the example of a risk-free, zero-coupon traded bond defined by a \$1 nominal price, paid at a future (maturity) time T. The price of such a bond at a given time t is $B_f(t, T)$. This price expresses the time preference of money in a given market at time t for the *sure payment of* \$1, $T - t$ periods hence. We can write the bond price as a function $R_f(t, T)$ which is called the *going risk-free rate* paid as a return for a debt of \$1 to be reimbursed for sure in $T - t$ periods. The functional form $R_f(t, T)$ is also called the *term structure of interest rates* and varies over time, reflecting various economic conditions. The price of a risk-free zero-coupon bond is then given by:

$$B_f(t, T) = \left(\frac{1}{1+R_f(t, T)}\right)^{T-t}$$

or

$$R_f(t, T) = \left[B_f(t, T)\right]^{-\frac{1}{T-t}} - 1 \tag{1.1}$$

In practice, bonds rates are often defined in terms of a summarizing and single rate which we call the *yield*. A growth in this yield will imply a growth in the discount rate, and vice versa. Say that the market price for a zero-coupon bond with one year to maturity is currently quoted at \$0.90. Its discount rate would be 11.11 percent, or:

$$B\,(0, 1) = 0.90 = \frac{1}{1 + R_f(0, 1)}$$

Or

$$R_f(0,1) = \frac{1.}{0.90} - 1 = 0.1111 \tag{1.2}$$

A bond that matures in two years and has a price of \$0.80 can be calculated in two ways. First, note that:

$$B(0,2) = 0.80 = \left(\frac{1}{1+R_f(0,2)}\right)^2 \text{ or } R_f(0,2) = \frac{1}{\sqrt{0.80}} - 1 \text{ and } R_f(0,2) = 0.118034 \tag{1.3}$$

where $R_f(0,2)$ is the yearly interest rate applied for a two-year bond. By the same token, since the bond has a guaranteed payment, its price can be calculated as follows:

$$B(0,2) = 0.80 = \left(\frac{1}{1+R_f(0,1)}\right)\left(\frac{1}{1+R_f(1,2)}\right) \text{ or}$$
$$0.80 = \left(\frac{1}{1+0.1111}\right)\left(\frac{1}{1+R_f(1,2)}\right) \tag{1.4}$$

where $R_f(1,2)$ is the next-year interest rate to be applied for one year. Such a rate is called the *forward* rate and is equal to:

$$R_f(1,2) = \left(\frac{1}{0.80\,(1.1111)}\right) - 1 = 0.125$$

This simple example indicates that the market expects growth in the interest rate in the following year.

Bonds may be used for many purposes. Governments sell bonds to finance their budgets, wars, or specific projects. Firms sell bonds to augment their working capital by leveraging with bond issues. Bondholders, unlike security holders, have no claim on the firm except the bond covenant that specifies the conditions and the explicit exchange terms of the bond.

Portfolios

When an investor or a firm owns several assets, consisting of securities, bonds, derivatives, real assets (such as real estate), cash, and so forth, the holdings define a *portfolio*. For example, assume an investor owns n shares of a security whose price and dividend at time t are S_t and d_t and the coupon bond whose price is $B_c(t,T)$ paying C_t at time t. The portfolio price defines then a wealth state at time t, denoted by W_t:

$$W_t = n(S_t + d_t) + C_t + B_c(t,T)$$

Portfolios can of course be far more complex, consisting of many securities held in various proportions, changing over time when trading in these assets. It

may consist also of other financial instruments such as options, whose values are realized at some future date (although these values can have a current price), and other assets of various liquidities (such as real estate holdings). Financial engineers use such portfolios for many purposes. For example, a portfolio may be constructed to meet an investor's financial needs. Portfolios are also used to replicate an unknown asset price but whose financial characteristics are identical to the known portfolio price. If prices are unique, the known price would necessarily be equal to the unknown one (such a procedure is used repeatedly in Chapters 7, 8, 9, and 10 to price options and other assets).

EXAMPLE: CONSTRUCTING A PORTFOLIO

Let a person's wealth be \$100,000 to be invested in one of three portfolios consisting of holdings in the Google security, currently priced at \$300, and Treasury bills (TB) (riskless bonds) priced at \$100. These portfolios are given by:

Portfolio 1	**Portfolio 2**	**Portfolio 3**
50% Google, 50% TB	60% Google, 40% TB	40% Google, 60% TB
Number of shares 166.66	Number of shares 200	Number of shares 133.33
Number of TB 500	Number of TB 400	Number of TB 600

Assume that the investor believes that Google's security will either increase by 15 percent or by 10 percent or decrease by 5 percent or by 20 percent, and let the risk-free rate for Treasury bills (TB) be 6 percent. What are the future portfolio prices?

Consider portfolio 1. The initial price of the portfolio is:

$$W = 166.66(300) + 500(100) = 100{,}000$$

If the stock price increases, the portfolio price is:

$$166.66[300(1.15)] + [500(100)](1.06) = 107{,}497.70$$

If the stock price decreases by 10 percent, the portfolio price would then be:

$$166.66[300(0.90)] + [500(100)](1.06) = 97{,}998.20$$

How would the first portfolio compare to portfolios 2 and 3? Each allocation has different outcomes depending on the future performance of the Google security, over which the investor has no control. The choice of an allocation by an investor is thus a bet based on the investor's predictions (derived from the information he has) and his risk attitude, as considered in Chapter 5.

A self-financing portfolio is defined as a portfolio with investments and returns made only by the portfolio returns. In other words, the price of such a portfolio is given by the market prices of its components (securities and bonds) changing over

time. In such portfolios, profits are reinvested and losses absorbed without changing the portfolio composition. This process is used repeatedly (see Chapter 8) to price assets and optional products using a portfolio that replicates the asset we seek to price. For example, the combination of securities and a bond might be used to replicate the price of a derivative if one is able to demonstrate that the price of the portfolio and its returns will coincide at all times and at all their future states.

Derivatives and Options

A derivative is an asset whose price is derived from some feature of an underlying asset (such as a security price, defined by financial markets) that trades the rights these derivatives confer. Options are particular derivatives that are now traded in many financial markets and in extraordinarily large volumes. They are used both for risk hedging and for speculating, singly or in a combined manner to create desired risk profiles, assuming or selling selected parts of an underlying asset or their combination. Options are defined in a standard manner, each defined by its specific characteristics. Essential and profusely traded derivatives include futures and forward contracts, call and put options—whether European or American—as well as exotic options such as hybrids and credit derivatives (these options are defined in the next section). Options are traded on many products, indexes, securities, and portfolios such as commodities, metals, securities, market indexes, currencies, the weather, carbon emissions, and so on.

In practice, options and derivatives can be used creatively to deal with a broad set of managerial and financial purposes. These span hedging, risk management, incentives for employees (serving often the dual purpose of an incentive to perform and a substitute for cash outlays in the form of salaries), and constructing financial remuneration packages. Options are also used to manage commodity trades, foreign exchange transactions, interest risk (in bonds, mortgage transactions, etc.), and to price real assets and options on these real assets—real options. Their use includes simple buy-sell decisions, as stated earlier, as well as complex trading strategies over multiple products, multiple markets, and multiple periods of time. In this sense, derivatives provide an opportunity to trade future financial outcomes here and now. Pricing these assets, theoretically and practically, is therefore extremely important.

Over-the-Counter Options Unlike some other options, over-the-counter (OTC) options are not traded in financial markets but are used to fit specific contractual needs. For example, swaps between banks and intermediaries or between insurers and reinsurers, trades in credit portfolios, and credit derivatives are such products (see in particular Chapters 9 and 10). Consider an airline company that contracts the acquisition of (or the option to acquire) a new-technology airplane at some future time. The contract may involve a stream or a lump-sum payment to the contractor (Boeing or Airbus) in exchange for the delivery of the plane at a specified time. Since payments are often made prior to the delivery of the plane, a number of clauses are added in the contract to manage the risks sustained by each of the parties if any of the parties were to deviate from the terms of the contract (for example, late deliveries, technological obsolescence, etc.). Similarly, a manufacturer can enter into binding bilateral agreements with a supplier by which agreed-on (contracted) exchange terms

are used to meet the needs of both parties. This can involve future contractual prices, delivery rates at specific times (to reduce inventory holding costs), and a set of clauses intended to protect each party against possible failures by the other in fulfilling the terms of the contract.

Throughout these cases, the advantage resulting from negotiating a contract is to reduce, for one or both parties, the uncertainty concerning future exchanges and their costs. In this manner, the manufacturer will be eager to secure long-term sources of supply and their timely availability while the investor, the buyer of the options, would avoid too large a loss implied by the acquisition of a risky asset, currency, or commodity.

Since for each contract there is one (or many) buyer(s) and one (or many) seller(s), the price of the contract can be interpreted as the outcome of a negotiation process where both parties are induced to enter into a contractual agreement. For example, the buyer and the seller of an option can be conceived of as parties involved in a strategic two-person game, the benefits of which for each are derived from the risk and rewards transferred from one party to the other. Some risks may be strategic, implied by the parties' preferences and the information each possesses. Note that given the information available to each of the parties, the utility of entering into a contractual agreement to both parties is always positive ex ante; otherwise there would not be any contractual agreement (unless such a contract were imposed on one of the parties!). When the number of buyers and sellers of such contracts becomes extremely large, transactions become impersonal and it is the market price that defines the value of the contract. Strategic behaviors tend to break down, the larger the group and the closer the price is to that of a market price.

On Incentive Options and Taxes Individual executives and employees in high-tech firms are often paid with options instead of cash. These options are used by firms as a mean to secure employees' commitment to the firm's bottom line and to delay cash outlays. These also help to delay the costs of compensation on the company's current balance sheet. Executives, too, profit from such a payment—often accounted for as a bonus, retention, or hiring incentive—due to the tax advantages it may confer. How and how much an executive can be taxed on future payments is an important question that has plagued lawyers, tax accountants, and tax authorities in general. The many billions of dollars that banks pay yearly in the form of stock options to their executives and employees is a testament to their attractiveness and to their tax advantages. This practice is not limited to financial institutions, however. A firm's ability to offer an attractive total compensation package, including a deferred compensation plan, is also a valuable recruiting tool for both for-profit and nonprofit organizations. While for-profit organizations have generally greater flexibility in offering deferred compensation plans to employees, there are limits on tax-exempt organizations. There are potential alternatives for deferral of compensation, however, including private stock option plans, split-dollar life insurance plans, and severance plans (see the American Institute of Certified Public Accountants [AICPA], July 2001).

For the recipient of stock options there are important tax ramifications. Generally there is no tax imposed upon the receipt of a nonqualified (common) stock option, the general guideline being that if there is no ascertainable value for the option at the time it is granted, then there is no tax liability to be paid until the option is

exercised. At the option's exercise, common options are subject to federal income tax withholding by the employer, and employees may actually have to pay money to the employer to facilitate withholding. At the time of exercise a number of alternatives are usually given to the option's holder:

- Cashing out at the time of exercise—exercising the option and having the stock sold simultaneously to pay the option price and taxes.
- Holding on when there is good reason to believe that the price of the stock may go up substantially.

Participating in like-kind exchanges. This allows for a pyramid or exchange of stock to defer tax, where the executive exercising the option delivers the shares purchased in exchange for a renewed option grant on the employer's shares (see the American Law Institute, http://ali.org/ for more details).

For example, consider incentive stock options (ISOs). These are statutory arrangements to avoid the recognition of a taxable gain on the option after it is exercised. To avoid this recognition, the stock has to be kept for at least one year after exercise. Then when the income is recognized, it can be characterized as capital gains income as opposed to an ordinary income (which has a much higher tax rate). To qualify as ISOs, the following requirements must be met:

- The exercise price must be equal to what the fair market value of the stock was on the date it was granted.
- ISOs cannot be granted to any person who owns more than 10 percent of the voting power of all classes of stock.
- ISOs may only be granted to employees. Once the employment relationship terminates, by reason other than death, the employee only has 90 days to exercise the ISOs, after which they lose their tax-qualified status.
- The number of ISOs granted annually is limited to $100,000 worth of stock priced at the underlying fair market value at the time of the grant.
- ISOs cannot be transferred to any person or entity other than at death by will, laws of descent, or beneficiary designation. If stock acquired in an ISO is transferred within one year of the exercise, then income has to be recognized on such disqualifying disposition (see the American Law Institute for further details).

Options of various sorts are granted by various parties and usually have well-defined properties with specific tax implications that require careful valuation and financial planning. For example, for *common* options, when they have an ascertainable fair market value by reason of being listed on a published exchange (the option must be listed, not just the stock), the tax on such returns may equal the personal income tax. In some unusual arrangements, the right to exercise such an option is conditioned on additional services such as competition covenants of the employee. In these situations, no income is recognized until such time as the option has an ascertainable fair market value and the employee is no longer subject to substantial risk of forfeiture with respect to the arrangement.

The tax differences may thus be important. If the option is considered as ordinary income it can be taxed as high as 40 percent, whether the option holder sells his stock shares or not. If shares are not sold at the time the options are exercised, any additional increase in the share price from then until the time shares are sold is treated as a long-term capital gain, and therefore taxed at a lower rate.

Buying Long and Selling Short The decision of prospective investors and speculators to buy (a *long* contract) and to short-sell (i.e., to borrow an asset or security now in order to resell it later, without the investor necessarily owning it) is not only based on their risk profiles. Perceived and estimated expected changes in stock prices, in risk, in interest rates, and in related economic and financial markets, as well as the private information of investor-speculators, are essential ingredients applied to solve the basic questions of what to do, when, and where by these investors-speculators.

Real and Financial Assets

A real asset, although worth money, is not a financial instrument traded in financial markets (as it is in the case of a security, a bond, or a derivative), but an asset whose owner may keep it or sell it at a going price. An apartment, a bridge, and a power station are examples of real assets. Real assets have value derived from the returns they provide, the rights they confer to their owners or imply, their appreciation (actual or expected), as well as their holding and maintenance costs. Real assets are not generally liquid (i.e., it takes time to sell them—try to sell an apartment you own!). Real assets can be liquefied, however, by pulling together similar assets into a portfolio and selling shares in such a portfolio. This is possible, of course, only if there are buyers and sellers who trade in these shares.

This process has assumed an increased importance in finance. It has also contributed significantly to the management and the growth of credit (see Chapter 9). At the same time it has been labeled as one of the culprits in the financial meltdown of 2008. For example, pulling together mortgage payments into portfolios and securitizing these portfolios (called mortgage-backed securities, or MBSs), buying and selling their various returns and obligations (in case of default), has made it possible to increase the volume of mortgages sold by banks.

At the same time, this practice has contributed to a massive shift of risk, owned traditionally by mortgage-granting banks, to abstract investors who buy and sell cash flows without being fully aware of the intricate risks these securitized mortgage contracts imply. In this case, mispricing, excess zeal in granting mortgages by bankers, as well as macroeconomic shifts (such as substantial increases in interest rates) can induce a market meltdown, as was the case in 2008. For example, say that a bank provides a mortgage of $900,000 for a house whose current price is $1,000,000 and which serves as collateral for the mortgage. If house prices keep increasing faster than the mortgage-holder debt, then of course there can be no default from the bank's viewpoint. However, if the house depreciates suddenly by 20 percent, the mortgage holder will be strongly tempted to default and let the bank face the loss of value of the house. Securitization is nevertheless an extremely popular technique (and likely to remain an essential financial tool in the future) applied to a broad set of products,

including for example insurance contracts, debts of various sorts, credit derivatives, and so forth.

Financial Markets

Financial assets are traded in financial markets. These markets operate all over the world, some of them specializing in trading specific financial products (securities, bonds, options, commodities, carbon, currencies, metals, etc.). These markets may be differentiated by:

- The type of financial asset being traded.
- The location of the financial market (including its currency and local trade regulation).
- The process for price setting or market making in the financial market.
- The technology used for trading.
- The financial regulation in effect.

For example, the Montreal Stock Exchange focuses on options trading, while at the exchanges in New York, Chicago, Tel Aviv, Paris, London, Hong Kong, Shanghai, Frankfurt, and other large metropolises an extremely large number of financial products and their derivatives are traded; these products are also compiled into indexes that characterize the evolution of prices and are used as well to market derivatives on such prices. The Dow Jones of New York in particular has indexes including the Industrial Average (DJIA), DJ Transportation, the DJ Utilities Average, and the DJ 65 Average. Standard and Poor's (S&P) also publishes and trades on its index, the S&P 500. Other indexes include the New York Stock Exchange (NYSE) Composite Index, the NASDAQ composite index, the AMEX Market Value Index, the Russell 2000 Stock Index, the Wilshire 5000 Equity Index, and the like. By the same token, the Chicago Board of Exchange (CBOE) is a very active financial market trading in commodities and options as well as other securities. In some cases, certain securities are traded in multiple markets at the same time, providing opportunities for trading on the same security in different time regions.

Overall, the quality of a financial market is defined in terms of its liquidity, size, transaction costs, transparency, and regulation. A public firm's decision to list its security in one market or another is therefore a strategic decision, which may affect the price of the firm and its access to the capital it requires for its development.

OPTION CONTRACTS

Although most people believe that derivatives are a recent innovation, they date as far back as twelfth-century practices by Flemish traders. The first futures and options contracts resembling current option types were in fact implemented in the seventeenth century in Amsterdam, which was at that time the financial capital of the Western world, and in the rice market of Osaka. Practice in derivatives has expanded into global financial markets following developments in financial and economic theory that have made it possible to price such contracts (see Chapters 7 and 8). A number of such options are defined next.

A *call (long)* option is an option contract that gives the holder the right but not the obligation to buy a specified amount of the commodity, stock, or foreign currency (the *underlying asset*) for a premium on or before the exercise date. A *call (short)* option is an obligation to meet the terms of this contract.

Put options give the holder the right to sell at a specified price—called the *strike price*—on (or before, for an American option) a specific expiration date. The short side of such a contract carries an obligation to meet the terms of this contract.

For example, a long call consists in paying $3 now to have the right to buy in three months an IBM share at the strike price of $52. If the price in three months turns out to be $59, then at the exercise date of the option, the buyer (long) of the call option would collect $59 less $52, or $7. If the price turns out to be below $52, the holder of the option collects nothing.

PROBLEM 1.1: OPTIONS AND THEIR PRICES

The data in Tables 1.2 and 1.3 summarize the record of options on IBM traded in a financial market. This data can be collected from Yahoo Finance, the *Wall Street Journal*, the *Financial Times*, and the many other financial services that publish such data daily. This data set provides all option prices of IBM that expired Friday, March 20, 2009. Buyers and sellers of options use such information for various purposes. Note in particular:

- The *bid* price—the price that a buyer of the option is willing to pay.
- The *ask* price—the price that a seller of the option is willing to accept.
- The *last* (current) and its change from the price at which a trade transaction has previously been made.
- The *volume*—the number of options traded.

These prices also indicate traders' beliefs regarding the future price of IBM security prices. If the price of the call option increases, this means that the most traders expect the IBM price to increase.

The *spread* at any given time is the difference between the ask and bid prices. It is used by market makers, whose essential function is to create liquidity (i.e., meeting as much as possible all requests for trades). Changing prices from instant to instant reflect both the spread and the inequalities between the bid and the ask sides, as well as changing expectations regarding IBM's future price.

Use the following questions to review your understanding of the data summarized in Tables 1.2 and 1.3:

- What do the IBM options indicators IBMFL.X, IBMFO.X, and the like, mean? Why are there so many such indicators?
- What are the prices of the call and put options? (Select a few.) Why do they differ?
- What is a bid and what is an ask price for some of these options?
- What is the spread, and what does a spread mean for a trader?
- What does the volume traded in options represent?

TABLE 1.2 Call Options (expire at close, Friday, June 19, 2009)

Strike	Symbol	Last	Change	Bid	Ask	Volume	Open Interest
60	IBMFL.X	45.35	0	47.4	48.1	1	1
75	IBMFO.X	31.3	0	32.4	33.1	23	33
80	IBMFP.X	26.4	0	27.4	27.8	5	35
85	IBMFQ.X	22	1	22.5	22.7	11	231
90	IBMFR.X	17.4	0.4	17.5	17.7	52	1,016
95	IBMFS.X	13	0.2	12.6	12.8	98	1,773
100	IBMFT.X	8.1	0.5	7.7	7.9	298	4,172
105	IBMFA.X	3.5	0	3.4	3.6	3,810	15,764
110	IBMFB.X	0.8	0.1	0.75	0.85	2,451	12,248
115	IBMFC.X	0.1	0	0.05	0.1	283	7,707
120	IBMFD.X	0.03	0.02	N/A	0.05	14	1,881
125	IBMFE.X	0.05	0	N/A	0.05	4	407
130	IBMFF.X	0.02	0	N/A	0.05	10	10
140	IBMFH.X	0.05	0	N/A	0.05	0	117

Source: Yahoo! Finance.

- Using this data set, can you see a relationship between the spread of specific options and the volume traded in such options?
- What is the strike of an option?
- What is the option price? What is the option price change?

Options and Specific Needs

Other options, some of which are not traded, are used to fit specific needs. For example, exotic options such as Bermudan options are used to provide the right to

TABLE 1.3 Put Options (expire at close Friday, June 19, 2009)

Strike	Symbol	Last	Change	Bid	Ask	Volume	Open Interest
60	IBMRL.X	**0.05**	0	N/A	0.05	10	310
65	IBMRM.X	**0.05**	0	N/A	0.05	10	15
70	IBMRN.X	**0.02**	0	N/A	0.05	10	607
75	IBMRO.X	**0.05**	0	N/A	0.05	50	981
80	IBMRP.X	**0.03**	0	N/A	0.05	2	1,721
85	IBMRQ.X	**0.04**	0.01	N/A	0.05	9	1,739
90	IBMRR.X	**0.04**	0.01	N/A	0.05	44	6,288
95	IBMRS.X	**0.06**	0.04	0.05	0.15	146	9,461
100	IBMRT.X	**0.24**	0.11	0.2	0.25	1,177	9,351
105	IBMRA.X	**0.9**	0.3	0.9	0.95	3,431	9,891
110	IBMRB.X	**3.19**	0.41	3.2	3.3	977	3,496
115	IBMRC.X	**7.4**	0.1	7.4	7.6	225	897
120	IBMRD.X	**12.2**	0.4	12.3	12.5	21	365
125	IBMRE.X	**17.3**	0	16.9	17.5	4	6
140	IBMRH.X	**38.6**	0	31.9	32.6	6	10

Source: Yahoo! Finance.

exercise the option at several specific dates during the option lifetime, while Asiatic options define an exercise price for the option as an average of the value attained over a certain time interval. Of course, each option, defined by its specific characteristics, is priced accordingly. In Chapters 8 and 9, options are dealt with in greater detail. Options on bonds as well as options on credit risk portfolios (credit derivatives) are priced in Chapters 9 and 10.

Option prices are defined by the bets exercised by buyers and sellers of options. The prices express option buyers' and sellers' beliefs regarding future market prices of the assets that underlie the options. As a result, these future prices (implied in current option prices) can be used for hedging or for speculating based on beliefs regarding the future prices that option prices reveal (see Chapter 11). Option uses are thus versatile. Some uses include:

- Buying and selling options to hedge a downside risk and to speculate.
- Estimating an underlying asset volatility.
- Motivating management and employees.
- Delaying a tax payment.
- Raising money for investments.

The use of options requires a competent understanding of options theory, financial markets, and financial engineering. Applications are considered next.

EXAMPLE: OPTIONS AND THE PRICE OF EQUITY

The equity value of stockholders is defined by the claims they have on the residual value of the firm—the value remaining once the firm has met its obligations to its debtors, the bondholders. For example, if a firm defaults on its interest payments for a loan, bondholders can force the firm into bankruptcy to recover the loan. A stockholder, a junior claimant in this case, has nothing left to claim. Hence, a bondholder has the right to sell the company at a given threshold or, equivalently, the bondholder holds a put on the value of the firm that the stockholder must hold short. Hence, a stock can be viewed as a claim or option on the value of the firm that is shared with bondholders.

EXAMPLE: MANAGEMENT STOCK OPTIONS

Stock options are granted to managers and consist of options to buy the firm's stock at a given future date and at a given (often very advantageous) price. These rights are granted to align executives' and employees' welfare with that of the shareholders. The rationale for such compensation is to skew executive's income to be heavily dependent on an upward movement of the firm's stock price. As a result, it is believed that executives will be more likely to pursue an aggressive policy leading to a stock price rise, as executives' payoff is a convex increasing function of the stock price. Shareholders will benefit from such a rise but they assume a risk due to the call (stock) option's limited liability granted to the executives. In practice, however, some executives' options payouts occur regardless of the firm's stock performance!

For this reason, stock options remain a much discussed and criticized means of payment to executives.

OPTIONS AND TRADING IN SPECIALIZED MARKETS

Options are traded for many purposes and in many markets. In this section we consider some specific examples such as trading carbon emissions; trading commodities such as metals, gold, silver, corn, oil, or orange juice; trading the weather, which consists in buyers and sellers of weather contracts betting on future temperatures; and so on. A brief introduction to securitization and its uses in marketing MBSs and CDOs (expanded in detail in Chapters 9 and 10) is included as well. Of course, these represent only a very small sample of the many financial products traded in specialized financial markets.

Trading the CO_2 Index

Following the ratification of the Kyoto Protocol agreement on carbon dioxide emission standards, European Union officials created a market for trading pollution credits. They claimed it to be a cost-conscious way to save the planet from global warming. "The results of CO_2 (pollution) trading using a number of optional contracts has not always delivered a cleaner environment however" (*International Herald Tribune*, July 24, 2006, page 10). "I do not suppose the environment has noticed the European emissions trading scheme," said William Blyth, director of Oxford Energy Associates in Oxford, England. The utilities that use CO_2 trading as well as traders and some hedge funds have done very well, though. Further, CO_2 emission contracts have on the whole been very volatile and perhaps irrelevant to improving the quality of the environment and global warming. The *International Herald Tribune* article just cited states further that Open Europe—a policy group that assesses EU laws—claims further that the $44 billion a year market is "an environmental and economic failure." To put it mildly, the jury is still out regarding the efficiency of financial markets for CO_2 emissions.

The U.S. entrance into carbon trading in 2009 introduced further confusion regarding the usefulness of such instruments to manage the quality of the environment. There are numerous explanations for this state of affairs. It is a commonly known fact that the EU was largely tolerant in its distribution of emission standards, signaling a preference for economic activity over environmental stewardship. At the same time, an increase in oil and gas prices in 2005 and 2006 has favored the production of energy by burning coal (which has a direct impact on the price of emission standards). Further, the codependence of energy prices and emission standards combined with governments' intents have induced an appreciable volatility in this market, which was noted by hedge funds and traders who have largely profited from such trades. The future of carbon trading, while presumed to be important in the future, is only at its beginnings today.

Trading on Commodities (Metal, Gold, Silver, Corn, Oil)

Commodity markets originated in the trading of agricultural products in the nineteenth century (cattle, hogs, corn, and wheat were widely traded at that time in the

United States with standard instruments). The need to manage the risks of price fluctuation, driven mostly by variations in supply and demand, has led to the expansion of commodities trades and to the inclusion of other commodities such as gold and silver, soybeans, and energy products (such as crude oil, natural gas, electricity, etc.). There are today 48 major commodity exchanges worldwide that trade more than 96 commodities. The high volatility and high return in this market has recently attracted a wave of new investments to what was previously considered a specialist market. New entrants including hedge funds, financial institutions, and speculators are some of the many parties involved in trading in such markets. In addition, a broad number of instruments are used including forwards, futures, and options of all sorts.

Tradable commodities include:

- *Precious metals*: gold, silver, platinum.
- *Other metals*: nickel, aluminum, copper.
- *Agro-based commodities*: wheat, corn, cotton, oils, oilseeds.
- *Soft commodities*: coffee, cocoa, sugar.
- *Livestock*: live cattle, pork bellies, and so on.
- *Energy*: crude oil, natural gas, gasoline, and so on.

Statistical time series broadly and openly available indicate the extent and the importance as well as the volatility of commodities markets.

Trading the Weather and Insurance

Trading the weather, which is traded on the Chicago Mercantile Exchange (CME), is done by buyers and sellers to hedge their energy- and climate-related costs. Insurance firms use such trades to better manage the risks of their climate-related claims. Typically, weather trade contracts consist in a payout based on certain weather conditions being met over a finite time period. For example, a ski resort could hedge against the risk that less than three inches of snow will fall in February (which would reduce the resort's income). Farmers, theme parks, and gas and power companies are the more important users of weather derivative products.

The first weather derivative contract consisted in a deal for purchasing electric power, in which the price was conditional on the weather of a specific place at a specific time. The CME currently trades weather derivative contracts for 18 cities in the United States, 9 in Europe, 6 in Canada, and 2 in Japan. Heating degree day (HDD) and cooling degree day (CDD) are the underlying quantitative indexes used to measure weather conditions and related to energy consumption—the basis for the most common type of weather derivative.

Securitization, Mortgage-Backed Securities, and Credit Derivatives

Ever since the 1930s, S&Ls have been profiting from a favorable regulation (Regulation Q), which gave them a competitive edge over commercial banks in this financial activity. However, the rise of interest rates in the 1970s made it possible for commercial banks to attract investors by providing better terms than S&Ls. This led to the demise of S&L banks as a preferential means for savings. The

mortgage crisis that followed had dramatic consequences on the S&L sector as well as on many savers, which led to the creation in 1968 of the Government National Mortgage Association (GNMA), called Ginnie Mae; the Federal National Mortgage Association (FNMA), known as Fannie Mae; and finally in 1970 the Federal Home Loan Mortgage Corporation (FHLMC), also called Freddie Mac. These institutions, by securing S&L obligations, have made it possible for S&Ls to repackage their liabilities at attractive rates.

The recent 2008 financial meltdown has emphasized that overleveraging and oversecuritization without risk controls can lead to the demise of financial corporate entities, even as large as Freddie Mac and Fannie Mae. Conditions imposed on capital guarantees on such firms—such as a maximal capital assets ratio to loan, or capital to value of the underlying asset—have made it possible to build portfolios of liabilities backed by assets that were subsequently securitized. In this manner, S&Ls were able to reduce their credit (mortgage) risks and reduce their capital requirements, allowing them to augment their loans to home buyers and make more money. In the 1980s these arrangements evolved into what we currently call mortgage-backed securities (MBSs). This has grown since then into an extraordinarily large and active market, in the trillions of dollars. In the United States more than 75 percent of mortgages are in fact securitized. Similar problems arose in England and France as well as in other countries, with the same remedy applied. Thus, MBSs and their derivatives have become an important part of financial trades.

Subsequent to the creation of MBSs, other categories of debt have also been securitized, with new products permanently introduced in financial markets. These instruments have provided loans to home buyers at generous terms and have at the same time generated large fees for the lending institutions. For some, the financial debacle of 2008 is due essentially to the uncontrolled proliferation of these contracts. Chapters 9 and 10 consider such contracts at length.

REAL-LIFE CRISES AND FINANCE

The ARS Crisis

Auction-rated securities (ARSs) are financial instruments renegotiated at regular intervals of time (a week, a month) through an auction of buyers and sellers (holders of the securities) to determine the contracted rates of return that such securities will pay. The intent of such securities is to provide liquidity to the buyers and sellers even though these are usually securities secured by terms spanning long periods of time. For example, to reduce the high cost of municipal bonds, municipalities have used ARSs to reduce their borrowing costs. They do so by pegging the security to a short-term spot interest rate (since the interest payment is determined each time the auction is taken). This seems to be a win-win for buyers and sellers, but important problems can arise. In mid-February 2008, sellers overwhelmed potential buyers, causing widespread auction failures for the first time:

> *The magnitude of the liquidity crunch that developed as a result of auction failures was not expected given that the market has operated smoothly for almost 25 years. Despite the relatively strong credit quality of the underlying*

> *collateral, the pronounced imbalance of sellers to buyers has overwhelmed all other considerations.*
>
> —CITI Smith Barney, "Fixed Income Securities," February 29, 2008

Problems thus arose owing to the lack of liquidity, not because of a rise in default risk. This has created many other problems (through diffusion-contagion and market dependencies, introduced in Chapter 4).

The Banking–Money System Crisis

The credit and liquidity crisis of 2008–2009 was extremely harmful, threatening the future of financial institutions and the banking system constructed so laboriously over many years. This system is based on the fiduciary trust granted to banks by depositors and governments to oversee the supply of money and to be in a position to redeem depositors' claims. For some, this trust was violated, leading to a near breakdown of our financial system and to the dire credit liquidity crisis of 2009. The subsequent Troubled Asset Relief Program (TARP) support to banks, a massive influx of government funds into financial markets to stimulate some liquidity and credit, has only been a short-run measure, with the fracture of finance as its essential long-run concern.

Such problems are not a new phenomenon, however. James Macdonald (*Financial Times*, March 7, 2009, p. 13) recalled a similar story, from 1719 to 1720 in France, involving the king's default on his finances (a notorious recurring problem). Its effects, like today, were a high followed by a dramatic low and loss of confidence. It started with a public debt of 100 percent of the national income in 1714 and was subjected to forced reductions of principal and interest. Confidence collapsed; government paper sold for discounts of up to 75 percent and the economy was in recession (as was the case in 2008). To face these problems, a Scot, John Law, suggested that debt be exchanged for shares in the Compagnie des Indes (a French corporation for the Americas, called also the Mississippi Company [MC], which owned all rights for economic exchanges between France and the Americas). He proposed that the government issue a new series of bonds on the company, paying 3 percent in exchange for its old debts, which had paid 4 to 5 percent. In this manner, service charges of the debt would be reduced.

However, the MC was an empty shell at that time, generating no profits. To stimulate activity in these worthless shares, John Law introduced *securitization* and activated it in as many trades as possible in shares of the MC. These trades led to the historic MC bubble. John Law's plan succeeded, and the French debt was sold, which seemed far more profitable but was based on a credit-driven bubble due to the MC which, in the end, had to default. This default created an economic problem, and it took a great many years for France to recover from it. The dramatic default resulted in losses and a loss of liquidity, as this was the case recently. It was at this time that the term *millionaire* was coined. Law used such a term to describe his investors at the top of the bubble, although he died penniless and a fugitive a few years after being arguably the most powerful man in the world!

The effects of a breakdown in liquidity and a fractured finance are in fact very important and a key source of collateral risk to other sectors, including the real economic sector, with GDP growth rates and consumer spending affected. In such

an environment, a financial crisis has been nurtured by financial markets and by the fear factor (measured by the VIX index, a volatility index). This has resulted in the threat of deflation, a lack of trust in financial institutions, and consumers keeping their money rather than consuming or investing. These factors were understood by central bankers who sought to reduce interest rates to stimulate spending and provide greater liquidity (by tax repayments to consumers, by augmenting central banks' lending to financial institutions, etc.). For example, the European Central Bank, citing "tensions in the euro money market," injected more than $130 billion in August 9, 2009, in the type of emergency operation that had not been conducted since the aftermath of the September 2001 terrorist attacks.

The *Wall Street Journal* (March 8–9, 2008, p. B14), for example, laid some of the blame for the losses of some banks on extremely poor financial risk management due to amateurish management blunders, and on the greed of bankers who appropriated the majority of corporate profits while acting only as intermediaries in the process of real wealth creation. The big losers did not have effective firmwide systems for collecting data about their risks. They allowed business heads too much leeway in setting and enforcing risk limits, and didn't work to break down bureaucratic barriers that kept bad news from flowing upward. This resulted in businesses focusing on immediate profits and ignoring consequences. At best, techniques based on static value at risk (VaR) models (see Chapter 3) and external ratings (see Chapter 9) were used to direct their actions, rather than a deeper understanding of credit risk derivatives. As a result, even when the dimensions of the crisis were revealed, it was too late to do anything about it. Errors were thus made, not only due to quants' analyses and the existence of derivatives that had made it all possible, but essentially due to greed, a lack of appropriate regulation to mitigate the misdeeds of financial markets, ignoring and misusing the basic elements of risk management.

THE 2008 MELTDOWN AND FINANCIAL THEORY

The meltdown of Lehman Brothers and AIG, the Wall Street liquidity crisis of 2008, and their extraordinary subsequent fallouts are probably the most significant and catastrophic financial events since the Wall Street Crash of 1929. While many explanations and reasons are yet unfolding, it is mostly agreed that financial markets and some financial processes were functioning under economic and financial assumptions that could not be sustained. This raised challenging theoretical problems to reconcile the financial and economic dogma (or the efficient market hypothesis, developed further in subsequent chapters) with financial practice. While some critics may have overreacted against the theory of finance, there remain some concerns. Ten of these concerns are as follows:

1. *Equilibrium*. The stable economic equilibrium implied in financial pricing and analysis has turned out to be fool's gold. The assumptions used in financial theory based on stable financial markets equilibrium may have been overly restrictive. The question is, are financial markets defined by a stable equilibrium, or is a dynamic equilibrium process with cyclical booms and busts more appropriate?

Answers to such a question will necessarily pit the conventional financial dogma against theories that have yet to be developed.

2. *Future implications.* The credit and liquidity crisis characterizing the financial meltdown of 2008–2009 has important implications to the future of finance. What are the theoretical and practical implications? How does liquidity affect the pricing process? The financial meltdown has revealed that economically viable assets became almost worthless due to a lack of liquidity! Two types of liquidity articulated by the Basel Committee on Bank Supervision are the *funding liquidity risk* of a firm unable to meet its obligations, and *market liquidity risk*, denoting the risk that a firm cannot offset a position or eliminate a position at the market price because of inadequate market depth or market disruption (Golub and Crum 2010). Liquidity, in particular, rather than being a firm-specific problem has been shown to be a common risk that can ignite default contagions and dislocation of financial market prices.
3. *Finance and complexity.* Ashby's second law of cybernetics essentially states that complexity can be managed only if regulators and controllers are more astute than the managers and processes they seek to manage (Ashby 1964). This in turn stimulates increased innovation and greater complexity and thereby contributes to a vicious cycle of complexity growth. The end result: Either financial managers or their regulators are overwhelmed. While simplicity and transparency would clearly be helpful rules for financial risk management in a complex world, one may argue for the opposite case. On the one hand, there is an apparent need for more regulation to protect investors and restore fiduciary trust in the banking system. On the other hand, financial managers have always found the means to circumvent financial regulation. This is particularly the case in a financial multipolar system, with financial centers and capitals competing with each other to attract capital. In addition, when markets are functioning well, asset prices (due to arbitrage) tend toward their intrinsic value. However, arbitrage depends on the presence of expert investors who actually know what the intrinsic value is. When markets falter, either experts do not know the intrinsic value or, even if they know, their positions may entail extremely large losses due to contagious behavior and a breakdown in financial market liquidity. For this reason, in complex markets, when the intrinsic price is very difficult to determine, there will actually be few experts trading, and thus the market will be dramatically reduced (see also Chapter 10).
4. *Financial intermediation.* Many financial institutions have become marketers while owning all the know-how and information regarding financial products and markets. This has created situations where all counterparty risks (moral hazard and adverse selection, introduced in Chapter 6) are held by consumers/investors while these same institutions hang on to all the profits. These have led to a large collection of corrupt practices, legalized insider trading, and the extraordinary heist that financial institutions were able to embark on with no threat of punitive action. These situations may in the future require a careful restructuring of financial products and their regulation to ensure they are *ethically green*. While greed can hardly be constrained willingly, greed prevention may be embedded in the manners in which financial products and transactions are made and managed. For example, if financial transactions can be made transparent and all parties involved in such transactions maintain a stake in them,

financial responsibility may be maintained across the financial supply chain that bridges the gap between those needing money for some productive ends and investors—the suppliers of funds.

5. *Integrated financial risk management.* Industrial enterprises have in these past decades undergone a revolution in the manner in which they manage quality, moving from controls to prevention and on to incentive-based prevention and robust design. Equivalently, such a revolution is being felt and needed in banking and other financial institutions seeking to unwind the complexity of financial products and financial markets while adopting an integrated view of financial risk management processes focused on the multiple and dependent risks financial institutions face (see Chapter 4).
6. *Globalization and finance's multipolarity.* Globalization in financial markets, unlike industrial globalization, cannot be managed or controlled by edicts, even if they are made by the strongest nation on earth. Money flows where it is most prized. A policy that does not recognize this fact is likely to fail. Further, the growth of global economies has led in parallel to the growth of financial markets and their numbers. As each has its own systems, cultural values, and regulation, this growth may result in competitive financial markets that are difficult to regulate.
7. *Complex financial products and insurance finance.* Complex financial and securitized products such as CDOs, and the like, are indeed intricate and cannot be treated routinely like securities of specific industrial enterprises (see Chapter 10). Further, the central role of insurance in marketing (i.e., to augment financial liquidity) has revealed that insurance finance has become an essential part of the market-making process. In a financial world where both buyers and sellers seek a flight from risk, without insurance, buyers and sellers of such products would be reluctant to assume the liquidity, market, and counterparty risks that such products carry. By the same token, rating of financial firms and products is both partial (and therefore misleading) and too slow in responding to major and sudden shifts in the economic environment of firms. In other words, there is an acute information and claim risk to raters' pronouncements in time of crisis.
8. *Intervention in financial markets.* The belief that markets are self-stabilizing has also turned out to be fool's gold. Rather, a new neo-financial Keynesian belief and practice has set in, calling for an active role of a national policy in managing as well as regulating financial markets and institutions. Issues such as *too big to fail* (Taleb and Tapiero 2010); the moral hazard implication of rescuing failed financial firms, and so forth, remain both an economic and a political problem. Restoring trust in the banking system and financial markets has, however, been the focus of the United States' and other nations' policies.
9. *Financial measurement.* Variability-like measurements (such as returns' standard deviations and their quantile value at risk effects, outlined in Chapter 3) have been found useless when struck by *black swans*, those rare and unpredictable events that nevertheless recur (Taleb 2007a, 2007b). As a result, financial risk management based on such measurements has proved to be insufficient, calling for an alternative approach embedded in processes, seeking to be in tune and integrated in the financial trading and speculation process without necessarily stifling the creativity and profitability of risk taking.

10. *Management's risk and moral hazard*. Last but not least, the economic and liberal financial theories that have contributed immensely to the economic and social welfare of modern societies are now challenged to compensate for the growth of biased financial intermediation, economic and financial behavior out of equilibrium, and off-equilibrium financial transactions and processes that have a negative social value (for example, contributing to social inequalities, hijacking of corporate profits by the few at the expense of the many, etc.). The persistent and extraordinary profits that financial institutions have made and the bonuses taken by lead bankers and traders in both good and bad times may have evoked social concerns whose effects on financial markets can yet trigger unpredictable reactions.

The credit crisis of 2008 has thus forced financial parties and institutions to rethink the current state of financial theories and their practice as well as realign financial risk management with the *reality* of finance and not its implied prices and processes only. In particular, behavioral finance, based on an observed rationality of decision makers and a return to expected utility with calibrated models consistent with the EMH, is providing preliminary approaches to reconcile real facts with the theoretical constructs of finance.

FINANCE AND ETHICS

> *Ethical considerations can only legitimately appear when the truth has been ascertained: they can and should appear determining our feeling towards the truth, and our manner of ordering our lives in view of the truth, but not as themselves dictating what the truth is to be.*
>
> —Bertrand Russel

Economic and financial decisions are about rational choices, often derived from values, culture, and politics. For example, is more (money) always better? Are the proper objectives of firms to maximize their profits and stock prices? If the attainment of self-satisfaction is socially condoned in our culture, then how can one question those entrepreneurs who do improve their lot? Is the credo of more money for executives at any cost ethical? By the same token, is wholly or partly fraudulent risk transfer to other investors ethical? Answer to these and related questions are not obvious, for ethical values (in their mild form) are often the product of our personal values, our tolerance, our social acceptance, and our inability to measure, audit, and control financial processes and their consequences. Financial risk consequences that are not assumed by their perpetrators are risk externalities. Voluntary compliance to prevent such risks and/or assume responsibility for them underlies ethical behavior, while risk perpetrators profiting from opportunities while consequences are assumed by other parties is unethical. For these reasons, in order to compel perpetrators to assume their responsibilities and compensate for their behavior, financial regulation is needed.

Do issues of partial information, insider trading, risk taking, and market power by some imply behavior that is not ethical? If speculators and profit takers assume the risks of their actions, there is no reason to claim that their profits were not

ethical. Without such speculators, willing to assume risks, no market can be efficient. However, if financial managers assume extraordinary risks but not, at the same time, their consequences, then there is a strong case to believe that this is unethical behavior. When such managers are celebrated as financial heroes because of the size of their returns, it may reflect the values of a society that celebrates winners who take all, whether ethical or not.

For example, the *New York Times* (December 29, 2009, Front Page) relates that a mortgage-based security called Abacus, launched when the real estate market became unglued, was created to make money for Goldman Sachs in case the market were to turn sour. Goldman, in selling Abacus shares to its clients, made millions while its clients lost billions on securities they believed were solid investments (according to former Goldman employees with direct knowledge of the deal, who asked not to be identified because they have confidentiality agreements with the firm). Are such behaviors, engaged in by other financial firms, ethical? Are they legal? These are questions that financial managers are confronted with daily on trading floors and in managing other people's money. They underlie fundamental questions regarding what is and what is not ethical behavior. If financial and economic choices are measured in terms of one's own interests only (as some economic theories support), irrespective of their consequences for others, would such pursuits be ethical or not?

These questions highlight many of the issues we deal with when evaluating financial institutions and their executives' pay. For example, are the extraordinary profits realized by Goldman Sachs ethical? Is the pursuit of profits combining self- and conflicting interest justified by such an august institution? Of course, these are relative matters: Goldman Sachs may turn out to be a hero for some and a villain to others, based on their assessment that no risk assumed by such large financial institutions can (or ought to) provide such returns. Insider trading is strongly regulated with penalties designed to impede those who have the opportunity to profit when they ought not to profit. Thus, in this context, unethical behavior would be clearly defined by the laws that regulate financial transactions. Such laws also ought to reflect responsibility for intended or unintended consequences. For example, does a polluter at sea assume responsibility for his actions? And if not, what are the laws of the sea that can be drafted and applied to such an unethical attitude by polluters so that they stop the acts whose consequences they do not assume responsibility for?

But these ethical and nonethical behaviors imply far more. They are complicated further by the growth of multinational and global corporate firms that have no national authority to respond to, or no accounting standards (and at times no values) to comply with. Some attempts are being made to mitigate this state of affairs by promoting international collaboration in regulating financial and other enterprises. For example, the International Federation of Accountants (IFAC) sought to set global accounting standards and recognizes the conceptual impossibility of creating one set of standards for a diverse world. Alternative standards might be discussed; ethics education, assurance, and a convergence of cross-boundary standards and regulation might be helpful in resolving the problems of accounting. However, in multicultural and complex global markets and firms, these problems are likely to remain daunting.

Of course, more courageous whistle-blowing by both corporate employees and the media would be helpful. This would point to excesses, facilitate better predictions, and open the way for an educated analysis of firms' or analysts' deviant behaviors. These occurrences of whistle-blowing are likely to remain outliers rather than the

norm and might even produce a plethora of false-alarm whistle-blowers with their own specific agendas. For example, while intense attention is given to manipulations of derivatives accounting, making it possible for some transactions to be opaque (and, as a result, direct huge profits to executives at the expense of shareholders and firms), these same derivatives ethically and properly used contribute hugely to financial risk management, economic efficiency, and financing for solutions to many of the outstanding social challenges of our day.

Crime and Punishment

Ken Lay and Jeffrey Skilling (Enron), Martha Stewart (Living Omnimedia), Bernard Ebbers (WorldCom), Dennis Kozlowski (Tyco), Richard Scrushy (HealthSouth), Frank Quattrone (Credit Suisse First Boston), Fannie Mae (the government-sponsored mortgage company), Bernie Madoff (the huge Ponzi scheme), and so many others are outstanding cases that have garnered media attention in 2000–2008. Such attention often turns into frenzy, seeking to remind corporate executives that crime does not pay. These are difficult lessons, however, for in finance, *crime* is often ill defined and the punishment is often a reflection of a financial ethic that is subject to the tunes of the times.

For example, when does personal information become an insider trading advantage? Inversely, would an investor, a hedge fund trader, or a market specialist trade on stock information he alone possessed, or only on common knowledge? Are arbitrageurs' decisions based on a strategy or on an appreciation, acquired by various means, that there are opportunities to profit from or due to mispricing and partial information? If financial markets are efficient, then there can be no profits without risk. In this case, why would a risk-averse investor invest in these efficient markets? If your tax rate (federal, state, and city) is 50 percent of your profits and risk-free (banking) rates are 1 percent with an inflation rate of 3 percent, what can you do legally with your investments? There is very little one can do unless one assumes financial risks. The assumption of financial risk by investors is therefore inherent to all financial activities.

These are limits that ethics and finance must confront, however, in order to establish a proper code of behavior—defined by a number of laws and regulations—that can be sustained by businesses and productive firms. Since the Enron verdict, which found Chairman Kenneth Lay and CEO Jeff Skilling guilty of wrongdoing, both the media and concerned readers have expressed widely differing views. Some claim that tolerance of unethical practices has led to excesses that financial markets, investors, and businesses cannot sustain. Some of the issues raised reveal an extraordinary complexity. Are accounting rules doing what they are assumed to do? Can accounting firms maintain their clients while at the same time not meeting their demands? Are accounting scandals imposing too big a burden on businesses that have to conform to new regulations? Can excessive controls impose costs on firms that would render them noncompetitive compared to foreign and unregulated firms? Are such firms likely to migrate to some markets and countries that are not subject to such regulation? A lesson learned from Enron demise has been that many of the machinations that allowed the company to book false profits, create cash flow out of thin air and hide billions of dollars of debt were at least arguably legal—hence they'd done nothing wrong. As often as not, Enron stretched accounting rules, contorted them,

twisted them to its own obvious end, but didn't actually break them. And many of the things Enron did that were illegal were extremely difficult to explain, because they had to do with arcane accounting rules.

In fact, most businesses do behave in an ethical manner, conforming to the law and to codes of ethical behavior. The reaffirmation of an ethical code of finance is the essential message that U.S. courts sent to corporations across America: that the line between properly acquired profits and improperly acquired profits can be thin!

The punishments to be met by those who would not comply are both lessons and a warning. Bernard Ebbers was found guilty of an $11 billion fraud that led the company to bankruptcy; he was sentenced to 25 years in prison. Dennis Kozlowski was convicted of looting Tyco of $150 million and was sentenced to 8.5 to 25 years—and not allowed out on bail. Martha Stewart was found guilty of lying to federal investigators looking into her sale of ImClone stock in December 2001. She spent five months in prisons, while her financial loss following her conviction was immeasurably larger than the few dollars profit she had accrued via insider trading. Richard Scrushy was accused of being involved in a $2.7 billion accounting fraud (although a federal jury in 2005 found the former chief executive not guilty on all charges). Frank Quattrone, battling charges of obstruction of justice, was exonerated. Fannie Mae, which had repeatedly overstated its profits, has been fined $400 million and has agreed to a list of restrictions and reforms. Fannie Mae's main regulator found that the company had overstated its profits consistently between 1998 and 2004 so that its bosses qualified for bigger bonuses: Of the $92 million paid to Franklin Raines, the then chief executive, $52 million was linked to profit targets. To accomplish this, it used political influence and applied shoddy controls and accounting practices In 2009, Bernie Madoff, the ex-president of NASDAQ, the swindler of the century, with a $65 billion Ponzi scheme, who has swindled so many individuals and firms—financial and others, with incalculable damage—is now in jail for the rest of his life. These punishments are forerunners of an increased intolerance of excesses that seeks to convey a louder and clearer message: that *ethics in finance does matter*.

SUMMARY

Risk can be found everywhere. It is omnipresent whenever we invest in securities or manage any resources, financial or otherwise. Risk is affected by the behavior of both traders and investors who interact in a financial market, leading to the establishment of the prices at which commodities, securities, and other risk-bearing assets are traded. Ethical and moral behavior is needed for market efficiency to be sustainable, and it has important effects on the risks we all (rather than a select few) assume and the price at which assets can or ought to be traded. The field of risk finance seeks to price these risks and at the same time to manage their adverse effects.

In this chapter, we considered some basic financial instruments (stocks, bonds, derivatives, real assets, and portfolios) that are needed to carry out financial investment and hedging and to price financial and real assets. In addition, a number of outstanding problems have been defined to motivate exploration and pinpoint some of the special problems this book seeks to focus on.

TEST YOURSELF

1.1 Evaluating risk:

- **a.** Why is it important to price risk?
- **b.** Why is it important for a CFO to manage risk?
- **c.** Name five types of risk you have encountered in your life.
- **d.** Name five risks a chief financial officer might be confronted with.
- **e.** What are financial managers assumed to do?
- **f.** Name three financial intermediaries, define what they do, and explain how they intermediate and between whom.

1.2 What are securities, bonds, and options? How do they differ?

1.3 What are call and put options? How do they differ?

1.4 Why do we need to *value* assets? Why do we need to price a financial asset, and why it is important? How do valuation and pricing differ?

1.5 What are risk sharing and risk pooling, and how do they differ? How do insurance firms use risk pooling, and how do they share risks with insureds and with reinsurance firms?

1.6 What is a hedge fund, and how does it differ from an investment bank?

1.7 What are currency exchange rates?

1.8 What does a security price stand for?

1.9 What are the differences and the similarities between the insurance, businesses and investment and banking?

1.10 What is a rare event, and how does it differ from a normal event? Why are rare events so important in risk management?

1.11 What are environmental risks? How do they differ from a personal risk? How do environmental risks differ from and how are they similar to financial risks?

1.12 What are the effects of genetic testing on individuals relative to insurance? What are the implications of personalized DNA profiles on health insurance?

1.13 All the following institutions are involved in the risk business. Explain how they are similar and how they differ:

- **a.** Insurance firms.
- **b.** Pension funds.
- **c.** Banks.
- **d.** Equity funds.
- **e.** Brokerage houses.
- **f.** Mortgage banks.
- **g.** Savings and loan banks.
- **h.** Hedge funds.
- **i.** Investment-hedge funds.
- **j.** Lloyd's of London.
- **k.** Reinsurers.

1.14 What are the problems in pricing risk events that are rare but have catastrophic consequences?

1.15 What are the problems in managing asset risks that are (1) very, (2) somewhat, and (3) mildly correlated?

REFERENCES

American Institute of Certified Public Accountants. 2001. [AICPA], July 21.
Arrow, K. J. 1951. Alternative approaches to the theory of choice in risk-taking situations. *Econometrica*, October.
———. 1965. *Aspects of the theory of risk-bearing*. Helsinki: Yrjo Jahnssonin Säätiö.
———. 1971. *Essays in the theory of risk bearing*. Chicago: Markham.
———. 1982. Risk perception in psychology and in economics. *Economics Inquiry* (January): 1–9.
Ashby, W. R. 1964. *An introduction to cybernetics*. London: University Paperbacks.
Bachelier, L. 1900. *Théorie de la spéculation*. Paris: Thèse de Mathématique.
Basel Committee on Bank Supervision. 2008. http://www.bis.org/bcbs/.
Bernoulli, D. 1954. Exposition of a new theory on the measurement of risk. *Econometrica*, January.
Black, F., and M. Scholes. 1973. The pricing of options and corporate liabilities. *Journal of Political Economy* 81:637–659.
Borch, K. H. 1968. *The economics of uncertainty*. Princeton, NJ: Princeton University Press.
Bouchaud, J. P., and M. Potters. 1997. *Théorie des risques financiers*. Eyrolles, Saclay, France.
Carr, M., and S. Kishan. 2006. EU pollution plan turns into "playground." *International Herald Tribune*. July 24, p. 10.
CITI Smith Barney. 2008. "Fixed Income Securities," February 29.
Cootner, P. H. 1964. *The random character of stock prices*. Cambridge, MA: MIT Press.
Cramer, H. 1955. *Collective risk theory*. Jubilee volume. Skandia Insurance Company, Stockholm, Sweden.
Duffie, D. 1988. *Security markets: Stochastic models*. New York: Academic Press.
Duffie, D. 1992. *Dynamic asset pricing theory*. Princeton, NJ: Princeton University Press.
———. 1965. The behavior of stock market prices. *Journal of Business* 38:34–105.
———. 1970. Efficient capital markets: A review of theory and empirical work. *Journal of Finance* 25 (2):383–417.
Federal Bureau of Investigation (FBI). 2006. Mortgage Fraud Report. www.fbi.gov/publications/fraud/mortgage_fraud06.htm#6.
———. 2007. Mortgage Fraud Report. www.fbi.gov/publications/fraud/mortgage_fraud07.htm#6.
———. 2008. Year in Review. www.fbi.gov/publications/fraud/mortgage_fraud08.htm#6.
Financial Times. 2009. By James Macdonald, March 7, 13.
Golub, B., and C. C. Crum. 2010. Risk management lessons worth remembering from the credit crisis of 2007–2009. Working paper, Blackrock, January 9.
Hull, J. 1993. *Options, futures and other derivatives securities*. 2nd ed. Englewood Cliffs, NJ: Prentice Hall.
Ingersoll, J. E. Jr. 1987. *Theory of financial decision making*. Totowa, NJ: Rowman and Littlefield.
Jarrow, R. A. 1988. *Finance theory*. Englewood Cliffs, NJ: Prentice Hall.
Jaynes, E. T. 1957a. Information theory and statistical mechanics. *Physical Review* 106:620.
———. 1957b. Information theory and statistical mechanics II. *Physical Review* 108:171.

Lowenstein, R. 2000. *When genius failed: The rise and fall of Long Term Capital Management*. New York: Random House.
Lucas, R. E. 1978. Asset prices in an exchange economy. *Econometrica* 46:1429–1445.
Markowitz, Harry M. 1959. *Portfolio selection: Efficient diversification of investments*. New York: John Wiley & Sons.
Merton, R. C. 1990. *Continuous time finance*. Cambridge, MA: Blackwell.
Modigliani, F., and M. Miller. 1958. The cost of capital and the theory of investment. *American Economic Review*.
Morgenson, G. 2009. Banks bundled debt, bet against it and won. *New York Times* [Business/Financial Desk], December 29.
Muth, J. 1961. Rational expectations and the theory of price movements. *Econometrica* 29:315–335.
Peter, Edgar E. 1995. *Chaos and order in capital markets*. New York: John Wiley & Sons.
Pliska, S. 1986. A stochastic calculus model of continuous trading: Optimal portfolios. *Mathematics of Operations Research* 11:371–382.
Raiffa, H., and R. Schlaiffer. 1961. *Applied statistical decision theory*. Boston: Harvard University, Division of Research, Graduate School of Business.
Samuelson, Paul A. 1963. Risk and uncertainty: A fallacy of large numbers. *Scientia* 98:108–163.
Sargent, T. J. 1979. *Macroeconomic theory*. New York: Academic Press.
Sharpe, W. F. 1964. Capital asset prices: A theory of market equilibrium under risk. *Journal of Finance* 19:425–442.
Taleb, N. 2007a. *The black swan: The impact of the highly improbable*. New York: Random House.
———. 2007b. Black swans and the domain of statistics. *American Statistician* 61:1–3.
Taleb, N., and C. S. Tapiero. 2010. Risk externalities and too big to fail. *Physica A* 389: 3503–3507.
Tapiero, C. S. 1988. *Applied stochastic models and control in management*. Amsterdam/New York: North-Holland.
———. 1998. *Applied stochastic models and control in finance and insurance*. Boston: Kluwer Academic Press.
———. 2004. *Risk and financial management: Mathematical and computational concepts*. Hoboken, NJ: John Wiley & Sons.
Tett, G. 2009. *Fool's gold*. New York: Free Press.
Wall Street Journal (Eastern edition). 2008. Japan's reserves top $1 trillion. March 8, B14.