Risk and Financial Catastrophe
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ERIK BANKS
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1. An overturning.
2. A sudden and widespread disaster.
3. Any misfortune, mishap, or failure; fiasco.
4. A final event or conclusion, usually an unfortunate one; a disastrous end.
5. The point at which the circumstances overcome the central motive, introducing the close or conclusion; denouement.
PART I

The Nature of Catastrophe
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Risk, or the uncertainty of outcome, is prevalent in all aspects of nonfinancial and financial life. There is very little that occurs in the daily activities of people and institutions that is not exposed in some way to a degree of uncertainty.

Some of these uncertainties are minor and inconsequential and have very little bearing on decisions or actions. For instance, if we walk outside on a cloudy day without an umbrella, there is a risk we may get wet if it starts to rain. While it might be a bit unpleasant walking around in damp clothes, it is unlikely to be particularly problematic. Or, if a large company decides to launch a new billboard advertising campaign costing a mere $10,000, there is some risk that it will not be successful in generating the expected response. While losing the $10,000 would be unfortunate, it is unlikely to be perceived as a major setback for the company. In fact, the decisions in either example are likely to be taken rather informally.

Other uncertainties are far more consequential and can lead to changes in behaviors or decision making. For example, if a heavy ice storm strikes and we decide to go for a drive, there is a chance we might have a serious accident. This would obviously be far more serious than getting wet in the rain. Similarly, if our company opts to spend $1b on building a new factory to produce an unproven product, there is a risk that the product acceptance will fail and a great deal of money will have been lost – dealing the company a serious financial blow. Before going for an icy-winter drive or spending $1b, a more serious decision-making framework needs to be applied – one that explicitly considers the costs and benefits of particular uncertain outcomes.

Risk, therefore, surrounds all of our activities – whether individual or institutional. In this chapter, we will consider the nature of an overarching risk management framework, discuss different classes of risk, consider in brief the essential probability and value characteristics of risk, and then relate some of these issues to catastrophe, which we will build on in subsequent chapters.
The Risk Management Framework

To deal effectively with risk, we must understand our risk exposures and place them in some numeric context so we can gauge downside (and upside); this permits us to then manage and monitor the relevant risky events. In fact, these components represent the essence of any conventional risk management framework.

Risk identification

Any discussion of risk requires, in the first instance, an identification of risks. We must be aware that some uncertainty exists before we can be in a position to quantify, manage, and monitor. Some risks are very obvious and self-evident and can be readily identified. For instance, at an individual level, we know the risks that exist with regard to smoking cigars, driving an auto, or walking through a dangerous neighborhood. We can identify that a potential “negative outcome” might occur in each instance: contracting lung cancer, having an accident, or getting assaulted. Once we have identified the existence of these risks, we can then move on to the next stages of the risk process. Of course, we also know that not every risk has a strictly negative outcome; sometimes we take risks with the hope of achieving some positive result. For instance, we might risk a few dollars to buy a lottery ticket in hopes of winning the jackpot, or we might brave the black diamond ski run to feel the physical rush of adrenalin or the psychic benefits of conquering a tough challenge (and maybe even win a few dollars in prize money if it is a competitive situation). Each still has a downside risk, such as loss of money on the lottery ticket or a few broken limbs, but it is accompanied by some perceived upside.

Naturally, the same risk identification process applies at an institutional level. For instance, a bank knows that lending to a small company involves a risk of default, just as an insurance company knows that writing a fire insurance policy generates a risk of a claim. Similarly, a pharmaceutical company knows that investment in research and development for a new cancer drug brings with it the risk of failed trials. Once again, each of these identified activities features some upside: a fee and interest margin on the loan, a premium on the insurance policy, and an increase in revenues on the new accepted drug.

Therefore, identifying risk is the essential starting point in the process, though it is not always an easy task. In some cases, the presence of risks is less obvious or does not lend itself to very clear ex-ante understanding. For example, a bank that is active in trading exotic securities maybe exposed to certain second- and third-order effects, such as correlation or volatility of volatility, which may not be obvious at first glance. These might ultimately
become a bit costly if not properly recognized at the outset. Equally, some risks can change, either with the passage of time, or through the triggering of some event. This means that a risk identified at the outset may no longer be present or relevant in the future, or it may indeed become larger, different, or more complicated. Again, a simple example serves to illustrate this point: a bank might hold an exotic derivative with a feature that increases exposure to currency rates when a market event is triggered; if the event does not occur, no risk will appear, but if it does, the bank’s currency risk might change dramatically. In fact, the changing nature of risk that might not be adequately captured over time is particularly insidious, as it can disappear from the “radar” and might end up being the source of “surprise” losses. Risk identification must, therefore, always be regarded as a dynamic process, to be viewed through the lens of changing personal or institutional circumstances, as well as changing exogenous events.

**Risk quantification**

A risk that has been identified can advance to the next stage of the risk management framework, which centers on quantification. It is nice to know that we face certain risks, whether from buying a lottery ticket, skiing down the black diamond slope, or extending a loan to a small company. The next issue to resolve is how much these risky activities might cost us and, when relevant, how much they might earn us. In some cases the quantification exercise is very simple and straightforward and involves only the most elemental mathematics (or even just common sense). For instance, if we choose to buy a lottery ticket for $10, we know our downside risk is $10 – we cannot lose more than that amount. The upside may also be relatively easy to compute: if we assume that 100,000 tickets are sold and that the jackpot prize is precisely equal to the pool, or $1mm ($10 \times 100,000), then it follows that the maximum we can gain is $1mm. So, we have quantified all aspects of this risky bet – downside as well as upside.

However, sometimes the identification process is a bit trickier. For instance, a bank lending $10mm to a company for 1 year might analyze the company’s financials, perform some due diligence, and determine that it is a BBB-rated credit. Based on historical default data, it might then verify that the probability of default on a generic BBB company is 3% per year, and that companies in the same industry that have defaulted in the past have generated recoveries of 30% for their senior, unsecured creditors. This translates into an expected loss of $10mm \times (0.03 \times [1–0.3]), or $210,000. In exchange for granting the loan, the bank might earn $100,000 in upfront fees and a spread of 250 basis points above its funding costs. While we now have some numerical framework by which to evaluate the risks (expected loss) and returns (fees and margin) embedded in the loan, it is important
to observe that this process is based on two central assumptions: the client company will behave just as the generic companies in the default database, and the amount recovered in the event of default will approximate the historical record. Clearly, these are both significant assumptions, which may or may not hold true. This means that although we have a quantification measure at our disposal, it is unlikely to be perfect – indeed, it can only serve as a general guide.

Unfortunately, it gets even more complicated: quantifying the risk of skiing the black diamond for $100,000 in first prize money is necessarily an exercise in assumptions and modeling, and may still only give us a general idea of what is at stake. For instance, we might build a simplistic model that assumes that an experienced skier commences the black diamond at an altitude of 10,000 feet, down a run that is two miles long, and which features a maximum slope of 30%, tightly packed with fresh snow, and with three angled turns. Negotiating this slope at a maximum speed of 75 mph and an average speed of 50 mph might yield, in our model, a crash probability of 2%. If a crash occurs, the impact is assumed to create four broken bones, a concussion, and lacerations covering 10% of the body, all of which can be treated in the local hospital at a cost of $30,000 (let us ignore time lost from work). Under these circumstances, and given some additional assumptions about the number of competitors and their relative skills, the probability of coming down the slope with the fastest time is estimated at 10%. However, to increase the probability of winning against an aggressive field of competitors (say from 10% to 25%), a maximum speed of 85 mph and an average speed of 60 mph might be needed, which increases the probability of a crash to 15%. The increased velocity at the point of impact will also increase the medical damage significantly, meaning the associated costs will rise to $50,000. So, here we have a framework to quantify the relative costs and benefits of tackling the black diamond – it is hardly perfect, as it is built on assumptions that maybe of questionable value, but it helps illustrate our point: any risk identified can, and should, be quantified in some way to help with decision making – but the shortcomings impacting the quantitative process need to be understood and ultimately factored into any decisions taken. Indeed, it would be of little use for the skier simply to go down the black diamond in search of the prize money without having objectively evaluated the downside of doing so. Similarly, it would be unwise for a bank running a large book of complex derivatives to do so without a core quantification process in place, or a reinsurer writing excess of loss insurance cover to do so without an in-depth actuarial model up and running.

Quantification is a substantial subtopic of its own, and many academic and practical works put forth different ways of analytically assigning “numbers” to risky events. But what we have learned over time, and what we will also explore in this book, is that quantification is a very difficult task for the
person or institution trying to evaluate risk. It is not perfect – though it is sometimes posited to be – meaning that results derived from this stage of the process have to be examined with a judicious and skeptical eye. Numbers are clearly a key element of the risk management process, but they cannot rule the process.

**Risk management**

Management of risk is the third step in the risk framework and brings us to the heart of initial and ongoing decision making. Having identified and then quantified risks, we need to determine how we should best manage their potential impact.

Risk management involves initial decision making on whether to accept or pursue a risky activity, and a subsequent decision of whether to alter that initial decision. Thus, if we choose to smoke a cigar every day, we will presumably do so after we have weighed the admittedly difficult-to-quantify nicotine-induced pleasures we derive from the experience against the risk of contracting lung cancer. This is an initial decision, followed by a series of ongoing decisions on whether or not to continue smoking. Perhaps after 5 years of smoking we feel that the supposed pleasure being derived from the activity is outweighed by the physical difficulties of labored breathing and the knowledge that a more chronic form of pulmonary disease awaits. Or, perhaps after coming out with a very fast start, our black diamond skier decides that the risk of skiing at a peak speed of 85 mph to increase the probability of winning the $100,000 first prize is not worth the added risk of more severe injuries, and adjusts accordingly by slowing to 75 mph, hoping still to gain second place. In our bank example, perhaps the responsible credit officer decides that the loan to the BBB company is acceptable, but that the spread does not sufficiently compensate for the expected loss and the profit margin the bank needs to justify the use of its capital. So, the initial decision maybe to take the risk at a higher margin. A year from now, when the loan comes due, a decision will have to be made on whether to renew the loan, which takes the bank back to the quantification step.

Each of the examples cited is based on the ability to freely make a decision regarding risk. Of course, in some cases we lack the freewill to make a decision: we must simply accept the circumstances and cope as best as we can. For instance, impoverished families living in the Bangladeshi floodplain exposed to devastating typhoons can do little, if anything, to alter their risk profile. They cannot prevent the typhoon from striking, they cannot prevent the coastal areas from flooding in the aftermath of the storm, and they cannot move to safer inland ground. They lack the resources or support needed to make a decision to reduce their risk. These are, of course, the most
unfortunate circumstances, because everyone would like to believe they can control, to some degree, their exposure to risky events – particularly those that feature only a downside.

While all aspects of the risk framework are essential, it is fair to say that this phase of decision-making surfaces as primus inter pares. This action sets forth in motion the entire chain of events that can lead to good or bad results. Decisions taken are elemental to future progress.

Risk monitoring

The last stage of the risk process involves monitoring. This is simply a stage of gaining transparency into what has been decided in the third stage, arming risk-takers with fresh information so that an adjustment in the decision taken can be made, if needed. Monitoring takes many different forms, some of them ad hoc and others very formalized.

If we are smoking our daily cigar, we maybe monitoring by comparing the relaxation and the pleasure we derive from smoking against the difficulty we experience in breathing. If one outweighs the other, as evidenced from our informal monitoring, we may decide to continue or cease. Our black diamond skier will similarly monitor time splits and standings at the end of the first run to see if any adjustments need to be made for the second run. Similarly, the bank granting the loan to the BBB-rated company will monitor the quality of the company and the performance of the loan at regular intervals during that 1-year period. If the bank has some concerns after 6 months into the loan it may have to take some protective measures, such as hedging the credit or renegotiating certain terms, or calling for collateral. Such a decision can only be made, of course, because of the transparency gained through a formal monitoring process. In fact, we can have no sense of trend or progress with regard to our risks if we cannot monitor them in some fashion. Though sometimes downplayed or disregarded, the monitoring phase of any risk process emerges as essential.

Figure 1.1 summarizes the key elements of a risk management framework.
CLASSES OF RISK

Many volumes have been written on risk, and many proposals have been put forth regarding the classification of risk. Given the breadth of the topic it is not hard to imagine that there are many ways of categorizing risk – implying that there is no single “correct” way of dealing with the matter. Knowing this, we will present a simple taxonomy that lets us consider risk in a way that ties into the theme of our book – financial catastrophe. Let us stress that this is just one way of looking at the classification issue – many other approaches can be taken, each of them quite valid.

To explore the topic from an overall perspective, we focus on three different angles: pure and speculative risks, financial and nonfinancial risks, and noncatastrophic and catastrophic risks. These are not mutually exclusive categorizations and indeed often intersect. For instance, it is possible for an institution to be exposed to a speculative, financial risk that is noncatastrophic in nature (e.g., a call option on dollar/yen exchange rates), or a pure, nonfinancial risk that is catastrophic in nature (e.g., a factory built on an earthquake fault line). While reviewing classes of risk we should also bear in mind that the exercise is essential to the identification stage of the risk management process.

Pure and speculative risks

The first distinction relates to the nature of an uncertain outcome. In some cases, a risky event has a potential outcome that is either negative or neutral: the event may occur and lead to some negative result, or the event may not occur, meaning activities will continue on their normal path. This type of risk event is considered to be a “pure risk.”

Let us consider a few examples. Suppose a homeowner builds a house in the middle of a forest that is uncharacteristically dry. In this case, the house is subject to a higher degree of fire risk. If lightning strikes and starts a forest fire some distance away there is a chance that the house will be damaged or destroyed – this represents the aforementioned loss scenario. If no forest fire occurs, the house will not be damaged and life for the homeowner will continue unchanged – this represents the previously indicated continuation scenario. It is relatively easy to see that this example is a pure risk scenario with two outcomes – loss or no loss. The same concepts can be extended to life and health issues (illness, mortality), property issues (earthquake, hurricane), and liability issues (fraud, environmental damage). In each case, we have the potential for the onset of an event that results in a loss or in the continuation of “business as usual.” Insurance risks are essentially pure risks.

Nevertheless, not all risks are pure. In some cases, a risk can create a profit scenario. These risk events, which we classify as “speculative risks,” yield
one of three outcomes: loss, no loss, or profit. Let us again consider some examples. Suppose a company is interested in introducing a new product by building a factory and distribution mechanism. This is a risky decision that can yield one of the three results: the product is a failure since consumers may not want it, meaning a loss on all of the capital investment associated with its production and launch; the product is a great success, leading to revenues and profits that cover the initial investment and create some incremental value for investors; or, the product is only a middling success, leading to a break-even situation where limited consumer demand for the new product covers only the investment and does not generate a profit. Or, we can consider a financial derivative contract purchased by an investor (e.g., a future or forward) that has the potential of producing a profit if the market rises, a loss if it declines, or breakeven if there is no movement at all. The same could apply to a loan extended by a bank to a customer, which generates fees and interest margin as long as the customer performs, a loss if the customer defaults, or breakeven if the deal is restructured on terms that are insufficient to cover the bank’s own funding costs. Financial risks are often speculative in nature.

Not surprisingly, the decision-making approach related to pure and speculative risk can differ, sometimes dramatically. In the case of pure risks, decisions must be regarded as defensive or protective, while in the case of speculative risks, they maybe considered defensive or offensive. Most of our discussion in the book will relate to the downside scenarios, that is, pure risks and the loss dimensions of speculative risks.

Financial and nonfinancial risks

The second dimension of categorization considers whether a risk exposure is financial or nonfinancial in nature. This is an important consideration that leads us to the source of a risky exposure, which is essential if we are to understand how risk impacts activities and how it can ultimately be managed.

Financial risk

Financial risks come in different forms, each with the potential of impacting financial and corporate institutions (as well as individuals); since our key topic of discussion is the catastrophic impact of financial risks we will go into detail on this class of exposure, illustrating potential impact through some simple examples.

Financial risk can be divided into market risk, liquidity risk, and credit risk, each with its own unique characteristics.

- Market risk: The risk of loss (or gain) based on the movement of a market variable. Within the general class of market risk we can consider
specific risk factors that generate the associated exposure. More specifically, interest rates, equity prices, commodity prices, currency rates, and credit spreads are all influenced by supply and demand forces in a freely traded marketplace, indicating they can move up or down at any point in time.

- **Interest rates**: Interest rates move up and down on a regular basis, through both market forces and trends established by monetary authorities. As a result of this dynamism, institutions may face higher or lower financing costs and/or face lower or higher prices on their fixed income investments.

- **Equity prices**: Equities (individually and as constituents of broader baskets, sectors, and indexes), can move up and down on a daily basis through market forces as well as earnings expectations and other micro and macro events. Prices may also be affected by index rebalancing, where constituents removed from the index trigger selling, and those added trigger buying. Again, those holding long or short equity positions in their trading, investment, or retirement accounts will be impacted as a result of price movements.

- **Commodity prices**: Commodity prices, which represent the values of a range of goods such as energy products, precious and industrial metals, and agricultural products, are also subject to daily price fluctuations for many of the reasons noted above. Speculators, traders, hedges, and producers involved in commodities will therefore experience daily fluctuations in the values of their short or long positions.

- **Currency rates**: Currency rates, representing the exchange value of one currency for another, move as a result of supply and demand activity fueled by hedgers and speculators as well as the macroeconomic policies put in place by various national governments. Institutions that hold currency positions in their investment accounts directly or indirectly, or that are exposed to currencies through their production, trading, import or export activities, will experience gains or losses on a daily basis through currency movements.

- **Credit spreads**: Credit spreads, representing the tradable component of credit instruments (such as bonds, money market instruments, and traded loans), can move on a daily basis through market forces and the short-term outlook of an institution’s creditworthiness. As the credit quality improves, the institution’s spread tightens against a risk-free benchmark (e.g., its all-in borrowing cost, including the base risk-free rate as well as the idiosyncratic risky spread component, declines); the reverse occurs as creditworthiness deteriorates. Investors holding such credit-sensitive instruments may therefore experience daily fluctuations in the value of their holdings.
Market risks can also be defined in terms of their risk parameters. In particular, market risks can arise from directional, volatility, correlation, dividend, basis, and curve movements. These can be applied to one or more of the risk class defined above.

- **Directional (or delta, gamma):** The risk of loss (or gain) resulting from small (delta) or large (gamma) movements in the direction of any one of the market risk factors detailed above.

- **Volatility:** The risk of loss (or gain) resulting from the change in movements in market risk factors.

- **Correlation:** The risk of loss (or gain) arising from changes in the relationship between two or more assets with specific market risk characteristics.

- **Dividend:** The risk of loss arising from changes in estimated future corporate dividend payouts.

- **Basis:** The risk of loss arising from changes in the relationship between an asset and an underlying derivative hedge.

- **Curve:** The risk of loss arising from changes in the shape of a market risk curve (e.g., interest rate or volatility).

Higher order risks can also be considered, but we will ignore these as they are not relevant for our immediate discussion. They are, of course, critical to a proper risk identification process.

- **Liquidity risk:** The risk of loss (or gain) based on the ability to gain access to funding or liquidate/pledge assets on a short-term basis to generate cash sufficient to meet expected or unexpected obligations. We can divide liquidity risk into at least three different components: asset liquidity risk, funding liquidity risk, and joint liquidity risk.

  - **Asset liquidity risk:** Asset liquidity risk is the risk that assets held on the balance sheet will not be realizable with enough value to generate proceeds needed to meet obligations. A typical balance sheet contains assets with a range of “realizability” that ranges from instantaneous (e.g., cash) to months or years (e.g., fixed assets). The actual composition depends heavily on the nature of the company and how it deploys its capital to create revenues: financial institutions tend to feature fairly liquid balance sheets, with assets that can be converted into cash very quickly through sales or pledges, while
industrial companies are far more likely to feature a great deal of fixed assets (such as plant, property, and equipment) that can generally only be converted into cash through a security charge or encumbrance. Actually disposing of fixed assets to raise cash is not generally a viable solution as it could take a long time to realize fair value, which is of little use when an emergency payment must be made. In practice, all corporate entities keep an inventory of cash and marketable securities/investments on hand to properly cope with unexpected payments. An insufficient amount of such assets could lead to losses when attempting to secure liquidity.

- **Funding liquidity risk:** Funding liquidity risk is the risk that a company will not have access to sufficient amounts or types of financing to meet obligations coming due; this aspect of liquidity risk relates to the liability side of the balance sheet. In practice, companies use all manner of liabilities to fund their operations, including short-, medium-, and long-term capital markets instruments and loans, which maybe unsecured or secured on fixed assets, and which may have fixed or floating interest rates. Such funding can be accessed to pay for regular operations or unexpected payments. However, there is always a risk that certain forms of funding maybe withdrawn or made available only with conditions, particularly during times of financial stress. If a company is unable to use different funding options to meet its obligations, it may find itself in the position of paying more for a particular form of financing or turning to the asset side of the balance sheet to generate required cash.

- **Joint liquidity risk:** The union of asset and funding risk can lead to a form of joint liquidity risk, which represents an extreme form of cash spiral. In essence, any company that is unable to access its liability facilities to generate cash may then be forced to turn to its assets, either selling or pledging them to create cash. Any such action is likely to have a negative effect on its creditworthiness that may cause lenders, providing any remaining liability facilities, to either cancel or alter their lines; capital markets investors providing liquidity via commercial paper or medium-term notes may also choose not to roll over their investments. This places the company in an even more precarious position and may require another series of asset disposals or encumbrances, and so forth, until the company becomes unable to raise any further monies; this is likely to culminate in some type of distressed sale or bankruptcy.

- **Credit risk:** Credit risk is the risk of loss (or gain) based on the ability of a counterparty to honor its contractual obligations, which may take the form of loans, leases, bonds, or derivative contracts. Like market risk, credit risk comes in a variety of forms, including default risk,
presettlement risk, settlement risk, and contingent risk. There is also, as noted above, a market driven form of credit risk, spread risk, which represents a key intersection between the credit and market risk dimensions.

- **Default risk**: Default risk represents the risk of loss should a company, as an obligor to one or more creditors, cease to make payments under financing or other contractual obligations. In most cases the cessation of payment, a defined event of default, occurs as a result of financial deterioration in the company, which becomes unable to make appropriate payments.\(^2\)

- **Presettlement risk**: Presettlement risk is the risk of loss attributable to any financial contract that is defined by a dynamic or changing exposure amount; this most often relates to financial derivative contracts (e.g., forward, swaps, options) that are characterized by a notional amount, but where the actual risk exposure is a fraction of the notional and reflects the mark-to-market value and some potential future exposure. Should a default occur, the amount owed to creditors will relate to the mark-to-market value and replacement cost.

- **Settlement risk**: Settlement risk relates to the risk of loss due to the brief period of time during which a company delivers cash or assets before receiving in kind assets or cash, during which time default occurs. Settlement risk is typically associated with foreign exchange and securities transactions that do not necessarily settle on a same day basis.

- **Contingent risk**: Contingent risk is the risk of loss arising from some future exposure that maybe generated in the course of dealing with a given company. While pure default risk noted above is the result of a drawn loan or issued bond, a contingent risk relates to the possibility that an undrawn bank line will be tapped at some future time, adding to exposure and the prospect of losses in the event of default.\(^3\)

### Nonfinancial risk

Nonfinancial risks relate to a broad range of operating risks that a company is likely to face in the normal course of its business – and, as the name suggests, exclude all financial exposures. The exact nonfinancial risks a firm will encounter depend on the industry in which it operates and the specific construct of its business – accordingly there is a systematic and an idiosyncratic element to such nonfinancial exposures. While the list of potential exposures in this area is quite long, we can define the key areas of exposure to include legal risk, operational risk, and property and casualty risk.

- **Legal risk**: Legal risk represents the risk of loss should some aspect of the legal process within a company fail to operate as intended. This can
take several forms, including flawed contracts which fail to protect the company’s interests in commercial matters, declaration of ultra vires on existing contracts (a party acting outside legal authorization), lawsuits related to a product or service deficiency, and so forth. Legal risks may force an institution to take active legal steps to protect its commercial rights (which maybe resolved favorably or unfavorably, suggesting some degree of gain or loss), or it may take defensive legal action to protect itself against legal claims (suggesting more of a pure risk, where the outcome maybe either the payment of damages or the dismissal of the legal action).

- Operational risk: Operational risk is the risk of loss attributable to any error or defect in the company’s standard operating process, procedures, and infrastructure. Common forms of operational risk include losses attributable to the compromise or collapse of core IT infrastructure (which can result in business interruption), accounting or financial fraud, erroneous payments made to suppliers, departure of key personnel, or loss of patents or intellectual property, amongst others. As we might expect, these risks are of a pure nature as they cannot result in a gain.

- Property and casualty risk: Property and casualty risk represents the risk of loss due to damage or destruction to productive property, which leads to business interruption and, potentially, to additional expenditures on property replacement (depending on insurance coverage). It also considers the risk of loss arising from employee health and disability issues, and their relative inability to contribute to the work process. In fact, property and casualty exposure is a key form of pure risk.

Clearly, nonfinancial corporate entities also face the prospect of risk of loss on any input costs that are used in the manufacturing of goods intended for sale: as costs rise, the cost of goods sold increases, and if a company cannot pass on the cost increase to its customers, it faces reduced revenues (or a de facto loss). However, such risks can be incorporated under the market risk category above, primarily with regard to directional risk of commodities (i.e., as the main source of raw materials used in many productive processes, such as steel in automobile manufacturing and fuel in airlines and transportation). Costs associated with salary increases and other selling, general, and administrative expenses are a further source of potential margin compression if not managed prudently.

**Catastrophic and noncatastrophic risks**

A third dimension of risk categorization centers on a distinction between catastrophic and noncatastrophic exposures, which brings us to the main theme of our book. Before expanding on the classification, let us first
take a brief detour to discuss the concepts of probability and value, which helps set the stage for our description of noncatastrophic and catastrophic risks.

Any discussion of risk must incorporate a view of both probability of occurrence, and value (or outcome) of any event that occurs; probability can also be termed as frequency or likelihood, while value can be considered as gain or loss (or simply loss for pure risks). Consider, for instance, that we can toss a fair coin and earn $1 for heads and nothing for tails. We know that for any single toss there is a 50% probability of obtaining heads and winning $1 (outcome) and a 50% chance of obtaining tails and winning nothing. This can be regarded as an event with an even chance of success or failure, but where the outcome is not particularly significant (e.g., whether or not we win $1 is not particularly important). Assume next that we can play the jackpot lottery, where we can pay $1 for a ticket for a pool where the probability of winning $1mm (outcome) is 0.1%, and the probability of winning $0 is 99.9%. This can be regarded as an event with a low probability of success and a high probability of failure, but where the speculative dimension is in our favor (e.g., we can win lots of money or lose only $1). Similarly, we may buy a $1mm house on the San Andreas fault line and discover that there is a 0.1% chance that the home will be destroyed and rendered worthless (assuming no homeowners insurance) and a 99.9% chance that no earthquake will occur and that our home’s value will be preserved. This can be regarded as an event with a low probability of devastation and a high probability of status quo – the pure risk dimension in this case is against us, as we have no upside other than preserving our house, but could lose everything if the disaster strikes. The same analysis can be applied to all manner of risky events, including auto accidents, health claims, stock market movements, and loan defaults. The two descriptors can be viewed in terms of some statistical distribution, with the y-axis reflecting probability and the x-axis reflecting value. Without getting into the specifics of what the distribution looks like at this point, the important fact to note is that a depiction of risk incorporates both dimensions. Furthermore, and as we will see in the coming chapters, the value dimension of an event (i.e., its outcome) can be decomposed further into severity and vulnerability, two terms that are especially helpful in a discussion on catastrophes.

**Noncatastrophic risk**

A noncatastrophic risk is an exposure that has the potential of creating a loss (or gain, though we will focus on losses) that is small and readily manageable in the context of normal activities and available resources. Such risks are considered to be “low severity,” suggesting that any losses that might arise might be unfortunate, but are unlikely to pose any threat to liquidity
or solvency. As we might expect, such low severity events are not at all unusual, meaning they are of high frequency: daily movements in stock prices, small “fender bender” auto accidents, the rising or falling price of crude oil, and so forth, are all representative examples. For instance, we know that everyday the foreign exchange market will move by some small amount and, if we hold a position on the “wrong side” of the movements of a particular currency pair, we will suffer some small losses. The same is true for virtually any risky event forming part of daily activities – some gains or losses may arise, but they will be small in magnitude, and they will occur very regularly.

**Catastrophic risk**

Catastrophic risk is, of course, the antithesis of noncatastrophic risk. We all know conceptually that a catastrophe is a disaster, or some extremely negative event that creates a great deal of damage. We also know from our own experiences, and from media coverage, that such disasters are relatively rare, appearing, thankfully, only once in a great while. These two basic facts, which are not derived from any formal statistical or mathematical discussion, but simply from our own experiences and knowledge, can also be expressed in terms of severity/probability. Specifically, a catastrophic event is a high severity, low probability event – that is, an event that creates a great deal of damage, but that happens only rarely. Many examples abound, such as a hurricane sweeping through an island frequented by tourists, a terrorist bomb impacting a crowded metropolitan area, the rapid collapse of an over-inflated stock market or the default by a country on its foreign debt. These events do not happen often, but when they do occur, they can lead to significant losses (human and financial).

Intuitively we may already suspect that risky events falling in the low severity/high frequency category must be managed differently than those in the high severity/low frequency category. We are likely to believe that our “protective” behaviors will be different in managing a foreign exchange position subject to small daily moves than those related to a cataclysmic collapse in the stock market. For instance, if we think that the foreign market will only move by a very small amount on any given day, we might choose simply to hold the position unhedged. In contrast, if we think that a big stock market collapse is imminent, we would probably take more dramatic action, perhaps withdrawing all of our capital at risk or spending some money to buy put options as a form of insurance. Either way, we know that the approach taken to manage the risky positions depends on the perceived frequency and severity of the event at hand. We will revisit this concept in the next three chapters.
We can consider catastrophes in the context of the pure and speculative classification. In general, we view a catastrophe as an extremely negative event, which creates losses for a number of parties – such losses maybe expressed in human and/or economic terms, depending on the specific event being considered. It follows therefore, that this type of risk is pure in nature – that is, there is the potential for loss or no loss, but no chance for a gain. This, in the main, is true. For instance, if a hurricane strikes a heavily populated coast, most of those impacted will be “losers,” suffering some economic damage through property destruction, business interruption, insurance claims paid, and, unfortunately, human injury or fatality. A small group will, of course, benefit from such a disaster; in particular, those providing emergency supplies, building reconstruction, and so forth. However, we can generalize sufficiently to say that the large majority of those impacted will lose, meaning that the risk is pure rather than speculative. The same is true for financial disasters: the massive stock market collapse will negatively impact the vast majority of investors who are traditionally “long-only” participants through their retirement and investment accounts. While a small group of short sellers will clearly benefit from the collapse, they will surely be in the minority and the gains that they make will be greatly outweighed by the losses sustained by long-only investors.

Finally, catastrophes can relate to both financial and nonfinancial (operating) risks. While our interest is on the category of financial risks described above, it should be clear that catastrophic events can just as easily affect an entire range of nonfinancial risks, including core business operations and even personal activities. Catastrophes can also impact the nonoperating risk element of corporate balance sheets, by creating disruptions that affect the normal functioning of production. As we might expect, the subcategory of financial risks is relevant primarily for financial crises, but can also be considered in the context of certain other devastating events that have a secondary impact on financial markets and economic activity (e.g., terrorist attacks).

Figure 1.2 summarizes the key risk classifications described above.

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**Figure 1.2** Summary of risk classifications
OVERVIEW OF THE BOOK

The rest of the book examines certain types of risks in detail: to understand how they fare in the conventional risk management framework and to consider where certain improvements or enhancements can be made. Using the taxonomy above, we will center our discussion on speculative financial risks that are of low frequency but high severity, as noted in Figure 1.3. This is clearly a special subclass of risks – one that contains the large, devastating events that may theoretically create gains but in practice tends to generate significant losses; as we have noted, our interest is strictly on the loss-making events.

A curious feature of these events relates to probability of occurrence. While we believe that real disasters happen “rarely,” or “once in a while,” or “every 100 years,” the reality of our collective experience in the financial world seems to be quite different. A review of the history of the financial markets indicates that significant crises are actually a fairly typical occurrence, striking every few years, rather than every few decades or even centuries as “standard” catastrophes might – this has been particularly evident over the past four decades, since the dissolution of the Bretton Woods Agreement, which introduced a new level of volatility and innovation into the financial markets. In fact, ubiquitous technology, rapid information dissemination, complex cross-border financial linkages, sophisticated financial products, market leverage, mobile capital, and dynamic economic and regulatory policies, all seem to influence the frequency (and severity) of a crisis. Events that are meant to happen once every few hundred or few thousand years have become a regular feature of our landscape. Knowing this, we may discover that the standard risk management framework that is applied to “normal,” or “average,” or “close-to-the-mean” risks is insufficient for dealing with a financial “meltdown.” Determining how the framework might be enhanced emerges as an important theme of our work.

Figure 1.3 The financial catastrophe focus
To address these issues, we will commence our discussion of catastrophes in Chapter 2, focusing on the general characteristics of both natural and man-made disasters. We will continue this discussion in Chapter 3 by delving deeper into the specifics of financial catastrophes. In Part II, we will focus on the general risk management framework that is employed at the institutional level. Specifically, in Chapter 4, we will discuss the financial risk management process commonly employed by banks, insurance companies, and nonfinancial corporates in their attempt to deal with a broad range of risks. In Chapter 5, we will turn our attention to the models and metrics that are commonly used in the financial markets and analyze some of their limitations; in keeping with our nontechnical approach, we will not discuss the financial mathematics used in model development, but provide further references for readers interested in the quantitative aspects of the topic. In Part III, we shift our focus to the practical issues associated with financial catastrophes. Chapter 6 kicks off the discussion with a series of past catastrophes that we present as short “case studies”; to provide an appropriate cross section, we examine different forms of financial dislocation, including banking crises, currency crises, and debt crises. In Chapter 7, we put forth a series of prescriptive measures that are intended to address some of the shortcomings that have become apparent in the institutional risk management process. We conclude in Chapter 8 with ideas related to the future of conventional risk management in an era where financial catastrophes appear with relative frequency. In fact, the very costly nature of such episodes demands that we make some attempts at learning from history. With this brief introduction in hand, let us now move to our first discussion of catastrophe.
We know from Chapter 1 that a catastrophe is a low frequency, high severity event. To set the stage for our discussion of financial catastrophes, which follows in the coming chapters, we begin by considering in detail the essential characteristics of natural and man-made catastrophes. Since our ultimate interest is on financial catastrophes, we are not particularly concerned with natural phenomena such as hurricanes and earthquakes, or even with other man-made events such as terrorism or environmental damage. However, the experience of such nonfinancial disasters gives us insight into the nature of rare events, so we consider the slight detour a worthwhile journey.

CONCEPTUAL FRAMEWORK

In our brief taxonomy of risk we introduced the concept of probability, which is simply the likelihood or frequency that an uncertain event will occur. We also considered the idea of value or the numerical magnitude of some outcome. Bringing probability and value together allows us to create a framework to consider risky events. To incorporate an extra step into this framework we can also decompose value into two separate components, severity and vulnerability. As we will note later, such granularity is particularly helpful when we deal with catastrophic events. For now, it is sufficient to indicate that we may be exposed to an event of some severity, but the value at risk (measured, for instance, as total dollar loss), actually depends on whether some exposure exists, which itself can be described in terms of vulnerability.

We can therefore say that

- Probability is the likelihood of occurrence.
Value is the value at risk, which is a combination of
- Severity or force/strength and
- Vulnerability or assets exposed to risk.

In addition to unique probability and value parameters, a catastrophic event also features various other distinctive characteristics:

- It may be a natural event (such as a windstorm or hurricane) or a man-made event (such as a chemical spill or national debt default). While natural events cannot be stopped, the same is not necessarily true of man-made events, suggesting some catastrophes may be preventable and others not.
- It may strike with varying degrees of speed, meaning it may be instantaneous or prolonged. While a catastrophe is often assumed to be a very sudden event (such as an earthquake, or terrorist bombing, or sudden stock market collapse), it may actually be a very prolonged one (such as environmental damage from years of chemical dumping or a broad financial dislocation based on a slowly inflating asset bubble). Indeed, a catastrophe may actually evolve over time, in stages. A gradual accumulation of many small incidents, perhaps precipitated by the same catalyst, can lead to the same scale of losses as a single large event. Interestingly, such events may not actually be recognized as catastrophes until a long period of time has passed and significant losses have accumulated.
- It may be measurable in very precise terms (such as wind speed or earthquake strength) or it may simply be gauged in arbitrary or anecdotal terms (such as ex-post tornado damage, nuclear fallout plume effects, or indirect loss to a national economy). In fact, the inability to accurately measure severity can be an additional challenge in the risk management process.
- It may impact vulnerable areas and assets (such as a metropolitan earthquake or a large hedge fund collapse) or it may actually occur in a non-vulnerable area (such as a typhoon on a deserted island or an atomic warhead detonated deep in outer space).

Not surprisingly, the most interesting issues to study are those that occur in vulnerable areas. While the typhoon sweeping across a deserted island is technically a natural catastrophe (and may indeed be a severe event if it ranks high in terms of force), the absence of any vulnerability means there is no impact and no event loss. Events with a nonvulnerable impact are important from the perspective of building a historical understanding and database and refining the analytical or modeling framework, but they require no particular risk management action and are therefore not of direct interest to us. This distinction again reinforces the point that value at risk is function of severity and vulnerability.
It is also worth noting that a trigger or catalyst may be present that allows the catastrophe to unfold – but the catalyst and the catastrophe should not be confused. In other words, exogenous causality may be present in a catastrophe, but it is not the “end game” of the disaster. For instance, the metal piece of the airplane that fell onto the runway before the Concorde rolled down the runway, hit it and burst into flames was the catalyst, but not the catastrophe; similarly, the faulty “O-ring” on the Challenger space shuttle served as the catalyst that caused the shuttle to explode, while the pools of questionable subprime mortgages served as catalysts in the 2007 Credit Crisis. Each of these represents an essential, though not sufficient, condition related to the disaster itself. As we might expect, the catalyst may be natural or accidental, or it may be the result of human misjudgment or intent.

Descriptors of catastrophic events are summarized in Figure 2.1.

**Frequency**

Frequency is a probabilistic concept that says risky events may occur very often (i.e., high frequency or probability) or rarely (i.e., low frequency or probability). High frequency risk events happen all the time, and their very regularity makes them comparatively easy to capture in standard analytical or actuarial frameworks. In fact, as per the Law of Large Numbers, such high frequency events become very predictable when we have a sufficiently large population of observations and allow for robust decision making related to risk pricing and management.

For instance, it is well-known that insurance companies writing millions of automobile policies are able to generate profits from their business: they simply use the large amount of high frequency data (e.g., the accumulation of all of the daily auto accidents that occur) to estimate through their actuarial methods how often an accident of a particular loss value will occur, and then adjust the average premium being charged by a small spread, so creating a profit. The same is true for a bank running a credit card operation: it knows, based on a large amount of accumulated data, the average amount of defaults it will incur amongst its millions of card holders, and it can then

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**Figure 2.1** Descriptors of catastrophic events

- **Natural or man-made**
- **Instantaneous or prolonged**
- **Precisely or arbitrarily measurable**
- **Vulnerable or nonvulnerable impact**
adjust its annual fees and interest rate charges by an amount sufficient to cover any resulting bad debts and generate an adequate return. Such high frequency events, with a well-behaved record of predictability, let insurers and banks manage their businesses in a profitable fashion. Naturally, the very predictability of the risks means that the profits that can be generated are individually quite small: this coincides with any standard concept of risk and return, where theoretical returns earned for smaller risks are lower than those for higher risks, and vice-versa.

The issue gets a bit more complicated with low frequency events. These events by definition happen only rarely, meaning that they are far less statistically or actuarially predictable than their high frequency counterparts. This creates extra challenges when it comes to risk management – as we will see later in the book. Consider for example, that the populated and developed portions of the Florida coast are only hit by a severe hurricane once every few decades. The infrequency and resulting paucity of experience and data mean the event cannot be nicely captured by the same statistical measures that are used to develop the framework for the millions of small auto accidents or credit card losses that occur every year. The statistical “predictability” of the hurricane is far less certain than it is for the auto accidents or credit card defaults, meaning it is much harder for an insurer to know how much to charge for the hurricane insurance policies it is writing. Using alternative modeling techniques (such as those outlined in Chapter 5), it may create a pricing framework that generates enough premium income to generate profits, but it may also lose it all, and more, if the rare event actually occurs. The unpredictability means that insurance companies (and banks engaging in high risk/low frequency banking business) must have additional risk/return metrics for their hurricane policies these are always sufficiently accurate – though whether is something that can only be determined ex-post and over time.

Since catastrophes are infrequent events, they often seem random: the earthquake or terrorist bombing or stock market crash may seem to happen without any pattern of regularity. In fact, this is not true for all types of catastrophes – some actually have a degree of reoccurrence which, while not predictable in the sense of auto accidents or credit card defaults, allow them to be viewed in a nonrandom light, particularly over the long term.

In fact, we can classify this catastrophe “frequency stratification” into at least four categories, including nonrepetitive, irregular, regular, and seasonal.

**Nonrepetitive catastrophe** A disaster that occurs only once in a particular area and can never be repeated in the same location to generate the same results. Examples include the collapse of a dam (which forever changes the channel, floodplain, and discharge dynamics above and below the dam),
a massive landslide from a mountain slope (which permanently alters the landscape and potential for a repeat event), or a terrorist bombing (which obliterates a landmark structure in a particular location permanently). Note that nonrepetitive catastrophes can recur, but always in different locations and/or under different circumstances (e.g., another dam can collapse, another building can be bombed); the time and location of future events remain unknown.

**Irregular catastrophe** A disaster that does not appear with any degree of statistical regularity, but which can occur repeatedly in a general location or marketplace, though specific time and location characteristics remain unknown. Examples of irregular catastrophe include a tsunami generated by an earthquake or a sovereign debt default.

**Regular catastrophe** A disaster that is characterized by the regular, if sometimes very long and gradual, accumulation of forces that lead to the triggering of an event. Though the pattern of buildup occurs on a regular basis and can be accommodated within a statistical framework, the precise timing of event occurrence remains unknown. Note that the term “regular” should not be taken to mean a high frequency event, but an event that displays relatively more predictable occurrence than other catastrophes. Examples of regular catastrophe include an earthquake on a known fault line, an eruption from an active volcano, or currency devaluation from persistent deficits and shrinking reserves.

**Seasonal catastrophe** A disaster that has the potential of occurring on a regular basis in a general location during a given time period; while this helps limit the time and space dimensions of occurrence, the precise location, severity, and moment of occurrence remain unknown. Seasonal catastrophes are typically associated with natural, rather than man-made, events. Examples include hurricanes, extratropical cyclones, floods, and droughts, all of which can occur in particular areas during specific seasons.

Catastrophes that are relatively “more frequent” (though not high frequency) such as regular or seasonal events have a slightly greater degree of predictability than those that are completely nonrepetitive or only irregular. That said predictability is still very poor compared to that of auto accidents or credit card defaults or other noncatastrophic events. In the main, the financial catastrophes we consider fall in the nonrepetitive, irregular and regular classes. Figure 2.2 summarizes the above-described classifications.

**Value at risk: Vulnerability and severity**

Value at risk, comprised of vulnerability and severity, provides a direct gauge of the potential loss impact of a catastrophe. Importantly, vulnerability can
be estimated without precise knowledge of risk levels, but the size of a loss cannot be quantified without also estimating the severity of a catastrophe – the two components thus go hand in hand.

**Vulnerability**

Vulnerability can be defined as an exposure that leads to a loss if a particular event occurs. More specifically, vulnerability represents the potential for losses from damage, destruction, and/or business interruption. When vulnerabilities are present and an event occurs, some amount of losses will result; when the event strikes and no vulnerabilities exist, no losses will occur. For instance, if a nuclear bomb is detonated deep in the Marianas Trench as part of a weapons testing program, no losses will occur because no vulnerabilities exist. If, however, the bomb is detonated by a terrorist organization in the heart of a metropolitan area, significant losses will occur because human and economic vulnerabilities exist.

Accurately gauging vulnerabilities is a complex process, and one that is absolutely critical to effective risk management. While improvements in modeling techniques, accumulation of historical data, refinements in the construction of loss distributions, and compilation of more granular information regarding assets at risk have together led to the development of better vulnerability estimates, the process is still less than perfect, as we will note in Part II of the book. This is particularly true for man-made events, including the very financial disasters that are the focus of our discussion: indirect or secondary vulnerabilities, which may ultimately lead to the largest amount of economic losses should a dislocation occur, can be very difficult to estimate on an ex-ante basis.

Not surprisingly, vulnerability is very dynamic, influenced directly and indirectly by socioeconomic, demographic, and technological changes. It is generally true to say that as the value of assets increases and concentrations of populations expand, vulnerabilities rise (though they may be offset, to some degree, by technological advances and other risk mitigants). This is true in both a human and economic sense: the growing population of Miami means that more lives and assets are at risk of loss should a Category 5
hurricane strike, just as growing value of employee and investor retirement portfolios (e.g., 401Ks, IRAs, guaranteed pension funds, etc.) means that more capital is at risk of loss should a devastating financial catastrophe occur.

Of course, there is an element of freewill associated with vulnerabilities: humans can, to a very large degree, choose to protect themselves against an adverse event, thereby reducing their vulnerability; the aggregate of all such individual actions can reduce the societal cost should a disaster actually occur. For instance, vulnerabilities can be controlled and managed by limiting participation or development in at-risk areas or introducing mitigation or loss financing techniques, such as portfolio diversification, hedging, and so on (as we will discuss in Chapter 4). It should be clear that if enough people do this (or are required to do so) economic (and also human) vulnerabilities can be reduced. It is important to note, of course, that in some cases vulnerabilities cannot be controlled, as there may be no effective mitigation tool and no other choice but to expand in a vulnerable area. In addition, vulnerabilities may be willingly increased by the population.5

Catastrophe, vulnerability, and losses represent an intersection of cause and effect. An extreme view suggests those humans who choose, or are forced, to develop or expand in areas that are exposed to natural or man-made catastrophe, cause losses; the “fault” lies with human action, rather than the event itself. A more moderate view suggests that losses occur because of joint interaction between human motivations and catastrophes. Regardless of perspective or semantics, it is clear that catastrophe exists independent of losses, but the interesting issues of risk management arise when vulnerabilities are introduced.

Severity

Severity reflects the intensity or strength of a particular event. When we can properly measure an event, we are able to speak of ‘more severe’ and ‘less severe’ catastrophes – but remembering that the measure relates only to the magnitude of the catastrophe, and not to the total loss sustained (which must incorporate the vulnerability dimension described above). For instance, a Category 5 hurricane is more severe than a Category 1 hurricane, just as an F6 tornado is more severe than an F1 tornado. But measuring severity is not necessarily an easy task, because events cannot always be evaluated objectively, on an ex-ante basis; in some cases the best we can do is measure them subjectively, or ex-post.

In some cases the metrics are well-established and widely accepted. For instance, in the case of natural disasters, measures such as the Richter scale, Shindo scale, and moment magnitude scale (earthquake), Saffir-Simpson scale (hurricane), Fujita scale (tornado), and volcanic explosivity intensity
(volcanoes), are well-defined and widely employed as severity gauges. These metrics are associated with very specific physical properties, such as shock strength, wind speed, storm surge, lava expulsion and flow, and so on.

In other cases, however, metrics are likely to be far less clear as far as ex-ante measurement is concerned – this is especially true of man-made disasters. For instance, there are no established metrics to objectively measure the severity of an oil-tanker spill, a terrorist attack, or even a financial crisis. Thus, we do not speak of a “Class 1” oil spill, or a “Force 3” terrorist bombing, or a “Grade 10” financial crisis. Here we might rely on ex-post analysis in an attempt to quantify the “strength” or power of the crisis which has caused human or economic losses. This, for example, might focus on the estimated number of barrels of oil spilled, or estimated tons of TNT exploded, or the percent decline in financial asset prices. We may also benchmark against certain known events to attempt to gauge relative severity; while this is hardly precise, it provides a basis for comparative analysis. For instance, we may reference the next great oil spill in terms of the Exxon Valdez disaster in Alaska, the next great terrorist event in terms of the 9/11 attacks, the next great financial dislocation in terms of the 2007 Credit Crisis, and so forth.

Regardless of the way in which we measure severity, we can see that it is an essential characteristic of a catastrophe. However, it is not sufficient on its own to convey all required information – for that we need to take account of vulnerability. To better understand the interplay between severity and vulnerability let us consider a very simple example: assume that a region is exposed to a catastrophic event that can range in severity from an arbitrary 1 (weak) to 3 (strong), and that we can apply this severity to the scope of vulnerability to determine financial losses. Our result is a matrix of economic losses where the impact is driven primarily by the level of vulnerability – a direct function of socioeconomic development. Assuming complete economic loss of vulnerable assets if an event occurs and a simple linear relationship between severity and loss, we can consider several scenarios that help illustrate our point.

**Scenario 1** If vulnerability is equal to 100 and an event of severity 1 occurs, the resulting economic loss is 100; if a severe event 3 occurs, the loss rises to 300. Thus, the catastrophe can cause a loss ranging from 100 to 300; nothing worse can happen in our simplified world.

**Scenario 2** Assume next that the state continues to develop its community and infrastructure so that the value of local assets increases from 100 to 300; in developing such assets it does not alter its actions (i.e., it does not change its mitigation or management policies). If a catastrophe strikes, the
economic loss will now range from 300 to 900 – significantly greater than in the previous state of development, despite the fact that the actual severity of the disaster is capped.

These relationships provide a boundary which we term a loss frontier; this frontier, illustrated in Figure 2.3, is a clear function of severity and vulnerability.

We can easily extend the example by increasing development that expands the vulnerable asset base from 300 to 500 to 1000, and so on. Assuming that the severity of the catastrophic event remains constant within the 1 to 3 range, and presuming no change in mitigation or management, economic losses will continue to grow – that is, the scope of impact will continue to grow as a result of vulnerability. In fact, the loss frontiers will continue to shift outwards. This is precisely what has occurred in recent decades. Empirical evidence indicates that, apart from certain weather-related events associated with global warming, geopolitical issues related to terrorism, and (importantly for our discussion) economic issues leading to financial crises, the frequency of catastrophes has not increased – yet the magnitude of social and financial impact has increased dramatically. As indicated, this is attributable almost exclusively to growing vulnerabilities, which often expand without any meaningful change in mitigation or management behavior. Urbanization, social progress, wealth/asset accumulation, and technological advancement have led to increased human and economic development over the past decades, and the pace of progress shows no sign of slowing. However, if this path continues without a corresponding increase in risk management activities, a point will eventually be reached where the actual or potential losses become so large that mitigation/management must be employed.

Figure 2.3 Loss frontiers
Ultimately human progress and development amplifies vulnerability and this can only be checked by proper risk management.

Let us now expand our discussion above to consider frequency and value at risk in an overall framework. It is common in any discussion of catastrophe to express the probability that a particular type of catastrophe will occur as an annual occurrence frequency; for example, there may be a 0.005% probability of a 7.5 magnitude earthquake occurring in a metropolitan area in a given year. We can compile similar frequency/severity points through historical data or modeling exercises and so create an entire curve, as in Figure 2.4. Events that occur very frequently but generate low severity outcomes dominate the left-hand portion of the curve (e.g., auto accidents); those that appear infrequently and have higher severity outcomes comprise the right-hand portion of the curve (e.g., terrorist bombings, financial crises); the two relationships are depicted in Figure 2.5. Although the graph suggests a very clear division between noncatastrophic and catastrophic events, reality is rather less elegant and is arguably subjective and institution-specific.

Figure 2.6 summarizes the key components of a catastrophic loss. We will return to the concepts of frequency and severity as related to financial disasters in greater detail in the next chapter.

![Figure 2.4](image-url) Frequency and severity, fitted and with observations
Expanding on our brief introduction of severity and vulnerability, we know that catastrophic events can generate significant human and economic losses. Such losses may appear over time horizons that span hours to years, and which may be direct, indirect, or secondary in nature.

While direct losses can generally be estimated ex-ante and reconciled ex-post, indirect and secondary costs are much more difficult to ascertain.
since a national economy is a complex system of interrelated parts, some of which may or may not be affected by the onset of a disaster.

- **Direct loss**: Financial losses associated with capital assets (e.g., property, factories, financial assets).

- **Indirect loss**: Business interruption resulting from loss of capital and human assets (and measured by lost output and earnings); in the extreme these can flow through specific economic sectors or the economy at large.

- **Secondary costs**: Costs associated with disruption of development plans and increased debt/public sector deficits.

For instance, a hurricane striking a densely populated city will create a series of losses – including building destruction and business interruption – that occur within hours of landfall. Similarly, a stock market crash will lead to an immediate recognition of losses, as stock prices plunge and investors crystallize their losses through liquidation of positions. These are examples of immediate and direct losses.

However, the financial toll does not necessarily stop there: depending on the nature of the catastrophe, the loss impact may continue to mount for weeks, months, or even years following the initial incident. In such cases, the losses may be regarded as indirect in nature, and may include losses in the local economy affected by the hurricane (e.g., from business closures, layoffs), or losses in the overall financial marketplace for other risky assets. Also note that just because the losses are “indirect” in nature does not mean they are smaller than direct losses – in some cases, the magnitude may be far greater. For example, the indirect effects of Hurricane Katrina on the New Orleans economy lasted for months, whilst the economic fallout from the Great Crash of 1929 lasted for years, eventually turning into a broader dislocation which we know to be the Great Depression. In both cases losses were multiples of the original direct losses. Ultimately, the long-term economic impact of any catastrophe depends on the size of the direct losses, whether direct losses influence indirect losses and secondary costs, and how well an affected company, marketplace, financial system, or country can cope.

**TYPES OF CATASTROPHES**

With some background on the conceptual elements of catastrophe in hand we turn our attention, in the balance of the chapter, to a review of the key types of catastrophes which have the potential of generating losses, and
which need to be mitigated or managed in some way. The purpose of this section is to provide a brief flavor of low frequency/high severity events facing individuals and institutions; we do not intend to delve into the intricacies of natural and man-made catastrophes, as these are clearly outside the scope of our book. Of course, in keeping with our theme, we introduce the concept of financial catastrophes in rather great detail.

**Natural catastrophes**

Natural catastrophes are those induced by natural forces. While such events are clearly not our focus, a brief review of major classes of natural disasters is worthwhile, as it helps us draw interesting parallels with man-made events.

Within the category of natural catastrophes we can distinguish between geophysical, atmospheric/meteorological, and other disasters, as summarized in Figure 2.7. Of course, not every event described in the figure need be a catastrophe: some events feature the same characteristics but are of smaller magnitude or are very contained, and therefore fail to qualify as a true catastrophe.

**Geophysical**

The category of geophysical catastrophes includes earthquakes and volcanic eruption. These disasters occur as a result of forces within the Earth’s physical construct and can, of course, create significant devastation in vulnerable areas.

Earthquakes, which we may define as any rapid dislocation or displacement of a land mass, generally along a fracture in the Earth’s surface known as a fault line, emerge as a dominant form of geophysical activity. The displacement typically centers on one of the Earth’s plates, which releases energy from the hypocenter and creates seismic waves; such waves have the potential of creating vast destruction in vulnerable areas. Earthquakes are described in terms of location, depth, magnitude and intensity, and tend
to strike in known areas around fault lines; they are measured with reference to known scales, including the Richter, Shindo, and Mercali scales. Key zones of activity include the Western Coast of the US and Mexico, the Midwestern US, Japan, China, New Zealand, and areas of the Middle East and Near East, among others. Those that strike in populated metropolitan areas (as in San Francisco, Kobe, Taipei, and so forth), can create extensive human and economic damage.

Volcanic activity represents the second major form of geophysical activity and is, in fact, influenced by many of the same factors that create earthquakes (e.g., 90% of volcanism is based on plate tectonics). Volcanoes can create damage through the expulsion of magma, lava, gases, and particle debris, and can erupt in various ways, some of which are particularly violent. The force of a volcanic eruption is generally measured via the volcanic explosivity index, which calibrates to a scale ranging from inactive to extreme. Like earthquakes, volcanoes tend to be centered in the areas surrounding fault lines, and those that erupt in vulnerable areas (to wit Montserrat, Mt. Pinatubo, Mt. Saint Helens) can create widespread damage.

Atmospheric/meteorological

Atmospheric/meteorological catastrophes include weather-related events such as hurricanes, tornadoes, and extratropical cyclones.

Hurricanes (based in the Atlantic Ocean), along with their counterparts (cyclones [Indian Ocean] and typhoons [Pacific Ocean]), are cyclonic storms that convert the heat energy of a tropical ocean into storm systems. The storms are seasonal in nature (typically appearing once sea surface temperatures reach a level of 80 degrees Fahrenheit to a depth of 200 feet) and have the potential of generating very heavy rainfall, tornadoes, storm force winds, and storm surges. The eye of a storm serves as the center of a system, with the surrounding wall of the eye containing the most intense activity. Hurricanes hitting a vulnerable land mass (e.g., Florida, Bermuda, Cuba, Louisiana, Taiwan, Bangladesh) have the possibility of creating very significant damage, which can include loss of life and destruction of property. Storm strength is measured via the Saffir-Simpson scale which bases readings on the speed of surface winds and storm surge and is calibrated from minimal (1) to catastrophic (5).

Tornadoes, generally confined to very specific regions (e.g., the central US), are rapidly rotating columns of air that form primarily around the leading edge of thunderstorms, which are themselves based on the confluence of dry and wet air masses from specific regions (e.g., the Gulf of Mexico and the US/Canadian Rockies). The vortex of a tornado is typically less than a half mile wide, the average path is approximately three miles, and the speed of the cyclonic action can range from a minimum of 72 mph to bursts of up
to 300 mph. Tornadoes are typically measured via the Fujita scale, which gauges both wind speed and path length, calibrating from 1 (moderate) to 6 (unexpected).

Extratropical cyclones are storms that form in the middle latitudes through atmospheric instability, itself a result of differences between warm and cold air masses. The storms, which tend to strike the United Kingdom and European continent, are seasonal in nature and feature strong winds, and significant rain or snow. Extratropical cyclones are generally not as strong as their tropical counterparts in terms of wind speed and precipitation, but have the potential of lasting far longer once they reach land masses and can cover a far greater area of land. This means that human and economic devastation can still be quite significant.

**Other**

The catch-all of “other” natural disasters includes a diverse set of events that are not readily classified in terms of geophysical or meteorological forces. More specifically, this category includes widespread fires (which may result from lightning strikes, human intervention, or other catalysts), mass movements (including landslides, loess flows, avalanches), and floods.

Like other events described above, fire may be noncatastrophic or catastrophic. A fire that affects a single house or building would hardly be considered catastrophic, while one that destroys entire city blocks (as in Chicago, San Francisco, or Kobe) or wide swaths of acreage and residential enclaves (as in Oakland and San Diego) would fall into the catastrophic category. Fire, which is ignited through a combination of fuel, oxygen, and heat, has the potential of creating damage from flames, smoke, and the associated use of water or other fire retardants. Fire spreads based on weather conditions, availability of fuel, topography, and the construction of the fire itself; winds are a particularly important feature, as dry winds can cause a fire to move rapidly across land. There is no standard measure of the severity of a fire.

Mass movements, which we define as the movement of large sections of land as a result of gravitational pull, represent a form of natural disaster that can be triggered by other perils, such as earthquakes, hurricanes/typhoons, or floods. Mass movements may occur very quickly, in a matter of minutes or hours, or through a very gradual process that spans weeks, months, or even years. Common forms of mass movement include landslides, subsides, avalanches, and mudflows and can be created through slope/angle erosion, compression of sediments under land masses, and the “liquefaction” of land. Though there is no objective metric for mass movements, it is clear that
damages can become very significant when vulnerable populated areas are affected.

The last major class of “other” natural catastrophes we consider relates to flooding which, like mass movements, can be triggered by other perils, such as hurricanes/typhoons, extratropical cyclones, violent thunderstorms, and other winter storms; it may also be caused by man-made failures, such as the collapse of a dam or levee for flawed engineering (as noted below). Floods occur, logically, when an area cannot expel a stock or flow of water rapidly enough to accommodate new flow. Floods can be seasonally occurring events, such as during the rainy season in a known floodplain, or they may be more random in nature, based on the occurrence of one of the other above-mentioned perils. Again, while many minor floods are of a regular and noncatastrophic nature, others can be quite devastating, destroying major parts of developed cities and agricultural land. As we have indicated, there is no single metric used to gauge flood severity, apart from feet or meter overflow over defined banks or a high-water mark.

Mad-made catastrophes

As the name clearly indicates, man-made catastrophes are disasters that occur as a result of human intervention. While there is nothing we can do to stop natural disasters such as windstorms and typhoons, the same is not necessarily true regarding man-made catastrophes. Such events are created by man-made actions, and are, thus, theoretically “preventable.” Interestingly, even though these events can be prevented, they often are not, for any number of reasons – economic shortsightedness, regulation or governance mistakes, architectural or engineering flaws, mathematical errors, ideological abuse, and so forth. While, it seems quite logical that we should be able to learn from past disasters so that future ones can be avoided, the regular occurrence of man-made catastrophes suggests that “lessons learned” are quite difficult to apply in practice – this seems to be particularly true in the financial arena, as we will note later in the book. In addition, though much is rightly made of the damage wrought by staggering natural events such as Hurricane Katrina or the Kobe Earthquake, facts suggest that the most economically expensive events to date have been created directly by man’s activities – the 9/11 terrorist acts and the 2007 Credit Crisis, serve as two examples.7

Man-made catastrophes can be categorized in various ways but for purposes of our discussion we choose to focus on four classes: terrorism, environmental contamination, technological failure, and financial crises; these are summarized in Figure 2.8.8
Terrorism can be defined as premeditated, illegal, and covert actions designed to advance political, ideological, or religious views in a violent and destructive form. The actions may be national or cross-border, and may involve destruction of property, taking of lives, or both. Terrorist activities can involve conventional weaponry (such as guns, improvised explosives, conventional bombs) or advanced weaponry (including nuclear, biological, chemical, radiological weapons). In some cases terrorist activities may comprise many small, repeated attacks (e.g., IRA and Basque separatist bombings), and in other cases they may center on single dramatic episodes (e.g., Al-Qaeda bombings). While events may appear very suddenly and could be regarded as “random” in nature, they are not, in fact, random occurrences – most are the result of extensive planning and are designed to achieve some goal.

Naturally, individual and isolated terrorist acts that create minimal damage occur very frequently in hot-spots around the world. Truly catastrophic events are fortunately rather less frequent, but can be very costly in terms of the human and economic toll (e.g., the 9/11 attacks, bombings in Bali, London, and Mumbai between 2003 and 2008).9 Interestingly, large terrorist actions appear to be the only type of disaster that can generate instability in affected financial markets. While natural and man-made disasters of various types may create significant economic losses, they do not appear from anecdotal evidence to have much market impact – they are not part of the transmission mechanism that can lead to financial instability. Large terrorist bombings, in contrast, can create a sense of panic within the financial markets on an almost instantaneous basis. Indeed, this may be one of the motivating factors behind such heinous activities. For instance, in the immediate aftermath of the 9/11, London, and Mumbai bombings, the financial markets grew increasingly volatile and experienced “flight to quality” as investors switched out of risky assets.

Environmental contamination

Environmental contamination, like other catastrophes, can occur through a series of repeated small events that accumulate to create catastrophic
losses, or through a single large and damaging event. Environmental contamination can affect productive land or water supplies, and in some cases can take a human toll (e.g., use of lead paint and asbestos in building materials, the chemical release in Bhopal, the radioactive meltdown in Chernobyl).

Environmental contamination can occur through the accidental spillage of pollutants, deliberate dumping of toxic waste or releasing of pollutants, or the incorrect disposal of medical, biological, chemical, or nuclear agents. It is worth noting that accidental spills that result from engineering deficiencies can also be included as a technological failure (as described in the section below), while the release of a biological, chemical, or nuclear agent into the environment as a result of hostile actions can be attributed to the terrorism subclass.

**Technological failure**

Technological failure, while not always resulting in a disaster, can certainly lead to one. This subclass can include engineering flaws leading to structural collapse and may also relate to technical inadequacies that culminate in widespread computer failure or power outage.

As with other catastrophes, technological failure may be sudden or gradual. For instance, a fatal design flaw on a mechanical component or engineering structure may be impacted once a stress point is reached and serve as the catalyst for an immediate disaster (e.g., the failure of the O-ring on the Challenger space shuttle, the collapse of certain levees in New Orleans, the explosion on the Piper Alpha oil rig) or it may lead to an eventual disaster (e.g., a computer programming or chip flaw whose weakness is eventually revealed via some system disaster). A technical failure may only become apparent through time and use. For instance, infrastructure may be used in excess of its age and capabilities, until such time that it reaches a breaking point and creates a broader dislocation (e.g., the 2003 infrastructure collapse of the US Northeast/Mid-Atlantic electric power grid which led to widespread outages and business interruption). It is notable that with society’s increasing reliance on technology, computing, and networking, vulnerabilities within this sector have grown exponentially – suggesting that future catastrophes may become quite significant indeed.

**Financial crises**

Financial crises are, of course, at the heart of our book, and represent the core of the topic that we begin to explore in greater detail in the chapters which follow. To avoid repetition, we present some general thoughts in this section and delve deeper in the coming chapters.
Financial activities, including commerce and banking, exist to advance society’s progress. They have existed for millennia and, when operating as intended, lead to economic prosperity and advancement. In fact, the successful application of global trade and banking has resulted in the development and accumulation of greater wealth around the world. But man-made endeavors cannot proceed without interruption or dislocation, and financial progress is no exception. Economic history shows us that financial disasters have occurred since the dawn of such activities; as we will see in the coming chapters; some have been extremely severe, causing billions of dollars of direct and indirect losses on a national, regional, and global basis. Interestingly, the historical frequency with which some of these crises have occurred is higher than we might expect under the standard low frequency/high severity framework.

Just as human intervention creates the path to economic growth and financial prosperity, so too is it the cause of its sometimes devastating collapse. The reasons for such collapses are varied and depend on the type of crisis, but can most often be traced back to a small group of catalysts – which we consider in detail in Chapter 3: economic fragility/weakness, asset bubble collapse, risk mismanagement, debt mismanagement, currency attacks, bank runs, and institutional flaws.

We can classify financial crises into three broad subclasses – banking/credit crises, currency crises, and debt crises:

*Banking/credit crisis:* A banking/credit crisis represents a severe state of dislocation, in which a national banking system ceases to function normally, making impossible the proper allocation of credit – which is the fuel of any economic engine. Such events appear to be the most devastating of all of the subclasses, as the effects can be far-reaching. A crisis of this type can be created through a consistent mispricing of risk during the growth phase of an economic cycle (e.g., the boom period), which tends to become more extreme as euphoria spreads. Once economic fortunes turn (e.g., through some catalyst, such as the bursting of an asset bubble built atop cheap financing) the mispricing evident in the extension of risk becomes clear – losses sustained by financial institutions at the heart of the financial system are no longer covered by the returns generated in previous years. Credit may be rationed as banks attempt to deal with mounting losses: borrowers who previously enjoyed favorable borrowing terms may be forced to repay their loans, creating liquidity problems and jeopardizing their own operations. In more extreme situations, the complete lack of credit in the down cycle can lead to growing corporate defaults, further losses in banks, and so forth, in a self-fulfilling cycle. Equally, borrowers who have used funds to pursue speculative ventures, such as real estate development or equity investments, may become forced sellers of assets to repay their loans – this
leads to asset price devaluation, a process that can lower values very quickly. Recessionary conditions may sweep into the economy, creating a period of economic uncertainty, corporate defaults, job losses, and so forth. Corporate defaults, in particular, have the possibility of creating significant economic instability, as a default situation leads to layoffs, loss of production, and decreased consumer spending power for those becoming nervous about job security. Both the Great Crash of 1929/Great Depression and the Credit Crisis of 2007 serve as important examples for this type of crisis.

It is worth noting that one of the most visible initial signals of an impending bank crisis relates to the presence of bank runs, where lack of confidence by depositors leads to a large and sudden withdrawal of funds, creating liquidity concerns for one or more banks; while not all banking crises feature bank runs, many do.

Though this framework is simplified for the sake of brevity, we stress that a banking crisis that affects the allocation of credit can have severe implications throughout national, regional, and even global economies. Unfortunately, since such crises tend to be driven by cyclical “boom and bust” forces, they must be considered relatively permanent fixtures of the financial system (e.g., a “regular” catastrophe, as discussed earlier in the chapter). In addition, and as we will explore in greater detail in the next chapter, the economic toll of such events has tended to become larger over time as a result of larger vulnerabilities and changes in the global financial system (including systemic linkages, use of leverage, capital mobility, and so on).

**Currency crisis:** A currency crisis is a form of financial disaster that relates more narrowly to a fundamental and significant devaluation in a country’s national currency as a result of inconsistencies between its exchange rate regime and its macroeconomic policies. The dislocation relates to a change in currency parity, dissolution of a peg, or migration from fixed to pure floating rates, leading to a very large devaluation; while the precise amount of a devaluation is at least somewhat subjective, one “rule of thumb” points to a year-on-year change of at least 30% following a year that features an initial change of 10%. Although a currency crisis can be considered a narrower form of a financial dislocation than a banking/credit crisis, we should not underestimate its potential for damage – a currency crisis can be a devastating event which can have significant spillover into the real economy. For instance, the Mexican Peso crisis of 1994 and the Asian currency crisis of 1997–98 began as currency dislocations that generated significant direct losses, but ultimately swept through national and regional economies to create enormous indirect losses.

There are different reasons why a currency crisis may form, and many studies exist which provide a good level of detail. For instance, in a
theoretical framework any country operating a fixed exchange rate regime which develops a significant and sustained budget deficit faces the specter of a currency crisis. The market-driven exchange rate mechanism seeks to adjust constantly to ensure that the real returns of domestic and foreign currencies are equal. A deficit covered by reserves is not a sustainable position – when the exchange rate reaches a level that can no longer be supported through reserves, speculative forces intervene and force a wholesale devaluation, which can lead to broader complications in the domestic (and perhaps regional) marketplace.

**Debt crisis:** The debt crisis is a third form of financial dislocation and appears when a country is unable to support its debt obligations. While the banking crises noted above tend to be liquidity-based events, debt crises center on insolvency, which implies default. Failure to service principal and interest associated with local and foreign currency bonds and loans puts a country in a very precarious position: its national balance sheet comes under pressure, its currency may suffer a similar fate, and a restructuring or default may shut down access to the international capital markets, in some cases for years. Associated national equity and debt markets may collapse, along with the value of other tangible assets such as real estate. In addition, local companies relying on external financing for their own operations may see their borrowing abilities restricted and their cost of borrowing rise to the level suggested by the distressed sovereign; in more extreme situations they may also be forced into restructuring or default. Finally, any supranational or bank-sponsored refinancing exercise will most likely be accompanied by economic austerity measures designed to bring the national economy back into a healthier state. As well as being politically unpopular, such measures can be especially severe and may impact the local economy for a period of years.

Debt crises appear on a reasonably frequent basis; while some are relatively minor, others are quite major and can involve the restructuring of tens of billions of dollars of outstanding debt. For instance, the emerging market debt crisis of the 1980s, which culminated in major debt restructuring deals for Mexico, Brazil, Venezuela, Ecuador, Peru, Colombia, Argentina, Poland, and Nigeria, amongst others, represents a very significant example of this type of crisis. Each of these debtor nations paid a heavy price in terms of economic contraction, collapsing local asset markets, defaulting companies, and higher future borrowing costs; similar events occurred in Russia in 1998 and in Argentina in 2001.13

In the most extreme situations, a financial catastrophe may bring two, or even three, of these subclasses into play at the same time. For instance, there is a history of currency crises leading to broader banking/credit crises as local banks get caught up in the foreign exchange dislocation and pull back
severely on their lending activities. Although empirical data suggests a far lower likelihood of occurrence, it is also possible for a currency and debt crisis accompanied by a series of bank failures to lead to an extreme credit contraction and attendant spillover into the economy. Precisely how these variables interact and the path that they ultimately take provides an indication of the depth, breadth, and duration of a crisis.

Objective ex-ante measures of severity are not readily available – financial crises still tend to be measured by subjective or ex-post measures. Regardless of the specific type of financial catastrophe we are considering, it is generally true that the impact can cover multiple dimensions. First order direct effects include losses that affect parties and assets14 most exposed to the source of the disaster; second order direct effects are losses that impact related assets or parties (as part of so-called contagion effects). Subsequent effects are the most difficult to ascertain as they are indirect, based on losses flowing through the economy at large. To be sure, these effects can be sometimes difficult to attribute to a financial crisis (as they may appear with some lag, in a relatively “unexpected” sector) and they can ultimately be quite sizeable.

Figure 2.9 summarizes the classes described above, which we will revisit in detail in the next chapter.

With this brief overview on catastrophe in place, we move next to a detailed look at financial catastrophes.
In the previous chapter we discussed the concept of catastrophe – the low probability, high severity event that can assume natural or man-made form. We now leave aside earthquakes, river floods, and politico-religious terrorist bombings and move to the heart of this book by focusing on the important subcategory of financial catastrophes. In this chapter, we consider the financial catastrophe by first describing some of the characteristics that distinguish it from its natural counterparts, then analyzing how in a theoretical way such disasters may arise, and then reflecting on how institutional and systemic bodies might react to such an event. We conclude with an overview of the historical experience regarding financial catastrophes. Since this is our first detailed look at the topic, we describe the issue in its conceptual light – saving our practical analysis of “real-life” events for Part III.

THE NATURE OF A FINANCIAL CATASTROPHE

We have noted that a financial catastrophe is a banking, currency, or debt dislocation that creates significant direct and indirect losses. Such a dislocation can have considerable negative implications, particularly when it involves a breakdown in the allocation of credit, which stops it flowing where needed. Such a scenario carries severe consequences, including the potential for direct and indirect losses that can reach well into the billions, even hundreds of billions, of dollars, the bankruptcy of financial institutions and other corporate entities, and the slowdown of national trade and economic growth. Though a financial catastrophe may be a severe event, there is nothing prescriptive about its duration – it may be a relatively short-lived event, such as the Long Term Capital Management crisis of 1998 (which was effectively resolved in a few months), or it may be very long, such as
the Great Crash/Great Depression (which lasted for years). Naturally, every financial disaster features unique catalysts and unfolds in specific ways – in fact, though common catalysts may exist, evolution is dependent on micro and macro conditions in evidence at the time.

It is also worth considering what a financial catastrophe is not: per our definition, a financial catastrophe excludes any event that is idiosyncratic, self-contained, and isolated, and which has no impact on the broader system. Such episodes do not transmit instability throughout the system. Financial history gives us a rich and colorful series of financial scams, and frauds, which sometimes cost involved parties significant sums of money – to wit the speculative “Tulipmania” bubble in the 1630s, the South Sea Company bubble that played out between 1711 and 1720, the Ponzi pyramid scheme of 1919 and, more recently the 419 Nigerian fraud of the early 2000s, the accounting scandals that resulted in corporate defaults of Enron, WorldCom, Parmalat, and others in 2001–02, and the Madoff and Stanford frauds that came to light in 2008–09. While such events can be devastating for those who have committed capital, they have not created broader systemic instabilities. As a result, we exclude them from our discussion of financial catastrophes.

To continue our analysis, let us place financial catastrophe in the framework described in Chapter 2, focusing on severity/vulnerability and frequency.

**Financial crises: Value at risk – severity and vulnerability**

A financial dislocation can mean a great many things: a run on a bank or banking system, abandonment of a currency peg leading to devaluation, a freezing up of credit, or a string of corporate defaults. But it has to be severe, or else it must be regarded as simply another event in the daily functioning of the economic or financial system of a country. So, while a 3% drop in the US stock market is certainly a form of dislocation, it is not particularly severe. The market system at large can readily absorb the 3% decline – so easily, in fact, that business will proceed uninterrupted, leaving only some amount of losses in the hands of investors. The same is true for an isolated bank run on a small building society in the UK Midlands, or ten corporate defaults in the Italian small and medium enterprise sector – unpleasant events, to be sure, but hardly severe.

When severity is amplified, we move closer to the definition of a financial catastrophe. Thus, the October 1987 Stock Market Crash, during which global equities dropped by 20%+ in both the United States and around the world in a single day, must be regarded as severe. Similarly, when corporate default rates spiked above 10% in the early 1990s and again a decade later,
the events were obviously severe. In such cases, it is much more difficult for
the financial system to recover quickly, and the direct and indirect costs that
accrue may be particularly large and widespread. Severity, as with all cata-
strophes, is thus essential in describing the nature of a financial disaster.

There is, unfortunately, no precise metric for gauging the severity of a
financial dislocation; the process tends to be subjective and ex-post. For
example, we cannot say, objectively and ex-ante, that if the stock market
decreases by x% or defaults rise to y%, or currencies devalue by z%, or eco-
nomic growth contracts by t% that we are facing financial catastrophe. In
some instances we may point to financial vulnerability indexes, which pro-
vide some gauge of the market/economic strength or fragility, but these are
likely to be backward looking and not able to fully capture all essential
elements.

Participants may have an intuition regarding severity, and one way of gaug-
ing this is to look at risk aversion, or the degree to which individuals or insti-
tutions are willing to take risk. Risk aversion is a behavioral reaction to the
financial environment. When participants believe they are heading toward
(or are in the midst of) a severe financial dislocation, they alter their behavior
by becoming risk-averse. In practical terms this may mean abandoning risky
assets in favor of safe-haven “flight-to-quality” assets – thus, selling equities,
high yields bonds, emerging market assets, or structured products and buy-
ing high quality government bills and bonds. In extreme cases it may even
involve purchasing hard commodities, such as gold, silver, and platinum. At
an institutional level it may involve additional actions, such as putting on
financial hedges to protect the downside of certain risky portfolios.

In fact, we can examine market indicators to identify instances of height-
ened risk aversion as a way of reflecting risk appetite and the general, if
not necessarily specific, severity of a financial dislocation which may be
underway. Figures 3.1(a)–(d) illustrate the conditions of a severe financial
crisis in 2007–08 (e.g., the Credit Crisis, which we discuss at greater
length in Chapter 6), when the global financial system was on the brink of
collapse after massive bank losses and defaults, and extensive government
intervention. The critical point came in the period after September 15, 2008
(when US investment bank Lehman Brothers defaulted), which caused the
“severity” of the event to increase even further. The proxy indicators below
include the S&P 500 Volatility Index (VIX, an options volatility contract
traded on the Chicago Board Options Exchange which is often used as a
risk-aversion proxy, with a high level of volatility reflecting fear and vice
versa), the S&P 500 index (as a representation of the general health of the
stock market), 10-year US Treasury Bond yields (with a declining yield/
rising price reflecting flight to quality), and the Gold Index (with a rising
price reflecting flight to quality, in this case to “hard assets”). In fact, with
the financial crisis intensifying in the third and fourth quarters of 2008, the
degree of severity can be drawn from spiking VIX, plunging equities, falling US Treasury yields and rising gold index levels.

We could, of course, select other proxies to reflect the severity of a crisis, but these are relevant and appropriate for this particular case. When looking at other financial crises, we see similar trends regarding risk-aversion, suggesting that there may be a useful correlation between averision and the depth and breadth of a financial disaster. The key point to emphasize is that severity is important in defining a financial catastrophe, but precise thresholds or measures that reflect severity are not really available; proxies reflecting risk-aversion may be the best available tool.
Vulnerability, as noted in the last chapter, must be linked to severity to derive ultimate economic loss. Like the vulnerabilities associated with natural disasters, those related to financial crises have intensified in recent decades as the value of accumulated wealth has risen – the multitrillion-dollar economies of the 21st century generate so much more wealth than they did in the 18th and 19th centuries, that any dislocation becomes much larger in absolute terms, and in some cases also in relative terms. The significant vulnerabilities apparent in the 20th and 21st centuries have led to far greater losses than similar events occurring in previous decades. By obvious extension, future accumulation of wealth means that any new crises will create even greater economic losses.
As we know, the loss depth created through the interaction of severity and vulnerability can be measured in various ways. In the first instance we can point to direct losses experienced by stakeholders, including investors, employees, and creditors (in the case of defaults). Following that we can point to indirect and secondary losses experienced in the economy at large, measurable as a function of lost output (e.g., contractions in gross domestic product). While the first-order losses can be gauged with some degree of accuracy ex-post, the indirect effects of economic impact are much more difficult to quantify and typically require some type of assumptions.

**Financial crises: Frequency**

Let us now focus on the frequency of a financial dislocation. Here we encounter additional challenges, because of underlying statistical assumptions. We will explore statistical issues in greater detail in the next chapter, but introduce some elemental concepts about distribution and probability of occurrence to frame our discussion.

Many of us are, by now, quite familiar from our educational studies with the standard “bell-shaped” distribution, known more technically as a normal, or Gaussian, distribution. This elegant and symmetric function is widely used as a way of estimating the likelihood of certain outcomes. For instance, using some basic statistical mathematics we can use the normal distribution to estimate that the probability of falling in the upper or lower portions of the function is relatively small compared to the probability of falling in the middle. Therefore, we know that in a large, normally distributed population of students, less will receive the top and bottom marks, and more will receive the average marks. In Figure 3.2, we see a 10% chance of

![Figure 3.2](image-url)  
**Figure 3.2** Normally distributed student results
the population receiving A’s and F’s, 15% receiving B’s and D’s, and 50% receiving C’s. We can easily apply the same standard to any other large sample population we are trying to measure, such as auto accidents, health claims, and so on. We can even indicate the degree to which a value in the distribution will be achieved or exceeded by applying a statistical confidence level. We, therefore, have a powerful framework that allows us to estimate the likelihood that certain things will occur; this has widespread practical applications in diverse areas such as insurance, medical diagnosis, political polling, credit scoring, and so on.

Of course, all of this works nicely when the event we are trying to measure is “well-behaved” – that is, when it possess properties that allow it to be measured in the context of the normal distribution, and particularly when the Law of Large Numbers applies. This can include random events that are very large in number and unbiased, such as random tosses of the coin, the number of auto accidents in New York City, the incidence of common colds in a northern community, the number of credit defaults in a large pool of middle income wage earners, and so forth. Unfortunately, a review of many years of financial price data indicates that financial assets do not tend to follow the normal distribution. Indeed, in most cases asset prices tend to follow nonnormal distributions, including those with unique features such as skew (a tilting to the right or left) and kurtosis (a degree of thickness in the tails). When introducing such changes, the probabilities of occurrence necessarily change as well. Thus, if we have a form of a fat-tailed distribution (i.e., Gumbel, Weibull) as in Figure 3.3 (let us assume it is similar to the normal [no additional skew] but with greater kurtosis), the probability of an event occurring may no longer be 1%, as under the normal distribution, but 5%. Not being aware of this fact, ex-ante, could actually lead us to very different results and decision making.

Figure 3.3 Normal distribution and fat-tailed distribution
Since distributions are used to estimate how frequently an event might occur, we can imagine that they might be quite relevant in estimating how often the stock market might decline by 1%, or 5%, or 10%, or how frequently credit spreads might increase by 10 bps (basis points) or 100 bps. In other words, the probability process, as expressed through some statistical distribution, gives an indication on whether an asset price, or index, or entire market, is likely to produce a move of “catastrophic” proportions. If we examine asset price history, we are likely to find that asset prices tend to move by small increments from one day to the next (or one hour to the next, or one tick to the next). This is a classic diffusion process that may be captured by a normal distribution. However, asset price history also shows us that large increment moves can and do occur – so-called gap risk. This discontinuity is not well-handled by the normal distribution and can indeed change dramatically the entire shape of the distribution, introducing skewness and fat tails. Such distributions, as we have just indicated, mean that the probability of an extreme event occurring are greater. If we did not know this beforehand, we might rather dramatically underestimate the riskiness of the environment. It is critical to emphasize that a traditional measure of risk – such as the normal distribution – excludes extreme events. Extreme events are not predictable, and, therefore, use of the normal distribution is inappropriate and conveys a false sense of comfort.

Consider, for instance, a study conducted by mathematician Mandelbrot, who examined the price levels of the Dow Jones Industrial Average between 1916 and 2003. Under the normal distribution we would expect that the 1-day index move would exceed 3.4% on 58 days; in fact, during the period in question it exceeded 3.4% on 1,001 days. In a more extreme, (e.g., catastrophic) scenario it should only move more than 7% in a day once every 300,000 years; in fact, it moved by that amount 48 times. This simple example, which can be replicated for other financial assets, reveals just how difficult it is to estimate the movement of financial asset prices and just how inappropriate the normal distribution may be. For institutions relying on financial models built atop statistical assumptions, this is a significant challenge.

We have already discussed that a catastrophe is a low probability event, meaning that it rests somewhere in the outer tail of whatever probability distribution best describes the situation. Thus, Miami is only meant to be hit by a Force 5 hurricane with 0.01% probability every year (a return occurrence of 10,000 years). Similarly, we might only expect a repeat of the 1987 Stock Market Crash to occur with 0.1% probability (a return occurrence of 1,000 years). But this is predicated on the use of the correct distribution. If we use the wrong distribution we will wrongly estimate the probability of occurrence. Thus, if the “true” distribution for Miami hurricanes has a fatter tail, the 0.01% probability might actually be 0.05% – and the return
occurrence may no longer be 10,000 years, but 2,000 years – quite a difference, and one which will impact decision making. Similarly, the 1987 Crash may not be calibrated to the right distribution, and if we refit it to a different shape, the probability of occurrence may rise dramatically, say to 0.75%. The risk decision will surely be differently armed with this information, as the return period moves from 1,000 years to 133 years.

In fact, from an informal and anecdotal perspective this seems to be a characteristic of financial markets. Most of us have heard the term “100 year flood” being applied to a catastrophic event. The Mississippi River or the Rhine River will only overflow its banks every 100 years according to historical data, and this may well be true. The same notion can be applied to financial crises – these dramatic events are catastrophic, and therefore infrequent. Unfortunately, these “100 year financial floods” seem to happen with far greater regularity. As we will note in Part III when we explore real case studies, major financial dislocations in equities, credits, foreign exchange, external debt, and so on, have occurred with an alarming regularity – one that suggests that we have been thinking about the statistical framework in the wrong way – using the wrong distributions and ignoring the thickness of the tail events. We will also see that the tidy definition of catastrophe as a low probability, high severity event may not be quite so tidy – fine, perhaps, for a hurricane, but perhaps inadequate for financial markets. What we may be witnessing is a different form of catastrophe, with high severity and moderately high probability of occurrence. If true, this requires us to adopt a different way of thinking, and may have significant implications for risk management.

Let us stress one further essential point related to the duration of a catastrophe. We have already said that the economic consequences of a catastrophe are the sum total of an initial event (direct) and the ensuing damage (indirect). While the initial event may appear and disappear quite rapidly, the aftermath of its impact may be quite lengthy. The catastrophe we speak of refers to the sum total of the process. For instance, the earthquake striking Kobe in 1995 lasted less than a minute, but the ensuing fallout (damage, dislocation, economic losses) were evident for years thereafter. Similarly, the 1929 Crash unfolded over a period of several days in late October, but its effects were felt far and wide for several years thereafter. Naturally, in some case the catalyst is less “dramatic” – though that does not mean that it cannot be equally (or more) damaging. For instance, the Dotcom bubble, which burst in 2001, was not a catastrophe of a day or a week or even a month, but a protracted period during which a large number of companies failed, dragging down rather significantly the entire global stock market and creating recessionary conditions in some countries. A suitable, if perhaps unfortunate, analogy describing these two extremes might be the sudden airplane crash and the slow motion train wreck – each equally devastating, but each following different time frames.
CAUSES OF FINANCIAL CATASTROPHES: CATALYSTS AND AMPLIFIERS

With a general framework on severity and probability in hand, we now turn our attention to some of the root causes of financial catastrophes. We will present this discussion in its conceptual light, saving for Chapter 6, a detailed discussion of “real-life” examples.

A discussion of competing theories of financial crises is interesting but obviously well beyond our scope. So, without entering into a very detailed review, we note that Mitchell (1941) suggests that financial crises are a normal part of the business cycle resulting from dislocated economic fundamentals. For instance, when an economy moves into recession, asset prices necessarily fall, borrowers cease to repay their loan obligations, depositors withdraw funds to protect their wealth, and banks face liquidity problems which lead ultimately to a panic and curtailment of credit. Kindleberger (1978), in turn, has indicated that financial crises are spontaneous and self-fulfilling in nature, driven by panic without necessarily being tied to a specific state of the business cycle. Gorton (1988) has determined that recessions (as a fundamental change in the business cycle) lead to, or are accompanied by, some form of financial crisis (e.g., in the United States, of 11 recessionary events, 7 featured some form of financial crisis). Other empirical studies suggest that dislocations during the interwar period were based on panics rather than the state of economic fundamentals.

Theoretical views are thus varied, leaving us to consider whether an economic dislocation creates a financial crisis, a financial crisis creates an economic dislocation, or whether either one can occur based on specific circumstances. Without trying to discern which view is right and which is wrong, we will instead focus on some of the common forces that either act as catalysts or amplifiers of a financial crisis. In particular, we consider economic fragility/weakness, asset bubble collapse, risk mismanagement, debt mismanagement, speculative currency attacks, bank runs, and institutional flaws. Let us also stress two other points: individual episodes may feature very idiosyncratic pressures that contribute to the “denouement,” and parallel forces are likely to be at work in any single crisis.

Economic fragility/weakness

Drawing a page from the Miller model, it seems quite plausible that an economy that moves into a weakened state is vulnerable to crisis and may be a root cause for broader problems. For instance, any national economy that is in, or on the verge of, recession is necessarily unstable. The issue is whether such instability, coupled with some exogenous shock event, can create a deeper and broader downward spiral in financial markets and economic
conditions, moving a country or region from a mere economic slowdown into a much deeper crisis. To be sure, many national economies have withstood recessionary pressures without plunging into a deeper morass. It is also true that seemingly strong economies have been drawn into a financial calamity as a result of one of the other root causes noted below. We might conclude, therefore, that a weakened economy (measured in terms of any applicable metrics, such as growth, inflation, unemployment, budget deficit, national debt, and so forth) has the potential of creating or amplifying a financial crisis but need not always do so.

In fact, empirical evidence related to financial crises suggests that macroeconomic conditions are often weak in advance of a financial crisis, particularly one centered on a banking/credit crisis. This tends to be reflected via high inflation, current account deficits, and fiscal imbalances, or some combination of the three; indeed, representative examples can be seen in the cases of Korea, Thailand, and Indonesia (1997), Russia (1998), Argentina (2001), and Iceland (2008).

**Asset bubble collapse**

Experience suggests that some financial crises can be precipitated by asset price collapses that lead ultimately to forced liquidation, losses, and liquidity runs or defaults; in the latter stages of such crises the contagion effect may also spill over to other sectors of the economy, compounding losses. While an actual asset price collapse may occur suddenly or gradually, the process of building asset prices to unsustainable levels generally takes months or years to achieve. At some point in the cycle, asset prices reach extreme levels and are triggered into decline by a catalyst (e.g., a tightening of interest rates, a rise in unemployment), which leads ultimately to extreme losses. In fact, Kindleberger identifies four stages of the asset bubble, which begins with “displacement,” or some action or innovation that captures the public interest, followed by “positive feedback,” in which growing interest is placed in the object of attention that leads to an increase in its value, until the third stage or “euphoria” is reached; this represents the peak of buying interest and becomes irrational and unsustainable and leads ultimately to the “collapse” in the bubble.

Note that when we speak of “unsustainable” levels in asset prices, we refer to price levels that exceed true or fair value by some significant amount; determining such value is at least somewhat subjective and can depend on the state of markets and assets, supply and demand dynamics, and so forth.\(^\text{15}\) It is also true that the pendulum can swing between technical and fundamental forces. Early in the buildup of a bubble technical forces may dominate fundamental valuation, but as the cycle progresses fundamental forces enter the picture – to the point where any technical bid can
easily be overwhelmed by fundamental selling. Empirical evidence supports the assertion that banking/credit crises, in particular, are often preceded by some form of credit-fueled asset inflation.\(^16\)

Several related points are worth noting. In the first instance, not every asset bubble is bound to lead to a financial disaster. Indeed, bubbles\(^17\) occur with some frequency, and while they may produce unpleasant losses for those involved as investors, creditors, or other stakeholders, they are unlikely to produce the types of losses that we would consider catastrophic. Second, while it is true that virtually any asset can be the “culprit” in creating broader disruptions, in practice it tends to be those that command significant value or participation. For instance, while the price of wheat, eggs, or freight index futures might rise to exorbitant levels, any subsequent collapse is unlikely to cause broader problems. In fact, real estate and equities have tended to create the most widespread damage through their inflated values (particularly in the latter 20th and early 21st centuries). Within the real estate sector this has occurred in both commercial and residential portfolios in various countries around the world (e.g., Japan in the 1980s, United States in the 1990s and again in the 2000s, and so forth). Within the equities market, certain sectors have proven more overbought than others at any point during a speculative frenzy and thus serve as the triggering agent for a broader market collapse (e.g., the Dotcom stock collapse of 2001). To be sure, damaging bubbles of the past have centered on other assets, including tulips (which were significant source of investor participation in Holland during the 17th century), gold, copper, and silver (which have been the focus of repeated inflation and collapse at various points in time), and so forth.

The speculative forces that drive the initial moves are often the result of loose monetary policies. In fact, any accumulation of excess liquidity recycled through the banking system is likely to lead to the bidding up of assets.\(^18\) Any economy that is coming out of a period of slow growth or even recession will be doing so, most often, via a permissive interest rate policy. Cheap credit\(^19\) is an essential ingredient in “jump starting” a weak economy, because consumers and companies can borrow at affordable rates and use borrowed funds to buy goods and services. Such cheap credit can also be used quite effectively to fund investment activities, which will surely appear more attractive than low yield savings deposits. The period associated with combating slow or low economic growth may last for several years, with interest rates remaining low all the while. Not until inflationary forces begin to take greater hold might a rate tightening take place. Once this happens, consumers and borrowers may change their attitudes, preferring to spend and borrow less. In more extreme cases high inflation and rising rates can bring economic growth to a relative standstill – making it difficult for asset valuations to remain at lofty levels. This, then, becomes a central step in the collapse of asset prices – investors and other stakeholders who find it...
unreasonable to hold assets that appear vulnerable commence a liquidation process that can either be absorbed by the market (meaning little knock-on effect and no catastrophe) or one that is too large to accommodate (meaning greater damage, perhaps of catastrophic proportions). The latter scenario may be associated with assets that are less liquid, such as real estate, where the process of selling may take months or years.

As part of our discussion in this section, we also make a brief reference to the theories of Hyman Minsky, the economist, to describe what has popularly become known as a “Minsky moment.” Specifically, Minsky has posited in his works a state of the economic system where leverage is at very high levels in comparison with asset prices. As this state of fragility continues, banks and other lenders begin to become more risk-averse, contracting their supply of credit through a tightening of standards and raising the risk premia charged on existing facilities. Banks may also call in their loans or cease to renew them. This leads to a withdrawal of credit from the system and can put borrowers in the position of having to liquidate assets to repay outstanding debt. Forced asset disposals, particularly those occurring on an accelerated basis, have the effect of creating more downward price pressure, leading to further cash calls (margin calls, covenant triggers, etc), more liquidation and, in some cases, growing instances of default (in cases where borrowers have insufficient asset coverage). The last “moment” in the Minsky process is a deflationary credit contraction which causes monetary authorities to ease monetary conditions and lower rates to avoid broader economic contagion. By all accounts, the process described by Minsky played out to its fullest extent during the Credit Crisis of 2007, as we will discuss later in the book.

Naturally, not all asset price increases are due to cheap credit, but may be attributable to other, more sustainable, forces, such as pure supply and demand. For instance, real estate in a particular city may gradually become more valuable if the city is a magnet for jobs and the supply of homes is limited. In such cases interest rate policies may have little to do with the upward trajectory of prices. Similarly, a period of strong economic growth may lead to rising oil and commodity prices as raw materials and production processes expand in support of customer demand. Interest rates (and speculative forces) may play only a secondary role in fueling rising values. High asset prices that are not driven solely by cheap leverage are more sustainable than those that reach high levels via debt. Any leveraged play is bound simply to compound the negative effects of a price collapse once the inevitable peak is reached, if only because redemption of leverage (e.g., repayment of loans) places downward pressure on the assets that are being debt-financed, intensifying and magnifying the downward valuations.

In an ironic twist it is worth noting that the banking system itself is often the cause of its own problems when it comes to asset bubbles. The growing
asset values that are fueled by cheap credit represent a source of earnings for the financial community – not only in a proprietary sense (through risk position-taking) but also in a client driven sense (through the loans granted to those interested in purchasing real estate, equities, commodities, or other assets). They are, thus, central players involved in inflating the bubbles and tend to suffer the consequences as much as other stakeholders. Unfortunately, as we will discover later in the book, the complexity of the system and the structural activities and motivations of the financial community make it unlikely that this type of behavior will change dramatically in the future.

**Risk mismanagement**

Bankers, insurers, asset managers, and risk managers like to speak of risk management as a core principle and foundation of the financial business (as we will discuss in Chapter 4). A properly structured risk management process, based on prudent market, credit, and operational risk governance and controls, is at the heart of any sound financial system. Reality may, unfortunately, be rather different.

An examination of many of the financial crises that have appeared over the years suggests repeated episodes of flawed risk management – or what we might more accurately term as “risk mismanagement.” While the underlying reasons for such flaws may be varied – including pursuit of profits over controls, technology inadequacies, governance problems, skill deficiencies, and so on – the result is a control framework that does little to prevent an accumulation of the risk exposures that can create systemic instability. If the risk management process is not firmly in control and functioning as required at an individual firm, and this is multiplied across many institutions, then the crucial safety net may be at risk of failure. In fact, banks (and other financial institutions) appear to follow a herd mentality in pursuing business and risk – while a small number of banks may operate somewhat more conservatively, the common benchmark tends to be what other industry players are doing. History has shown that this tends to be a problem, particularly in the period leading up to a crisis or correction.

Of course, risk mismanagement operates in tandem with other root causes, thus compounding any dislocation that may already be underway. So, real estate may be an inflated asset that is driven by monetary policies and speculative pressures, but it can be exacerbated by poor underwriting standards that grant real estate loans on very liberal terms (e.g., high loan to value loans, no equity loans, no income verification loans, and so forth). The flawed risk management process does not create the real estate bubble on its own, but it may permit further expansion of the bubble.
Debt mismanagement

Fiscal stability demands diligence with regard to overall debt levels employed in financing of activities – this is true at both the level of individual institutions and the sovereign system. While debt is obviously a legitimate and tax-beneficial form of financing, its use needs to be optimized with other forms of financing, such as equity capital. An excess of debt can lead to a heavy fixed interest burden which, in the extreme, detracts from revenues to produce an unsustainable level of financial pressure. We know that at a micro level, an excess of debt can lead to instances of corporate distress and, ultimately, bankruptcy. When highly leveraged corporate balance sheets exist during the start of an economic slowdown, sectoral pressures can create broader systemic instabilities. This, for instance, has occurred at various points in the 1990s (during the junk-bond crisis) and early 2000s (during the Dotcom bubble/corporate governance scandals), with a rash of corporate defaults having subsequent negative effects on local equity markets. This form of “debt mismanagement” can be regarded as troubling and obviously leads to stakeholder losses, but is unlikely to create broader systemic dislocations unless entire sectors are following the same course.

The more significant issues regarding debt mismanagement appear when the national balance sheet is overleveraged. When a country finances itself through an excessive amount of debt, it puts the national interests at greater risk and may, in dire circumstances, create the catalyst which leads to a financial catastrophe. In fact, this leads us back to the debt crises we described in the last chapter, where such events can be regarded as one of the main forms of financial collapse. The actual triggering event may take years to build up, as it is unlikely that a sovereign will debt-finance itself to extreme levels within a short period of time. It has other sources of revenues, including taxes, privatization proceeds, and so forth. It can also become more fiscally prudent by controlling expenditures.

Since our interest is primarily at the sovereign level we can consider that excessive national debt can be denominated in either local currency (internal) or foreign currency (external) terms. A country may build up one or both, though its course of action may be different as debt starts to accumulate. In extreme scenarios, when the burden becomes excessive, it can choose to print more money to repay local currency liabilities, though this will invariably lead to a significant rise in inflation and further instabilities; default only on its internal debt; default only on its external debt; or, default on both its internal and external debt. For instance, during the 1998 crisis, Russia defaulted on its local GKO obligations, but not on its Eurobonds (though these were heavily discounted in the market for some years). Depending on the nature of its contractual obligations, a local currency default could trigger a cross
default on other external obligations. To be sure, any default on external obligations brings with it a very heavy toll in terms of market access to external financing, sometimes for a period of years. Regardless of the specific construct of liabilities and the form of default, it is clear that mismanagement of debt over a period of years can fuel a debt crisis and broader financial disaster.

**Speculative currency attacks**

Speculative currency attacks can be a catalyst for broader financial distress, as history has shown on repeated occasions. In fact, currency attacks can feature prominently in the commencement or intensification of a currency crisis. Speculative currency attacks occur in foreign exchange rate regimes that feature semifixed exchange rates, which may include currency boards, baskets pegs, crawling pegs, and other management techniques. (Note that national currencies that are either completely floating, or completed restricted are not necessarily subject to the same issues as their rates are determined by market forces or hard currency exchanges are simply not permitted). When a national monetary policy breaks down and causes the currency to appear expensive on a relative basis, speculators may move to capitalize on the vulnerability. While a national central bank or monetary authority with sufficient reserves may be able to protect its currency for a period of time (i.e., by buying the local currency that speculators are selling and selling hard currency from its reserve holdings), this is almost certainly unsustainable over any meaningful period.

The global financial system has learned the hard way that fixed but adjustable foreign exchange rates are ultimately unworkable when capital is truly mobile. To be sure, some temporary stabilization measures can usually be imposed, but these are unsustainable in the long term, particularly given the pool of investable, speculative capital that can be deployed (e.g., through hedge funds, bank proprietary trading desks, and other conduits).

**Bank runs**

Bank runs have historically been a central cause of widespread financial distress and can fuel some of the banking crises described in the last chapter. Such events are not, of course, anything new and have occurred periodically throughout modern times. In a classic bank run an institution faces cash withdrawals from depositors in excess of its access to ready cash. This lack of liquidity to meet deposit cash calls (which may be compounded by lack of access to a banking system that acts as a temporary lender or lender of last resort) can quickly spin out of control. Rumors of
funding problems and the sight of depositors standing outside a branch can quickly dissolve into fear and panic, leading quickly to a bankruptcy spiral. Any severe bank run that affects a large number of banks or a particular segment of the banking system (e.g., private banks) can lead to a curtailment of credit, setting the stage for a broader economic decline. As noted in the last chapter, many banking/credit crisis are accompanied by bank runs of consequence.

It would be wrong, of course, to consider a single bank run as a financial catastrophe, or of even being a catalyst in a catastrophe. While it might certainly be regarded as a disaster for depositors losing money and the local community that may no longer be able to access credit as readily, it can hardly be considered to have a systemic impact. However, bank runs are occasionally systemic in nature, sweeping through multiple institutions in rapid succession as a level of panic emerges and spreads. In such instances the financial dislocation can be rather more severe, possibly assuming catastrophic dimensions. For instance, in 2000, DemirBank in Turkey was no longer able to access overnight funding, which led to the cutting of credit lines and forced sales of government securities, whose rapid plunge frightened foreign investors already concerned about Turkey’s fragile state. Within days, the Turkish lira devalued and the government was forced to step forward with a guarantee of bank liabilities.

Bank runs are based primarily on rapid withdrawal of interbank and/or retail liquidity, as well as cancellation of counterparty credit facilities, which leads ultimately to lack of confidence and further withdrawal of funds. The triggers for funding withdrawal may include extensive credit losses, market risk losses, fraud, and so forth – in fact, any losses that are significant enough to cause depositor and creditor concerns. Events of the past years have also shown that when a bank features a plunging equity price, it may wind up in the same position – even if it happens to have sufficient liquidity and can demonstrate this to the market. In fact, a falling stock price that is driven by fundamental earnings concerns (and is fueled, perhaps, by the actions of short sellers) can damage public confidence in a short time frame – even if full access to liquidity is available. This can lead to a spiral that ends up in default (to wit Washington Mutual, IndyMac, and Lehman Brothers, which collapsed in 2008). Government intervention to prevent an institution from collapsing, such as was done in 2008 with Bear Stearns, AIG, Citibank, and others, can help avert a worsening of a financial collapse, but introduces the topic of moral hazard, as noted below. In fact, the “too big to fail” concept, which has existed in theory and concept for decades and which has occasionally played out in full, appears to have intensified in recent years. Short of much stronger regulation, governance, and alignment of interests, the moral hazard risk remains a real threat to financial progress and financial stability.
Institutional flaws

Various components of the institutional system can actually become flaws and exacerbate a financial crisis. While such flaws may not act as direct catalysts, there is little doubt that they can compound or prolong the negative effects of a dislocation. For our purposes we focus on three of these: regulation, moral hazard, and internal governance.

Regulatory issues are at the forefront of any discussion on financial disasters. Regulators exist to provide a degree of control, oversight, and protection, and instill confidence in the marketplace. Regimes that feature strong financial regulators seem quite able to create the right level of confidence and attract more business than those that are weaker. The reality, however, is that regulators are, for the most part, backward-looking and reactive. With few exceptions, financial regulators cannot be seen as the proactive protectors of the financial system, halting problems before they become serious. At best they may be able to limit the overall level of financial damage to stakeholders by requiring minimum levels of capital and liquidity, enforcing certain disclosure and transparency rules, and ensuring orderly conduct of markets. At worst, regulators may be completely unaware of what their national institutions are actually doing or the damage they can potentially create through excessive risk-taking, regulatory arbitrage, inadequate controls, weak governance, and so forth. Lack of coordination and communication amongst national regulators compounds the problem, as individual countries may approach regulatory breakdown and systemic crises in a “piecemeal” fashion. This relative lack of effectiveness means that regulators can “aid and abet” risk-taking institutions, compounding the negative effects of a crisis situation. We need not look too far to find examples of how flawed regulation and poor oversight have led to fundamental mistakes and deeper financial losses (to wit, the S&L crisis of the 1980s, the Japanese Banking crisis of the 1990s, and so forth).

Moral hazard is a second institutional flaw and relates to the risk that knowledge of certain available protections or support will alter a firm’s risk-taking approach, pushing it into taking greater risks than its financial standing would otherwise support. If a financial institution believes that the government will “bail it out” should it run into financial difficulties, then it has every incentive to continue with, or even expand, its risky activities – if it is right it will profit, and if it is wrong it will be backstopped by government funds. This problem exists when monetary authorities declare implicitly or explicitly that certain institutions within its purview are “too big to fail” – that is, they are of such systemic importance that they cannot be considered to be “at risk” of default. When this perception exists the potential for increased instabilities can actually rise, as the chosen institutions may simply behave recklessly, at the ultimate expense of the taxpayer.
In fact, moral hazard was a key consideration during the Japanese crisis of the 1990s and extensive banking bailouts of 2008.

Poor internal governance is a third flaw that can exacerbate a financial crisis. Governance exists in corporate entities to ensure that directors and executive managers are operating in the best interests of shareholders, who act as providers of capital. General rules exist regarding separation of duties, audit, risk and financial controls, compensation programs, and so forth, so that investors can feel a proper degree of comfort regarding the delegated management of the firms to which they have contributed capital. If governance is not functioning properly, a firm increases the likelihood that it will encounter some type of financial difficulties and may, in fact, alienate its core investors; vociferous and activist investors may seek to oust directors and/or management, all of which can create a period of uncertainty or instability. If such governance problems are apparent in many firms, the likelihood of systemic instability increases. For instance, a series of corporate governance failures at major corporations such as Enron, Tyco, WorldCom, Parmalat, and others, contributed to the corporate defaults and stock market declines of 2001–02. Similarly, governance flaws at major firms such as Merrill Lynch, UBS, and Citibank appear to have been a factor in compounding problems at these banks in the period leading up to the Credit Crisis of 2007; the problems at these financial behemoths (manifested via multibillion-dollar losses) added greatly to the overall financial instability apparent in the market.

Root causes and amplifiers of financial disasters are summarized in Figure 3.4.

**SYSTEMIC INTERRELATIONSHIPS AND LEVERAGE**

Regardless of the specific form of financial crisis we are considering and the root cause or amplifier of the event, it is important to note that the effects
of contagion can compound the initial negative impact, amplifying its severity and prolonging the cycle of damage. There are at least two major factors that can contribute to this amplification: systemic interrelationships and leverage.

In the modern financial era interbank claims, information dissemination, and cross-border freedoms can benefit the system by increasing opportunities and hasten any downward spiral by creating a negative feedback loop. For instance, asset price declines in one market can serve as a negative signal to other markets, causing a sell-off in those markets, a heightened sense of panic in the original market followed by further sell-offs, and so on. Such a domino effect becomes more plausible when we consider all of the associated linkages that exist in today’s financial markets, including:

- Interbank payment and clearing systems
- Collateral exchanges, rehypothecation, margin calls, and collateral liquidation
- Counterparty derivatives trading and correlated credit states
- Mark-to-market accounting processes
- Structured product market triggers, rating downgrade clauses, and so forth.

Events of the past few years have demonstrated the additional damage that can be wrought as a result of such relationships. Perhaps most worrisome is that even after all of the experiences of the past decades, we still do not fully understand all of the linkages that exist as a result of cross-border capital movements, extensive and complex business and financial relationships, and general lack of transparency.

Leverage is another factor that can exacerbate an unfolding crisis. Leverage is certainly nothing new, having been used for centuries by all manner of parties to enhance returns, optimize balance sheets, or take advantage of tax benefits (e.g., interest deductibility). However, the presence and use of debt financing has expanded greatly in recent years, both directly and indirectly. This is particularly true with the growth in derivatives and other leveraged contracts, as well as leveraged vehicles, such as hedge funds, conduits, structured investment companies, and other off-balance entities.

The advent and expansion of derivatives has been a key driver in the leveraging process. OTC derivatives that are executed on an uncollateralized basis make it easy to establish a leveraged long or short position in a particular asset class. An unfunded position that is shared by many
participants (e.g., a long credit position in subprime securities) can become an amplifier of market moves in the event of unwinding or liquidation. With more leverage coursing through the financial system, the positive and negative impacts of financial asset movements are magnified, sometimes substantially. While this is positive when markets are rallying, it becomes quite negative during a market downturn and can help fuel a financial disaster.

To be sure, the positive and negative effects of mobile capital, widespread use of leverage and the complex web of systemic interrelationships are increased even further by today’s technology and information dissemination capabilities. This became apparent in the early 1980s as more banks and brokers began employing new computerized technology to track and execute transactions. It accelerated in the early 21st century as the sophistication of web-based technologies became more widely employed by all manner of participants. While providing a very efficient and powerful mechanism for arranging and managing financial affairs, the technology/information nexus has demonstrated the potential of exacerbating any disruption; it appears, in fact, to reinforce the systemic linkages. The existence of a “vicious cycle,” or negative feedback loop, in a financial crisis cannot be underestimated. Destabilization can feed into the macro economy, further exacerbating the destabilizing event from there, with all of the attendant capital and liquidity issues that are involved in the process.

INSTITUTIONAL AND SYSTEMIC RESPONSE

No financial disaster follows the same path – each one has unique characteristics that are the result of specific factors in play at that time. That said, many of the financial crises that have affected the system over the past years appear to share certain similarities, including excessive risk-taking, excess liquidity, leverage, and speculation that lead to asset price inflation, misbalanced risk-return profiles, and so forth.

When a financial catastrophe is either anticipated (to the extent it can be, which seems to be somewhat rare) or underway (far more likely), some degree of institutional and systemic response generally follows. This is necessary and logical, as stakeholders – including directors, executives, investors, regulators, and government authorities – have every interest in minimizing the resulting financial damage. The degree to which they respond, and the nature of the actions they take is, of course, event-dependent. An isolated local or regional financial catastrophe, such as a run on local banks, or a decoupling of the national currency from its peg or basket, may be handled at a regional or national level. A more severe catastrophe, with cross-border impact, is likely to involve the actions of many market participants from multiple nations. The degree to which such actions may be coordinated varies. Anecdotal evidence
suggests that response is not always synchronized, particularly when the depth and breadth of damage is unclear. In the extreme coordinated efforts may not occur until a later stage; even in these instances, a single national authority may assume a leading role in guiding the process.

It is worth noting that in the financial system of the 21st century an event that at first glance may be considered local or regional, with limited scope of damage, can quickly move beyond its original borders to “infect” other areas. In fact, this contagion, as it is often known, can spread quite rapidly as a result of the forces of deregulation, capital mobility, technological advancement, and information dissemination mentioned above. Financial crises of the 19th century were, in general, more contained by virtue of limited capital mobility and only rudimentary telecommunications abilities. That started to change with the advent of the telegraph (permitting rapid transoceanic communications between capital centers such as London, Paris, and New York), the growing sophistication of investors and intermediaries, and the generally informal regulatory framework of the time. Dislocations of the 20th century were more likely to lead to regional and even cross-border impacts – the Great Crash of 1929 serves as a key example, where the financial crisis enveloping the United States soon found its way into major capital markets in Europe and Asia. Needless to say, events of the late 20th and early 21st century have exhibited greater tendencies toward regional and global impact, with events sometimes moving at great speed. We need only think of the October 1987 Crash and the Russia/LTCM Crisis of 1998 to realize this. And, while information and technology advances have been important drivers, we cannot underestimate the impact of deregulation, particularly in permitting capital to travel across borders with ease. Indeed, the ability of institutional players to quickly redeploy their capital funds based on perceived or actual risk situations is the essential ingredient that allows volatility to rise and destabilization to accelerate.

Institutional response

The response of individual institutions to financial catastrophes is the first step in the process. While all institutions can theoretically be caught up in the turmoil, those that are impacted initially (and perhaps most severely) tend to be financial institutions – they are, after all, the intermediaries of the financial system and very intimately associated with the transmission mechanisms of markets, products, and capital flows. Corporate institutions in the main appear to be impacted primarily in the “second wave” of effects, when economic slowdown may appear and default experience may rise. Our focus in this section is therefore on financial institutions, primarily banks, brokerages, and institutional asset managers (including pension funds, mutual funds, hedge funds, trusts, and insurance companies).
Each institution involved in the financial catastrophe may have its own criteria for defining the degree to which it is at risk, and the actions that it needs to take. More enlightened institutions may have a full crisis management process in place to deal with the impact, allowing them a quick transition from offense to defense. The majority feature a formalized risk management process, as we describe in Chapter 4.

The initial responses at the level of any single institution depend largely on the scope of business being conducted. For example, banks that are heavily involved in wholesale business and lack stable retail deposit funding, may move rapidly to lock in funding commitments for longer terms so as not to increase funding and liquidity vulnerabilities. Similarly, those that take a great deal of market risk may move as quickly as possible to offset or sell such exposures. As we might expect, such actions tend to be defensive in nature – preparation for potential worse times to come, when corporate priorities may shift from profit maximization to preservation of value as a “going concern.” Though this may sound quite dramatic, historical events have proven that this is also likely to be the overarching expectation of shareholders. Indeed, investors who are not comfortable with an institution’s ability to manage through a crisis period will simply sell their shares. If this happens en masse, the institution may be threatened with market value erosion, which can have an impact on its core business and on the trust clients place in the franchise – in an extreme, though still conceivable, scenario, the impact can lead to liquidity problems and even default.

We can, therefore, consider at least three major institutional responses to a crisis – preservation of liquidity, reduction of risk, and defense of capital.

Preserving liquidity is the cornerstone of financial institution crisis management. While any firm needs cash to operate, this is of special interest to financial institutions, which perform a major function in the recycling of systemic liquidity. For instance, if a bank loses deposits too rapidly it will have insufficient funds on hand to cover its own obligations. Similarly, if the bank’s access to wholesale funding is threatened, the ability to continue supporting its asset base is quickly jeopardized. While most financial institutions operating in the modern era spend considerable efforts in ensuring a strong and robust liquidity process to cope with both normal and catastrophic events, there is never a total guarantee that liquidity will be available in the quantities required – particularly during times of extreme crisis. To help overcome this threat, monetary authorities responsible for regulated financial institutions may make available certain standby funding and repurchase agreement facilities to reinforce comfort at the level of individual creditors (whether retail or institutional). Indeed, access to such facilities may become increasingly generous and flexible as systemic threat rises, and the population of qualifying institutions may expand in tandem.
Once the liquidity position is adequately defended the next set of responses is likely to center on the risk profile of the institution. As we have noted above, risk-aversion is a natural response to an unstable and volatile environment and financial institutions may alter their risk profiles in response. This can take different forms. For banks that are active lenders to the retail or commercial sectors, it may mean a cutback of credit to less creditworthy customers or an increase in the security or collateral arrangements backing loans. Universal banks and securities firms that are active traders in risky assets, such as equities, bonds, and currencies (either for proprietary or customer-driven reasons) may begin to “derisk” their portfolios by liquidating assets or putting on protective hedges. In more extreme crises, banks may curtail their activities with each other – such as reducing the amount of interbank lending and depositing they engage in, or reducing the counterparty dealing they do in derivatives and money markets. This is indeed a more severe state of distress, because when banks lose confidence in one another, the balance of the financial and economic system can be impacted very rapidly.

Reducing balance sheet and off–balance sheet leverage is closely related to the derisking process. The ability to quickly shrink assets places less stress on funding requirements, which lowers the specter of liquidity, market, and credit risks. But such deleveraging often comes at a cost – quickly selling off portions of the balance sheet (e.g., securities, loans) as well as off–balance sheet commitments (e.g., derivatives unwinds) may occur at suboptimal prices, particularly if the overall environment has become risk-averse. In addition, once assets are removed from operations, the earnings generation capability of the institution declines as well. Accordingly, there exists a trade–off between deleveraging institutional activities and reducing earnings capacity.

Capital preservation is the third essential institutional response. Without sufficient capital (whether regulatory or economic) a financial institution may be forced to curtail operations or may even be placed under administration or receivership. Capital generation is, of course, a function of issued capital (in all of its qualifying forms, including equity, preferred stock, and certain forms of convertible and subordinated debt) and retained earnings. Regulatory requirements generally demand certain minimum levels of capital which can be negatively impacted by a loss-making environment (i.e., creating a drop in retained earnings). Recapitalizing through new issuance may be difficult in times of financial stress, when investor appetite for new shares is likely to be limited. Accordingly, defense of the capital position through active management of risk (to avoid or at least minimize losses), preservation of earning businesses, and reduction or suspension of dividend payments, forms the critical third pillar of institutional response.
There is at least some evidence to suggest that institutions already prepared to deal with a financial crisis can move quickly to take advantage of opportunities that others may relinquish or avoid. The “prepared” firm can enact its crisis plan quickly and, assuming some degree of prudence in its risk management, continue to pursue potentially lucrative business opportunities – at a time when others are unable to do so. For instance, JP Morgan was able to turn the crisis of 1907 into a rather profitable period simply because it was well-prepared to deal with the financial dislocation that it saw coming. While other examples exist, too often the opposite scenario appears to play out, with institutions seeking merely to survive.

**Systemic response**

The more severe the financial catastrophe, the greater the likelihood we will witness a systemic response. A systemic response, per our definition, involves the direct actions of multiple bodies in both the private and public sectors. While the response should ideally be coordinated, both within a country and outside, in practice this may or may not occur. If it does not occur immediately, it may occur eventually, though any delays could prove costly in terms of market confidence. Systemic response may unfold in different phases, with a short-term phase focused primarily on halting the spread of the crisis and a medium-term phase concerned with rebuilding the market mechanisms and institutions impacted by the dislocation. It is not surprising that public sector institutions, including government agencies, are theoretically meant to play the leading role in both phases.

Systemic response involves multiple parties comprising the financial and economic system. In the first instance we find the very individual financial institutions mentioned above which constitute the foundation of the financial marketplace. As a catastrophe spreads, these players may find opportunities to reduce their risk with one another and with their clients, to improve communications on potential problem areas, and to identify ways in which exposures can be exchanged. Clearinghouses, serving as risk-mitigating intermediaries within the financial system, may become more active and more collateral may be exchanged between parties dealing in the OTC market. As noted earlier, it is during this period that most institutions are likely to be reinforcing their liquidity positions. They may simultaneously seek to publicly reassure customers of the strength and creditworthiness of their operations to ensure continued flow of funding.

While risk management is generally conducted by individual entities at a micro level, certain financial catastrophes are so large and have the potential of generating such large direct and indirect losses that government authorities must also participate. In fact, certain aspects of disaster recovery can only be conducted effectively at a government level, as individual efforts
may prove inadequate, duplicative, or disorganized. Accordingly, the second focus of activity surrounds public sector institutions – more specifically to financial regulators and monetary authorities. Such authorities are constituted in unique ways, but their operating concepts are quite universal.

Financial regulators are responsible for overseeing financial institutions and marketplaces located within their national boundaries. Though each regulatory regime is unique, the common oversight functions are based on continuous review of the financial health of banks, brokers, exchanges, and other market conduits to make sure they are functioning as required and are not facing vulnerabilities related to liquidity, funding, capital, or asset quality. This activity becomes particularly important during a period of market stress, as financial positions can deteriorate rapidly, causing systemic instability to rise. It is also likely that during such a period a “domino effect” can come into play, where a vulnerable institution seeking protection can impact others in a form of chain reaction. This is particularly true when public confidence is damaged, since confidence is the backbone of banking; if it erodes, the knock-on to other institutions may occur rapidly. On a short-term basis financial regulators may also be solely or primarily involved in enforcing “circuit breakers” (e.g. maximum market movements or exchange “holidays”), implementing temporary rules (e.g., banning short selling), and suspending certain others (e.g., minimum capital or liquidity requirements) to minimize asset price depreciation and volatility. These may be effective in calming markets and some of the dynamics fueling or amplifying the crisis – though they are not always guaranteed to work as intended. Over the medium term, financial regulators may be responsible for reinstituting and perhaps tightening any prudential rules that may have been suspended on a short-term basis, intervening in troubled institutions and taking over their operations (through nationalization or assisted sale to a healthy party, or splitting assets into “good” and “bad” components). However, such intervention activities are not always arranged on a timely basis, to the detriment of the system at large (to wit the US savings and loan crisis of the 1980s and the Japanese banking crisis of the 1990s). Note that the actions may not be limited to financial institutions, but could extend to nonbank financial institutions (which in some countries are important conduits and intermediaries, and thus susceptible to the same problems as financial institutions).24

Monetary authorities play a very significant role during a crisis period, as they are responsible for enacting short-term policy adjustments designed to help alleviate crisis factors. The national central bank, treasury, or monetary body responsible for establishing monetary policy, altering reserve requirements, managing systemic liquidity through open market operations, and/or serving as lender of last resort, is typically at the leading edge of public sector response. Monetary authorities, working with financial regulators, may take actions designed to protect financial institutions in the short run, such
as permitting the temporary suspension of deposit convertibility, guaranteeing bank deposits, or making available additional secured or unsecured funding liquidity. The intent in such instances is to reinforce public confidence in those institutions that are so critical to the efficient allocation of credit. In periods of extreme systemic stress, the national authority may also choose to lower reserve requirements, inject additional funds into the marketplace, and/or lower official discount rates. Further functions may include defending the national currency or serving as a lender of last resort in supporting troubled institutions that may be regarded as “too big to fail.” In the most dramatic instances, monetary authorities may orchestrate much broader remedies, including creating comprehensive sector bailouts (e.g., partial or complete recapitalizations), establishing taxpayer funded rescue packages, and so forth; this places government in the uncomfortable position of being, at least temporarily, whole or partial owner of financial institutions, something which most prefer not to do. In fact, we have seen numerous examples of such behaviors, such as the US S&L restructuring of the mid-1980s and early 1990s, the Scandinavian bank interventions of the early 1990s, and the global financial institution support efforts of 2008 and 2009. Monetary authorities may also work with legislators on the establishment of fiscal stimulus packages to restart activity in an economy that has been hard hit by a financial dislocation. This reverts to the phased approach we have mentioned earlier.

The activities of national authorities may be supplemented by supranational efforts. This may occur when an entire country’s economic health is severely impacted by a financial catastrophe. In such cases multilateral lending to national governments may be required, often with stipulations on fundamental changes to macroeconomic policies. Again, we can point to various examples, including the IMF financing packages granted to the governments of Indonesia, Korea, and the Philippines during the Southeast Asian crisis of 1997–98 and similar facilities arranged for Iceland and Hungary during the Credit Crisis of 2007. This can be viewed as a form of national recapitalization. Supranationals may also be involved in broader debt forgiveness packages, particularly for extremely troubled debtors that have no realistic prospect of repaying their obligations.

Table 3.1 summarizes some of the key short- and medium-term responses that are associated with a financial crisis period.

While each of the functions noted above is vital, the sum total leads to the critical result, which is restoring systemic stability and public confidence. Successful execution of these can help ameliorate the worst of the damage and lead individual economies back into the growth path by ensuring lending and investment restart in a meaningful way. Naturally, an inability to inject stability or persuade the public that the crisis is in hand can simply lead to a lengthening and deepening of the crisis, such as was evident in both 1929 and 2007–09.
The theoretical response from the public sector may be different from the practical one. In fact, response may appear chaotic in its earliest stages, reflecting the degree to which the system at large may be unprepared for crisis or is dealing with incomplete information. Moving quickly to concerted action is essential to manage effectively the stability and confidence issues mentioned above. It is relatively easy to see what can happen when a proper, coordinated private/public effort (whether national or cross border) is not successfully implemented. During the Japanese banking crisis of the 1990s, an ill-defined and executed package of protections and reforms, including in its earliest stages the continued masking of bad loans, simply prolonged the devastating downturn, hampering economic growth for many years. Similarly, the lack of coordinated public action during the Credit Crisis of 2007 until early/mid-2008 lowered confidence and increased the level of volatility and instability. By way of contrast, a strong and concerted effort by a syndicate of international banks, the US Federal Reserve, and the US Treasury was instrumental in allowing the damage wrought by the near-collapse of the highly levered Long Term Capital Management (LTCM) hedge fund in 1998 to be contained – had that coordinated systemic response not occurred, the financial damage (already heavy) would likely have been far greater.

Effective institutional response may also be hampered by deficiencies associated with the bankruptcy and liquidation process. Countries that lack the proper judicial infrastructure and governing law to handle significant bankruptcies bring to a halt any attempts to restructure companies or entire industries. This can, of course, delay any recovery process. Insufficient accounting transparency and ill-defined investor and creditor rights can also complicate the issue, leading to further delays.

The state of the local economy dictates how quickly a crisis can be absorbed. Ultimately, a resilient economy that is capable of handling the financial shock of a catastrophe will fare better than one that is already in the midst of a contraction or structural dislocation, or which lacks the resources necessary to assist those that have been affected. Since major catastrophes

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<td>Suspension of market activities, specific rules</td>
<td>Intervention in distressed institutions</td>
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<td>Provision of additional liquidity</td>
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<td>Adjustments to monetary policies</td>
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<td>Adjustments to fiscal policies</td>
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<td>Arrangement of debt forgiveness, emergency loans</td>
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Table 3.1 Government response to financial crises
may require a reallocation of financial resources from existing economic programs and planned investments, economic goals can be jeopardized. Exports may also be disrupted, causing deterioration in the country’s trade balance and a worsening of the balance of payments account. Public borrowing may also be required if insufficient government funds exist, increasing the local/national interest burden (and possibly lowering the credit rating/increasing the general cost of funding at the sovereign level).

Institutional and systemic response to a crisis is likely to remain in place until the crisis is considered to have “passed.” Unfortunately, there is no particular time horizon or signaling event which serves to declare that a crisis has been overcome. Indeed, not until an ex-post reflection occurs might we understand that a critical point has been passed and a return to “normalcy” has commenced. In fact, we may draw some signals from the financial markets or from economic indicators. For instance, a strengthening of the equity and credit markets, a decline in asset price volatility, a return of market liquidity, an easing of interbank rates, and a decline in default rates are often associated with a return to a “normal” state of affairs. From a macroeconomic perspective, an upturn in housing prices, consumer sentiment, business confidence, and GDP growth can also signal the end of a disaster. Over the past century the average “major” financial crisis has lasted between 2 and 3 years and generated direct and indirect losses estimated at up to 5% of GDP; evidence suggests that combined banking and currency crises have created the most havoc. Of course, any single crisis may be more or less severe.

THE HISTORICAL EXPERIENCE

The history of financial catastrophes is extensive, dating back centuries. Since the creation of fiat money in the 3rd century and the widespread expansion of money and credit that began with the Italian merchants in the 14th century, the world has been exposed to any number of dislocations, most of those gaining in intensity and frequency as vulnerabilities and interdependencies have increased. Many of these historical crises were driven, in the first instance, by financial speculation leading to asset bubbles and subsequent collapse. While a full review of the history of financial crises is interesting, it is unfortunately out of our scope; recommended readings are included in the reference section for those so interested. More useful for our purposes is to briefly characterize certain periods of the past decades to give some flavor about the topic. We will then examine some select crises in Chapter 6 to understand more about their structure and evolution.

The Gold Standard Period, which includes the period from 1880 to 1913 when the world’s key currencies were firmly tied to a supply of gold to protect value, was a time of relative stability that had followed a period of rather
turbulent speculative activity.\textsuperscript{28} Indeed, only minor, and generally quite contained, bank runs and currency dislocations occurred during this period\textsuperscript{29} with the US banking crisis of 1907 standing out as the notable exception.\textsuperscript{30} In general, we might regard this period as the “calm before the storm.”

By most measures the period from the start of World War I in 1914 until the eve of World War II in 1938 was one of the most troubled in modern history, from both a social and economic perspective. We can point to various devastating financial events, including the effective collapse of the German economy following World War I, when the burden of reparations and strong bouts of hyperinflation spun the country’s economy and financial system into a tailspin. We can also refer to the Great Depression, which announced its arrival via the Great Crash of October 1929. It was a financial catastrophe of epic proportions, spinning national economies into severe recession and, ultimately, depression. The event was also prolonged – not until the US authorities rearchitected major portions of its financial system and created significant public works programs did the US economy begin to revive from the collapse. In fact, the onset of war and the need to provide materiel was vitally important in helping propel the economy out of its weakened state. The reverse, of course, occurred in Europe as World War II took hold – the financial systems and economies of most countries collapsed as deficits, hyperinflation, and recession gripped the Continent and Great Britain.

In contrast to the war years, the Bretton Woods period of 1944–71 was a study in control and regulation, designed expressly to ensure that the crises of previous decades were not repeated. The centerpiece of the framework was a fixing of foreign currency rates into the US dollar, and a conversion of the US dollar into gold at a fixed price of $35/oz. Financial innovation was kept to a minimum and regulatory coordination was the order of the day. As a result, there were no major financial or banking crises of note and only some minor currency crises during this period. In fact, the stability continued throughout the 1950s and 1960s as entire regions “reindustrialized” in the aftermath of the war. As Europe and Asia became increasingly powerful producers and consumers, the United States began accruing greater trade imbalances, depressing the value of the dollar (which was still fixed to gold). The growing US debt burden and the trade imbalances ultimately forced the United States into a de facto devaluation: in August 1971, the country abandoned fixed gold conversion and the fixed exchange rate regime, bringing the global economy into a new era of financial asset volatility.

The period from 1971 to the present is typified by a significant number of financial crises of mounting severity and lengthening duration. In fact, this period has been the most turbulent in the history of financial markets. At least one major study sponsored by the IMF has noted that in the nearly four decades starting in 1970 the market has been rife with financial dislocation, including several hundreds of some significance and several dozen of major
importance that are well-documented. Referring to our classification from the last chapter, we can consider the results of the IMF database by type of financial disaster and historical evolution over the past four decades. Naturally, each one of these events is characterized by varying degrees of severity, further to our discussion above, and not all of the crises can be seen as having a regional or global impact; some have been very contained, but perhaps still devastating in the context of a local or national economy. Figure 3.5 reflects financial crises by type, while Figure 3.6 depicts the

![Figure 3.5 Financial crises, # by type, 1970–2007](image)

![Figure 3.6 Financial crises, # of events per year, 1970–2007](image)
number of events per year. It is quite interesting to note that 1994 and 2001 stand out as relatively high frequency years; this coincides with the Mexican Peso crisis and surprise US Federal Reserve rate hikes in 1994, and the collapse of the Dotcom bubble, the implosion of Enron, WorldCom, Tyco, Parmalat, and other corporations, and the unwinding of the Argentine financial system in 2001.

With this additional detail on financial catastrophes in hand, we turn our focus in Part II to the risk management framework as well as models, methodologies, and limitations. We will return to the practical dimension of financial disasters in Part III.
PART II

The Risk Framework
In Chapter 1 we introduced the four basic components of a conventional risk management framework that can provide discipline in the evaluation of risk trade-offs. This practice is widely followed in the financial services industry – which we again define to include banks, securities dealers, asset managers, insurers, and other nonbank financial institutions – as a way of balancing, continuously and dynamically, the risk and return decisions that are needed to guide risky behaviors. Of course, many aspects of the framework are also employed by nonfinancial corporations so that they, too, have some way of gaining control of their risky activities.

In this chapter we will explore the risk management process in greater detail, focusing first on the goals of risk management and the general techniques of risk management. We will then analyze separately the risk management approaches of banks and insurers (as the two primary takers and recyclers of risk in the global economic system and those most heavily exposed to financial disasters). To be sure, many of the same points are applicable to the corporate sector as well, where risky decisions must be considered on a daily basis and where indirect exposure to financial catastrophes may occur as a matter of course; we will briefly mention some of the issues with which they must contend. Then we will consider the challenges that exist in catastrophe risk management. We will note that, while conventional risk processes may be quite acceptable for low severity/high frequency risk activities (i.e., the “close-to-the-mean” events that characterize daily business life), they may not be sufficient for dealing with disasters. And, if we believe that extreme events happen a bit more often than the normal distribution suggests, some changes to the risk framework must necessarily be created. We will pair our discussion on shortcomings from this chapter with a series of case studies in the Chapter 6 to arrive at certain prescriptive measures in Chapter 7.
THE GOALS OF RISK MANAGEMENT

The management of risk is a difficult endeavor, partly because risk is an abstract and dynamic issue. We know that risk cannot be seen or touched, though its ultimate impact can certainly be detected after physical or financial damage has been wrought. Catastrophic risk is even harder to manage, because its relative infrequency makes it much more difficult to conceive and measure. In fact, its low frequency/high severity characteristics can create a mindset that allows exposed parties to believe that the “worst case scenario” will not occur and may lull institutions (and individuals) into a false sense of security. Hazard perception is an important element of the risk management process; if firms (or individuals) do not believe that an event is likely to happen, risk management decisions will be very different than if they believe otherwise. Accordingly, it is essential for those exposed to risk to be proactive in managing risks. The starting point in the exercise is establishing an understanding of the goals of a risk management process. Before considering the overarching goals of a risk process, let us begin by quickly recapping the essential elements of a typical risk management process, which we have said span four distinct phases:

- Risk identification
- Risk quantification
- Risk management
- Risk monitoring

Ultimately institutions that are involved in risky activities require a process to manage their risks actively rather than passively. Indeed, being a passive risk manager can be dangerous: simply accepting risky outcomes as they appear is not necessarily an enlightened way to operate, as those empowered should contribute to the active advancement of the firm. Note here that we make a distinction between being a passive risk manager and a risk manager who decides not to take a specific risk action – the two may be similar in terms of result, but the latter actually goes through the process of evaluating risks before deciding not to take a specific action, while the former simply disengages from the process entirely.

Clearly, institutions do not simply institute a risk management framework for no reason. In practice, they may do so for one or more reasons:

- To evaluate risky decisions in a disciplined and objective fashion.
To avoid concentrations of risk that might put undue strain on liquidity and solvency.

To help generate revenues in an appropriately diversified and balanced fashion.

To help protect, and ultimately maximize, shareholder value.

To meet regulatory requirements.

These are all admirable and sensible goals – which is just as well, since the creation of a risk process and culture is an expensive, time-consuming effort (and one that is unfortunately not always guaranteed to work effectively, as we will note in Chapter 6). Figure 4.1 summarizes these goals.

**Evaluate risky decisions objectively**

Institutions are faced with the need to make decisions regarding risky activities very frequently, sometimes even daily. It seems quite obvious that the best way to make reasoned decisions is to have in place a framework that permits an objective view of the relevant costs and benefits. In the absence of such a framework, decision making becomes ad hoc and subjective, and may lead to inconsistencies and, ultimately, difficulties in achieving some of the goals noted below. While the actual decision-making framework can be as simple or complex as is required for a given institution or market circumstance, the point is to be able to rely on an objective mechanism that generates rational decisions after having weighed all salient facts.

**Avoid risk concentrations**

Experience reveals that one of the key causes of widespread loss at the institutional level emanates from risk concentrations, or an accumulation of risk that is impacted by the same type of risk factor. We have long been taught
that diversification benefits our actions and activities – while we may not benefit from the full upside, we will be protected from the downside, under the assumption that if one asset or risk or exposure fares poorly, others can provide some balance or upside, thereby dampening the overall negative effect. The financial mathematics that proves these are well-established.

However, the process is not as straightforward as it might seem, because avoiding risk concentrations through diversification requires correct assumptions about correlation, or the way in which assets or risks interact with one another – a notoriously difficult task. For instance, during a period of stock market sell-offs, investors may choose a “flight-to-quality” strategy that causes government bond prices to rise – the reverse is also true, where a roaring bull market causes investors to sell their “safe” government bonds in exchange for the prospect of higher returns from the stock market. This negative correlation between stock prices and government bond prices can help in the construction of a diversified portfolio that minimizes concentrations. Naturally, it is possible to create correlations between all manner of assets or risk as part of the process, the result being a matrix of correlation coefficients between various pairs such as equities versus corporate bonds, corporate bonds versus government bonds, emerging market equities versus developed market equities, and so forth. However, correlations may not always be stable since historical relationships can break down. In fact, this issue is particularly relevant in a discussion of catastrophes, where extreme market moves have a tendency of obliterating previous historical relationships, breaking down correlations and making a seemingly diversified portfolio of assets or risks appear quite correlated and concentrated.

**Generate diversified and balanced revenues**

A commercial enterprise wants to run a sustainable business that allows it to operate in the upward and downward phases of the business cycle. It may be able to do so by creating a properly diversified stream of business lines that create revenues under different market conditions, and by paying close attention to its cost structure, even in good times. But it can also do so by managing its risks sensibly, as errors in the risk process can detract immediately from top-line revenues.

A key part of this goal is for the firm to understand precisely how it makes and loses money, and to constantly question its sources of income and expense. This tends to work reasonably well as an ex-post exercise in the face of loses, as management and directors will surely be questioning how money has been lost. However, it rarely works when results are strong and revenues are flowing in. In such cases the firm is assumed to be operating just as it should, meaning few questions are asked. In fact this is precisely the time when the analysis should be undertaken, as it is quite possible that
revenues are being generated by taking excess risk (this is, of course, particularly applicable for financial institutions). While excess risk may generate today’s profits, it may also be responsible for tomorrow’s losses, particularly if the risks in question have a long duration of “tail.” Note that the same is true of general corporate operations. A company that is prospering in its core business lines may feel emboldened to assume more risk of a financial or property and casualty nature, preferring to spend less on risk mitigation to continue showing strong results. Firms that are financially sound and performing well may feel as though they are “masters of the universe” and may be making reckless decisions as a by-product of such hubris. A disciplined risk management process that questions profits, loss, and revenues can serve as an important part of the control framework.

Maximize shareholder value

Maximizing shareholder value is a key imperative imposed on the directors and executive managers of any publicly listed institution. The concept is relatively straightforward: investors provide capital in exchange for an expectation of returns, which may come through periodic dividends, capital appreciation, or both. Maximizing this shareholder value is therefore an integral part of a company’s goals. To maximize value, those assigned responsibility must focus on at least three fundamental tenets: generating revenues and net profits, preserving liquidity, and ensuring solvency. If these goals can be met, then there is every expectation and hope that the company will not only remain a “going concern” but will also actually gain in value over time.

Consider, for example, a bank that makes loans, accepts deposits, and runs a money market trading book. The bank faces a series of market, credit, and liquidity risks that it needs to manage actively. If it does so, it stands a better chance of generating more loan income (i.e., through active and diligent management of its credit risks) as well as fee and trading income (i.e., through active and diligent management of its trading, market, and funding risks). Failure to do so may result in losses that detract from shareholder value. Of course, managing these risks comes at a price, which also detracts from value, as costs flow to the bottom line. However, by engaging in a proper cost/benefit analysis, it is quite likely the bank will discover that the cost of implementing risk management controls is far lower than the cost of losing heavily on its credit and trading activities. Naturally, the same applies to all corporate entities, regardless of business. While they may face different kinds of risks (e.g., operating rather than financial), with different time horizons and response times, the conceptual process is identical. For instance, an auto manufacturer may be concerned about its property and casualty exposures, and may choose to manage these risks actively to boost
its enterprise value. The cost/benefit analysis in this case relates primarily to the cost of insuring or otherwise shifting its property and casualty risks. While these examples are simplified, they help illustrate the decisions that any public firm must make when evaluating strategies designed to protect and maximize enterprise value. The fundamental cost/benefit decision, and how this can impact the value of the firm, is thus critical.

Maximizing enterprise value is an overarching goal for public corporations, but it can only be achieved when corporate operations are in a liquid and solvent state. If either of these is jeopardized, the chance of creating a sustainable operation that is truly value maximizing is virtually nonexistent. Recalling our discussion from Chapter 1, we may define liquidity as access to cash in an amount sufficient to meet current obligations (i.e., unsecured funding, unencumbered assets that can be pledged as collateral, or outright asset sales). Solvency, in turn, can be defined as the excess of asset value over liability value available to meet unexpected losses. A company that cannot preserve liquidity and solvency is almost certain to enter into a phase of financial distress; not only does this reduce the ability to maximize value, but it also actually calls into question survivability.

Since equity investors tend to suffer considerable losses if a company migrates from financial distress to outright bankruptcy, a sensible risk management program must ensure preservation of prudent levels of liquidity and capitalization. Indeed, liquidity/solvency can be regarded as primary goals and value maximization as a secondary goal. Not surprisingly, liquidity and solvency can be threatened in the event that financial and operating risks lead to excessively large losses; while this is unlikely to happen with high frequency/low severity risks, unless management repeatedly ignores the lessons of many small loss events or fails entirely to identify a particular source of risk, it can occur with catastrophic risk. In fact, a single catastrophic event that has not been properly considered in the risk management framework can lead to instantaneous financial distress and insolvency.

Let us return to the example of the bank making loans and running a trading book. While enterprise value maximization may be the bank’s main objective, it must first ensure that it can preserve sufficient liquidity and capital. In the normal course of affairs the bank will arrange its liquidity program so that its current assets and unsecured funding adequately meet current liabilities. In addition, it will ensure that its capital account (i.e., the net of assets over liabilities) is large enough to withstand unexpected losses (of a particular magnitude, probability, and/or statistical confidence level). Since the bank is operating in the financial sector, it must take account of the fact that a high severity/low probability financial disaster may occur. If a meltdown occurs, the bank will no longer be concerned with maximizing enterprise value, but surviving as a going concern (such as was the case amongst many banks in 2008 and 2009). If it has not managed its risks
and liquidity in a prudent fashion and established a good level of transpar-

cy and exposure diversification, then it will sustain significant losses. If
depositors fear the worst, they may withdraw funding leading to a liquidity
squeeze – perhaps one that is so great that it sustains large losses by sourcing
new funding at higher rates, or selling remaining assets at a deep discount.
The financial impact of the catastrophe on the liquidity profile of the bank
may therefore be significant. Similarly, if its loan portfolio is riddled with
defaulting customers in excess of that anticipated through its credit process,
then the bank may post a loss large enough to threaten its capital levels.
Obviously, if the bank protects itself on an ex-ante basis it can minimize or
avoid the prospect of illiquidity and insolvency. As we have already noted,
the risk protection subtracts initially from enterprise value, but dramatically
increases the likelihood of survivability in the event of a disaster.

Meet regulatory requirements

Many firms institute a risk management process to satisfy particular regula-
tory requirements. It is common in the 21st century for financial regulators
to demand a minimum amount of risk controls so that institutions under its
purview are able to operate in a prudent and transparent manner, and sys-
temic risks can be kept in check. This is an admirable goal in the main, but
only if it comes as a by-product of a truly useful risk management process.
Institutions that create risk controls only to satisfy regulators in a “form
over substance” exercise do themselves, and their stakeholders, no particu-
lar favors, as such a framework is unlikely to be effective in spotting prob-
lems or avoiding losses. Fulfilling the regulatory goal is useful only when
the process is based on first meeting a firm’s own needs.

GENERAL RISK MANAGEMENT TECHNIQUES

For a company operating to meet the risk management goals outlined imme-
diately above, it must align its risk process (i.e., identification, quantifica-
tion, management, monitoring) with one or more of three broad techniques:
loss control, loss financing, and risk reduction. Each of these techniques can
be considered in the context of financial and nonfinancial exposures and
in relation to catastrophic and noncatastrophic risks. Let us describe each
in turn.

Loss control

Loss control, also known as risk mitigation, is based on taking ex-ante
actions to help minimize the level of vulnerability and reduce the chance
that a loss event will impact operations. Loss control is typically based on rules, regulations, education, and safety measures and can be divided into two general categories: avoidance and resistance.

- **Avoidance**: A technique that reduces the financial impact of a risk by prohibiting expansion in vulnerable areas.

- **Resistance**: A technique that reduces the effects of a risk through safety precautions or rules/standards in vulnerable areas.

Note that a key element of focus is on the ability to control a risk. Some risky events can be reduced or eliminated through loss control measures, while others cannot; this means that some losses can be prevented and others cannot. When a risk cannot be reduced or eliminated the focus of loss control must turn toward reducing vulnerabilities.

Education about the potential for damage is an important part of loss control as it focuses attention on what might occur if a disaster strikes. The education process is often most effective when it conveys information on actual events that have occurred and those that are seemingly “unthinkable” and how these can shape economic and social forces – we do well to remember that every so often the “unthinkable” actually happens (e.g., the 9/11 collapse of the World Trade Center towers, the flooding of New Orleans, the 2007 Credit Crisis with attendant bank recapitalizations, the $50b Madoff Ponzi scheme).

Consider a bank that wants to reduce the likelihood that it will sustain small operational losses from its settlement processes. It can enact certain loss control measures that may include establishing daily settlement procedures, ensuring synchronicity in its front-to-back IT platform, performing daily trade reconciliations, and so on. These mechanisms reduce risks, which can reduce the likelihood of a loss. All involve some type of investment (i.e., qualified personnel, IT interfaces) and must therefore be considered in the cost/benefit framework to determine potential impact on enterprise value. Generally speaking, however, such activities can be seen as beneficial and advisable.

We can also consider an example of loss control of a catastrophic risk. A bank attempting to control credit losses may willingly adopt very stringent credit underwriting standards for potential clients in the highest risk categories, such as highly leveraged companies in cyclical industries. These standards may include very aggressive collateral requirements, tight documentation, short loan maturities, and high fees and margins. Through these actions the bank is taking steps to minimize the likelihood of a high level of credit losses in its portfolio; note, however, that, it is not reducing or eliminating the risk of loss – certain high risk clients will default regardless of
what the bank does, so the best the bank can do is protect itself in advance through its loss control techniques.

Of course, we have presented simple examples based on a financial institution and certain financial risks. It is easy to extend the framework to encompass corporate operations and nonfinancial risks, such as property and casualty exposures arising from fire in a factory.

Loss controls are a central element of any sensible risk management program, regardless of risk. While all involve an initial and/or ongoing capital outlay that must be considered within the context of costs, benefits, and corporate/national goals, there is little doubt that broad-based application across risk activities can lead to a meaningful reduction in the financial burden that arises in the wake of a catastrophic or noncatastrophic event.

**Loss financing**

Loss financing, the single largest class of risk management mechanisms, centers on risk retention, risk transfer, and hedging.

- **Risk retention**: A technique where a company chooses to retain a certain amount of risk in its operations.
- **Risk transfer**: A technique where a company chooses to transfer, to a third party, some or all of its exposure to a particular risk.
- **Hedging**: A technique where a company preserves a risk in its operations, but protects itself through instruments or mechanisms designed to offset any associated losses.

Under the overall umbrella of loss financing we can distinguish between preloss and postloss financing. Preloss, or anticipatory, financing, includes all techniques/mechanisms arranged in advance of a loss, and generally involves an ex-ante cost (e.g., payment of premium or fee); insurance, contingent capital, and derivatives are all examples of preloss structures. Postloss financing, or financing arranged in response to a loss event, includes cash/reserve access, short- and long-term debt issuance, and equity issuance. Though postloss financing does not involve an ex-ante cost, it may feature an ex-post cost in the form of a higher cost of capital, particularly if an exposed company has suffered a large loss and has become less creditworthy.

As indicated at the beginning of the chapter, risk retention can be a passive or active exercise. Passive risk retention occurs when a firm keeps more exposure than it wants because it has not managed to properly identify its risks in the first stage of the risk management process. For example, a bank that operates a very complex book of credit derivatives may not
properly dissect the interrelationships and correlations that exist between the constituent elements of the book, meaning that any change brought on by a dislocation could leave it vulnerable to losses. Active risk retention occurs when a firm consciously keeps certain risk exposures (i.e., classes and/or magnitudes) because it believes it can manage them properly and does not believe the cost/benefit of getting rid of them is in the best interests of the firm or its enterprise valuation. Active risk retention generally centers on risky exposures that have the possibility of producing only small losses, and which appear on a very frequent, or statistically predictable, basis. Those that are unpredictable or have the potential of generating catastrophic losses are typically regarded as good candidates for some form of transfer. For example, a bank may want to keep an unhedged portfolio of credits extended to large, investment grade companies. It may believe that the risks associated with preserving the exposure are acceptable on an expected loss basis, and preferable to the cost associated with purchasing credit derivative hedges.

Risk transfer shifts exposures from one firm to another firm via financial or insurance mechanisms; common techniques include securitization, insurance, and reinsurance, though in each case there are limits to what types and amounts of risk can actually be transferred.

Securitization involves the pooling of risky assets (e.g., commercial loans, mortgages, credit card receivables) and the subsequent structuring of liabilities funding the pool into multiple tranches reflecting different strata in the capital structure. Investors purchase the tranches which correspond with their own views of the risk/return trade-off and, in so doing, absorb the risk from the originating firm. While originally quite an effective transfer mechanism, securitization was a key catalyst in the 2007 Credit Crisis, falling thereafter into a relative state of dormancy – future activity will almost certainly reappear, if under tighter conditions.

Insurance transfers the cost of financing from the cedant (or insured) to the insurer; in exchange for a premium from the cedant, the insurer agrees to provide the cedant with a compensatory payment if a specified loss-making event occurs. The compensation provides the ceding company with the earnings stability, liquidity, and solvency it requires in the aftermath of an event. Recalling our discussion on the Law of Large Numbers, the risk transfer mechanism functions primarily because of risk pooling by the insurer: grouping together a large number of independent (uncorrelated) risk units (e.g., policies) allows an insurer to reduce the overall level of risk and the possibility of extreme outcomes (not unlike the pooling of assets in a diversified securitization pool). Insurance can be obtained on a broad range of risks.

For instance, a firm seeking to protect against a fire can purchase an insurance policy from an insurer by paying a premium. If the fire occurs,
the firm will receive a compensatory payment that will cover the loss generated by the event. The insurer, if it is managing its own risk process correctly, will group the policy with its other fire insurance policies into a diversified portfolio that reduces its expected loss level. The same approach can theoretically apply with certain catastrophic risks: a firm can purchase terrorism insurance from a private sector insurer or public sector agency paying an ex-ante premium for an ex-post settlement should a terrorist event occur and create damages. Again, the insurer or public agency providing the cover can pool the policy with others located in different areas to lower the overall level of flood risk exposure. However, if the pool cannot be constructed with a sufficient number of statistically independent events (e.g., all the policies are located in the same floodplain), the Law of Large Numbers does not apply and an accurate assessment of potential losses becomes very challenging and correct pricing may be difficult to estimate. This effectively means an insurer or public agency providing cover is in the same position as the entities requiring protection – risk is shifted, but not reduced. The same may be true for financial catastrophes.

Hedging is a third form of loss financing and is often associated with unique or uninsurable risks that cannot be handled through a standard contractual insurance arrangement. While risk transfer via insurance can lead to a net reduction of exposure as a result of diversification and pooling, hedging shifts an exposure from one party (hedger) to a second party (generally a financial intermediary), which then preserves the exposure or hedges it with yet another party. For instance, a company that relies on oil as a manufacturing input is exposed to rising oil prices; as prices rise the cost of goods sold detracts from revenues and results in a smaller amount of operating income. To protect against this eventuality the company can hedge the risk by entering into a derivative with a second party, which provides a compensatory payment if the price of oil rises. Hedging can also be arranged for certain types of catastrophic risks, though this is far less common.

**Risk reduction**

Risk reduction can be considered in two forms, withdrawal and diversification.

- **Withdrawal**: A technique where risk is removed by exiting a risky business or situation.

- **Diversification**: A technique where risk is reduced on a portfolio basis by incorporating other risks that neutralize or offset the original risk.
Withdrawal refers to the partial or complete abandonment of any business that generates risk. For example, if a firm is exposed to the movement in the US dollar/Euro foreign exchange rate by virtue of its sales activity in the European markets, it can lower or eliminate its exposure by reducing or eliminating such activities. Similarly, if a bank is exposed to the credit quality of high yield companies, it can reduce or flatten its exposure by curtailing or eliminating its lending to the high yield sector. The same applies to catastrophic risk: if a firm’s manufacturing facilities are located on an active fault line, it can eliminate the threat of loss from earthquake by closing down the facility and relocating it to another area.

Diversification is a second form of risk reduction and is effectively an extension of the risk transfer pooling concept we have described above. Portfolio management theory indicates that combining uncorrelated assets produces a superior return without a commensurate increase in risk; assets that are negatively correlated can actually lead to a reduction in risk, while those that are positively correlated can lead to an increase in risk. Knowing this, we can create a diversified pool by assembling a large portfolio of independent (e.g., uncorrelated) and identically distributed assets (risks) so that the variance of the average expected return in the portfolio increases (or the losses decline); the mean of the expected returns (losses) of the pool is greater (smaller) than the individual assets (risks) in the portfolio.

For example, an investment manager holding a portfolio of automobile stocks (highly correlated with one another) can reduce the risk of the portfolio by adding financial or technology stocks (less correlated, though still correlated with the general stock market). To create even more diversification, the manager can add in some government bonds (which are even less correlated with the stock market), and so on. Depending on the construction of the portfolio, the result will be a lower amount of risk exposure for a given level of return. The same principle applies to physical or financial assets exposed to other risk exposures, including catastrophe.

In practice, the mitigation and minimization of risk exposures and potential losses (whether catastrophic or noncatastrophic) tend to be a combination of the approaches described above. In fact, these decisions will change over time, as a result of market conditions, corporate imperatives, cost/benefit analyses, and so forth. This helps reinforce the point that risk management is a dynamic process that must continually be revisited through the monitoring and management dimensions of the framework.

Figure 4.2 summarizes the common risk management strategies described above.

We note again that in pursuing the goal of value maximization, a corporate entity must rigorously consider the cost/benefit trade-off. Eliminating risk reduces the probability of loss to zero, but it is not generally a practical or desirable goal; indeed, some firms, such as banks, are in the business
of taking risk to generate returns. The marginal returns from each dollar invested in loss control, loss financing, and risk reduction decline, sometimes rapidly, as risk elimination moves toward 100%. This means each exposed party must find an optimal solution. Since absolute protection against loss can never be guaranteed without 100% elimination of risk (e.g., withdrawal from risky activities), some level of “acceptable” loss – expressed as the institutional “risk tolerance” – must be established. Tolerance levels, which can vary widely, are based on knowledge of exposures and risk management solutions, and the availability of financial resources. Tolerance also requires a definition of acceptable levels of catastrophic risk. While many corporate entities may be willing and able to take some amount of noncatastrophic risk, they are likely to want to eliminate their catastrophic risks – to the extent this can be done in an economically rational way. There is no single “correct” solution regarding optimal risk management techniques – a great deal depends on the specific goals of each company, its operating environment, the totality of risks that must be managed, individual pricing dynamics during different market cycles, and so forth. That said, a conventional risk management “rule of thumb” suggests that high severity/low frequency risks be eliminated entirely.

**RISK MANAGEMENT AT BANKING INSTITUTIONS**

Risk management at banking institutions is, as we have noted, a multifaceted process that allows identification/quantification and management of a variety of speculative risks. In Chapter 1, we described the range of market and credit risks a banking institution may face and have considered how the four-stage risk process operates in theory. Let us now consider the practical aspects of bank risk management.36
Banks are risk-taking institutions that willingly assume various market and credit risks. The risks they absorb are speculative in nature, meaning they have the potential of generating gains or losses as a result of market movements or counterparty performance. While banks generate relatively stable fee income from their businesses, at least some portion also derives from the way in which markets move, whether or not a counterparty continues to perform on its contractual obligations, and so forth.

Banking contracts are binding in nature and commit the bank and its client to certain performance requirements. In some cases the contracts are very conventional, almost “boilerplate” in nature. This relates primarily to standard “cash products” such as equities, spot foreign exchange, bonds, and the like. In other cases the contracts are more detailed and bespoke, defining very specifically the terms governing a particular client transaction. This tends to be the case with loans, OTC derivatives, and other structured deals. In fact, the assumption of risk through such contracts (which may take the form of credit and/or market risk) needs to be well-defined with regard to conditions precedent, legal authority and capacity, right and duties, governing law, collateral/security, and must of course create the appropriate level of consideration to be legally enforceable. A banking contract therefore represents the exchange of funding or risk parameters for some form of compensatory payment.

A bank often establishes a formal “outer perimeter” of risk taking; that is, its risk tolerance (or risk appetite). This tolerance may be established through both quantitative and qualitative measures: quantitative measures relate heavily to the amount of financial resources on hand, in particular the level of capital available to absorb unexpected market and credit risk losses, as well as the amount of liquidity and funding on hand to support risky business; qualitative factors center on the skills and experience of the business originators, risk takers, and risk managers, and also to the level of technology and automation that underpins the business. Specific regulations may also define certain limitations or prohibited areas for a given institution, and these must be factored into the overall perimeter.

With a defined risk tolerance in hand, a bank may then follow some allocation scheme where it passes capital to individual business lines. While this may be done on the basis of very objective measures, such as the risk adjusted returns that can be obtained from a given product, market, or business, it may also contain some subjective components as well, such as importance of client relationships, revenue targets, market presence, strategic goals, and so forth.

Reverting to our discussion in the section above, a bank can manage its risk via loss control, risk reduction, and loss financing. Loss control, through avoidance, is a legitimate risk management technique, and simply means a bank chooses not to participate in a given line of business (e.g., an advisory
boutique may avoid all market and credit risks by exempting itself from trading and lending businesses). Risk reduction through withdrawal of a particular line of business is also an applicable risk management technique if a bank chooses to temporarily or permanently exit a line of business. Risk reduction through diversification can be achieved through representation in a variety of distinct business lines with different risk characteristics – but only if such risk characteristics reflect a low degree of correlation. In fact, analyzing the correlations inherent in certain financial risk factors is a challenging issue, particularly during times of market stress, when correlations become unstable and may actually result in an increase, rather than decrease, in exposure.

While these are legitimate solutions, the main risk management mechanism used by banks is based on loss-financing techniques, including retention, transfer, and hedging. In the first instance, banks retain a great deal of the risk that they originate or assume. This is particularly true for banks that have the financial resources and expertise to run large loan/credit books or which willingly take a great deal of proprietary risk in their trading or treasury operations. It is worth noting, of course, that such risk retention tends to decline in the aftermath of a financial crisis, when large losses cause individual banks and the industry at large to become more risk-averse. Such behavior, however, can be reversed as a crisis subsides and market opportunities and profits return.

But banks cannot take risk without limit; indeed, this is what a risk tolerance level is intended to corral. Accordingly, they must turn to alternate risk management techniques, including risk transfer and hedging. Through the risk transfer mechanism, a bank can repackage its risks into an alternative form for onward distribution to other intermediaries or investors. In fact, this is the key aim of the “originate and distribute” model that characterizes securitization activities (but which were essentially suspended, for a time, in the wake of the 2007 Credit Crisis, as we will discuss in Chapter 6). Transfer also extends into other structuring activities, such as asset repackagings. In addition to risk transfer, a bank can examine its hedging alternatives. Hedging is akin to risk transfer, except that in some cases it can result in the substitution of one risk for another; for example, reducing, through an OTC hedge contract, risky exposure to interest rates or equity prices by assuming the credit performance characteristics of another counterparty.37 Hedging is, of course, widely practiced by banks on a daily basis as a means of bringing all forms of market and credit exposure within prescribed limits.

RISK MANAGEMENT AT INSURANCE INSTITUTIONS

Risk management at insurers (and reinsurers) is a formalized process that is similar, yet still distinct, from the process followed by banks. The starting
point for most firms follows our discussion above, for example, definition of a risk appetite that is a function of capital resources, liquidity, and profit targets. Thereafter the approaches diverge, if only because the risk-related business of the insurance industry is, in many cases, different than that of the banking industry. The core insurance function is based on providing risk protection to clients, rather than lending money or trading on a proprietary basis; to the extent insurers act as asset managers their risk management techniques are likely to be quite similar to those followed by banks and other investment managers, so we will not repeat the discussion.

The cornerstone of insurance risk management is the core insurance contract, a unique legal form that is defined by certain features. In particular, an insurance contract is designed to cover an event that is unforeseen, unexpected, or accidental; it must cover a large enough number of homogenous exposure units so that the losses are predictable and measurable; it must feature a cedant (e.g., one exposed to risk) that has an insurable interest and be able to demonstrate an actual economic loss; it must allow the risk of loss to be transferred from the cedant to the insurer and involve appropriate consideration (i.e., exchange of risk for upfront premium payment); and, it must be dealt in “utmost good faith,” and allow for the transfer of loss recovery rights from cedant to insurer.38

Insurers tend to write contracts on pure risks that are based on a large number of noncatastrophic exposure policies. There are, of course, some exceptions to this: some insurers, for instance, underwrite risks where the expected loss is difficult to estimate or the potential for a catastrophic outcome exists, or where the risk characteristics are so unique that a large number of homogenous policies cannot be written. Some insurers write catastrophe policies related to a range of perils, including earthquake, hurricane, industrial contamination (ex-nuclear), sovereign political/financial events, and engineering/mechanical failure. Some write cover related to risks that are only partly insurable (or occasionally uninsurable) such as terrorism and flood. Those writing the broadest range of insurance covers face a different set of internal risk management issues than those that are more specialized. In all cases, however, insurers tend to build pricing frameworks that rely heavily on actuarial processes and which incorporate a profit load factor that reflects the return due to capital providers.

Insurers providing loss-financing opportunities39 for their own clients (e.g., cedants) must then manage the resulting risks. If they fail to do so properly, they will no longer be in a position to provide risk capacity to cedants requiring coverage. Insurers focus primarily on loss-financing and risk-reduction techniques.

A key loss financing tool of the insurance industry is the reinsurance contract, which is central to the effective management of insurance risks and the creation of risk capacity. Reinsurance is insurance cover written by
a reinsurer for a primary insurer, while retrocession is insurance cover written by a reinsurer for another reinsurer. A primary insurer seeking to lower its risk will transfer the exposure to a reinsurer, obtaining a cover known as a cession. The reinsurer, as retrocedant, will itself pass any unwanted exposure to the retrocessionaire in the form of a retrocession. Reinsurers can therefore create well-diversified portfolios of noncatastrophic and catastrophic risks (across perils, time, and regions) by virtue of their business and operational breadth. However, their ability to do so depends on the state of reinsurance and retrocession capacity.

Insurers clearly need reinsurance to balance their portfolios. An insurer transferring selective risks by entering into a reinsurance contract lowers and diversifies its exposure. For example, an insurer might have certain constraints related to large line capacity (a large loss exposure on a single policy) or premium capacity (a large volume of policies written on the same line of cover); by using reinsurance it can reduce concentrations and achieve a more balanced portfolio. Since reinsurance cover allows insurers to reduce their unearned premium reserves, the process permits more insurance to be written in a particular sector. Reinsurance cover can also create profit stability and reduce the probability of financial distress. Risks can be ceded and accepted as facultative or treaty reinsurance, and as quota share, surplus share, or excess of loss arrangements; all are common tools in the insurance risk management arsenal.40

Insurers also employ risk reduction. The main form of risk reduction is portfolio diversification, where an insurer examines the nature and magnitude of its risk exposures and attempts to optimize the risk/return balance by diversifying into additional risks within the same line (e.g., a greater geographic dispersion) or additional forms of risky business (e.g., new lines of business). Again, such an approach demands rigor regarding the analysis of correlations (and the stability of such correlations) to ensure that one type of cover is not magnified by changing market events. For instance, an insurer writing fire insurance policies can diversify by writing health insurance policies; the two are considered uncorrelated, so that even if the insurer has to make a series of claims under one line of business it should not necessarily have to do so through a second line.

RISK MANAGEMENT AT NONFINANCIAL CORPORATIONS

Nonfinancial corporations must also manage their risks actively if they are to fulfill their corporate goals — which, in the main, are not largely different than those of banks and insurers. While our focus is primarily on banks and insurers in their role as the primary originators and recyclers
of risk, we would be remiss in ignoring the corporate sector. Accordingly, we briefly consider the fact that corporations use all of the available risk management mechanisms noted above to manage their operations, including loss control, loss financing, and risk reduction. Unlike banks and insurance companies, which typically have a formalized process that defines risk appetite, nonfinancial corporations may address the issue on a less formal basis. For instance, large multinational companies may have a formally defined risk tolerance and risk management framework, while small companies may not.

From a pure loss control perspective, a company can choose to avoid entering into certain risky activities; by doing so it eliminates any possibility of creating an exposure that might otherwise lead to losses. This, however, has to be viewed as a rather limited way of managing risk, because a company must still be involved in some businesses, each of which will generate some type of risk. Similarly, a company may opt for risk reduction techniques which, in the first instance, would include a partial withdrawal from a business line (product or region) that generates exposures or, as in the discussion above, diversification of business lines (products or regions) with unique characteristics that seek to spread, rather than concentrate, risk. For example, a company involved in the production of microwave ovens and other white goods may choose to use its factory infrastructure to produce mechanical toys, as each may be driven by different dynamics occurring during the business cycle. Again, a thorough examination of the correlations of such risky exposures is a condition precedent to successful deployment.

A far more realistic and pragmatic approach is for a company to consider a range of loss-financing techniques, which can include any or all of retention, transfer, and hedging. To be sure, many companies are comfortable retaining a certain amount of risk, particularly when it relates to their core competencies or when it is cheaper than engaging in a full transfer or hedging program. Even when they transfer certain risky exposures, such as employee liability, disability, and health, a company is more apt to include a deductible, coinsurance, exclusions, and a cap to lower the risk management costs. The same is true for financial risks that might relate to core operations (e.g., commodity prices, currency rates, funding costs). In such cases a company may do well to hedge away some portion of these exposures, paying the cost for creating greater earnings stability. Once again, cost/benefit analysis is crucial.

All of these points are applicable with regard to low severity/high frequency risks, for which some degree of predictability is possible. The situation changes when considering catastrophic risks, where a company may wish to transfer or eliminate as much of this exposure as possible, not to put itself in a position where it threatens its solvency. Accordingly a company may distinguish between risks with a known probability of loss and
expected size of loss (e.g., fire), risks with an uncertain probability/size of loss (e.g., earthquake), and risks with an unknown probability/size of loss (e.g., nuclear accident or terrorist attack). Companies exposed to the latter two may seek catastrophe insurance coverage. In fact, common areas of catastrophic coverage include property and casualty, liability, business interruption, workers’ compensation, life, and health (of course, these elements of coverage are available for noncatastrophic risks as well). Not all elements of coverage are available to all parties at all times; only the most comprehensive (and expensive) full insurance policies provide protection against economic losses sustained from all factors. It is important to remember in this discussion that nonfinancial corporations are also exposed to financial catastrophes – history has shown that the fallout from a severe financial crisis can have a direct/indirect impact on the corporate sector at large, which can manifest itself via reduced demand for corporate goods and services, higher costs of borrowing, employee layoffs and, in the extreme, corporate default.

**CHALLENGES OF CATASTROPHE RISK MANAGEMENT**

It should be clear from the points above that institutions have the opportunity (and some would argue fiduciary duty) to diligently manage the risks impacting their operations. Regardless of the specific form of risk, firms have available a series of tools and techniques that can help them cope with the effects of pure or speculative exposure. To be sure, these approaches are not always perfect, and losses can still arise. And, as we have seen, the exercise is not about avoiding all losses that come from risky operations, but about balancing the costs and benefits of the risk exercise to find a solution that optimizes enterprise value.

It is also true that managing risks that appear frequently and are of relatively small severity is a different exercise than managing those that are infrequent (or seemingly infrequent) and carry a potentially large downside. Coping with small, every day risks that are either financial or nonfinancial in nature can be handled through well-established mechanisms, including insurance, hedging, diversification, withdrawal, and so on. The same is not necessarily true with catastrophic risks, which can only be managed in limited ways and which may prove too costly to transfer or mitigate. Some catastrophic risks can be transferred, at a price, to the insurance community (e.g., hurricane, earthquake, flood damage that could destroy manufacturing facilities), while others may be more difficult to shift. For instance, it may be temporarily impossible in the aftermath of a disaster to find an economic risk management solution (e.g., terrorism risk insurance in the aftermath
of 9/11, hurricane insurance after Katrina, and so on) without invoking the government simply because there is no risk solution or risk capacity provider that can absorb the risk.

The issue of holistic solutions for financial catastrophe risk follows the same line. It is not clear that the risk management techniques used for non-financial catastrophes are available and applicable; for example, there is no reinsurance market or securitization market for financial catastrophe risk, diversification may be difficult to craft in the face of unstable correlations, and so forth. In fact, it is questionable whether financial catastrophes can be managed in the conventional risk management framework which is by now “second nature” to many companies, as the challenges are considerable:

- Difficulties in modeling financial catastrophes.
- Lack of standardized loss-financing coverage for a financial catastrophe.
- Introduction of crisis-induced correlations and the potential need for systemic intervention.43

To build on this topic, we move to consider the challenges imposed by the conventional quantitative risk management framework in the next chapter.
We know that a credible risk management framework requires a quantitative process to allow for a uniform evaluation of risks and returns, and a consistent approach to portfolio and exposure management. While the subjective and qualitative dimensions of risk management are critical (and are unfortunately sometimes sacrificed in favor of purely quantitative approaches), some form of numeric evaluation is necessary. In fact, stochastic processes (for financial risks) and actuarial processes (for insurable risks) are considered to be an elemental part of modern risk management.

In this chapter we will consider general risk modeling issues, the modeling framework that may be applied generically to catastrophic risks, and the typical metrics that tend to be used from a risk perspective. We then consider the special topic of extreme value theory models as an attempt to explain tail risks and present a brief discussion of stress testing as a mechanism for capturing hypothetical disaster events. We also consider the applicability of dynamic financial analysis, a framework which is used in the reinsurance industry for dealing with catastrophes. Finally, we describe some of the limitations that quantitative approaches impose on the risk discipline.

RISK MODELING ISSUES

Though never perfect, a modeling framework may work reasonably well for high frequency, close-to-the-mean risks that can be handled within the confines of the normal distribution. Since the normal distribution is a closed-form process, performing computations and manipulations is very straightforward, which makes it very efficient and attractive. If a high frequency risk can be modeled with confidence in such a framework, a key pillar of the risk process is in place.
Unfortunately, the standard modeling framework is less credible for risks that exhibit “gapping” rather than diffusion characteristics, as well as any far-from-the-mean catastrophic or tail event. In fact, the widespread use of normal models appears to have been one of the flaws surrounding the major financial dislocations of the past decade. Financial institutions that take on faith the fact that financial assets follow an orderly diffusion process (with a minimum amount of price gapping) have clearly underestimated or misvalued their risks. As a consequence, such institutions appear to have periodically taken far more risk for a given level of return than might be advisable and, in some cases, have failed entirely to pick up on specific types of risks. Consider, for instance, standard value-at-risk (VAR) models that are in mandatory use at all major banks are quite inappropriate for measuring risk in volatile financial markets. VAR is intended to measure loss levels, to a specific confidence level, that may arise if a portfolio of market risks is liquidated over some time horizon (generally measured as 1 day or 1 week); VAR models do not, of course, speak to the potential magnitude of any losses that exceed the confidence level. VAR models rely on the assumption of normality, stability of correlations between the market risk elements of the portfolio, and a sufficiently liquid market that permits neutralization of the risk in the portfolio. In fact, every financial crisis that we consider in the next chapter challenges these assumptions – disasters are characterized by fat tails, unstable correlations, and illiquidity, rendering VAR a rather useless risk measure. To compound the misfortune, institutions that use VAR to define their risk tolerance or alter their risk profiles during volatile times may be creating a self-fulfilling cycle that actually increases systemic risk. For instance, as market volatility rises, VAR increases in tandem, meaning risk positions need to be liquidated. Liquidation of positions by individual banks leads to a decline in the prices of assets and almost certainly causes institutional players to step back from further buying, leading to very illiquid market conditions. Such illiquidity can lead to further volatility and price declines if large sellers enter the market, de facto increasing VAR further, and so on, in a continuing loop. In fact, this behavior was certainly in evidence during the LTCM/Russia Crisis of 1998 and the Credit Crisis of 2007.

Ultimately, financial asset movements and financial disasters may be more appropriately handled by alternate distributions that depict the true characteristics of financials assets, including gapping and fat tails. Unfortunately, none of the available distributions feature the mathematical and computational simplicity of the normal distribution, meaning an extra degree of complexity is necessarily injected into the process.

**General catastrophe modeling**

Formalized quantification methods to cope with the unique characteristics of catastrophic risk are a fairly recent development. Though catastrophe
models date back to the 1970s and 1980s (based primarily on deterministic algorithms for estimating the potential impact of natural disasters on nuclear power plants, dams, and liquid natural gas plants), increased use did not commence until the 1990s, after insurers and reinsurers were impacted by a series of large natural disasters.

New generations of catastrophe models are under continuous development and refinement, as new disasters (with unique parameters) add to the base of experience and knowledge. For instance, some models have been extended from relatively well-established areas such as earthquakes and hurricanes into more complicated and idiosyncratic areas such as terrorism and tornadoes. The onset of large and unique events such as the 9/11 and 2008 Mumbai terrorist bombings, 2005’s Hurricane Katrina, and the 2007 Credit Crisis add to the modeling database and framework.

Not surprisingly, there is no single “correct” approach to the modeling of high severity/low frequency risks; various methods are used, and all are quite different than those used in the modeling of high frequency/low severity financial and insurance risks.

In a theoretical sense a properly constructed catastrophe model should allow the following tasks to be performed:

- Estimate the probability of occurrence of a catastrophic event.
- Estimate the upper severity limits of a particular occurrence.
- Estimate the financial loss that will result if an event of a particular severity occurs.
- Evaluate the costs of retaining, transferring, or otherwise managing an exposure.
- Price each incremental exposure.
- Gauge accumulations/concentrations of risk, optimize the portfolio of risks, and provide a metric for acceptance/rejection of incremental risks.

But even the best models cannot do everything. In particular, a catastrophe model cannot be expected to

- Predict when, or where, a catastrophic event will occur.
- Predict the precise severity of an event in a particular location.
Provide an exact assessment of the financial losses that will occur.

Apply universally to all catastrophic perils.

We must remember that modeling is a risk assessment exercise, not an event prediction exercise and is predicated on a series of assumptions that may, or may not, hold true. If we understand modeling limitations at the outset, we come to realize that the quantification framework is an important tool in the risk manager’s toolkit, but should never be the sole driver of a risk process.

Not surprisingly, modeling catastrophe risk is a complex process that depends heavily on subjective and objective inputs. To begin our discussion we consider alternative modeling approaches, and then provide details on a typical multiphase approach. Regardless of the specific technique employed, the end goal of the exercise is to generate useful information about expected catastrophic loss and the potential distribution of losses, so that rational estimates of pricing can be made and risk management decisions can be taken.

Under the first approach, a probability distribution of future losses can be created based on historical loss data for a peril and an assumption of static vulnerabilities. While straightforward, this method suffers from several flaws, including limited historical data for some perils (resulting in the creation of an incomplete or incorrect distribution) and potential understatement of vulnerabilities (particularly in fast growing regions, where assets and wealth may be accumulating rapidly). The lack of historical loss data is clear for various types of catastrophes, including financial crises, terrorism, and natural events such as earthquake and volcanic eruption. As a result of these shortcomings, future losses might be significantly larger than those suggested through the loss distribution function (i.e., the “fat-tail” problem we describe later in the chapter).

An improved version of this procedure adjusts data to reflect asset growth, inflation, and other material changes in vulnerability; this essentially means that historical catastrophe events are applied to current vulnerability data. This approach, however, does nothing to eliminate or reduce limited sample size and the “fat-tail” problem.

An alternative approach centers on making assumptions about the parameters used to construct the loss distribution. For instance, by assuming that the number of events occurring at a particular location and the parameters of each event are independent, “synthetic events” can be created by sampling from distributions independently. This approach is essentially a combination of historical information and parametric assumptions incorporated
MODELS, METRICS, AND LIMITATIONS

in an intensive simulation process. Probabilistic simulations of this type are common in modeling of terrorism, earthquakes, and tropical cyclones and may also have some applicability to financial crisis modeling.

In some cases it is possible to create a model of the process describing a catastrophic event, which can then be applied to vulnerability data to obtain loss estimates. This is a complex process that requires detailed scientific knowledge of the interaction between all of the variables that generate an event. In the financial catastrophe sector this might imply the use of an econometric model.

A multistage modeling process is common regardless of the specific approach used. The ultimate goal is to assess expected and unexpected losses, which are a function of the specific hazard/peril, vulnerability and, for portfolios of exposures, contract characteristics. Expected losses are, of course, simply an expectation, or statistical average, of losses that are derived from the distribution. Unexpected losses are those that figure several standard deviations away from the expectation, depending on the desired confidence level. Determining expected and unexpected losses on a nonnormal distribution introduce an additional degree of complexity.

The modeling process can therefore be seen in terms of three distinct phases:

- Hazard/peril assessment phase, which generates a catastrophic event/probability function based on nature, frequency, and severity.

- Vulnerability phase, which estimates the potential for direct and indirect losses for an event of a given severity based on the degree of damage.

- Contract assessment phase – commonly used by insurers, reinsurers, investors, and other financial institutions involved in supplying catastrophic risk capacity – centers on determining individual and portfolio losses generated during the vulnerability assessment stage based on insurance/reinsurance or derivative contracts that have been written to ceding or hedging parties.

We will explore phase 1 and 2 in greater detail below. Since phase 3 is out of the immediate scope of this discussion, we point the reader to alternate material noted in the reference section.

Phase one: Hazard/peril assessment

Hazard/peril assessment is the first step in any catastrophe modeling exercise and defines catastrophic events by characteristics (severity and
vulnerability) and probabilities of occurrence (frequency). We already know that high frequency/low severity risks have a rich history of data, meaning construction of a statistical loss distribution is relatively straightforward.

Since catastrophic events occur infrequently, the required depth and breadth of historical loss data is not generally available, suggesting an alternate process must be considered. In particular, using the third approach mentioned above, a probability distribution can be created from simulated events generated via random draws. The simulated events themselves may be based on historical data and certain user-specified rules, so that they resemble actual events (such as financial catastrophes). The hazard/peril simulation kernel generates event activity through repeated samplings until an entire catalog of potential activity — including events of a catastrophic nature — is created. Accurate hazard/peril modules, which must be flexible enough to allow for changing parameters, can allow annual loss amounts to be estimated with greater confidence.

Perils need to be modeled in light of their unique characteristics. Natural disasters, for instance, may feature upper boundaries on potential losses due to the laws of nature (e.g., maximum severity of a particular event such as an earthquake), and these must be properly incorporated in the modeling process.46 The same may not be true of all man-made disasters, including financial crises, where it is theoretically possible for very large losses to mount, some to extreme boundary conditions. For instance, in the face of a massive credit crisis, risky credits that normally price at 50 bps over a risk-free benchmark may reprice at several hundreds or even thousands of basis points above the benchmark, meaning very significant losses can accrue to investors holding such bonds. This is clearly a tail event, and greater flexibility is required in the modeling framework as a result of this difference.

While the hazard/assessment module yields information about frequency and intensity for natural catastrophes and certain man-made disasters, it does not apply fully in the case of terrorist acts or financial crises. Though certain aspects of the modeling effort parallel those used for natural disasters, two key differences exist: lack of historical data (as noted), and the influence of human behavior on location and frequency. First, the record of loss data related to these man-made events is still relatively sparse compared with natural disasters, and examining events on an ex-post basis to obtain additional detail is still limited, meaning the ability to create probabilistic hazard models is constrained. Hazard determination for these extreme events therefore remains a combination of objective assessment and subjective input. Second, from an objective/quantitative perspective a model must weigh random human behavior against causal factors. For example, the behavior of monetary authorities or speculators may ultimately influence the development and denouement of a financial crisis, though such behaviors may appear somewhat unconnected, and even random, years before the
crisis unfolds. Of course, nonrandom factors also play a role. For instance, in the context of financial crises, some of the catalysts we have discussed in Chapter 3 appear as nonrandom drivers and need to be factored into the quantitative framework.

**Phase two: Vulnerability assessment**

Vulnerability assessment, the second phase of the quantification process, is designed to estimate the degree of loss that can be caused by events generated in the first phase; this stage essentially overlays an event of defined severity on vulnerable assets through a mathematical damage function. Though output can take different forms (as we note below), it essentially conveys the damage, loss, or loss ratio for each level of severity, along with the variability of losses.

We indicated in Chapter 2 that disasters that strike a nonvulnerable area produce no losses, which is not of particular interest. When vulnerabilities are present, losses can occur, which means specific details must be factored into the modeling process. Losses can come from direct sources, such as damage to infrastructure and assets, and indirect sources, such as loss of use and business interruption, and broader slowdown in the local or national economy. In practice, it is useful to determine expected losses and the variability of losses from both direct and indirect sources.

Vulnerability assessments can be created by superimposing hazard/peril events generated in the first phase onto data related to assets at risk. Since it is not always possible to analyze all assets at risk in extreme detail, a workable alternative is to categorize assets by general class, where each class shares certain common features that allow for reasonable estimates (e.g., financial assets, commercial real estate, etc., depending on the risk we are trying to model). Not surprisingly, accurate and granular data regarding assets at risk is essential in attempting to model vulnerabilities. Indeed, the output that is generated for the third phase of the process is only as good as the input in the second phase. Though considerable strides have been made in some nations in compiling granular data, the effort is by no means complete, and incomplete data leads to assessment errors. Some dimension of this relates to transparency, and is particularly applicable to financial data, where a large amount of information exists (e.g., mortgage outstandings, asset-backed securities issuance, commercial lending), but where truly meaningful information may still be difficult to obtain or may not be publicly available. For instance, while asset managers may hold certain types of fixed-income securities, such securities may be asset-backed bonds that are secured by pools of assets that may react in different ways, depending on the crisis at hand. Thus, pools backed by subprime mortgages may be very vulnerable and capable of producing
real losses in a disaster, while those backed by government guaranteed prime mortgages may be perfectly safe, producing no losses at all, even in the case of a severe crisis. Stopping the transparency at the level of the fixed income portfolio is therefore not sufficient to produce a workable framework.

Regardless of whether the peril is natural or man-made, the result of the vulnerability assessment phase is an estimate of losses due to asset impairment and business interruption. Financial assets can be measured by loss of market value for mark-to-market assets or impaired value for banking book assets. Physical assets can be measured through the replacement cost ratio (the ratio between repair cost and replacement cost), mean damage ratio (the ratio between total loss and value of insured objects), or mean damage degree (the ratio of total loss amount and total value of damaged insured objects).

Regardless of the source of losses, the exceedance probability curve (illustrated in Figure 5.1 (a) and (b)) is a common way of conveying loss information, depicting the probability of losing more than a particular amount on the vertical axis versus the amount of loss on the horizontal axis. The curve allows derivation of expected and worst case losses, such as the likelihood that a loss of a given magnitude will be exceeded. Output can also be used to construct a loss-return period curve (as in Figure 5.2), another version of the frequency/severity curve that reflects the size of loss on the vertical axis and the estimated return period on the horizontal access. Consistent with our earlier discussion, this function reveals that larger loss events have longer return periods; this coincides with our intuitive belief that the more damaging the event, the less frequent the occurrence. The precise shape of the curve depends, of course,

![Figure 5.1 (a) Exceedance probability curve (1)](image-url)
on specific model output. Note that estimates can also be derived for indirect losses, such as business interruption and secondary impact into the real economy.

Let us emphasize several important points. First, the more granular the vulnerability data, the more accurate the damage estimates; the more accurate the damage estimates, the more precise the pricing of risk capacity by institutions that are active in creating and managing risks. Second, vulnerabilities are very dynamic, and this is particularly true in

![Figure 5.1 (b) Exceedance probability curve (2)](image)

![Figure 5.2 Loss-return period curve](image)
a 21st-century world that operates with nearly complete and unhindered capital mobility. The fluid nature of the asset base means that it can be more challenging to gauge vulnerabilities in the absence of a uniform approach to data measurement and transparency. In addition, while physical assets (e.g., commercial property) are quite fixed, they tend to increase in size as wealth accumulation grows and development expands. This again means data must be updated on a relatively frequent basis. Third, under any reasonable modeling framework, expected and worst case losses should decline as risk mitigants are introduced (e.g., diversification, hedging, insurance, reinsurance); such results must be properly captured by the relevant model.

From our discussion above, we know that every model must focus on the defining characteristics of the hazard/peril and how these interact with vulnerabilities to produce damage/losses. It is possible to see how this concept can extend to financial catastrophes. Historical and simulated events related to micro- and macroevents can be used to construct dimensions of hazard (e.g., gross domestic product, interest rates, inflation rates, systemic leverage, money supply, key market references, trade deficit). The intensity of the financial hazard can then be applied to vulnerable assets to determine financial losses.

Models can also be extended to consider the effects of disaster on an entire economy – this is particularly useful for any discussion on financial crises, where we know that the impact on an economic system is vital – sometimes even dominant. An effective catastrophe-driven macromodel requires assumptions about the correlation between financial dislocation and reduced industrial output (including recession), unemployment, decreased consumer spending, and so forth. For natural disasters it may focus on essential and nonessential replacement of infrastructure, costs related to reconstruction, changes in trade balance and tax revenue accounts, diverting of government funds from planned investments, external borrowing requirements, access to foreign aid, and so forth. The ultimate goal is to determine how a natural or man-made catastrophe can affect a country’s gross domestic product. For instance, a severe event with a 100-year return period (e.g., a currency devaluation and bank runs leading to a credit crunch) striking a developing nation can deplete economic resources, force external borrowing, and lead to a slowdown in economic growth over time. Figure 5.3 illustrates an example of the effects of “moderate” and “mega” catastrophes on economic output over time. While this framework has universal application across catastrophes, it is not difficult to imagine overlaying it on different types of financial crises, such as the Russian/LTCM crisis (qualifying as a “moderate” catastrophe) and the 2007 Credit Crisis (qualifying as a “mega catastrophe” with a resounding impact on most global economies, pushing them, or moving them deeper, into recession).
EXTREME VALUE THEORY MODELS

As we noted in Chapter 4, the 1990s saw the advent of the VAR framework as a tool for dealing with close-to-the-mean financial risks. Knowing the flaws or limitations inherent in such models, particularly with regard to distributions and tail events, a separate group of study developed around extreme value theory (EVT) models.

As we know, events that can have extremely negative results (e.g., large losses) need to be considered in an appropriate probabilistic framework. EVT is an attempt to capture extreme, tail-based events in a statistically rigorous manner. The purpose of the tail estimation that underpins EVT is to compute values outside the normal data range, providing not only information on expected losses and unexpected losses but also on expected excess losses. EVT thus does away with the limiting assumptions that characterize VAR models. In fact, EVT is based on the external types theorem (the so-called three types theorem), stating that there are only three types of distributions needed to model the maximum or minimum of the collection of random observations from the same distribution. Thus, if we generate N data sets from the same distribution and create a new data set that includes the maximum values from these N data sets, the resulting data set can only be described by one of the three models, which are the Gumbel, Fréchet, and Weibull distributions.\(^{49}\) Samples of two of these distributions, for different levels of kurtosis (tail thickness) and skewness, are shown in Figure 5.4. The Generalized Extreme Value distribution, effectively a general version of the specific distributions, is illustrated in Figure 5.5 in the form of a pure loss function.

EVT is most useful when we focus on excess loss thresholds, as illustrated by the excess loss distribution in Figure 5.6. That is, EVT is designed
**value**

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<th>Probability</th>
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<tr>
<td>Frechet (0.5, 1)</td>
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<td>Gumbel (1, 0)</td>
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**Expected**

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**Figure 5.4** Sample Frechet and Gumbel distributions

**Figure 5.5** Generalized extreme value loss distribution

**Figure 5.6** Excess loss distribution
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to estimate the maximum excess loss possible for a given confidence level and liquidation period (while the VAR framework simply indicates that some maximum loss could occur, failing to designate what that value might actually be).\textsuperscript{50} Since the thrust of EVT is on extreme loss, its primary concern is on magnitude rather than frequency. Implementation of a sensible EVT framework allows an institution to calculate capital provisions for the entire range of financial risks (credit, market, liquidity, operational) under catastrophic loss conditions.

EVT is not, of course, without its own flaws. Like all other statistical processes, the framework still relies on a robust data set which, for extreme events, is still rather sparse. In addition, assumptions used in the creation of an EVT framework are still institution-specific, for example, exceedance levels can be set at different levels, so comparison across the industry can prove difficult. Finally, some of the extreme events that go into creating massive losses cannot be modeled statistically (e.g., financial fraud such as that perpetrated by the rogue trader at Societe Generale in 2007–08, and the Madoff scandal that came to light in 2008 – each massive losses, running into the billions of dollars). An additional problem with EVT (as with all models) is the false set of comfort that may be conveyed to users: to believe that a model is accurate can lead to blind overreliance and, ultimately, a series of decisions that may not always be optimal. Like other models, EVT must be regarded as a tool in the toolkit, not a perfect solution to the problem of quantifying tail events.

STRESS TESTING

Stress testing is a key component of any risk management process, as it allows analysis of the extreme events that are of interest to us in this book. Stress testing, by definition, focuses on the tail events in the distribution, making firms more aware of what might happen if a disaster strikes. Indeed, within the financial sector, robust stress testing is a regular feature – and in some cases is even a regulatory requirement.

But constructing a credible stress test that is both plausible and useful is not easy. It is, of course, possible to create a range of very extreme scenarios that reflect a collapse in equities and credits, a spike in volatility, a flight to quality, a steepening in the yield curve, a rise in precious metals prices, and so forth. However, these assumptions need to be applied at the appropriate level of granularity and must exhibit a high degree of internal consistency, or else the utility of the output will be questionable.

The stress construction process can start with historical risk data from past crises to reflect how extreme events have impacted the market and individual sectors. This gives us a sense of first order, or direct, effects of a
financial catastrophe. But a significant cautionary note is required: assets have the potential to decouple in a stressed market environment, which can skew significantly the results generated through the scenario process. For instance, during the Credit Crisis of 2007, credit spreads on both structured products and vanilla high grade credits weakened considerably. However, global equities remained relatively unaffected for the first 6 months of the crisis, in some cases reaching new all-time highs; in addition, equity volatility remained relatively low. Not until 2008 did this relationship change with equities weakening in the direction of credits. Any stress scenario constructed on the basis of “logical” assumptions would thus overstate the potential losses in the first wave of the crisis and would perhaps underestimate them in the second phase.

Another note of caution in the construction process relates to the path and nature of the “domino” effect. Every crisis is unique, meaning that it travels a specific path that is necessarily new. This means that the standard stress scenario approach may be too limiting to be useful, and that an additional dimension of “creative thinking” is required. Returning again to the 2007 Crisis, there were probably not many stress scenarios in the industry that tied, ex-ante, a collapse in subprime US mortgages to soaring bank funding levels or massive investment grade credit spread widening. Creative thinking is bold and has its skeptics, meaning that risk managers may face an uphill battle in convincing others of the validity of proposed domino effects. Nevertheless, this has to be a fundamental element of stress scenarios, as the “traditional” approach is clearly inadequate.

Measuring or estimating the indirect impact of a financial crisis is the second step of any stress scenario framework and can again be extremely difficult to construct given the tremendous web of linkages that exist between different economic sectors. In fact, given the paucity of data the most obvious solution is to employ econometric modeling techniques to develop a range of plausible scenarios that reflect recessionary impact/credit crunch arising from a financial collapse. As with all scenario construction, the framework is necessarily dependent on assumptions, which may or may not play out in a real-life crisis. Nonetheless, it is perhaps the only credible approach available to risk managers. To be a useful part of the risk management process, stress scenarios should be incorporated in the establishment of firm-wide risk tolerance, or else the exercise becomes one of theoretical or academic interest.

**DYNAMIC FINANCIAL ANALYSIS**

Insurers and reinsurers are used to dealing with a range of catastrophic risks in the normal course of their business operations. In practice, insurers prefer
to manage “close-to-the-mean” high frequency risks, and so turn to the reinsurance sector to cede more extreme or potentially severe risks. Reinsurers, in turn, are often willing to write catastrophic covers, but even they must take protective measures by diversifying their exposures through retrocession to other reinsurers. The insurance industry, in total, requires catastrophe modeling capabilities to evaluate and price extreme risks. While many use the techniques described earlier in the chapter (depending on their specific level of involvement in a given class of risk), some also employ a framework known as dynamic financial analysis (DFA).

Through the DFA model framework an insurer draws on a series of inputs to develop a simulation that allows assessment of risk tolerance, risk diversification, and reinsurance opportunities. The inputs vary by institution, but generally focus on the financial and business drivers of the insurer, including risk tolerance, balance sheet variables, premium projections, large loss capacity, reserve runoffs, and the particulars of a modeled catastrophe risk.51 Risk tolerance, as we know, relates to the probability of impairment or the point at which an insurer’s capital falls below some lower threshold – as defined either by the institution itself or by the relevant industry regulator.52 Probability of impairment can therefore be seen as a trade-off: given a particular probability of impairment, and comparing this to the amount of risk capital on hand, an insurer can create an entire series of functions, such as those depicted in Figure 5.7.

With this model output in hand, and knowing the market price of reinsuring a particular series of catastrophic risks, the insurer can assess whether it makes sense to cease writing a line of catastrophic risk, purchase catastrophe reinsurance, or preserve the risk and raise more capital to avoid any possibility of financial distress. The fundamental trade-off is thus between

![Figure 5.7 Impairment curves](image-url)
the cost of retaining risk (itself a function of the risk premium or fee generated from the risk and the additional cost of capital needed to fund the risk) and the market price of shifting the risk to a third party. This is an ex-ante decision that has to be taken in advance of a period of distress, because once a dislocation occurs, the market price for risk cover becomes prohibitively expensive.

The DFA model framework can thus be seen as an attempt to merge catastrophe modeling and traditional financial analysis to examine logically the best way to optimize the risk profile.

**LIMITATIONS OF MODELS AND METRICS**

We know that catastrophe modeling is challenging at best, suspect at worst. Much of the established framework relies on the successful accumulation of data and correct assumptions about distributions. In general, natural disasters rely on stochastic simulation techniques to estimate frequency and spatial distribution and severity. The simulations depend, of course, on a history of past occurrences. Man-made disasters, such as terrorist events and financial catastrophes, cannot make use of the same techniques, for reasons we have indicated above and describe in detail below. Accordingly, we must look outside the conventional modeling scope to focus on supplementary techniques of a qualitative nature (e.g., specialist/expert opinions communicated through underwriters,53 game theory simulations).

The real issue we need to consider is whether catastrophe models developed for natural events can be adapted sufficiently to evaluate financial catastrophes. Referring back to Chapter 2, we know that critical differences exist between natural and man-made catastrophes – including historical data availability, risk ambiguity, and the sometimes uncertain or irrational nature of human decision making and actions. Information dissemination is also different: while national governments are often quite happy to exchange data related to natural events so that the proper lessons can be drawn, the same is not true for certain man-made events. In such cases issues associated with national and economic security may dominate, leading to asymmetric information problems.

Quantifying catastrophic risk is therefore a challenging process that must be regarded as an “imprecise” and evolving science; indeed, there is a great deal of subjectivity, qualitative input, experience, and judgment involved in the creation of a workable model – which is still only a best estimate of possible losses. In this section we highlight some of these key challenges and limitations, which include model characteristics and assumptions, ex-post model validation, distributions and fat-tails, and data quality and granularity.
Model assumptions

Modeling sophistication varies by institution and depends on resources, exposures, and goals. Each institution must define precisely the scope of its model coverage: models that are extremely comprehensive are very time- and resource-intensive and may be driven/influenced by a larger number of assumptions; those that are more basic are easier to implement but may lack the depth to provide a realistic assessment of potential damage. Trade-offs must be evaluated in light of specific needs.

Ultimately, probabilistic models are susceptible to errors that can arise in the hazard/peril phase (frequency, intensity, event parameters, correlations), the vulnerability phase (value and characteristics of the assets at risk), and the contract phase (nature of contract conditions), meaning due care must be taken when calibrating the model and interpreting results. Importantly, institutions that outsource their modeling to third parties must still understand how specific parameters are treated and how sensitive a model is to assumptions.

Models cannot be overly simplified just to create an analytically tractable process. In addition, some account must be made of situations where historical experience and/or data are lacking; this is an epistemic problem that can only be resolved by acquiring additional experience and data, a process that takes time (and unfortunately costly experience) to complete. If key information is missing or flawed, the model may collapse in the face of a significant event.

As we have noted, traditional natural catastrophe modeling relies on construction of a loss exceedance probability curve that reflects the likelihood that a certain loss level will be surpassed at some point in time. Given the relatively extensive historical data set, it is somewhat easier to create a loss exceedance curve for a natural disaster than it is for a man-made disaster. In fact, the relative paucity of data for the latter category can lead to erroneous assumptions about distributions. When an institution has doubts about the quality of the loss exceedance curve it is creating, its tendency will be to take a more conservative stance with regard to risk pricing – meaning that the returns it may seek will be excessive (a fact that will only become known ex-post). In addition, the onset of one or two incidents, regardless of magnitude or severity, may place further upward pressure on pricing as risk cover moves into short supply.

If models are constructed incorrectly, or if the parameters are flawed, output errors will result; more importantly, risk management decisions based on the output will lead to mispricing of risk exposure and erroneous cost/benefit decisions, including risk underpricing. Since a sustainable level of profit is an essential requirement for sustainable risk capacity, continuous mispricing as a result of flawed model assumptions will eventually lead to greater than expected losses and contraction of risk capacity. Consider the simple illustration in Figure 5.8, which depicts three loss exceedance
curves: a “correct” curve (Model B) based on an accurate model, and two “flawed curves” (Models A and C) which contain model errors. It is easy to see how simple model flaws can lead to overpricing or underpricing of risk – and overly aggressive or conservative decisions. This ultimately has an impact on shareholder value.

The model assumptions that underpin core quantitative process extend to other frameworks we have discussed above, which are subject to the same type of questioning and criticism. In particular, we must consider whether alternative or supplemental frameworks, such as EVT, stress testing, and DFA, are too closely associated with the same fundamental model assumptions/flaws to be of practical use.

**Ex-post model validation**

Financial models are typically validated or benchmarked so that the accuracy of the results can be verified and any biases identified and corrected; this includes underestimates of event frequency or magnitude, miscalculation of event correlations, and assumptions of long-term stability in low-risk areas. This process is especially vital when model output is being used for mark-to-model pricing purposes or other elements of the risk management process. In fact, it is generally straightforward to validate results in markets involving high frequency/low severity risks as there is a rich history of price/market data and strong secondary liquidity. Even financial instruments that are not traded frequently can be benchmarked to certain tolerance levels through extrapolation and other accepted techniques.

Lack of historical data or actively traded markets makes this approach more complicated for catastrophe models. In practice, validation is generally limited to obtaining the parameters of known historical events and applying them to a portfolio of exposures to construct an ex-post simulation. Ultimately, each new catastrophe provides additional information that
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modelers can use to test, validate, and refine their models, but the relative lack of data and the unique characteristics of any individual catastrophe limit the efficacy of the validation exercise.

**Distributions and fat tails**

It is important, during the model building and validation phase, to be skeptical regarding empirical data and distribution construction. This essentially means that institutions need to change their way of thinking, from one where a statistical distribution such as the normal distribution (with its attendant limitations) is taken on face value, to one where non-Normal distributions and tail events become the focus. As noted by Taleb (2007), this implies a move to “black-swan” thinking, where institutions change mindset and actions to be more properly synchronized with so-called rare events that appear far more frequently than the normal distribution suggests.

To be sure, we know that the tail of a statistical distribution can be difficult to measure with precision and can lead to an underestimate of losses. Since construction of loss distributions is central to catastrophe modeling, the accuracy of the construction has a direct bearing on the result of the output. As noted in Part I, if the tail of the realized distribution is larger than the tail of the modeled distribution (i.e., the “fat tail” problem) then an exposure of a particular severity will occur with greater frequency than expected, or an exposure of a given frequency will be larger than expected. Either situation can create unexpected losses and possible financial distress.

We know, therefore, that the construction of an appropriate distribution is critical. Much of the analytical framework developed in finance is centered on the normal distribution – which is acceptable for certain risky events, but clearly not those that are more readily characterized by fat tails (and perhaps skew). However, if we operate under the assumptions related to other distributions, then the level of uncertainty associated with an event does not diminish under averaging as sample size increases, which is the foundation of the normal process. This is a key limitation. In addition, large deviations become more likely over time, so that use of a distribution that cannot properly describe extreme events becomes even more problematic.

To demonstrate just how sensitive this issue is, let us step away from financial disasters to consider the levees surrounding the City of New Orleans, which were breached rather severely by Hurricane Katrina in 2005. The Army Corps of Engineers, responsible for building and strengthening the levees, originally designed the infrastructure to provide 200-year protection – meaning that the exceedance rate was computed as once every
200 years, translating into a 0.5% annual probability of occurrence or a 99.5% probability of nonoccurrence. While this sounds like rather a conservative assessment, it is actually just a probabilistic statement that is driven by use of the normal distribution. But the history of levee breaches during hurricanes is rather sparse, so using the Normal distribution to characterize a random future event represents something of a “leap of faith.” Indeed, events of this nature clearly cannot be nicely described by the normal distribution, meaning an error can easily be introduced into the process. If the tail is a bit fatter than the normal distribution would suggest, the annual probability of occurrence might increase from 0.5% to 1%, or 5%, or even more – meaning the likelihood of a breach of the levees is no longer once every 200 years, but once every 100, 50, or even 25 years – rather a significant difference for those living in the area. This discrepancy has a significant effect on financial institutions and insurers attempting to provide cover for this, or any other catastrophic, risk – the capital and pricing required to cover an unexpected event in the tail will vary considerably depending on the thickness of the tail. In the extreme, an incorrect estimate based on the use of an incorrect distribution could lead to some degree of financial pressure to those providing the risk management cover and the disaster actually occurs.

For a greater degree of accuracy institutions can consider turning to the class of so-called stable Pareto distributions, which include the distributions noted in the EVT section above (along with others, such as the Cauchy function). Stable Pareto distributions feature higher probabilities in the tails, which is consistent with the catastrophe quantification framework. The question at hand is whether we can determine, ex-ante, whether a function, such as the Cauchy, Fréchet, Weibull, or Gumbel, is sufficiently accurate. In practice, it is difficult to know for sure, though certain simulation attempts can be made to provide a semblance of comfort. Ultimately an institution has two alternatives: assume that it can never be certain about the correct distribution used in its modeling, accepting the shortcoming by adopting more conservative risk standards; or, assume that it can be reasonably certain of the distribution, accepting the error that is inevitably introduced as part of the process and hoping that revenues generated are sufficient to cover losses. In fact, there is at least one school of thought that suggests it is more sensible to accept the limits of knowledge and the inevitable results (designing alternate risk management process along the way), rather than create some false sense of comfort from the use of erroneous quantitative frameworks.

**Data quality and granularity**

It is clear that modeling exercises in general and catastrophic modeling exercises in particular are strengthened by good data. The more dependable
and granular the information, the more accurate the loss distribution functions, and the more meaningful the decision-making process. Obtaining high quality, granular data, and updating it frequently is therefore vital. We have already mentioned the limitations that exist regarding hazard/peril data insufficiency. When direct data is lacking, inferences can sometimes be drawn from contingent data, though this still influences the quality of the model. Greater possibilities exist regarding the accumulation of vulnerability data; when information can be an asset, portfolio or institutional level, loss estimates improve dramatically. That said, gathering detailed data is still a nontrivial task touching on confidentiality, heterogeneity, and collection. Unless these issues are resolved, model efficacy will continue to be limited.54

Quantification is a vital element of catastrophe risk management, but it is also a complex area that is dependent on simplifying assumptions and simulations, and which may be prone to errors. A model should always be regarded as a limited view of the world. In practice, the end goal should not be to create a perfectly accurate model – indeed, this has to be viewed as an impossibility – but a workable one that allows exposed parties to determine how best to manage expected and unexpected losses.

We reemphasize that a catastrophe model is only a tool and cannot be the driver of risk decisions. It also cannot be viewed as a process that attempts to predict when a disaster might occur, but one that allows users to create a meaningful distribution of future events so that associated, expected, and extreme loss patterns can be developed. This allows a firm to gain an understanding of its risks and how it may be financially impacted under different scenarios; by incorporating a sufficient degree of realism and a margin of error, the output can be used as supplemental information in the management stage of the risk process.

Figure 5.9 summarizes key limitations related to quantitative methods.

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Figure 5.9 Limitations of quantitative methods
With this background in place we turn our attention, in the next part of the book, to an examination of “real-life” financial crises and the lessons that can be drawn from such dislocations. It is worth bearing in mind the ways in which traditional risk management processes failed during these episodes, which will allow us to consider ways in which such shortcomings can be overcome.
PART III

Practical Management
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In Parts I and II, we have considered the nature of financial catastrophe and the suite of risk management tools and techniques that are available to manage risks. We have also noted that the theoretical risk management framework does not always work as intended – if only because we come to deal with events that are far away from the comfortable world of normally distributed events.

Perhaps the best way to reinforce this point, and to bring us a step closer to understanding how we might actually manage these risks, is to mine the rich history of financial disasters. As we have mentioned earlier, the financial landscape is littered with the debris of disaster – failed banks, strained money markets, abandoned exchange rate regimes, defaulted credits, dislocated economies and, of course, severely disappointed depositors, shareholders, creditors, and taxpayers. Let us now delve into some of these past disasters in detail to understand the causes and effects of particular events; this will help us develop, in Chapter 7, lessons learned and certain prescriptive measures that might be taken to minimize the negative effects of future crises.

The history of financial disasters is considerable and the list of potential case studies can take us back decades, even centuries – to wit, well-known “watershed” events such as the South Sea Bubble of the 18th Century, the Panic of 1792, the London banking crisis of 1866, the US Panic of 1907, the Great Crash of 1929, and the Secondary Banking Crisis of 1973–75. There are, of course, many others we might examine, including those with a somewhat “lower profile,” though perhaps no less damaging in their outcome, certainly in relation to the time period during which they occurred.

Reflecting on the era of modern finance, which we can define as beginning with the postwar Bretton-Woods Agreement, we again have plenty of candidates to choose from: the collapse of the fixed exchange rate mechanism in 1971, the emerging market debt crisis of the 1980s, the junk-bond
collapse of 1990, the European Exchange Rate Mechanism collapse of 1992, the failure of the Scandinavian banking system in 1987–91, the “Dotcom” bubble of the early 2000s, and the corporate accounting scandals and defaults of 2001–02, amongst others.

However, since we have to winnow the list in the interest of space, we will focus our attention on eight specific episodes:

- The Great Crash of 1929
- The LDC Debt Crisis of the 1980s
- The US Savings and Loan Crisis of the 1980s
- The Stock Market Crash of 1987
- The Japanese Banking Crisis of the 1990s
- The Southeast Asian Financial Crisis of 1997
- The Russian/LTCM Crisis of 1998
- The Credit Crisis of 2007

We have selected these cases because each one provides a unique glimpse of credit, currency, and debt crises that have impacted the global system: some have been of short duration, while others have lasted for years; some have been relatively contained while others have had a very deep and broad impact; and, some have been managed reasonably well, while others have reflected varying degrees of mishandling.

THE GREAT CRASH OF 1929

The Great Crash of 1929 represents one of the most wrenching and dramatic instances of financial disaster in the history of global economy. In fact, what started as a severe stock market crash triggered by a buildup of leveraged speculative forces, eventually turned into a sweeping global economic dislocation. The resulting losses, accumulating to both investors and the economy at large, were enormous and enduring.

To trace the path of the Crash, let us take a step back to the early 1920s when the US economy entered a period of relative prosperity and strength. Economic output expanded and key industries, such as steel, automobiles, and railroads, created new jobs and a degree of economic security. In
addition, the practice of using credit to finance household purchases was on the rise, helping boost consumption. Though not all sectors of the population enjoyed advancement equally, the period was relatively benign. Much of this progress was reflected in the US stock market, which achieved new highs steadily throughout much of the decade. While a portion of the advancement was driven by economic growth, some was also driven by speculative forces – a point which became more apparent in the latter part of the decade, as the asset bubble inflated to unsustainable levels. In fact as we see later, the “Roaring Twenties” would soon give way to the “Black Thirties.”

The economic picture started to change in the second half of the decade. Interest rates began climbing as the government attempted to keep inflation in check, which resulted in a slowdown in economic growth and a moderate contraction in installment loans. However, this was not enough to deflate the ever-increasing stock bubble. Not until late 1928 did small cracks in the façade become apparent, with the market experiencing the first of several sudden sell-offs. These retracements, however, were papered over by exuberant “bull market” pool operators, which tried to propel the market forward by convincing investors to buy shares of automobile companies, railroads, radio/media companies, and trusts (a leveraged version of today’s mutual funds) – regardless of weakening fundamentals. By mid-1929, stock market participation was relatively widespread and included institutions as well as individuals. An increasing amount of purchased volume was done through margin financing facilities, which proved ultimately to be a key source of systemic instability – at its peak, brokers would willingly lend up to 90% of the value of shares being purchased, under the belief that the market would continue to rise. In fact, in the lead up to the Crash, the outstanding margin loan balance reached a record $16b, equal to approximately 20% of the stock market’s total capitalization. Leverage was not limited to margin loans, however, but was also generated structurally, through trusts and holding company structures with multiple layers of debt. In addition, many listed companies, such as utilities, already ran their operations on a very highly leveraged basis.

After a torrid 25% rise in August, the stock market reached its peak on September 3, 1929. Thereafter, a series of gradual, and then sharp, sell-offs brought the major indexes to a fraction of their peak value. The initial cracks in the equity asset bubble were magnified through increasingly negative comments from respected analysts and through selective unwinding of margin loan financing. Despite the warning signals, new trusts were launched during early October, but met with limited demand. Concerns in the stock market were not, at this point, reflected in the money markets, which continued to operate smoothly. However, on Thursday, October 24 (so-called “Black Thursday”), stocks opened down several points, with large
capitalization stocks in particular suffering from absence of bids; selling volume was very heavy, which created a ticker delay of 1½ hours. Late in the day a consortium led by JP Morgan stepped into the void to buy shares, helping the market close down by only 2% – though on 12mm shares, or triple the normal volume. The following day was one of relative calm, but on Monday October 28, the Dow Jones Industrials fell 38 points to 260, a record plunge, with the ticker posting a 3-hour delay. On “Black Tuesday,” October 29, the index fell a further 30 points to 230, as margin finance positions led to widespread liquidations; total market wealth declined by $14b on that fateful day, causing many investors and institutions to suffer losses from which they would not soon recover. The 16mm share volume that passed through the exchange was also a record – and one which would stand for the next 30 years. Indeed, volume was so heavy that exchange clerks were recording transactions until the morning of October 30. The collapse of the stock market on October 29 marked the beginning of a much broader systemic dislocation which would eventually flow through the entire economy. Figure 6.1 traces the movement of the Industrials through the month of October 1929.

US stocks drifted down through November at a steady pace, despite government efforts to instill a sense of confidence. Deleveraging continued through stock and portfolio liquidations, with outstanding margin loans declining by 50% between the September peak and the end of November. Fortunately, there were no bank failures during these early post-Crash weeks, though such failures would become very apparent in the months and years to come. Once the initial wave of panic selling and deleveraging occurred, the market started to drift back, and by June 1930 the Industrials were
trading back at 300. By all accounts this was a classic “dead cat bounce” or sucker’s rally, and the bear market retreat soon set in. In fact, by 1932, as corporate defaults, bank failures, and economic stagnation took a firm grip, the Industrials hit a new low of 40, equal to just 10% of the September 1929 peak, with virtually no volume changing hands. Figure 6.2 traces the evolution of the Dow Jones from 1928 through 1934 and clearly reflects the sustained bear market in equities.

The economic retracement that followed the Crash became especially pronounced between 1930 and 1932: US real income fell by more than 35%, economic output contracted by 30%, and unemployment rose to 13mm, or more than 25% of the able workforce. The devastation was so extensive that some industries, such as automobiles, nearly collapsed, with output falling by 90% or more. Job losses also led to property foreclosures as homeowners lacked funds to pay their mortgages; foreclosures rose to more than 1,000 per day and remained high until the government stepped in with an aid package. Bank failures increased steadily during this period as well. The venerable Bank of United States collapsed at the end of 1930, capping a year when 1350 banks had already succumbed. By 1933, 10,000 of the country’s 25,000 banks had become insolvent and credit extension had come to a virtual standstill: bank failures also led to the loss of $2b in customer deposits, further straining household finances.

The economic dislocation was not, of course, confined to US borders but soon spread to other countries, which suffered some degree of slowdown as well. International trade between the United States and Europe declined by more than 2/3 during the early 1930s, thus impacting exporting nations such as England and France. In fact, England was particularly hard hit, with
exports declining by 50% and unemployment rising to 20% by 1930. In some parts of Northern England and Scotland, which were traditional centers of shipping and trade, the scene was even worse, with ship production falling 90% and unemployment rising to 70%. Weimar Germany suffered as well, under the weight of continued World War I reparations, and a cessation of loans from the United States by 1932; unemployment soon soared, the currency devalued, and the scene was set for a shift in the power balance within the country.

The effects of the Crash and Depression were prolonged, spanning the better part of a decade. While a number of measures were put in place by the US Government to rescue the beleaguered economy, including such programs as the Reconstruction Finance Corporation (1932) and various elements of Roosevelt’s New Deal (starting in 1933), the real recovery did not occur until the war years at the end of the decade.

There are many competing theories as to what caused the Great Depression. To be sure, the collapse of the stock market is seen by most as the key catalyst in creating the broader dislocation. The stock market’s sharp decline was a surprise to many, including those who had bought into the idea that the era of “boom and bust” economic cyclicality had come to an end with the creation of the Federal Reserve in 1913. Unfortunately, the regulatory environment during this period was weak and surely fomented the buildup of the speculative bubble. In fact, inadequate regulatory oversight allowed for lack of transparency; excessive use of margin loans and trust schemes; aggressive and abusive pool operators (who acted as “touts” in a variety of stocks); disposal of unsalable assets by banks to trusts; and insider trading, stock price manipulation, and outright fraud. But other factors supplemented the effects of the Crash, including plunging commodity prices, excessive protectionism via tariffs, rigidities of the Gold Standard, prevention of wage declines as the economy weakened, and refusal to loosen monetary policies in the years following the Crash. In practice, all of these may have contributed to a prolongation of the disaster.

To summarize some of the key issues related to the Great Depression we may note:

- Systemic leverage, both personal and institutional, helped fuel a significant bubble in the stock market.
- Rudimentary regulatory measures were ineffective in controlling an extensive series of market abuses that contributed to the inflating equity bubble.
- Inadequate risk management processes within the financial sector, especially as related to credit extension.
Transparency regarding the financial position of investors and financial institutions was inadequate, so that their true condition was unknown to regulators.

Market mechanisms were insufficient to cope with a quick response to the market plunge.

Government authorities were unprepared to deal with the aftermath of the stock market collapse (which ultimately included massive bank failures and corporate defaults) and lost time in creating programs that might have softened the resulting economic blow.

**THE LDC DEBT CRISIS OF THE 1980s**

The lesser-developed-country (LDC) debt crisis that shook the banking world throughout much of the 1980s traces its origins to the 1970s, a period during which borrowing by emerging nations began to shift from public sources (e.g., provision of credit by other governments or supranational agencies) to private sources (e.g., provision of credit by large, private sector, international banks). During the 1950s and 1960s there was, in fact, very little borrowing from banks, and capital markets access by LDCs was restricted. That changed in the early 1970s as large banks (particularly the US money center banks, such as Citibank, BankAmerica, Chemical Bank, JP Morgan, and the like) began to develop their international branch networks as a way of gathering new business. The international financial markets, including the rapidly expanding Eurodollar markets, allowed capital to be granted and recycled with ease, to the benefit of both borrowers and lenders. As the international branches of large banks expanded into Latin America, Africa, Eastern Europe, and Asia, medium- and long-term loans became available to a willing population of public sector borrowers; most banks expanded their operations rapidly, meaning LDC borrowing grew very significantly throughout the remaining years of the decade and into the 1980s.

While lenders were willing and able to provide capital, borrowers had growing needs for such funds. Most emerging economies were undergoing transformational growth during this time, expanding their economies through infrastructure development and capital projects that required long-term financing. Many were also becoming active consumers of goods and services from abroad, meaning they were generating trade deficits that needed to be financed externally. This put them in a fragile position, where even a single market event could tip the balance. In fact, that event came with the first oil shock of 1973, when the average price of crude oil rose from $7/bbl to $14/bbl; the priced would rise steadily throughout the
late 1970s, eventually peaking at $37/bbl in 1980, before gradually drifting back down to the $20s. The oil shock had at least three major implications: the higher cost of energy put a severe strain on the finances of emerging nations, which required oil to drive economic growth – most began suffering from increasing balance of payments deficits, which they financed by borrowing from international banks; the inflationary pressures created by the oil shock caused the United States (and other nations) to raise interest rates, which caused key floating rate indexes such as LIBOR to rise steadily – making the cost of borrowing higher for LDCs; and, the new wealth created by oil-exporting nations needed to be recycled into the financial system and was done through “Petrodollar recycling” where oil producers placed funds in Eurodollar deposits offered by international banks, which then on-lent the funds to willing LDC borrowers, who were sorely in need of capital.

Between 1970 and 1978 the amount of borrowing by LDC nations expanded from $29b to $159b, with 80% of that amount arranged via sovereign borrowers and the balance by local private sector borrowers. Mexico and Brazil were far and away the single largest debtors, accounting for $89b of the $159b total by 1978. Most of the credits arranged by banks during this period were structured as medium- and long-term syndicated loans with amortization or bullet repayment; more than 2/3rd of all loans referenced 6-month LIBOR and, in an era where interest rate swaps had not yet been developed, borrowers were exposed to a rising rate environment. In fact, average LIBOR rates increased from below 10% at the end of the 1970s to 16% in 1982.

Between 1979 and 1982 total LDC debt increased from $159b to $327b, with the share coming from US money center banks increasing from $36b to $55b. The pressure on individual countries had become particularly intense by this time: debt service as a percentage of exports increased from a relatively normal and manageable 30% in 1979 to as high as 60% in some countries by 1982. High oil prices, rising rates, plunging commodity prices (an important factor for emerging nation exporters), and slowing global economic conditions proved a toxic combination. Regulators recognized the growing risk facing the banking sector, as loans extended to increasingly troubled borrowers were supported by relatively thin levels of bank capital. Still, no specific actions were required or taken at this juncture (apart from the issuance of certain nonbinding “warning letters” and the establishment of extra monitoring groups).

The first stage of the crisis came to a head in August 1982 as the Mexican Government declared an interest moratorium on $80b of outstanding external debt. With this precedent set, the “ripple effect” soon spread to other countries, which followed a similar path. By the end of 1982, 40 countries were officially in arrears on their interest payments, and by October 1983, a total of 23 countries had followed the rescheduling path blazed by Mexico,
placing a total of $239b of international debt up for renegotiation.\textsuperscript{71} 16 of the borrowers were Latin American, with the “Big 4” of Mexico, Brazil, Venezuela, and Argentina owing the banking sector $176b. In a dramatic example of concentration risk, the eight largest US money center banks were owed $37b, which was equal to 150% of their combined capital and reserves.

In the wake of the interest moratoria, the international banking and regulatory communities began what would become the first of many rounds of renegotiation and debt rescheduling, a process that would move from country to country and take months, sometimes even years, to conclude; indeed, the period from 1983 to 1989 was characterized by extensive restructuring programs. Lending particularly by US money center banks into the LDCs dropped off sharply, and most credit granted during the mid-1980s was in the form of rollover credits, rather than new money. This meant that most debtor nations were simply “treading water,” no longer able to access any external funding to develop their economies. Indeed, the decade from the early 1980s to the early 1990s emerged as a “lost decade” for emerging nations, as their damaged financial and credit standings meant they lacked the ability to finance economic growth.

Interestingly, during this sensitive period of debt restructuring the US regulators did not require the major money center banks to increase their reserves,\textsuperscript{72} as they knew that doing so would destabilize the system – given their concentrated risk exposures and thin capitalization, most would have been deemed technically insolvent, creating even larger problems for the global financial system. This regulatory forbearance appears, in retrospect, to have been the correct approach. In the event, loan reserving actions did not commence until May 1987, when Citicorp announced a $3.3b addition to its provisions – equal to 30% of its LDC portfolio – so that it could begin writing its risks down. Annual provisions for the eight largest US money center banks increased from $751mm in 1979 to a peak of $13b in 1987; the total allocated for the decade from 1979 to 1989 amounted to $42.7b, a stunningly large amount. Similar provisioning actions were, of course, taken by other international banks, with the UK, French, and German banks all following the same path. By 1989, the world’s largest banks had provisioned an average 50% of their troubled exposures. Not surprisingly, bank profitability plunged during the 1987–89 period, with most major banks reporting net losses which accrued to shareholders. The debt crisis was very prolonged and extremely costly, and included direct losses to bank shareholders, and indirect losses to all of the involved national economies which suspended growth and investment for a period of years; however, broader systemic instability was effectively contained.

After 6 years of rescheduling activities,\textsuperscript{73} a market-oriented solution was created under the sponsorship of US Treasury Secretary Brady. Under the
Brady Plan, as it became known, banks offered participating nations debt relief in exchange for assurances on future collectability of principal and interest; such debt relief was explicitly tied to economic reforms, and the resulting refinancing instruments were created in liquid and marketable form so that participating institutions and investors could quickly alter their exposures. The basic Brady plan (tailored for individual countries) called for the creation of par bonds where loans were exchanged for bonds at par, but carried a below market rate, and discount bonds, where loans were exchanged for bonds at a discount (30%–50%) but featured a market rate. Principal was guaranteed at maturity through a US Treasury zero coupon bond, and a portion of the interest coupon was backed by a rolling collateral pool. Mexico sealed the first Brady bond program in 1989–90 and was followed by 17 other countries covering $160b of face value loans. The Brady bond market became a very liquid dimension of the financial sector of the 1990s, and the reappearance of economic strength in many participating countries allowed the retirement or repurchase of outstanding securities by individual countries by 2006.

Recapping the salient points of the LDC crisis, we note the following:

- Unstable economic conditions fueled by excessive borrowing and triggered by an oil shock created a treacherous operating environment for developing nations.

- Debt mismanagement at the sovereign level led to excessive, and ultimately unmanageable, debt burdens.

- Lack of proper risk management techniques (and awareness) led to growing financial liabilities in individual countries as global interest rates rose.

- Bank lenders ignored diligent risk management and prudent underwriting standards by blindly following seemingly profitable opportunities, building up excessive concentrations in risky sectors in the process; bank shareholders ultimately lost tens of billions of dollars as a result.

- Regulatory actions did little to avoid a buildup in bank lending concentrations; efforts were passive and reactive, though forbearance on reserving actions may have helped forestall a bank liquidity crisis.


Savings and loans (S&Ls) is the name given to a group of US financial institutions that have historically existed to accept retail deposits and grant home
mortgages. The business model is not unique to the United States, but exists in many other countries, including the United Kingdom (as building societies), Spain (as cajas de ahorro), and so on. While the US S&L industry was a stable core pillar of the national financial system for decades, it encountered significant problems during the 1980s, forever changing the country’s financial landscape in the process. Indeed, the US S&L crisis became a banking catastrophe which ultimately cost taxpayers and investors, and the economy at large, several hundreds of billions of dollars in losses.

Let us trace through some of the factors that reshaped the S&L industry and which led ultimately to its partial demise. Deregulation proved to be a critical element: through key legislation passed in the late 1970s and early 1980s, S&Ls were increasingly permitted to act as banks, but under the cover of much weaker control and oversight standards. Part of the lobbying efforts came in the late 1970s, during the period of high interest rates. Prior to 1979 interest rate ceilings prevented S&Ls from paying competitive rates, which led to a steady loss of retail funding to commercial banks and other financial institutions; in fact, money market funds developed as a significant competitor to S&L deposits, which destabilized the industry’s business model. In addition, since most S&Ls funded their activities with short-term retail deposits but extended long-term fixed rate mortgage loans, they were vulnerable to inversion of the yield curve – they were caught in a classic asset-liability management squeeze that could easily erode profits. Finally, S&Ls had historically been limited to funding fixed rate home mortgages, meaning that their ability to pursue other forms of business was effectively constrained. As a result of these factors, nearly 90% of S&Ls were unprofitable during this period.

Given this business environment, lobbyists argued that the industry should be able to expand its business scope and its funding options. The central piece of legislation, the 1982 Garn St Germain Depository Institutions Act, allowed S&Ls to broaden their operating scope by making consumer and commercial loans, issuing wholesale deposits and credit cards, dealing in derivatives, and engaging in a wide range of investments (including commercial real estate, structured notes, and so on); the Act also lifted, over time, interest rate ceilings on deposits. As regulations were liberalized, the asset base of S&Ls increased dramatically, rising 56% between 1982 and 1985, with a growing amount of business portfolios redirected from the residential to the commercial sector – particularly to real estate development projects heavily reliant on strong economic times and robust real estate values. As soon as economic conditions weakened, as they did from the mid-1980s, these projects became unsustainable and led to a growing level of nonperforming assets.

Funding and leverage created further instabilities. As noted, S&Ls had historically financed their activities with deposits gathered from their retail
networks. As part of the legislative changes, the sector was able to expand into institutional-type funding, offering, and gathering large denomination jumbo certificates of deposit (e.g., individual CDs greater than $100,000). This “hot money” gave the S&Ls access to cheap and plentiful funding during the boom years, but it disappeared very rapidly when the market turned. Loan-to-value (LTV) ratios were also liberalized, which reduced credit protection and increased leverage (e.g., LTVs of 40% for commercial mortgages, 30% consumer loans, and so forth)\(^78\) – this created much larger credit losses for S&Ls when the credit cycle turned.

Throughout this crucial period the Federal Home Loan Bank Board (FHLBB), as key regulator for the industry, failed in its duties by passing a series of rules that allowed S&Ls to disguise their true financial condition. For instance, in 1981 the FHLBB permitted the issuance of “income capital certificates” purchased by the Federal S&L Insurance Corporation (FSLIC) to be included as a form of capital. It also allowed “supervisory goodwill” from acquisitions to be included in capital calculations. In addition, in 1982, the regulators permitted a further decrease in net worth to deposits, from 4% to 3%. In this case, however, the base for net worth measurement was not driven by Generally Accepted Accounting Principles (GAAP), but on the liberal, and quite fictional, Regulatory Accounting Principles (RAP), which permitted all forms of “synthetics” to be included as a form of net worth.\(^79\) This forbearance covered up the deteriorating health of many institutions.

The temporary, if illusory, prosperity finally came to an end with a turn in the real estate market in the middle of the decade. The passage of the Tax Reform Act of 1986, which removed the last of the tax shelters on real estate investment, caused a de facto bursting of a very significant real estate bubble that had grown rapidly\(^80\) and revealed that the true asset quality of many S&Ls was substandard. Along with the collapse in real estate prices, a 50% fall in crude oil prices hit the Texas S&L industry very hard, leading to a large number of spectacular failures.\(^81\) At this point some 25% of all S&Ls were technically insolvent. However, rather than putting troubled institutions into receivership, the regulatory forbearance allowing accounting machinations continued, permitting insolvent thrifts to carry on operating. By 1986, it became clear that FSLIC’s insurance fund was well underwater, with only $4.6b in available resources versus cumulative industry losses of more than $20b. FSLIC was declared insolvent in early 1987, at which point the US Government moved into action, recapitalizing the fund by $10.8b, phasing out the fictional RAP standards, pushing for intrastate and interstate mergers of certain S&Ls, and consolidating all insolvent Texas thrifts under one umbrella (covering 205 institutions with $100b in assets).

Just as Garn St. Germain and the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) marked the legislative start of the
S&L crisis, the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) emerged as the legislative antidote. FIRREA, passed in 1989, transformed the industry by abolishing the previous regulatory regime under FHLBB and FSLIC and creating the new Office of Thrift Supervision (OTS) as part of the US Treasury with depositor insurance provided by the Federal Deposit Insurance Corporation (FDIC). The law also created new minimum net worth metrics and other control and oversight standards. Perhaps most importantly, the legislation also authorized the creation of the Resolution Trust Corporation (RTC) as a body to forcefully resolve insolvent thrifts. To give an indication of the RTC’s more aggressive approach, FSLIC closed or resolved 296 institutions with $125b in assets between 1986 and 1989, while the RTC resolved nearly 530 institutions with $260b in assets in 1989 and 1990 alone (and added to the total until its wind-down in 1995). By the time the crisis came to an end, a total of 3000 institutions had gone under or had been resolved or merged.

While the original government estimate of the S&L “cleanup” via the RTC was estimated at between $30–50b, this ultimately fell far short of the mark. Ex-post estimates of the cost of the crisis amounted to $160b (of which $125b was paid by the government between 1986 and 1996). Naturally, the indirect costs were significantly higher – most economists attribute the onset of the 1990–91 recession to the financial and real estate collapse that had been fueled by the activities of the S&L sector.

Let us summarize some of the key issues surrounding the S&L crisis:

- Deregulation led to an unsound business model and “misbalanced” operations.
- Excessive risk-taking by individual S&Ls was used to boost profits; risk/return profiles became misbalanced over a short period of only a few years.
- Inexperience in the underwriting of commercial credits added to bad loans when the credit cycle weakened.
- Asset-liability profiles, which centered funding on the short-end of the yield curve and revenue generation primarily in the long-end, were out of synchronization; this became a particular problem as the curve flattened and then inverted.
- Regulatory mechanisms were inadequate and regulatory forbearance was ill-advised – lax oversight and willingness to allow a fictionalization of the true financial position of many institutions exacerbated and prolonged the problems.
Management and board oversight related to changing business operations was insufficient; these, in some cases, led to instances of outright fraud.

The industry operated in difficult economic conditions that included, through the cycle, high interest rates to combat oil price inflation, and then falling rates and collapsing oil prices, which negatively impacted real estate development projects (particularly in the “oil patch” states).

The asset bubble in commercial and residential real estate, fueled in part by favorable tax credit treatment, exacerbated losses when it finally collapsed.

THE STOCK MARKET CRASH OF 1987

The Stock Market Crash of October 1987 represents another seminal event in the history of the financial markets and continues to remain at the forefront of public memory by holding the infamous claim as the single largest 1-day percentage drop in United States and other global stock markets. Unlike some of the other crises considered in this chapter, however, the October 1987 Crash wrought its devastation in a short period of time and remained relatively self-contained in terms of contagion and indirect losses. It thus serves as an interesting counterpoint to the October 1929 Crash and ensuing Depression and the Japanese Banking Crisis of the 1990s, where the denouement and subsequent damage lasted, in each case, for many years.

The US stock market enjoyed a period of relative hegemony during the early to mid-1980s, achieving a market peak in August 1987 as the Dow Jones Industrials reached an all-time high of 2587, equal to a 43% gain for that year alone. While the rise in the stock market was primarily the result of strong economic growth that had followed the Federal Reserve’s very tough inflation stance of the late 1970s and early 1980s, it became increasingly clear to some observers during the early part of the third quarter of 1987 that asset valuations were becoming unsustainable. This was compounded by growing fears of renewed inflationary pressures and dollar weakness caused by capital repatriation by Japanese investors. As US bond yields started rising and becoming more attractive vis-à-vis stocks, investor sentiment began to sour further.

Early warning signals of an impending sell-off became apparent in the days leading up to the Crash itself, driven in part by automated “sell programs” enacted by asset managers through the so-called portfolio insurance schemes (which at that time covered approximately $90b of equity portfolios). When asset managers discovered in the days before the Crash that buying interest individual stocks was thin, they took to selling the market via index futures, executing $4b of orders (a large amount at the time), which placed considerable pressure on the markets.
The actual collapse of the stock market began in the Far East on Monday, October 19, which posted sell-offs in the trading hours leading up to the New York open. This selling carried through to the European markets and, by the time the New York Stock Exchange opened, negative sentiment was apparent in all sectors and across virtually all stocks. Most stocks opened “offer only,” gapping down in the absence of bids, and the sell/buy imbalance grew rapidly during the course of the morning. To add to the problems and growing sense of panic, the Exchange’s automated trading system broke down temporarily, leaving many trades unconfirmed for a period of up to several hours. As waves of selling entered the market, including those generated by portfolio insurance programs, stock volatility spiked, rendering option pricing models useless and causing option market-makers in both single stock and index contracts to pull back from quoting two-way markets – a key risk management contract was thus rendered temporarily unavailable.

By the time the trading day was over and all trades had been confirmed the S&P 500 had recorded a 20.5% decline, while the Industrials had fallen 508 points, or 22.6%; trading volumes had exceeded the previous record by a two to one margin. The spillover continued in the Asian markets the following day, with indexes in Hong Kong, Tokyo, Singapore, and Australia all posting sharply lower results; the selling continued into Continental Europe and then into London. However, by the next day’s New York open, as the Federal Reserve moved to pump liquidity into the market and purchase $12b of securities in the open market, a modest rally ensued. Perhaps more than any other financial crisis up to that point, the October Crash revealed just how intertwined the global financial markets and economies had become. Figure 6.3 traces the movement of the Dow Jones Industrials

![Figure 6.3 Dow Jones Industrials, 1983–89](image-url)
from the “bull market” phase of the mid-1980s, through the Crash and its immediate aftermath.

Figures 6.4(a)—(c) illustrate the critical period of late August 1987 to the end of 1987 for various global benchmarks, including the Dow Jones Industrials, the Nikkei 225, and the FTSE 100. The global nature of the sell-off is clearly evident.

The rest of October became a battle between bulls and bears, but the damage had been wrought. Table 6.1 summarizes the October 1987 declines of a sampling of global equity markets to illustrate the magnitude and breadth of the sell-offs.

<table>
<thead>
<tr>
<th>Date</th>
<th>Dow Jones Industrials</th>
<th>Nikkei 225</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/31/1987</td>
<td>28000</td>
<td>3100</td>
</tr>
<tr>
<td>10/1/1987</td>
<td>27000</td>
<td>2900</td>
</tr>
<tr>
<td>11/1/1987</td>
<td>25000</td>
<td>2500</td>
</tr>
<tr>
<td>12/1/1987</td>
<td>24000</td>
<td>2300</td>
</tr>
</tbody>
</table>

**Figure 6.4 (a)** Dow Jones Industrials, August–December 1987

**Figure 6.4 (b)** Nikkei 225, August–December 1987
The financial losses for US individual and institutional investors alone reached $1t, with further sums accruing to local investors in other markets. The crisis also took its toll on financial institutions that were overly exposed to the stock markets. For instance, in the United States EF Hutton, LF Rothschild, Thomson McKinnon, and more than 60 small brokers all failed. However, and in contrast to the Great Crash, the losses created by the October 1987 Crash remained relatively contained – the crisis did not lead to a broader loss of confidence or spill into the economy at large. There is at least some evidence to suggest that although stocks had reached a high level in August and there was significant margin buying in force, many individual companies were not tremendously overvalued and were thus able to recover relatively quickly as investors renewed their capital commitments to the marketplace. In fact, even though the Crash was a significant stand-alone crisis that created losses, it created less systemic damage than the collapse of the junk-bond market just two years later. In the aftermath

Table 6.1 Global equity market performance, October 1987

<table>
<thead>
<tr>
<th>Market</th>
<th>October 1987 Performance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>−60.0</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>−45.8</td>
</tr>
<tr>
<td>Australia</td>
<td>−41.8</td>
</tr>
<tr>
<td>Spain</td>
<td>−31.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>−26.4</td>
</tr>
<tr>
<td>United States</td>
<td>−22.7</td>
</tr>
<tr>
<td>Canada</td>
<td>−22.5</td>
</tr>
</tbody>
</table>

Figure 6.4 (c) FTSE 100, August–December 1987
of the crisis various exchanges decided to adopt “circuit breakers” – effectively intraday trading halts that would allow buyers and sellers to halt their activity to restore some degree of balance to the market. The circuit breakers were designed to be activated following particular point or percentage declines. In addition, various exchanges sought to improve their processing capabilities to handle larger volume trading days, a feature that would become increasingly important throughout the 1990s. Portfolio insurance was largely discredited as a result of the Crash and was subsequently abandoned by asset managers.

Let us consider some of the key issues characterizing the crisis period:

- Investors active at the time of the Crash ignored a series of market warning signals that suggested some type of correction was overdue.
- Margin balances for stock purchases (both retail and institutional) grew to very high levels in the months preceding the Crash, compounding the downward pressures once the sell-off began.
- Technical infrastructure at various exchanges was not properly equipped to handle a very high-volume day, particularly one with a significant sell: buy misbalance.
- The ill-conceived concept of “portfolio insurance” had never been tested in a crisis and exacerbated the sell-off once it was put into execution mode.
- A move to quickly add liquidity into the system helped avert what might have otherwise been a prolonged period of instability.
- Financial institutions that were undercapitalized and too heavily concentrated in equity-related business were unable to sustain the resulting market losses and became insolvent.

**THE JAPANESE BANKING CRISIS OF THE 1990s**

The Japanese Banking Crisis of the 1990s serves as an interesting example of a financial catastrophe that arose from a gradually inflating asset bubble, which then burst and propelled the country into a deep and protracted recession. Unlike the crashes of 1929 and 1987, there was no dramatic “single day” event that marked the start of the decade-long economic dislocation; this, in some ways, makes the entire episode less identifiable as a
financial disaster. However, if we examine the component phases comprising the entire period, there is little doubt that this was a disaster of epic proportions. In fact, the Japanese crisis evolved through various stages. During the late 1970s to early 1980s, as the Japanese economy continued to power ahead on the world stage, financial deregulation was introduced, which added flexibility to the operations of domestic banks, brokers, and non-banks. This laid the foundation for future risk-taking, some of which would prove damaging. From the mid- to the late-1980s the value of Japanese property and stocks soared (for reasons we discuss below), which spurred an increased amount of bank lending into various projects – many of them speculative rather than productive. And, from the early 1990s onward the country’s economy entered a period of asset price collapse and economic stagnation, characterized by repeated restructuring of loans before the first “bold” loan write-off actions were taken; this period also featured the country’s first large bank failures and the arranged mergers of many of the largest banking institutions.

Let us examine some of the specifics of the case based on the phases described above. Under the Japanese postwar policy of providing a “guiding hand” in economic and financial affairs, the relevant ministries (including the Ministry of International Trade and Industry, Ministry of Economy, and Ministry of Finance [MOF]) were active in promoting actions designed to strengthen the country’s position in the global economy. MOF, in particular, directed very strictly the actions of banks to ensure a steady supply of cheap loans was available to propel economic growth. This had the effect of allowing the country to post strong growth and record surpluses, and to build up strong reserves throughout the 1970s and early 1980s.

While it is difficult to point to any single event that marked the start of Japan’s bubble, a watershed event came with the Plaza Accord in September 1985, when the finance ministers of the major world powers agreed to push down the value of the dollar, which had become substantially overvalued. In fact, the Japanese yen became a key beneficiary of the policy, and within months of the Accord the value of the yen had strengthened from JPY259/$ to JPY150/$, de facto increasing the country’s purchasing power by 40%. This gave the country’s companies and consumers the ability to acquire and spend aggressively, which they did. Of course, this was a two-edge sword, as the strong yen would eventually come to haunt the country’s exporters, which would find it increasingly difficult to continue their strong export growth. To combat the potential export slowdown, the Bank of Japan (BOJ) began a series of cuts in the official discount rate in late 1986; this, of course, had the effect of accelerating monetary growth and fueling investment inflows into property and stocks. By late 1986, the Nikkei 225 stock index stood at 18,000, a rise of 40% for the year.
As the domestic financial markets liberalized in the mid-1980s, banks and nonbanks became more creative in offering their clients financial solutions that increased the speculative pressures within the system. Indeed, deregulation plus cheap credit was a powerful mix in inflating the asset bubble. Financial engineering, also known as “zaitech,” provided clients with leveraged, multicurrency investments built atop very inexpensive (sometimes even negative) funding obtained from the Euromarkets. Such opportunities were offered to numerous corporations and funds (so-called tokkin funds) and became a significant source of profits for many; indeed, even large capitalization “blue-chip” companies participated, to the point were nonoperating sources of revenue outstripped revenues from core operations – a worrying trend, though one that was blithely ignored by analysts and investors, who continued to propel stocks of such zaitech-hungry companies ever upward. Another key deregulation measure centered on abolition of mandatory postal savings accounts, which put $2t of investable funds into the market – a great deal of which would ultimately move into stocks.

Naturally, investment was not limited to stocks. In fact, the real estate sector became the focus of much larger speculative forces and valuations rose to stratospheric levels during the course of the decade. While the inflation was due to cheap credit, it was also fueled by the nature of the tax code, which discouraged short-term liquidation and encouraged long-term holdings, effectively keeping supply off the market, so pushing values higher; indeed, supply constraints meant real estate values increased by 5000% between 1956 and 1986. Such a lengthy record of price escalation led to a self-fulfilling belief that domestic real estate prices could never decline. This led to further lending with real estate as collateral, which put more credit in the hands of speculators, and so forth. The result was that land values drove credit creation.

During this key period domestic banks operated on a highly leveraged basis. While the MOF enforced the Basel I capital requirement of 8%, it gave the banks until 1993 to comply. In addition, it permitted banks to use a portion of hidden reserves as capital (i.e., up to 45% of unrealized gains were eligible for inclusion). This meant that the traditional cross-shareholdings held by banks in group companies (loosely organized in the keiretsu fashion) overstated the combined capital position during the ascendancy of the stock market, permitting the creation of additional credit through inflated stock values. Naturally, when stock prices plunged, the value of such hidden reserves plunged in tandem, making the banks seem woefully undercapitalized.

By early 1987, it became clear that dollar devaluation and yen appreciation had moved too far, and in February 1987, the Louvre Accord put a halt to the policy developed in 1985. Throughout the year Japan’s stock
market continued its ascendancy, propelled by further rate cuts and a growing belief that the economy would continue to expand. In fact, during the October 1987 stock market crash discussed above, the Japanese markets suffered the least (e.g., peak to trough of 19% versus 30%+ for most others) and rebounded the fastest. Buying on margin fueled the fire even further, and retail investors emerged as a major investor block. By the end of the decade, stock prices had increased three times faster than corporate earnings, and the price/earnings ratios of many were trading at levels of 300 times or more – clearly an unsustainable situation. Interestingly, all of this was happening against a background of repeated real estate and stock market scandals, which included bribery, fraud, insider dealing, manipulation, and corruption, some of which enveloped leading political figures and major financial institutions. While these episodes gave the Japanese markets a negative taint, they did little to halt the continued upward march in prices. Real estate also inflated rapidly, particularly during the second half of the decade. Between 1985 and 1990, banks created $725b of new loans as a result of the “money creation” forces described above, much of which found its way into new real estate projects; by some estimates half of all loans went to small businesses, which used the money to invest directly in property. The nonbank financial sector was another source of credit for the sector, adding $600b of new credit to the housing and real estate market. By 1990, the total estimated value of Japanese real estate had increased to $24t, approximately four times greater than the value of US real estate.

The Japanese bubble economy reached its peak in late 1989 on the back of consumption, investment, acquisition, and speculation. All tenets of prudent financial and risk management had long since disappeared and, as the Nikkei reached an end-of-year peak of just under 40,000 (up 27% for the year and 500% for the decade), the beginning of the bursting was about to take place. Again, while it may be difficult to point to any single catalyst that caused a reversal of the speculative bull run, a key event was the appointment of Mieno as the new governor of the BOJ. Mieno had a different philosophy than his predecessors and was quite prepared to end the era of cheap credit – which he commenced with hikes in the official discount rate in December 1989 and May 1990. Unlike the crashes of 1929 and 1987, there was no immediate collapse in the Japanese stock market, nor was there any sharp drop in property values. In fact, the unwinding process was much more gradual, in part because the Japanese authorities maintained a policy of “price keeping operations,” or directed institutional buying through major brokers and government pension funds, so that some semblance of orderly liquidation would ensue and instabilities would be limited. Unfortunately, this managed decline simply prolonged the crisis, as would become evident during the early years of the new decade.
By the first quarter of 1990, the Nikkei had fallen to 30,000, its lowest level in 2 years, and it continued its descent from that point on; volumes tailed off dramatically, and in the years following the peak registered barely 1/10th of the late 1980s peak volume. By August 1992, the stock market traded at 14,300, 60% off its peak, as reflected in Figure 6.5. Real estate prices began to decline as well, and by late 1992 Tokyo property prices were 60% below their peak levels – putting an end to the myth of ever-increasing property valuations. Critically, the twin decline of stocks and assets meant hidden bank reserves declined in tandem, creating capital adequacy problem for most of the major banks. Declining capital adequacy coincided with a spike in bad loans as a range of borrowers defaulted and banks took possession of collateral that was well underwater. The combination of these effects put an effective halt to lending, bringing into play a full-fledged credit crisis. By the end of 1992, the estimated bad loans in the banking system reached $450b.

With Mieno’s postbubble policies in full force, consumer spending declined in the early part of the decade, putting extra stress on the Japanese economy. Multitrillion yen fiscal stimulus programs were introduced at various points in the 1990s, but none achieved any lasting success. Loosening of monetary policy to reverse Mieno’s rate hikes was also ineffective: by 1995, after successive rate cuts had brought the discount rate to 0.5%, the BOJ had run out of “dry powder.” In fact, the fiscal and monetary measures were wholly insufficient, which became increasingly apparent as the country moved through the decade with a “zombie” banking system – banks were unable to shed bad loans, grant credit, or generate profits.

The growing credit crisis was exacerbated as authorities backed away from their previous “convoy” policy, allowing banks to fail (rather than be

![Figure 6.5 Nikkei 225 Index, 1984–2000](image)
rescued by larger, but equally distressed, institutions). Defaults of financial institutions commenced as early as 1992, but appeared in earnest after 1995 when household names such as Hanwa Bank, Sanyo Securities, Hokkaido Takushoku, Yamaichi Securities, Nippon Credit Bank, and Long Term Credit Bank collapsed. By 1998, the country’s financial system was on the verge of collapse as the banking system continued to be paralyzed by hidden losses, bad loans, and lack of capital; the rating agencies estimated a bad loan burden of $1t (excluding write-offs taken during the first half of the decade). At this point the government mobilized JPY60T of public money to recapitalize the banking system; the authorities also approved the merger of various large banks, bringing together many of the country’s biggest financial institutions. While these moves eventually allowed the Japanese economy to stabilize, the country had lost the better part of a decade of economic growth as a result of the spectacular asset bubble of the 1980s.

A brief summary of the key points of this crisis indicates the following:

- Deregulation led financial institutions to seek new forms of business, which included an aggressive move into real estate lending.
- Loose monetary policies and cheap credit allowed for a steady and prolonged inflating of the domestic asset bubble.
- Bank underwriting standards were based largely on the belief that collateral values (stocks, properties) would continue to rise, rather than on fundamental credit analysis of the borrowers.
- Investors ignored fundamentals in the market, preferring to buy stocks and properties based on the belief that prices would continue to rise.
- Excessive margin and corporate leverage coursed through the system, compounding the magnitude of the sell-off once the peak had been reached.
- Regulators did not move quickly to recognize the growing bad loan problem, preferring to gloss over the growing difficulties in favor of ensuring public confidence in the system.
- Regulatory forbearance regarding capital requirements led to an excessive amount of systemic leverage and a process of unilateral “credit creation” within the banking system.
- Banks were unable to contribute to the postpeak credit creation process as they were saddled with bad loans.
Early government stimulus programs failed to create an effective economic rebuilding phase as they effectively ignored bad loan portfolios.

THE ASIAN CRISIS OF 1997

The Asian economic growth “miracle” that commenced in the 1950s and 1960s, but became very evident throughout much of the late 1980s and early 1990s, created a new benchmark in global economic expansion. Many of the newly industrialized countries (NICs, or “Asian tigers”) posted consistent average annual growth rates of 6%–10% for a period of at least several years. While very impressive and clearly a driving force in creating a new population of producers and consumers, the economic growth – driven in large measure by a significant influx of foreign capital – was not entirely sustainable and would eventually give way to much harsher economic realities. Indeed, while much of the Asian economic growth was real, at least some portion was created atop a somewhat fragile base: excessive capital inflows, sustained balance of payments imbalances, vulnerable currencies,94 excess productive capacity, and overvalued real estate and stock markets (suggesting that the capital flowing into individual countries was not being used in an optimal, productive manner). In fact, growing asset bubbles throughout the region were a key factor in the crisis. The conditions for a financial disaster were therefore already in place by the mid-1990s.

The fact that private capital was able to enter most Asian countries quite freely95 made the overall economic picture very difficult for government authorities to manage. Local companies and parties were permitted to contract liabilities directly (rather than via a national authority), meaning the degree of capital inflow and outflow could no longer be regulated without the imposition of capital controls (a rather dramatic, and generally unfavorable, action). And while the Asian crisis was ultimately triggered via the foreign exchange markets, it was clearly the leading edge of much larger problems associated with the economic and financial health of national balance sheets.

We know from Chapter 3 that currency crises are one of the three classes of financial disasters that can affect a country and its local institutions. Pegged currency rates (whether aligned to a currency or a basket, or managed via a crawling mechanism) that do not adjust quickly enough to reflect changing economic realities may create a sense of stability for a period of time, but will eventually dislocate as pressure builds to unsustainable levels. For instance, high inflation can cause a local currency to depreciate but the real currency rate (adjusted for inflation) to remain stable. This demands active management, hopefully in a steady and concerted fashion. Downward pressure on an overvalued currency can appear from time to time but, if
managed properly, need not necessarily lead to a dramatic collapse. If a sequence of steady depreciations can flow through the markets, pressure is eased, meaning that the large “jump” devaluation need not occur. In practice, this can be difficult to carry out for an extended period of time. A country can target its policies to a specific currency rate (as many Asian countries did) but in doing so it sacrifices economic performance. In addition, defense of an exchange rate means a country will have to use its reserves and generally increase interest rates to attract capital, but this has the rather consequential effect of slowing the economy. In addition, local borrowers face greater liabilities on their nonlocal currency borrowings, which can increase the incidence of default.

The high economic growth rates apparent in Asia during the 1990s created problems for authorities attempting to balance their current accounts and trade accounts. However, such problems were offset for a period of time by strength in the capital accounts, as foreign investors continued to funnel money into the local economies of Korea, Malaysia, Thailand, Indonesia, and the Philippines. For instance, during 1995–96 Korea was running a surplus in its capital account of $24b, more than offsetting a $23b deficit in its current account.

Compounding the problems arising from current account deficits and overvalued currencies was a growing level of debt financing, which appeared through a variety of conduits. Government agencies and government-sponsored companies borrowed heavily in the local and offshore markets, while financial institutions (and particularly nonbank financial institutions) tapped the local bank loan markets almost indiscriminately (as a result of significant deregulation, which allowed for financial engineering and speculative investments). In some cases, as in Korea and Indonesia, mandatory government-directed lending policy loan programs would ultimately create bad debt problems for private sector institutions. Furthermore, many national and banking sector balance sheets were vulnerable as a result of maturity and currency mismatches; it was common during this period for many countries and institutions to fund long-term domestic infrastructure projects with short-term hard currency loans, which made it difficult to arrange rollovers as the financial noose tightened. While each individual loan may have been acceptable in and of itself, the sum total eventually became quite overwhelming, in light of both systemic capabilities and available reserves.

Let us review the chronological unfolding of the Asian currency crisis to get a sense of the scope and scale of the devastation. During the first half of 1997, Thailand, Malaysia, Philippines, and Indonesia engaged in multiple rounds of currency defense as pressure on their currencies mounted. Local authorities sold portions of their foreign currency reserves and increased local interest rates. This was, of course, a dangerous (and ultimately unsustainable)
course of action, as it led to a depletion of valued reserves, a slowing of the local economy, and growing pressure on local companies. As currency strains continued, more significant actions were required, including widening of existing currency bands and introducing faster crawls on their pegs.

The beginning of the financial crisis occurred in early July 1997, when Thailand found that it could no longer defend the value of the Thai baht (THB) against its basket (comprised at the time of US dollars, German deutschmarks, and Japanese yen); speculative forces had become so great that the exercise was pointless. The currency collapsed 14% in the onshore market and 19% in the offshore market in a matter of days, and deteriorated further in the following weeks; Figure 6.6 traces the dramatic decline of the THB throughout 1997, with total devaluation ultimately reaching 78%. Not surprisingly, the Thai stock market plunged and onshore inter-bank rates soared in response. Less than a month later the IMF made available a $17b economic aid package. Nevertheless, the economic damages would eventually prove far deeper and more devastating, subsuming various large corporations and banks. Indeed, the banking sector would eventually undergo a major transformation as several large banks became insolvent.

Thailand was just the first of several countries to go through this wrenching process. In August 2007, Indonesia abandoned the crawling peg that had defined the value of the Indonesian rupiah (IDR) for many years, causing the currency to plunge, as illustrated in Figure 6.7. Just 2 months later the Indonesian government requested and received economic aid from the IMF.

![Figure 6.6](image-url)  
Figure 6.6 USD/THB exchange rate, 1997  
Source: © 2009 by Prof. Werner Antweiler, University of British Columbia, Vancouver BC, Canada.
At about the same time, pressures built in both the Philippine peso (PHP, see Figure 6.8) and Malaysian ringgit (MYR), which also succumbed to the inevitable devaluations.

The story was a bit different in Hong Kong, where speculators attempted to delink the Hong Kong dollar (HKD) from its longstanding peg against...
the US dollar. Though costly, the monetary authorities were successfully able to defend the currency; in fact, Hong Kong was one of the only economies to emerge from the Asian crisis with minimal damage (Taiwan also escaped the worst of the problems, while Singapore suffered moderately).

Less fortunate was Korea, which saw the Korean won (KRW) tumble from KRW886/USD to KRW1701/USD during the latter part of the fourth quarter of 1987, doubling of the country’s foreign debt obligations as a consequence; Figure 6.9 traces the rapid and dramatic fall of the KRW. Given the size of the Korean economy (particularly compared with Thailand, Malaysia, Philippines, and Indonesia) and the level of its internal and external debt, the Korean collapse was devastating and led eventually to a restructuring of both the banking sector and the corporate sector (once dominated by the all-powerful chaebol conglomerates). In early November 2007, the Korean Government received a $40b stabilization package from the IMF and a $3b credit line from the United States. However, these funds proved insufficient and less than a month later the package was increased to $57b and was supplemented by $10b of additional loans in December. Further concessions were necessary through the extension and rollover of short-term debt coming due in early 1998.

Currency speculation by offshore funds and banks played a role in the unwinding of the crisis, though it is very difficult to ascertain the exact magnitude. However, speculators can only be “blamed” to a certain degree: if a local economy is not in a sound state, it becomes very difficult for authorities to control the value of a currency, particularly when

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**Figure 6.9** USD/KRW exchange rate, 1997

Source: © 2009 by Prof. Werner Antweiler, University of British Columbia, Vancouver BC, Canada.
significant differences start to build between onshore and offshore markets. As a result, the Asian devaluations appear in retrospect to have been inevitable. Table 6.2 summarizes peak to trough devaluations against the USD.

Apart from economic imbalances and speculative forces, the crisis was exacerbated by insufficiently developed local financial institutions and market mechanisms, which were unable to act as an effective conduit in the intermediation process. Indeed, by all accounts the local financial institutions and exchanges were willing participants in the recycling of speculative capital into real estate, stocks, and other national assets, which soon ballooned well above fair value.

The systemic shock did not stop with financial and hard asset devaluation, but soon found its way into the local economies. Each individual economy suffered considerably, as did some of the key global economies that relied so heavily on trade and investment with Asia. For instance, the Asian crisis is estimated to have caused a slowdown in US GDP from 3.8% to 2.5%. The foreign banking sector did not escape unscathed, with many major institutions posting very large losses as a result of their dealings in the region. This, once again, demonstrates the “two edge” sword of capital mobility: ability to capitalize on attractive opportunities wherever they may appear, but vulnerability to loss should the worst come to pass.

While the currency crisis was wrenching for the Asian economies, and though the price that most ultimately paid in terms of higher borrowing costs, national banking system recapitalizations and general austerity and deleveraging were very high, the ultimate change in policy focus and systemic restructuring emerged as a net positive.

Let us summarize some of the key issues in the Asian crisis:

- Significant growth in local economies over many years led to balance of payment pressures.

- Market deregulation occurred at a time when local financial markets and institutions were unprepared for any significant changes in the operating environment.

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**Table 6.2 Asian currency depreciations, 1997–98**

<table>
<thead>
<tr>
<th>Country</th>
<th>Depreciation versus USD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>52</td>
</tr>
<tr>
<td>Philippines</td>
<td>52</td>
</tr>
<tr>
<td>Thailand</td>
<td>78</td>
</tr>
<tr>
<td>Korea</td>
<td>107</td>
</tr>
<tr>
<td>Indonesia</td>
<td>151</td>
</tr>
</tbody>
</table>
Accounting transparency was lacking in the local markets, making it difficult for investors to gauge true fundamentals in the market.

Foreign direct investment and capital inflows became very heavy, with capital flowing into real estate and local equities, helping inflate the bubble.

Foreign investors took on blind faith that asset prices would continue to rise, despite signals to the contrary.

Artificial pegging of currencies to the dollar or baskets set the stage for speculative pressures from outside parties.

Extensive private sector borrowing added to national debt burdens, making combined national balance sheets appear weak.

THE RUSSIAN/LTCM CRISIS OF 1998

The global financial system had little time to stabilize in the aftermath of the Asian crisis of 1997 when it was hit by a new, multifaceted crisis that involved Russia and a key player in the burgeoning hedge fund community, Long Term Capital Management (LTCM). While the two began as separate dislocations, economic troubles in Russia soon created broader financial market volatility, which became a major problem for LTCM and other financial institutions. We thus consider them jointly in this section.

LTCM was founded in the early 1990s by ex-Salomon Brothers traders who were well-regarded in fixed income arbitrage. By virtue of their pedigree (which included two Nobel Prize winners) they were able to attract a significant amount of capital quite quickly, along with additional amounts during the first few years of operation. The fund was formally launched with $1b of capital in February 1994 and attracted further capital after posting returns of nearly 43% in 1995 and 41% in 1996. In fact, LTCM became so flush with capital – nearly $7b – that it began expanding outside its core expertise of fixed income to take risk in equity volatility, convertibles, and other strategies. In early 1998, the fund returned $2.8b to investors as it began to suffer from style-drift, or weaker returns based on investing outside of core expertise.

The primary strategies pursued by LTCM featured profit opportunities of only a few basis points each. To make these into truly profitable investments, the fund needed to leverage its bets considerably and did so through listed and OTC derivatives. In fact, the reputation of LTCM at this point was such that it could secure counterparty credit lines from major international
banks at very attractive levels – in some cases posting little or no collateral, suggesting its ability to lever its capital base was quite formidable; of course, leverage was not confined to LTCM – systemic leverage during the mid-1990s was already high, and spread across hedge funds, banks, and even retail investors.\(^{101}\) In addition to providing a significant amount of leverage, many banks put on the same (or substantial similar) trades, meaning that as markets grew more volatile and the fund’s strategies fell apart, participating banks suffered the same fate.

While LTCM was building up its risk positions in 1997 and into 1998, Russia was contending with severe economic pressures. As a result of a fiscal deficit, declining productivity, sliding commodity prices, inflated asset prices fueled by an influx of foreign capital, and an overvalued currency (the Russian ruble), the country’s financial position grew increasingly precarious during the early second quarter of 1998. The dislocation in the Asian markets in 1997 and early 1998 contributed to a feeling of investor nervousness, and this played out in Russia during July and August 1998. In July, refinancing of maturing external debt was achieved with difficulty (and at very high credit spreads), despite the injection of $22.6b from the IMF. A series of short-term ruble debt rollovers (GKOs and OFZs) several weeks later failed completely, and on August 17, the Russian Central Bank was forced to devalue the ruble (RUR, see Figure 6.10) and declare a moratorium on its local debt obligations (though not its external debt). The local equity market fell by 75% as confidence collapsed. These actions caused a ripple wave through the credit markets, causing spreads on all rated paper

![Figure 6.10 USD/RUR exchange rate, 1998](source: © 2009 by Prof. Werner Antweiler, University of British Columbia, Vancouver BC, Canada.)
to widen dramatically; for a period of several weeks, liquidity, even in AAA and AA corporate names, was virtually nonexistent. Flight to quality was the order of the day, as many investors became risk averse and shifted assets out of global equities and into government bonds.

As a result of the market turmoil, triggered by the Russian devaluation and default, LTCM (and many other institutions, it must be added) lost a considerable amount of money in a very short period of time. During the critical month of August, LTCM reported a loss of $1.85b to investors. This was followed by a further $2.3b in September, bringing the 4-month period ending in October 1998 to $4.6b, leaving the fund with a mere $600mm in capital. Naturally, the impact on other financial institutions was considerable as well, with major banks such as UBS, Credit Suisse, Deutsche Bank, and Merrill Lynch losing on risk positions that were caught up in the dislocation – including credit spreads, swap spreads, and emerging market bond and equity positions.

As in other crises, the models employed by LTCM (and other banks) failed to take account of the fact that, when markets are dislocated, liquidity tends to disappear rapidly and asset correlations become unstable, assuming very different relationships than historical data suggests. In fact, both of these features appeared during August and September when credit markets, in particular, became very illiquid and pairwise correlations between risky assets moved in the same direction, creating increasingly concentrated risk positions. Indeed, LTCM’s supposedly diversified strategies looked very concentrated as markets collapsed. The broader concern was that the fund’s excessively leveraged, and deteriorating, portfolio would be unwound precisely when liquidity was already thin (increasing the prospect of further price-gapping to the downside, increasing losses, and accelerating the need to deleverage, and so forth in a continuing downward spiral).

The immediate concern as the fund’s leveraged operations moved into free-fall was the broader impact a collapse could have on the global financial system. The fear of regulators (who had no direct oversight of LTCM) was that many large banks were counterparties to LTCM on derivatives transactions, and that many had the same trades on their own books. A default by LTCM on the contracts had the potential of creating billions of dollars of default losses for individual banks, while the unwinding of LTCM’s book could create mirror image losses for banks holding the same risks – again, raising the prospect of billions in potential losses. As the fears of a systemic collapse mounted, the Federal Reserve orchestrated a private sector bailout that called for participating banks to contribute several hundred millions of dollars each. In exchange, the consortium was given control of the LTCM fund management company and appointed a panel to conduct an orderly wind-down of the portfolio. In the event, markets stabilized in November as the market absorbed the news and came to realize that a major crisis had
been averted. To be sure, while LTCMs investors and major banks collectively lost billions of dollars, the “dominoes” did not topple into the financial system or global economy. By the first quarter of 1999, the risk impact of the portfolio had been largely neutralized, allowing the fund to be disbanded and the banks to be repaid. In the aftermath of the crisis, the extent of LTCM’s leverage became clear: while the fund’s balance sheet assets indicated leverage of 30X (not unlike that of major securities firms), the real leverage was to be found in its off–balance sheet contracts, which had reached a staggering 300X. Little wonder that there had been such intense concern about the potential systemic effects of a collapse.

The example of LTCM is interesting because it indicates a relative “success story”: through a series of rapidly arranged public and private efforts, a private sector solution was crafted to stop the bleeding, calm the markets, and minimize total sector losses. To be sure, the Russian dislocation continued into 1999, achieving stability in 2000 as oil price stabilized and then increased. Banks that had lost heavily on the episode used the experience to redesign their risk management processes to avoid future problems (a process that clearly failed, as witnessed by subsequent disasters). But the true systemic collapse that had been very close to happening was avoided.

Let us summarize some of the key issues related to the Russian and LTCM crises:

- The fund (and bank counterparts) relied excessively on flawed VAR and risk models that misrepresented the degree of risk-taking, particularly with regard to liquidity and correlation risks.

- Bank counterparts, eager for business with LTCM, granted leverage on liberal terms without proper knowledge of the fund’s operations.

- Bank counterparts “piggy-backed” LTCM trades, adding a significant degree of concentration risk to the system.

- Lack of regulation and scrutiny related to the hedge fund sector made it difficult to know the amount of risk-taking and leverage that was actually being assumed.

- Style drift was introduced into the fund, which led the portfolio managers to shift their focus from traditional fixed income arbitrage activities into credit, equity, and volatility strategies that were clearly not their strength.

- Russia’s own economy was in disarray, with deficits being covered through increasing amounts of local and foreign debt issuance; the ruble
was overvalued, and hard currency reserves were on the decline in the months leading up to the default.

Banks again ignored warning signals coming out of Russia, continuing to take risky bets in the local currency, equity, and bond markets.

THE CREDIT CRISIS OF 2007

The “granddaddy” of modern day financial catastrophes is the Credit Crisis that began in 2007 and carved a very destructive path through the global economy for more than 2 years – literally reshaping the face of banking, commerce, and the national economies in the process. Since this particular catastrophe has so many complexities, including those related to risk transmission mechanisms, we take the liberty of injecting additional technical details as needed, mostly in the form of notes.

The origin of the Credit Crisis is generally attributed to a decline in the US housing market that triggered widespread default on subprime mortgages, or home loans granted to borrowers of less than desirable credit history or financial capacities. The reality is a bit more complicated and involves a confluence of players and events – at the risk of using a cliché, the idea of the “perfect storm” seems applicable in this instance. Subprime mortgages alone could not have created the damage ultimately sustained by the financial system – in fact, a rather toxic blend of loose monetary policies, rising (and then falling) real estate prices, complex risk structures, punitive mark-to-market accounting principles, lax regulatory oversight, poor corporate governance, and inadequate risk management practices joined to create the disaster. A lack of appreciation regarding the severity of the crisis by regulators and government authorities meant that precious time was lost early in the crisis in crafting solutions that might have halted or curtailed the damage.103

Let us take a step back to review the salient points of this case. From a macroeconomic perspective the Federal Reserve’s low interest rate policy, put in place in 2001 to reverse the weak economy, permitted excess liquidity to build within the US system. From 2001 until the eve of the crisis in mid-2007, excess liquidity induced by low rates was channeled into the purchase of goods and services and, more importantly, into hard assets such as residential real estate.104 In addition to this bank-based leverage, additional debt was injected into the system by hedge funds and through a variety of off–balance sheet vehicles which acted as a de facto shadow banking system. Property prices escalated steadily throughout many parts of the country for a period of 6 years; in fact, average housing prices in the United States nearly doubled in nominal terms. While this provided some homeowners
with true gains as they sold or “traded up” it also fueled the belief that real estate prices would continue on the same upward trajectory. This caused some to purchase second homes as “investments” (creating some overextension in financial resources once the bubble burst) and also caused banks to loosen their underwriting standards. However, all was not well behind the scenes. Despite strong real estate and stock markets evident from 2002 to 2006, the US macroeconomic picture was weakening with current account deficits reaching very high levels (e.g., 7% of GDP) as a result of fiscal deficits and high household expenditures; jobless claims were also on the rise and, starting in 2006, fuel prices began to soar.

Flaws at the institutional level compounded the macroeconomic pressures. As noted in Chapter 4 many large banks were basing a portion of their business models on the “originate and distribute” scheme, whereby assets they originated (including subprime and prime home mortgages) were repackaged as asset-backed securities (ABS, which includes subclasses such as collateralized debt obligations [CDOs], residential mortgage-backed securities [RMBS], and so forth), with different tranches placed with a range of investors. This activity became a major source of revenues for many large banks, and the compensation paid to those responsible was a powerful incentive to keep printing additional transactions. In fact, on the eve of the crisis the US ABS market amounted to $2.25t in outstandings (including $430b of assets securitized by “subprime” mortgage105 pools), while the European ABS market had grown to €1.3t.

Unfortunately, not all of these ABS tranches could be successfully placed, meaning risks began to accumulate on bank balance sheets. And, in a curious twist, the banks tended to retain large amounts of supposedly “low risk” AAA and super senior tranches, while successfully placing the equity tranches with hedge funds. This created a false sense of comfort, because even though the securities were AAA-rated, they were ultimately impacted by the market sell-off that followed during much of 2008. In addition, as the housing boom seemed unstoppable, banks were all too happy to lower their underwriting standards and accept subprime mortgages in their pools under certain assumptions. That is, they would not keep these pools on their balance sheets and that even though default experience would invariably be higher than normal, the average would still be sufficient to repay the securitized tranches when grouped together with thousands of other loans. Both of these assumptions proved to be wrong as indicated, banks were unable to distribute all the tranches they originated and, when the real estate markets finally retraced, a much larger portion of mortgages entered the distressed and default stages. It is worth noting that while the United States was the primary culprit in the real estate bubble and the flawed “originate and distribute” model, the same events occurred in other countries, such as the United Kingdom and Spain, which eventually added to the total of global financial losses.
The US housing market reached its peak in mid-2006 and began a fairly rapid descent from that point on. The first significant losses attributable to US housing appeared at HSBC Finance in February 2007 (though seemingly enormous at $10b, they would come to represent the tip of a very large iceberg). New Century Financial, a large subprime lender, filed for bankruptcy 2 months later. Spreads on structured credit products based on mortgages then started to widen steadily, spilling over into broader “vanilla” credit indexes. Intervention by Bear Stearns in two of its mortgage hedge funds followed in June 2007, and the crisis reached its first critical stages in August 2007. The global extent of the problem became clearer when institutions in the United Kingdom and Germany declared large losses from credit-related activities (to wit Northern Rock, which was de facto nationalized by the British Government, and Sachsen Landesbank and IKB, two German state banks that were bailed out by their respective governments).

The full depth of the problems remained unknown at this point, in part because risks were incorporated in the form of complex financial contracts. While the financial industry has long prided itself on its very clever, and generally useful, financial engineering techniques, it has become evident in examining the damage that even the creators of such exotica failed to truly understand all dimensions of the risks on their books. As noted, the linchpin of the “originate and distribute” centered on securitization. Some of the securitization structures (which can be created on both a cash and synthetic basis) have very interesting and challenging correlation features that proved to be difficult to manage in a stressed market environment. Tranches that remained unsold, even the safest AAAs, began to react very poorly as the subprime mortgage default experience increased and spilled into other securitized assets (including commercial mortgages, Alternative-A mortgages, SME loans, and so forth). In addition, most of the structures were rated by the rating agencies on the basis of certain flawed methodologies which greatly underestimated the degree to which defaults in certain pools could occur and trigger structural unwinding.

Other structured credit instruments, including credit default swaps (and variants, such as basket swaps and first-to-default swaps) and structured credit notes, among others, fueled additional losses because they served as leveraged credit vehicles, magnifying the effects of negative movements in the credit markets. The default correlation inherent in structured products produced further losses, as many internal models appear to have underestimated or ignored the effects of such risks. In a systemic crisis we would expect joint default probabilities to rise, leading to an increase in implied default correlations, which can result in a significant drop in the valuations of structured credit products, including those at the “top” of the capital structure. In fact, this is precisely what happened. Many structured products became completely illiquid by the third quarter of 2007 and could only
be “valued” through proxies or models, rather than actual traded bids and offers; the valuations became something of a “voodoo science” based atop a whole range of assumptions.\textsuperscript{111} As the value of assets contained within these structures declined, internal triggers were breached, causing unwinding and disposal, which put further downward pressure on asset prices. Deleveraging in an illiquid market created a great deal of damage.

Various investment vehicles, including structured investment vehicles (SIVs\textsuperscript{112}) and arbitrage conduits\textsuperscript{113} compounded the effects of the crisis. Such vehicles had entered into the classic “borrow short and invest long” paradigm by making use of short-term commercial paper (CP) funding to buy a host of longer-term credit assets. As asset-backed CP investors became more nervous in July and August 2007 they stopped rolling over their obligations, causing SIVs and conduits to begin deleveraging via asset liquidation: this put an additional amount of credit assets into an increasingly illiquid marketplace, causing asset prices to fall in response.

Of course, the excess liquidity was not confined to the housing and real estate markets – capital was also put to work in other asset classes. For instance, private equity funds accumulated a great deal of extra capital from investors, which they channeled into debt-finance leveraged buyouts and public-to-private transactions. As these deals became more competitive, the leverage multiples paid for such target companies grew to very high levels, increasing the debt service requirements of individual companies and intensifying the financial pressure on sponsors. The excessive leverage flowing through the financial system in support of LBOs and public-to-private deals (and characteristic of the final stages of the Minsky framework described in Chapter 3) reached an all-time in the first half of 2007. Many major banks were, of course, financiers in such LBO deals and more than a few had multibillion-dollar commitments on their books which they hoped to syndicate to end investors. As the market weakened in the summer of 2007, arranging banks were left with tens of billions of dollars of unsold leveraged loans on their balance sheets, many of which would ultimately be written down, creating additional losses.

Throughout late 2007, major global banks such as UBS, Citibank, Merrill Lynch, Deutsche Bank, RBS, Bank of America, JP Morgan Chase, Barclays, and others reported significant losses coming from their structured credit portfolios and their LBO portfolios, as well as any SIV activities they may have been sponsoring. Any bank holding substantial vanilla and structured credit risks saw its results deteriorate as spreads continued to widen to record levels. Many banks admitted failures of their risk management processes on many fronts, including business trumping risk control, ineffective risk managers, flawed models\textsuperscript{114} and stress tests, and so forth.

In response to the unfolding disaster, central banks engaged in a series of liquidity injections and rate cuts; these commenced in a rather
uncoordinated fashion in September 2007, and truly synchronized efforts
did not appear until the first quarter of 2008. Central banks made avail-
able funds through special borrowing facilities and repurchase agreement
facilities that allowed banks to pledge certain structured assets in exchange
for cash. This, however, did little to ease tightness in the interbank mar-
kets, which remained frozen – from late 2007 and into 2008 banks sim-
ply refused to lend to one another as they moved into a “defensive mode.”
This had the critical effect of halting credit to individuals and companies,
leading the system into a classic credit crisis. Figure 6.11 illustrates the tra-
jectory of the US LIBOR/Overnight Index Swap basis point spread during
2007 and 2008, helping illustrate just how tight conditions were.

The situation remained dire into the first quarter of 2008, with credit
spreads continuing to widen and liquidity in credit-related assets remain-
ing scarce. In March 2008, US investment bank Bear Stearns became
the subject of liquidity and capital rumors and was forced into a “shotgun
bailout” by JP Morgan (which benefitted from a $29b Federal guarantee
to cover unknown valuations in the investment bank’s portfolio). Financial
losses continued to mount throughout 2008, and the IMF’s estimate of $1t
in losses in the sector (which it published in April 2008) became a reality
(and by 2009 even appeared low); even ignoring the recessionary spillover
effect into the global real economy and the additional burdens imposed on
taxpayers for a variety of bailouts, the dislocation represented a financial
catastrophe to rival that of the Great Crash/Depression. The spillover into
such a broad base of assets caught most by surprise, and while some of this
was clearly justifiable, at least some amount was the result of pure panic
selling, which amplified the negative transmission.

Figure 6.11  US$ Libor/Overnight Index Swap, January 2007–December 2008, bps
The second half of 2008 became a critical period for financial institutions. While external private capital raising was possible during the first months of the crisis, primarily via sovereign wealth funds in Asia and the Middle East, it soon dried up, meaning that depletion of bank capital from multibillion-dollar losses had to be met through government-sponsored solutions; this became especially prevalent in the third and fourth quarters of 2008. During this period (and particularly after the default of US investment bank Lehman Brothers in mid-September) the two US housing agencies, Fannie Mae and Freddie Mac, were bailed out by the US Government. UBS was rescued by the Swiss Government, RBS was de facto nationalized by the UK Government, Wachovia was taken over by Wells Fargo, Bradford & Bingley was taken over by Lloyds TSB, Alliance & Leicester was taken over by Banco Santander, Fortis was rescued by the Dutch and Belgian Governments (with portions of the bank being acquired by BNP Paribas), AIG was de facto nationalized by the US Government, and so forth. As indicated, Lehman was less fortunate, and was permitted to go under in September 2008 by the US Government, which may have sought to “make an example” of a major institution to dampen future moral hazard concerns. With the default of Lehman the global monetary and financial authorities set in motion a “second phase” of the crisis – a domino effect that exceeded their “worst case expectations,” and which demanded systemic actions. Within days AIG received its first bailout, after which a number of national governments provided de facto “safety nets” for their banking systems by guaranteeing deposits, providing capital and/or, guaranteeing second loss positions on bad bank assets. This occurred in United Kingdom, The Netherlands, Belgium, France, Germany, Austria, and Italy, among others. Iceland, unfortunately, was not as lucky and saw all of its major banks collapse. The US Treasury introduced the Troubled Asset Relief Program (TARP), a $700b package designed to purchase “toxic assets” (but which was eventually used to provide preferred capital to most large banks). This was accompanied by additional measures in late 2008 and early 2009, including a residential mortgage relief program to avert a further rise in foreclosures and the Term Asset Backed Securities Lending Facility (TALF), a government program providing investors with financing to purchase a range of qualifying ABS. Further ad hoc bank recapitalizations and bad asset guarantees continued into 2009 (to wit, Citibank, Lloyds TSB, and so forth).

The evolution of credit spreads throughout the crisis provides a useful glimpse at the damage that was wrought throughout 2007 and 2008 (and into 2009). In fact, credit spreads widened steadily throughout 2008 and spiked to new highs during the Lehman default; the fourth quarter of 2008 created massive losses for many major banks. Figures 6.12(a)–(d) highlight the evolution of credit spreads from January 2007 (a period of relative calm)
into the first phase of the crisis in August 2007, through March 2008 (when Bear Stearns was rescued by JP Morgan), and into the second phase of the crisis (which commenced with the Lehman default). The spread representations cover US and European high grade corporate, crossover (high yield), and financial institution index CDS contracts.

While the initial impact of the Credit crisis was felt by financial institutions (banks, mortgage brokers, subprime lenders, monoline insurers
providing credit protection\textsuperscript{122}) and various structured vehicles, hedge funds eventually succumbed as well. Though hedge funds emerged relatively unscathed during the first 12 months of the crisis, they began to suffer losses in the second half of 2008 as poor market conditions impacted various strategies, including commodities, convertibles, long equities, and global macro. This led to the filing of redemptions by investors, causing funds either to gate their funds (e.g., temporarily halting withdrawals) or to begin liquidating portions of their multibillion-dollar portfolios, putting more pressure
on asset prices. The annualized returns of the hedge fund industry plunged to $−19\%$ in 2008, the worst ever on record.

While we can certainly point to the misadventures of individual institutions (which, together with loose monetary policies, were certainly at the heart of the crisis), various structural flaws contributed to the spread of the crisis; these included inappropriate accounting rules, flaws in the credit rating agency process, an ineffective regulatory framework, and lack of coordinated regulatory actions at the earliest stages of the crisis.

In the first case, we can point to accounting rules, where a giant “negative feedback loop” impacted the system based on mark-to-market (MTM) accounting. Under standard IAS39 MTM rules, assets held by institutions in a trading account need to be valued at fair market value; those held in a banking book account can be held at cost, with any permanent impairment taken on a periodic basis. MTM trading book accounting therefore forced many investors in credit assets to show increasingly lower valuations on their portfolios throughout 2007 and 2008 as a result of the complete lack of liquidity characterizing the market. For investors subject to triggers, the downward spiral resulted in the sale of credit assets into an illiquid market at increasingly lower prices, which crystallized losses and established new lower MTM price points for other investors, and so forth, in a continuous loop. The damage was recognized by European authorities, who permitted suspension of MTM accounting rules in the third quarter of 2008 (retroactive to mid-2008); the United States did not follow suit at that time but joined in 2009.

In the second instance we can point to the overreliance by banks, regulators, and investors on a flawed credit rating agency process. The agencies, which have historically been responsible for rating corporate, institutional and sovereign credits, expanded into structured finance in the 1980s. Securitizations and structured credit transactions they rated in the lead-up to the crisis were ultimately found to be based on faulty models, which overestimated the AAA and AA ratings implied by structural features. Such errors affected hundreds of billions of dollars of outstanding assets, to the detriment of investors holding such paper in a weakening market – when a wave of downgrades occurred. The performance of the rating agencies was so poor that questions soon turned to the inherent conflict of interest existing in the sector, where agencies have enjoyed tremendous power in the pricing of credit risk through their ratings on an issuer-fee basis, effectively dictating which issuers can enter the market and at what relative cost – and can still not guarantee they will not make fundamental errors.

In the third instance we can point to problems with certain regulatory rules, and specifically those developed under the Basel II Accord, which sets minimum capital levels for various types of banking risks. The Basel II framework, while useful as far as capital is concerned, places excessive faith in, and reliance on, models (and particularly the VAR framework described
earlier in the book), and opens itself up to continued regulatory arbitragess
(to wit, the SIV example cited earlier, as well as other off–balance sheet
activities). In addition, the framework is intended primarily to deal with
solvency and does not really address liquidity issues – which were at the
center of the storm during the first 18 months of the crisis. Finally, unless
local supervisors choose to operate differently under Pillar II of the frame-
work, the Basel II process does not systematically penalize concentrations
of regional risk factors, meaning the buildup of risk concentrations (delib-
erately or through a breakdown in correlations) does not attract additional
capital – this is clearly a problem, particularly once liquidity drains from
the market.

Finally, we can point to true lack of coordinated regulatory action early
on in the crisis. As events unfolded in August 2007, the response from
regulators reflected a misunderstanding of the magnitude of the crisis. For
instance, during August 2007, as the market situation worsened dramati-
cally, the European Central Bank and the Federal Reserve undertook mas-
sive liquidity injections, but the Bank of England and other central banks did
not. During the latter part of 2007 similar uncoordinated actions occurred
with regard to liquidity, repoable assets, and so forth. Indeed, not until the
first quarter of 2008 did a uniform approach to liquidity injections begin
to appear. The same occurred in the area of bank bailouts following the
Lehman bankruptcy: each country created its own plan and developed its
own timing in a seemingly uncoordinated fashion. While sovereign deci-
sions and actions are a given, coordination (or the appearance of coordi-
nation) during a time of global crisis would certainly add comfort to the
marketplace.

By 2009 it was clear that most major global economies had entered a
recessionary phase as a result of the financial crisis; continued instability in
the financial sector (with major banks still holding billions of dollars worth
of “toxic” assets), frozen credit conditions, growing corporate defaults,
steady foreclosures, lack of a “bottom” in real estate prices, and increasing
job losses combined to create an economic contraction of global propor-
tions. By any measure, the Credit Crisis of 2007 was a disaster of rather
epic dimension. The ultimate direct and indirect impact of the catastrophie
may take years to determine, but estimates of at least $2t in direct losses and
additional (and almost certainly larger) indirect losses to the global econ-
omy appear credible.

Summarizing the key points of the Credit Crisis we note the following:

- Excessive leverage in the system built atop loose monetary policy cre-
ated significant asset bubbles in various risk classes, particularly resi-
derential real estate; misbalancing of risk and return dynamics became
apparent during the early part of 2007.
Lack of in-depth understanding by banks regarding the risks they were creating and structuring compounded the problems; most underestimated completely the effects of illiquidity, contagion, and default correlation.

Risk management processes at virtually every major risk-taking institution (banks, dealers, monoline insurers, insurers, hedge funds) failed to provide adequate protections for stakeholders; failures touched on credit underwriting standards, risk modeling, and market risk concentrations.

Interests between banks and other stakeholders were misaligned, particularly with regard to compensation and tail risks.

The rating agency framework collapsed as a result of flawed modeling and conflicts of interest.

Accounting standards forced the liquidation of assets that might have otherwise become “money good”: ex-post changes to the standards (even on a retroactive basis) were insufficient to repair the damage.

Regulators failed to close loopholes, leading to instances of regulatory arbitrage, particularly in off–balance sheet activities.

Regulatory frameworks (both national and supranational) were fractionalized and unprepared to deal with a financial crisis characterized by extreme illiquidity, volatility, and price gapping.

With a handful of case studies in hand we are ready to explore, in the next chapter, the lessons that can be drawn from such episodes. We will then build on those lessons to consider what prescriptive measures exist to manage these events with more foresight and diligence.
Lessons Learned and Prescriptive Measures

It becomes apparent, based on the history of business cycles and the flaws that characterize human development and progress, that preventing the future occurrence of financial catastrophes is impossible. Given this inevitability, the best we can hope to do is absorb lessons from the costly episodes of the past so that we can develop ways to minimize the effects of future financial disasters.

In the previous chapter we described through a small handful of case studies the devastation that can be wrought by the onset of a financial crisis. In this chapter, we examine “lessons learned” from these cases, all the while bearing in mind the risk processes and tools we have described in Chapters 4 and 5. We then propose a series of “prescriptive measures,” or practical steps that can be taken by institutions and external bodies to help battle the impact of future disasters. Reverting to our discussion from Part I, we know that any set of solutions must balance the needs of a distinct set of stakeholders – including private sector institutions, investors, regulators, and taxpayers. Ultimately, each one of these stakeholders can be damaged by the onset of a financial disaster, and the possibility that each group will bear costs in excess of their involvement or direct responsibilities is of paramount concern. Adjusting the risk management framework to minimize such damage is thus an exercise that merits attention.

LESSONS LEARNED

With a rather unfortunate list of “100-year floods” at our fingertips, we focus first on “lessons learned” – that is, the specific education we derive from the case studies discussed in the previous chapter as well as other historical instances that have affected the markets over many decades. For ease, let us consider these in terms of institutional and systemic lessons
learned. Once again, we focus our discussion primarily on the impact to financial institutions, but note that many of the same lessons can also apply to nonfinancial corporations.

**Institutional lessons learned**

- Investors need to take responsibility for their invested capital by holding board directors accountable.

- Board directors need to hold executives accountable for managing business in a prudent fashion.

- Board directors need to be educated regarding the specifics of business and risk.

- Executive management must understand its business in detail.

- Internal business and risk transparency need to be increased.

- Compensation packages must be rational and aligned with the goals of stakeholders.

- Business needs to be turned away when the risk/return is misbalanced.

- New business models need to be developed to meet new market realities.

- Risk governance must be improved and a firm-wide risk culture must be established.

- Risk identification processes must be sufficient to pick up on all dimensions of risk.

- Risk standards have to be tightened and maintained consistently, even during “good times.”

- Risk and return need to be balanced; P&L must be understood and questioned at all times.

- Market risk and credit risk need to be viewed and managed in a holistic manner.

- Models need to be viewed with skepticism, particularly during times of stress.
- Statistical distributions for financial assets need to be analyzed closely and applied with care.
- Qualitative judgment should not be replaced by quantitative input.
- Warning signals have to be defined and followed.
- Stress scenarios must become even more extreme and should be used in a practical manner.
- Tail events can be at least partly protected through sensible hedges or insurance.
- Liquidity must be “stress proof” under all conceivable scenarios.

**Systemic lessons learned**

- Macroeconomic factors, such as national debt and currency value, can be a cause of dislocation and must be monitored for warning signs.
- Extended periods of very cheap credit can create asset bubbles that lead to crises and must be held in tighter check.
- Leverage comes in many different forms and can exacerbate system risk and must be held in tighter control.
- Market liquidity, even in high quality assets, can disappear rapidly in times of stress and needs to be monitored regularly.
- Regulatory forbearance does not always work as intended, so regulatory actions need to be analyzed carefully.
- Public sector oversight needs to be strengthened.
- Regulators need to add more value in the inspection process.
- Self-regulation is of limited use.
- Coordinated regulatory actions are necessary during a crisis.
- Quick action needs to be taken to avoid loss of public confidence in the financial system and a “slow grind” on the economy, but the medium-term implications of such action needs to be well-understood.
Financial innovation is likely to continue, meaning more managerial and regulatory scrutiny is required.

Systemic linkages are dynamic and difficult to understand.

Regulatory arbitrage will continue until rules are harmonized.

Artificial accounting and regulatory rules can amplify a crisis by forcing ill-advised actions; they should not drive business or markets.

Stakeholder interests need to be aligned, if necessary through specific regulation or legislation.

Nonfinancial companies are not immune to the actions of the financial sector.

To be sure, individual firms draw additional, idiosyncratic lessons from each crisis they undergo, since they will do a better or worse job of coping with a specific dislocation based on their own structure and process. The same applies to regulators and other public bodies responsible for managing the economic and financial mechanisms of the global markets. Enlightened firms and authorities continue to build on, and improve upon, their mechanisms through each crisis, so that they fare better over time. Those that ignore the lessons, or that dismantle the protection and control with the onset of the next cycle of “good times,” fall into the same trap over and over again. In fact, the majority of institutions seem to fall in this category.

PRESCRIPTIVE MEASURES

Though history suggests that ignorance or greed can trump the search for rational reform, we believe the attempt to link some of the lessons noted above with “prescriptive measures” is a worthwhile endeavor. We stop short of calling these solutions, as it may not be possible to create perfect and enduring solutions to the problems that have coursed through the financial system over the decades.

To organize our discussion, we once again divide these measures into institution-specific and systemic classifications.

Institutional measures

From an institutional perspective, the following measures emerge as important:

- More accountable directors and executive managers.
- Better scrutiny of financial innovation.
Improved financial transparency.

Better use of warning signals.

More rigorous business analysis.

Greater use of “disaster hedges.”

Strengthening of the qualitative approach to risk management.

**More accountable directors and executive managers**

In Chapters 1 and 4 we indicated that public companies create risk management processes to achieve a variety of goals, which include evaluating risky decisions in a disciplined manner, avoiding risk concentrations, generating revenues in a balanced manner, meeting regulatory requirements, and helping maximize shareholder value. There seems little point in pursuing these objectives unless management and board directors are held to account in implementing a useful risk process. And, as we have seen, even though such processes may be far from perfect, they add an essential level of control and comfort to the benefit of all stakeholders.

In fact, there seems to be little evidence that this has worked in the past. Board directors have not, by and large, been held accountable for any failures in oversight appearing during their tenures. In looking back at the examples of the past, it appears that most of those within the financial industry have not suffered any consequences when their risk-taking activities have resulted in unexpected losses (and when they help fuel broader dislocations). The prescriptive measure in this instance, then, is to ensure that executive managers and external directors who are in charge of a company are held responsible by shareholders for successes and failures. While this is a fundamental tenet of good governance, it is often ignored – this should no longer be regarded as acceptable. Unless responsibility begins at the top, it is virtually certain that the mistakes of the past will be repeated time and again. This means, of course, that investors must be much more forceful in ousting ineffective directors (not simply leaving such actions to activist hedge funds), while directors themselves must be prepared to discipline executive management when results are not delivered.

**Better scrutiny of financial innovation**

The financial sector has been, and is likely to remain, a center of financial creativity and innovation. In the main, such innovation is very constructive
in advancing economic interests and must be seen as integral to continued progress. Innovation may ebb and flow with each crisis (in some cases reaching a relatively low point where business reverts to very “grass roots” products) but the general trend toward new mechanisms remains in place. For instance, even after major dislocations over the past few decades involving innovative financial products such as portfolio insurance, junk bonds, structured mortgage derivatives, structured notes, credit derivatives, SIVs/conduits, and so forth, the industry continues to come up with new financing, risk-taking, and risk transfer mechanisms. We must expect that the reappearance of new financial innovation will continue to follow in the aftermath of future crises – simply put, new products will not disappear.

Knowing this, the prescriptive measure calls for institutions (and regulators) to be much more diligent in vetting new products, particularly those that introduce leverage or volatility into the system, or which generate opaque or “hidden” risks. This exercise requires a much more in-depth review of costs, benefits, and risks, and decisions on whether to proceed with a new product should be taken at the highest levels of a firm. External stakeholders have a strong, if indirect, role to play. If they are not convinced they can properly assess risk transfer or investment opportunities coming through new financial schemes, then innovation will not take hold. The main issue is whether stakeholders will be diligent enough to scrutinize the opportunities as they should, or whether they will “fall victim” to the temptations of higher returns or seemingly attractive hedging or transfer activities.

**Improved financial transparency**

The financial and corporate communities have generally improved their ability to transmit useful financial information to investors, regulators, rating agencies, and other stakeholders. Some of this has come from specific regulatory measures (e.g., Securities Exchange Act of 1934, Sarbanes-Oxley of 2002, Basel II Accord, and similar legislative decrees in other countries), while the balance has come from certain self-regulatory or self-motivated initiatives (e.g., the Counterparty Risk Management protocol of 1995). Such disclosure is still insufficient, however, for the marketplace to be able to assess the true nature of financial operations. It is also likely to be inadequate for stakeholders in individual firms. Key details remain missing, particularly with regard to risk-related issues. In addition, much of the information is point-in-time or backward looking, and so becomes relatively useless even as it is in the process of being printed and distributed.

The prescriptive measure in this instance is to insist, through individual corporate charter as well as formal regulation, on a much higher degree
of reporting transparency, which includes sufficiency of detail (to make sure useful information is conveyed), consistency of definition (to allow cross-entity and cross-border comparison), and thoughtful assessment of future events (to make the exercise forward-looking and useful); the most powerful and effective version of this needs to be based on cross-border standards that are agreed between, and enforced by, global regulators. This obviously has political implications that need to be addressed, but the result is likely to be worth the effort.

**Better use of warning signals**

We know that each new financial crisis is unique, featuring characteristics and dynamics that set it apart from past crises. That said, we have enough lessons at our disposal to be able to look for certain common warning signals. Identifying and tracking these warning signals can give an institution some indication of where it stands in a particular cycle and whether, based on past experiences, certain dangers are becoming more evident. Tracking these warning signals does not mean that a catastrophe can necessarily be stopped, but it may give a firm, or an entire sector, the opportunity to take certain safety actions that can help minimize damage. The prescriptive measure relates, therefore, to the development and use of certain warning signals, including such factors as

- Large current account deficit.
- Currency peg under continuous threat.
- Steady asset price inflation (in real estate, equities, credits).
- Tight interbank conditions.
- Rapid compression of asset returns, misbalancing of risk/return profile.
- Herding or crowding into a business sector.
- Liberal financing terms offered to borrowers, and so on.

The results of such monitoring need to be communicated to executive management, so that appropriate actions can be taken to protect the firm. The most effective version of this embeds the review of warning signals into the risk monitoring process so that they can be reviewed and acted on.
More rigorous business analysis

In Chapter 5, we considered the idea that rejecting a quantitative framework due to the lack of certainty regarding distributions might be preferable to blindly accepting a flawed one and creating a degree of false comfort. If a firm chooses to accept the belief that it cannot know the distribution that governs extreme events, it might be better-off taking a conservative stance by preparing for the financial crisis that will invariably come in 1, 2, or 5 years. In practical terms this means that a firm might reject more business than it has in the past, as it will ignore opportunities that might seem acceptable at the margin, but become wholly unacceptable when viewed in the context of an extreme scenario.

Under this prescriptive measure, management and directors should consider whether this is an acceptable approach to business and risk management and, if so, implement a very rigorous business analysis framework that permits a fair assessment of marginal risks and returns, at a relationship and transaction level. With such a business analysis framework in place, it then also requires a commitment on the part of business leadership to sacrifice those risky transactions that would seem misbalanced when viewed through the prism of the next financial disaster.

Greater use of “disaster hedges”

The advent of derivatives and other financial engineering products and structures has been instrumental in giving participants easier access to speculative or hedge opportunities and are generally used to good effect within the financial and nonfinancial sectors. While such instruments are occasionally misused or used to excess, they have an important role to play in the daily functioning of the financial markets and the global banking system.

The prescriptive measure in this case relates to the development of a hedge program to create the right level of protection against a future disaster. The “disaster hedge” (or macrohedge) can be viewed as a form of insurance against the onset of a remote event and in practice may comprise a portfolio of purchased OTC or listed options, with the premium paid for such protective positions translating into a payoff should these move in-the-money. OTC options that rely on counterparty performance need to be considered carefully, as the relevant counterparties may encounter financial difficulties of their own during a period of financial stress (e.g., high correlation between market risk and credit risk). The portfolio of options is likely to focus on underlying market references that can generate profits in the face of a disaster – this most often relates to the creation of call options on “flight to quality” assets, such as US Treasury bonds, US dollars, and gold, and put options on risky assets likely to be impaired in a crisis, such as equities,
structured products, and so on. The appropriate sizing of such a hedge is institution-dependent, but may relate to compensatory payments sufficient to cover some unexpected loss level or a particular percentage of lost revenues due to market dislocation/business slowdown.

But a disaster hedge needs to be constructed with care and managed diligently over the medium-term. If it is not analyzed properly, or if it is removed after a very short period of time, then it must be seen as little more than another proprietary trading position – increasing the firm’s risk profile, rather than trying to provide protection against an extreme event. Importantly, any P&L accruing from such disaster hedges must be for the account of the firm at large, and not for a specific business area or else incentives become misaligned.

**Strengthening of the qualitative approach to risk management**

While financial (and nonfinancial) institutions may be capable of managing “close-to-the-mean” risks, they have demonstrated a relatively consistent pattern of being unable to effectively cope with high severity events. They may make certain alterations to their risk processes in the wake of a crisis, but at least some of those “lessons learned” appear to fade from memory (and practice) once the market normalizes and profits are generated. The measure in this instance relates to making sure that this does not happen in the future. Accordingly, it is incumbent upon directors and executives (and, to the extent necessary, regulators) to reexamine risk processes and make them more useful and credible in managing crisis events. This applies especially to qualitative risk management.

It is obviously difficult for an institution to manage its operations solely to low probability crisis events, because fair profit opportunities may be left on the table. That said, it is important to give much more weight to such events when establishing risk tolerance and developing a decision-making framework. This may imply a change in philosophy and mindset, which moves from an attitude of “it can never happen” to “it can happen, and it will happen.” This is a fundamental change, and its importance to the future success of risk management efforts cannot be underestimated. Risk managers, executives, and directors must come to realize that the tidy world of the normal distribution does not apply in the financial markets – the sooner this can be inculcated within an organization, the greater the likelihood it will succeed in navigating through the next crisis. It requires a willingness to abandon the blind faith reliance which is often placed on financial models. Of course, some quantitative measures are still needed (e.g., implementing catastrophe-based models (recognizing, of course, the shortcomings) to provide additional insight into financial disaster risks, using real stress testing
as a key link in the definition of risk tolerance (rather than as a “report to show regulators”) but the point is to reduce unwavering reliance on any metrics in favor of subjective judgment and experience. Let us remember that risk management is part “art” and part “science” – the “art” component tends to be obscured with the creation of new models and the implementation of new technologies, but in the final analysis it is the judgment of professionals that have lived through some of the crises we have described in Chapter 6 that provides the real difference in risk management.

The lessons of history have proven very expensive for many, suggesting that qualitative judgment and experience should feature much more prominently in the conduct of business and risk management. Directors and executive managers should continue to use the quantitative tools that are available to them, but should forcefully supplement the lessons of the past and the experiences of those that have lived through such episodes. In addition, and in connection with the point on financial innovation above, the results of any quantitative exercise should be challenged continuously – not only when the economic environment is becoming difficult or an institution is posting losses, but also when the environment is strong and profits are being generated. There is, of course, an embedded fear to challenge business units when profits are being made – but this is precisely the time when such challenges must occur.

**Systemic measures**

Systemic measures are equally important in attempting to reform some of the problems that have affected the global financial system. These include

- More diligent application of macroeconomic policies.
- Better control of “amplification” or “domino” mechanisms.
- Stricter control of moral hazard.
- More pragmatic and useful external regulation.
- Greater understanding of the issues surrounding regulatory forbearance.
- Greater use of clearinghouse structures and collateral exchange.
- Tighter control of institutional and systemic leverage.
- Comprehensive reform of the credit rating process.
LESSONS LEARNED AND PRESCRIPTIVE MEASURES

- Rigorous alignment of stakeholder interests.
- More rapid development of financial catastrophe risk transfer mechanisms.

**More diligent application of macroeconomic policies**

In reviewing the most devastating crises of the past decades we see that the root causes often center on mismanagement of macroeconomic policies by government authorities. While the actions of individual institutions can rightly be criticized as a crisis is unfolding, it is important to consider that the resulting problems may have their genesis in overarching economic decisions taken by monetary or government authorities. For instance, the creation of asset bubbles is predicated on cheap credit, itself a function of the base interest rate level set by the national central bank, as well as mobile cross-border capital, which is, again, flexibility that can only be granted by the relevant government. Financial institutions do not enter the picture until after these core macroeconomic decisions are in motion, so we cannot disregard the key role played by authorities. The same applies to the management of domestic and external sovereign debt, and to the valuation of the currency and management of currency reserves – these factors, which can lead to financial disasters, are under the management of the relevant authorities.

Accordingly, the prescriptive measure in this instance calls for increased diligence to be applied by those responsible for initially establishing, and subsequently monitoring and adjusting, macroeconomic policies. One practical implementation of this measure is based on the establishment of private/public sector expert panels to review precisely how macroeconomic conditions are impacting the economy at large, and the financial sector in particular, and whether any trends or conditions point to a repeat of worsening scenarios, such as those we have witnessed in the past. Government authorities should be required to provide a more transparent and open view of how their decisions are being absorbed by the marketplace.

**Better control of “amplification” or “domino” mechanisms**

One of the key factors contributing to the rapid spread of financial losses and lack of confidence arising during market dislocations relates to amplification mechanisms that cause actions to be taken that actually worsen the crisis (i.e., a negative feedback loop or a “toppling of dominos”). Some of these mechanisms relate to industry practice microstructures while others concern regulators or other industrial bodies. For instance, from a microstructure perspective we may note that during the 1987 Stock Market Crash
the use of portfolio insurance resulted in an amplification of downward market moves and fueled greater instability. Similarly, the use of deleveraging triggers in structured credit instruments such as CPDOs, SIVs, and structured notes caused the rapid disposal of assets during the Credit Crisis of 2007; this, unfortunately, occurred precisely as markets were already fragile and ill-equipped to absorb further asset supply, meaning that the deleveraging activities simply amplified the downward moves and caused a greater spillover into other asset classes. We can point to similar systemic examples. For instance, the use of mark-to-market accounting, while normally considered to be a good discipline and a help to stakeholders, does not necessarily function when markets are illiquid and valuations are difficult to obtain. Such marking can result in a self-fulfilling downward spiral, to wit the actions also apparent during the Credit Crisis. Banks began marking down their trading books on the basis of increasingly questionable values as markets grew thin and volatile. The negative marks, and the large unrealized losses they revealed, put pressure on banks to dispose of more assets (e.g., the deleveraging scenario), meaning they had to sell into increasingly difficult conditions at “fire sale” prices, resulting in both realized losses on their disposed assets and unrealized losses on the balance of their portfolios, and so forth, in a negative loop. A further example relates to regulatory arbitrage mechanisms that are created through specific regulatory rules. For instance, the favorable capital treatment under Basel II of off–balance sheet vehicles such as SIVs and conduits caused many banks to set up such activities and take more risk away from the “spotlight.” This regulatory loophole simply amplified risk levels to significant levels, leading to increased losses as the markets dislocated.

Knowing that such amplifiers are embedded within individual institutions, specific market practices, or the overarching regulatory community, the prescriptive measure relates to necessary alterations to try and mitigate future effects. In particular, tighter control and greater consistency of regulatory rules appears essential to continue eliminating risk-generating arbitrage opportunities, particularly those that appear off–balance sheet. While this is a nontrivial task, certain advancements have been made in the past to try and close these loopholes so some precedent exists. However, the “end game” for regulators must be the complete elimination of any regulatory arbitrage, as this will effectively shut down an opaque avenue of risk transmission. A second measure calls for revisiting accounting rules to ensure consistency on a cross-border basis, and to build in a form of “circuit breaker” on mark-to-market rules that allows temporary suspension when market valuations become suspect as a result of illiquidity and lack of reliable marks. Establishing such a circuit breaker increases the opacity of a financial institution’s operations for a period of time, which is not necessarily optimal for investors and other stakeholders, but it ensures that
business decisions (such as the disposal of assets into an illiquid market) are not driven solely by accounting rules. Such a suspension should always be regarded as temporary, to revert to standard rules (e.g., IAS 39) as market conditions normalize. A third measure relates also to our earlier point regarding financial scrutiny of innovative products. The very transactions that have embedded amplification mechanisms that can result in deleveraging need to be understood and managed much more carefully by individual institutions and regulators. This should result in more transparency regarding deleveraging mechanisms and affected markets.

**Stricter control of moral hazard**

The moral hazard issue has been revealed in a number of financial crises, including some of those we have reviewed in the previous chapter. For instance, during the Asian crisis of 1997 and the Russian collapse in 1998, the speed and willingness with which the IMF was able to respond with financial aid packages raises the question of whether behavior in the future may be tinged with some amount of recklessness – knowing that the safety net is particularly large. There was excessive private bank lending, which helped fuel speculative asset bubbles throughout the region, and which may have been done indirectly on behalf of the sovereigns in question (which had every interest in continuing to demonstrate year-on-year economic growth). The same argumentation applied during the 2007 Credit Crisis. Moral hazard (and the misbehaviors it creates) is a fundamental issue that the markets and regulators must be prepared to deal with very aggressively. Unfortunately, the rather significant bailouts that occurred both in the late 1990s and again in 2007–09 mean the issue has taken a step back, as governments (and, ultimately, taxpayers) have de facto accepted the preservation of financial stability over the risk of moral hazard.

The prescriptive measure focuses on more diligent vetting of potential “rescue” solutions that could introduce moral hazard, and to move further in the direction of public-private solutions (rather than pure public solutions). In crafting a public-private solution, it is important to focus on the magnitude and management of the “first loss piece” (e.g., the estimated losses in a bailout or restructuring situation, how these are borne by different stakeholders, and so on).

When pure public solutions are the only course of action, the focus must turn to proper protections for the public (e.g., taxpayers). Such solutions cannot be without accountabilities, and in an era of greater sensitivity toward governance issues, it is incumbent upon those bearing the costs to extract concessions that lead to future alignment of interests and improved governance and control (including compensation, and so on). For instance, a situation that puts the government (and taxpayers) into the role of preferred share investors or
troubled asset owners demands improvement in all of the measures that created the stressed situation in the first instance. Failure to do so will simply perpetuate moral hazard and lead to a replay of the same difficulties in the future.

More pragmatic and useful external regulation

The concept of self-regulation within the financial industry has existed for decades and is by now a well-established element of the control process. While this type of self-policing can add a degree of additional security, events of the past decade have cast a doubt on its efficacy. In addition, even though the banking business is built atop trust and reputation, it seems that a regime of reputational checks and balances have proven insufficient. Many institutions have damaged their reputations over the years, suggesting that industry-driven actions are “nice to have” but must be supplemented by a stronger regime of external regulation.

The prescriptive measure in this case calls for useful and coordinated external regulation. Regulation that aims at providing true protections for stakeholders (and the system at large), rather than just addressing political motivations is welcome. For instance, rules that enforce greater transparency, those which establish consistent capital requirements for similar risks, and those that define the limitations of quantitative process might be seen as valuable additions to the control process. If regulators can inject such controls into the daily workings of institutions without creating an excess of costs or bureaucracy, they strengthen the system at large. Equally, those that add burdensome data, cost, or management requirements without necessarily adding value to the control framework must be discouraged.

In addition, while every country has its own imperatives and must manage its financial system as it sees fit, historical experience suggests that the more concerted and forceful the regulatory measures before and during a crisis, the more effective the result. Delays in achieving coordination can be costly in terms of public perception, market confidence and stability, liquidity – all of the factors that need to be brought under control as early as possible in the unfolding of a crisis. One potential solution is to develop a cross-border/cross-regulator crisis management team that is empowered to discuss and coordinate, at the highest levels, a series of actions as required. Short of creating such teams, regulators must at a minimum ensure a high degree of communication between relevant market, economic, and risk experts within their organizations.

Greater understanding of the issues surrounding regulatory forbearance

Just as regulators shape the rules and regulations that govern the markets and institutions operating within their purview, so too can they suspend or
disregard such rules when they believe it is beneficial to do so. Such regulatory forbearance, which may exist as an explicit or implicit right, can be used to good or bad effect, as history has shown. For instance, we have noted in the previous chapter at least one instance when regulatory forbearance was used to good effect, namely the decision taken by US regulators during the mid-1980s not to force US money center banks to establish specific provisions against their LDC exposures. If regulators had indeed forced the issue, it is quite likely that the financial system would have grown unstable, as the largest money center banks would have been technically insolvent. By postponing the provisioning actions for a number of years, the banks were able to accumulate further earnings, dispose of certain assets, and enter the 1987–88 provisioning period in better financial condition. The forbearance was thus successful. We can, of course, point to instances when forbearance actually exacerbated the problems at hand. For instance, we recall that in the mid-1980s the FHLBB, as regulator of the US S&L industry, permitted institutions to use the liberal (and we might argue nonsensical) RAP standards to measure leverage and net worth, which made the weakest institutions even more vulnerable during the downturn; FHLBB also supported the passage of legislation which allowed S&Ls to enter into business lines where they lacked experience. The combination of these two regulatory mistakes exacerbated the industry’s problems. Similar forbearance problems occurred during the Japanese banking crisis, when the MOF and BOJ allowed banks to carry on their books troubled loans for a period of years, without forcing write downs or any true reflection of deteriorating financial condition. The actions simply helped prolong the effects of the country’s “lost decade.”

The point of this prescriptive measure is to ensure that regulators thoroughly analyze and understand the implications of any forbearance decisions they may make. While some decisions may be made in haste, particularly during the midst of a stressed crisis atmosphere, diligence in examining the short- and long-term implications of any decision is an absolute requirement. In an intricate financial system where linkages are significant and complex, the analysis and decision making are nontrivial but essential and should not be rushed as a result of political or financial pressures – the ultimate consequences could prove far more damaging.

**Greater use of clearinghouse structures and collateral exchange**

The financial system operates heavily on the basis of two distinct forms of contracts: OTC and exchange-traded. Contracts that are individually negotiated between two parties are extremely customized and have the benefit of matching a desired asset or liability profile very precisely. They do, of
course, have the disadvantage of creating counterparty exposures, which creates additional systemic pressures, particularly during times of market stress. Contracts that are standardized in nature do not necessarily provide parties with the precise profile needed (so introducing a dimension of basis risk), but can be passed through an independent clearinghouse which has the effect of neutralizing counterparty risks through the use of collateral or the release of cash/securities once both “legs” of a deal have been received.

In fact, the financial sector has made effective use of clearinghouses, or secured and independent entities standing between two trading counterparties, for decades. Such clearinghouses have been key to the safe settlement of a range of transactions, including cash payments, listed futures and options, securities, foreign exchange, and a range of slightly more tailored OTC transactions. Even during periods of financial stress, such as the collapse of Barings in 1995, which put extreme pressure on the exchanges of Japan and Singapore, clearinghouses have been able to properly secure and settle a range of transactions. Systemic instability can be fueled by counterparty risk and counterparty default. Accordingly, greater voluntary or mandated use of clearinghouses to settle transactions and mitigate the effects of such risk surfaces as another important prescriptive measure. Indeed, for any class of structures (such as derivatives on credit indexes) that can be traded on a standardized basis, there is little reason not to move forcefully in such a direction.

The same applies to standardized collateral agreements for derivatives and loans. While such agreements are by now standard and well-accepted in the OTC derivatives world (primarily through the ISDA framework, though other agreements can be, and are, used), expanded use should certainly be encouraged. The regular posting of high quality collateral helps neutralize the effects of counterparty risk, leading to the same ultimate impact as that obtained from a clearinghouse structure. Within the loan market, taking of collateral from debtors on secured loan transactions is again standard practice, though one which needs to be expanded further.

**Tighter control of institutional and systemic leverage**

Leverage is the proverbial “double-edge sword” that is alternately helpful and harmful to both institutional and systemic operations. On the positive side, leverage helps optimize operations with regard to the best and most efficient capital structure and can permit the funding of projects on an immediate basis. It can also lead to improved returns on core asset positions for investors. On the negative side, leverage can add fixed charges to balance sheets and national accounts, and exacerbate the downside of an investment’s returns. In more extreme situations excessive leverage can lead
to the debt mismanagement problems and debt crises we have described in Part I of the book. We recall, of course, that leverage is not confined to balance sheet operations. In fact, off–balance sheet operations are perhaps the more “damaging” source of leverage, as the amount that can be accumulated without the same degree of transparency is far greater.

Leverage at the institutional and sovereign levels are held in check, in part, through the credit ratings process (which we discuss below). In fact, leverage is a key driver of ratings levels, with more highly leveraged entities or countries penalized through lower ratings (and higher funding costs) than their less leveraged counterparts. For certain regulated industries, minimum capital standards may also be imposed as a way of keeping debt levels in check (e.g., through minimum capital to risk weighted assets ratios in the banking industry, and so on). But during strong economic times, when revenues are strong and memories of past crises fade, even the checks of credit ratings and regulatory measures may be insufficient to prevent an excessive accumulation of leverage. This can create systemic pressures, eventually becoming the catalyst for a very significant financial crisis.

Accordingly, the prescriptive measure is to ensure greater internal and external control of leverage levels, with a special focus on off–balance sheet debt. From an internal perspective, executive managers and board directors must collectively place greater focus on understanding their total debt profiles and how these may react in a dislocation. Where necessary, they should impose restrictions on the amount of leverage generated through off–balance sheet contracts and vehicles, without necessarily relying on the edicts of credit rating agencies or regulators. From an external perspective, regulators should place tighter restrictions on maximum levels generated in the financial industry in particular, doing so also by closing down any regulatory loopholes which can be exploited by clever financial engineering to create synthetic leverage. Again, the point is not to eliminate leverage from operations – that is neither possible nor desirable. The primary point is to create transparency and understanding of optimal debt levels at the micro level, and to ensure that contributions to systemic leverage are held in check.

**Comprehensive reform of the credit rating process**

Credit ratings are integral to much of the financial business of the 21st century, as they impact the ability of sovereigns, corporations, and banks to raise funds, the specific cost of funding they face, the ability of investors to invest in credits, the structural enhancements that may be required on complex assets, and so forth. Given the importance of this function, the relative “oligopoly” position rating agencies occupy, and the repeated problems and flaws that have become apparent in a variety of crises as a result of a
dysfunctional process, some reforms are clearly required. If these reforms can be successfully prosecuted, then credit ratings may yet again become a credible and useful dimension of the financial markets. In fact, this should be viewed as an imperative, because a proper rating framework is essential for capital raising efforts.

Under this prescriptive measure, various reforms can be considered. In the first instance, conflicts of interest inherent in the business model should be eliminated. For instance, corporate and sovereign issuers cannot access the broad debt markets without a rating, and they must pay a fee for that rating. While the largest agencies generate additional revenues through subscribers’ services, the rating fees represent a significant source of revenue and a clear conflict of interest. Unwillingness by a potential issuer to pay the fees demanded by the agencies means that it will either be shut out of the public markets (which is driven by ratings) or will have to pay the higher costs of an unrated issue. The same applies to securitization and other structured credits; in fact, such businesses emerged during the early 2000s as a major source of revenue. Structured credit issues could not be absorbed by investors without ratings driven by structural components, meaning the same conflicts existed.

In the second instance, the ratings methods and models applied to the ratings frameworks for both corporate and structured credits need to be vetted by independent parties, possibly even regulators. Just as the market and credit risk models of individual financial institutions are reviewed on a regular basis by regulatory authorities, so too should the quantitative processes of the rating agencies be reviewed at arm’s length. This has become a critical point evident in the aftermath of the Credit Crisis of 2007, when the structural models used to evaluate asset pools and assign ratings to different levels of the capital structure proved to be flawed.\textsuperscript{131}

**Rigorous alignment of stakeholder interests**

The compensation of executives, particularly in the financial sector, has long been criticized as being outside of the norm and in conflict with the interests of a broader group of stakeholders, including investors – and, in a time of extreme crisis, taxpayers as well. This tends to occur because executives are paid significant compensation packages (cash as well as stock) that are often based on profits generated on a present value basis – ignoring the fact that tail risks may be a key element of the business proposition. For instance, the profit on a 10-year derivative transaction is “present valued” for purposes of generating today’s revenues and this year’s compensation, while the risk stays on the bank’s book for the next 10 years. When we multiply this by thousands of deals across thousands of institutions, we see the potential of generating a great deal of tail risk and a great deal of current
year income and compensation. The lack of connection/retention\textsuperscript{132} means there is little accountability between an individual executive and the risk that is being generated.

The prescriptive measure involves better alignment between stakeholders. Regulators should consider imposing greater discipline and transparency in the compensation-setting process, and recommending stronger linkage between compensation, performance, and tail risk; claw backs of compensation based on the development of profit and loss over a period of time can also be considered. From a governance perspective this type of change must be sanctioned by the shareholders of individual companies, who should insist, through the board directors they select to represent their interests, more discipline in the process and should demand a higher degree of accountability. While this seemed to improve somewhat in the aftermath of the corporate governance scandals of 2001–02, it never fully extended to the financial services industry, which has been at the heart of many problems. To be sure, some of the changes may require broader reform of corporate governance rules at individual companies, such as separating the roles of board chairman and corporate chief executive, establishing compensation committees and audit/risk committees with true expertise, and so forth.

More rapid development of financial catastrophe risk transfer mechanisms

We have noted in Chapter 4 that risk transfer is a well-established way of managing risk exposures, allowing exposed parties to identify some portion of risk that is deemed undesirable and then transferring it, at a cost, to another party.

In fact, the insurance mechanism provides for a defined amount of risk transfer between cedant and insurer, and from insurer to reinsurer, with an exposure amount that is dependent on deductibles, exclusions, policy caps, and so on. While much of the insurance paradigm is predicated on the low severity/high frequency risks that are well-described by the normal distribution, some degree of catastrophe insurance is also available in the marketplace. We have noted such catastrophe insurance is based primarily on earthquake, hurricane, flooding, and windstorm and, to a lesser degree, to man-made events such as technological failure and terrorism.

We have already described the shortcomings evident in trying to create an accurate catastrophe insurance pricing framework, and this is particularly true for man-made events with historical data insufficiencies, information asymmetries, and other limitations. The same applies to financial catastrophe insurance, which still exists only as a concept. The measure in this case calls for a detailed examination regarding the rapid development of a financial catastrophe insurance framework to give financial institutions
(and others) the ability to transfer their exposure to certain financial dislocations.

To move forward, the following issues have to be defined:

- Named peril and triggering events.
- Premium payable/market pricing.
- Counterparty risks/need for government support.

Some parallels may exist through an examination of the terrorism risk insurance package put forth in the aftermath of the 9/11 disaster. Following the tragic events, no insurers or reinsurers were willing to write coverage for any terrorist exposures, meaning the government needed to step in to take certain exposures and provide additional subsidies. This carried on for several years, until the industry was able to recapitalize itself and prepare to offer coverage at prices that were relatively competitive.

In the first instance, it is most likely that some form of government support would be needed for a financial catastrophe program to ensure appropriate participation and mitigate the effects of correlated counterparty credit risk (e.g., cedants exposed to the creditworthiness of the insurers writing the coverage, who would most likely sustain financial distress precisely during the financial catastrophe). In the second instance, some “leap of faith” would be required in the modeling and pricing efforts – bringing us back to the assumptions that drive so much of the risk management process.

Insurance is not the only risk transfer mechanism available in the market. In fact, another key structure for shifting risks between parties comes via securitization. While securitization has worked as a successful risk transfer mechanism since its advent in the 1980s, we also recall from Chapter 6 that it was at the heart of many of the difficulties in the Credit Crisis of 2007 and was effectively shut down for a period of several years as investors lost confidence in the process, structure, ratings modeling, and so forth. That said, the securitization market will remain in the future, a valid and viable risk transfer mechanism – though one which reverts to a more simplified and transparent process.

While the market for securitizing low severity/high frequency is by now well-established, there is also a parallel market for securitizing high severity/low frequency catastrophic risks, primarily those related to natural disasters (e.g., hurricane, earthquake, and windstorm). In fact, since the development of these catastrophe-based insurance-linked securities (ILS) in the late 1990s, average annual issuance (primarily by insurers seeking to shift exposure to create new capacity) has grown steadily through shelf registered issues into the range of $5–7b, and the asset class has tended to fare very
well versus traditional financial assets since the returns are uncorrelated.\textsuperscript{134} Again, the issue is whether the catastrophe ILS structure can be refined to accommodate a financial, rather than natural, catastrophe. While the basic structures are by now well-established, some of the same issues we have described immediately above for catastrophe insurance contracts are topical, as are others related to optimal structuring:

- Potential triggering events.\textsuperscript{135}

- Pricing of a financial catastrophe ILS versus catastrophe reinsurance.

- Potential investors in such securities.\textsuperscript{136}

In the final analysis, this prescriptive measure is likely to be viable only after the establishment of a robust insurance mechanism that provides relevant reference points with regard to modeling and pricing. Indeed, this has been the sequence of events in natural catastrophe ILSs, which only developed after years of experience with catastrophe insurance and reinsurance. Nevertheless, it is a potential future solution that can help mitigate certain risks.

Prescriptive measures such as those we have discussed above, and others that will invariably emerge with the onset of the next unique financial crisis should be considered by all stakeholders with a degree of urgency. Implementing such measures is likely to be difficult and expensive, but may in fact appear relatively “cheap” when compared to the direct and indirect costs of the next financial dislocation. Perhaps more important than the pure cost of such prescriptions will be the change in mindset and discipline that individual institutions and regulators at large will need to adopt. It is not easy, of course, to undo established practices that have developed over many decades.
Up till now, we have attempted to frame the discussion on financial catastrophes by focusing on the nature of such disasters, the ways in which a formalized risk process can help or hinder, and how some of the lessons of history can be used to our advantage to create a stronger control framework. Let us now conclude by considering the efficacy and future of risk management.

THE EFFICACY OF RISK MANAGEMENT

We have indicated that risk management exists to help a corporate institution achieve several goals, with maximization of enterprise value emerging as primus inter pares. Indeed, while all the goals are important, in the final analysis it is the maximization of the value of shareholder capital that stands above the rest: the corporate model is predicated on external capital which is only given in exchange for the promise of true value creation. If we assume that liquidity and solvency are being properly managed, then it is the maximization of profits that creates shareholder wealth. A risk management process that helps a company drive in that direction can, therefore, play a pivotal role.

This is fine in a theoretical sense, but takes on a different light when we examine corporate performance during and after a financial crisis. The question we must ask, and answer, is whether the risk management process really helps achieve that overarching goal; in other words, we wish to know whether the risk management function used by institutions is effective in helping control risks, so that losses are minimized and value is maximized.

The answer, unfortunately, is not entirely clear. Each financial crisis features different loss dynamics, with some corporate entities emerging
relatively unscathed and others being affected very dramatically. Those that are negatively impacted – to the point of generating shareholder losses, which obviously detracts from shareholder value – may fail for one or more of the reasons we have cited in Part II of the book. This includes both idiosyncratic and systemic factors, some of which can be controlled or managed at the institutional level and others that cannot.

Let us quickly recall some of the most dramatic crises of the past two decades to reinforce the point. In each case we leave aside the macroeconomic factors that might have been in play during the crisis period, as our focus is necessarily on how individual institutions and industry sectors at large were able to cope with the crisis in terms of capital and value protection. During the LDC crisis, when dozens of countries rescheduled billions of debt and caused significant write-offs, the clear losers were international bank shareholders, who had to bear the brunt of reduced earnings for several years and then outright losses as reserving actions became more pronounced. The risk management framework at most of these banks failed in advancing the tenet of maximizing enterprise value; in fact, by the late 1980s, bank stocks had plunged in value. Arguably, the time and expense spent on building risk management processes within these institutions was of somewhat limited value. We can also focus our attention on the Japanese Banking Crisis of the 1990s where, once again, individual firms – which included city banks, regional banks, credit cooperatives, housing banks, and other nonbank financial lenders – got heavily caught up in the frenzied lending process, absorbing risks that were wholly unsuitable for their operations and level of financial resources. As we know, many of these institutions became technically insolvent by the mid-1990s as a result of their misguided risk management processes, which failed to properly corral the exposures that proved ultimately to be so damaging. Again, bank shareholders who provided capital were the clear losers in this instance – not only were they unable to maximize the value of their equity stakes following the bursting of the asset bubble, but also some lost virtually all of their investment as banks were taken over or filed for bankruptcy. The value of the risk process in this episode was, again, questionable. Finally, let us examine briefly the performance of the institutional risk management process during the Credit Crisis of 2007. It is quite clear that investors in institutions from various sectors, including financial institutions, asset managers, and nonfinancial corporations, emerged as clear losers during the dislocation. The massive amount of direct and indirect losses that flowed through the system obliterated trillions of dollars of market value from the global equity markets, plunging some institutions into severe loss-making situations and even insolvency. Unfortunately, shareholders were not the only victims in this instance: taxpayers in most national systems paid some price as well, particularly as related to stimulus and bailout packages. Virtually by any measure, global
risk processes failed to protect shareholders. In fact, the most basic elements of risk management were discarded in the early part of the 2000s in favor of pursuing “quick profits” – all present valued to the current period, giving shareholders and employees the benefit of near-term gains at the expense of a misbalanced risk profile with a very long tail. Never in the history of the financial markets have such massive losses accrued in such a short period of time.

These are only three examples, but they help demonstrate the point that while risk management theoretically exists to protect and ultimately enhance shareholder value, it has done so unevenly in the past years. In the three major financial disasters in the past two decades, several trillions of dollars of shareholder value have been temporarily or permanently obliterated. To be sure, not all wealth destruction is attributable to risk management deficiencies – it also comes from general corporate mismanagement, bad macroeconomic policies, inadequate regulation, and the other factors we have discussed earlier in the book. But risk management is surely at the heart of many of the problems.

In the final analysis, it may be fine for a risk process to help manage the daily risk exposures that are necessarily part of our economic world, but the real test comes when the environment is stressed, as during a financial disaster. If the risk process is not up to the task of protecting against, or at least minimizing, the unexpected loss levels that can prove damaging, then there may be little point in pretending otherwise.

THE FUTURE OF RISK MANAGEMENT

If the efficacy of risk management is called into question in the face of repeated financial crises, then we must reassess its future role. Though the issue is complex and institution-specific, we can generalize by focusing on three options, which include

- “Do nothing”: Continue with the current framework, recognizing its inadequacy in the context of financial catastrophes.
- “Fix it a bit”: Enhance the current framework to allow for somewhat better handling of financial catastrophes.
- “Overhaul it completely”: Completely change the thinking and process behind risk management, abandoning some of the building blocks that have proven ineffective.

Let us consider each one in turn.
Option 1: Do nothing

It comes as no surprise that the easiest option is for institutions to do nothing substantive with regard to their risk processes. In other words, they can continue to manage the four-stage risk management process as they always have, relying on standard tools from the “risk toolkit” to assess their risks and making decisions in the same way they always have – recognizing, perhaps, the potential shortcomings, but willing to “take a chance.” This option has the benefit of being the least expensive on an ex-ante basis (though not necessarily on an ex-post basis, when the next disaster strikes) and the least disruptive from a corporate perspective because the structure, organization, and operation need not be changed in any meaningful way.

While preserving the “status quo” is certainly comforting (and perhaps the only practical alternative for an institution affected by inertia), it also demonstrates a lack of understanding regarding the risks that affect the financial markets of the 21st century – which, as we have illustrated, are subject to reasonably frequent dislocations. It also reveals an unwillingness to learn from the rich and expensive history of the past, reflecting a somewhat misguided corporate attitude. Importantly, this type of approach reflects the concept of risk retention – deliberately accepting a risk, but doing so in a manner that does not reflect a proactive approach to management.

In fact, this type of thinking appears flawed, as there are perhaps few (if any) institutions (particularly in the financial sector) that have not been negatively impacted by one or more of the crises we have described. To continue with the same approach and thinking is to disregard a complex and changing environment and to indicate a degree of mismanagement which shareholders should not tolerate. The massive losses that have been incurred in the past years as a result of financial crises indicate that the “do nothing” option cannot be a realistic alternative, except for institutions that have performed perfectly well during these “storms” – and there are very few such institutions.

Option 2: Fix it a bit

The second option reflects willingness by an institution to change by fixing some aspects of what has clearly not worked with regard to risk process and indicates a more forward-looking attitude. Fixing a problem requires analyzing the elements that have failed to identify the proper protections; it then demands investing sufficient resources to effect necessary changes. As we have noted in Chapter 7, the onset of large losses within an institution generally brings with it a significant “postmortem” exercise to see how the losses occurred and what processes may have failed in defending against such losses; many institutions have conducted such postmortems in
the wake of events such as 1998, 2001, and 2007. The output of this post-
mortem can prove a useful analytical tool to determine what needs to be
fixed – but it needs to be acted on.

Of course, the issue of which elements of the risk process need to be
enhanced is idiosyncratic and likely to relate to the current approaches to
risk management with all of the attendant flaws we have described earlier.
For instance, an institution may decide that it needs to enhance its model-
ing of tail events by creating a much more credible stress-testing platform.
Alternatively, it may try to improve its new product/financial engineering
vetting process so that it can get a better understanding of any new risk
dimensions that might affect the bank in the future, or it may reinforce distri-
bution efforts to sell its risk exposures to a broader number of clients.
Finally, it may alter its compensation policies so that executives and risk-
takers receive levels of pay that are in line with the long-term performance
delivered to shareholders. These are just a few examples, and others could
certainly be selected.

Under this approach it is unlikely that the changes will be radical in
nature (e.g., abandoning wholesale the conventional risk framework). We
must remember that the governing view and philosophy of the current state
of risk management relates to high frequency/low severity events, rather
than catastrophic events. It is difficult, within the current confines of think-
ing, to manage risk and business operations to tail events, though some of
these modest changes can be at least somewhat helpful.

Option 3: Overhaul it completely

The third option, which entails a complete change in the risk management
framework, involves individual institutions but is likely to be driven by sys-
temic forces. The intent under this more radical option is to redesign much
of the risk management process that currently exists into a form that can
cope more ably with the financial realities of today’s market environment.
This approach does not call for abandoning basic techniques for managing
high frequency/low severity risk events. In fact, the track record of finan-
cial and nonfinancial institutions in this area is acceptable, and retaining
this skill set and approach is important. In addition, even when errors are
made, the relatively small magnitude involved means little damage can be
wrought – certainly not enough to create solvency issues or to otherwise
threaten systemic stability.

Rather, the internal and external overhaul focuses on future handling of
high severity events, encouraging or requiring institutions to view them as
being of “moderate” frequency rather than low frequency – that is, to believe
that the tails are fatter than anyone likes to believe, and that significant losses
can accrue more frequently than the statistics would imply. This requires a
decided break with past thinking and practice, and in reality can be based on implementing the individual and regulatory systemic measures we have described in the previous chapter, which, to recap, include

- More accountable directors and executive managers.
- Better scrutiny of financial innovation.
- Improved financial transparency.
- Better use of warning signals.
- More rigorous business analysis.
- Greater use of “disaster” hedges.
- Strengthening of the qualitative approach to risk management.
- More diligent application of macroeconomic policies.
- Better control of “amplification” or “domino” mechanisms.
- Stricter control of moral hazard.
- More pragmatic and useful external regulation.
- Greater understanding of the issues surrounding regulatory forbearance.
- Greater use of clearinghouse structures and collateral exchange.
- Tighter control of institutional and systemic leverage.
- Comprehensive reform of the credit rating process.
- Rigorous alignment of stakeholder interests.
- More rapid development of financial catastrophe risk transfer mechanisms.

We stress two points which speak to the “philosophy” of risk management: firms need to properly empower their risk functions, and business should be guided heavily by experience rather than model output.
One possible organizational implementation of the “radical change” option calls for the creation of a specialized risk management team whose sole responsibility would be to enact measures and to monitor processes centered specifically on financial market tail events that might be building in the system. This team would ignore the daily risk management process applied to high frequency/low severity risks (though would certainly take as input the changing risk profile of the institution based on such exposures) and instead devote its energies to high severity events. Given the fact that many disasters seem to have their genesis in macroeconomic factors (e.g., balance of payments deficits, weak reserve levels, loose monetary policy), deep economic expertise would be a valuable addition to such a team. The mandate of this “financial disaster” risk management team would be to very clearly trace the risk profile of the firm and how it might be impacted by the onset of a new credit crisis, debt crisis, or currency crisis – making use of stress testing, catastrophe modeling, and disaster hedges as tools, but relying ultimately and primarily on the experience of the team in past crises to reshape risk exposures that might be susceptible to tail events.

We must not forget that risk is not, in itself, a destructive force – it is an inevitability of human activity and it can be managed and turned to our advantage. Bad risk management is, of course, a destructive force, as past financial crises have shown. The final decision on how to proceed may ultimately be taken by regulatory authorities (particularly as related to financial institutions, but perhaps also for nonfinancial corporates in the manner of Sarbanes-Oxley style legislation\(^\text{137}\)), or it may simply be left to individual institutions to determine for themselves. The speed at which any reforms are enacted is, of course, uncertain. The most effective way to move forward is to create change in the aftermath of a disaster, such as the Credit Crisis of 2007, while the memory of the financial damage is still fresh. Naturally, in such cases there is a tendency to “overreact” by developing excessively constraining measures that may not be value-added or may prove too restrictive in a normal business environment. However, with a proper “cooling-off” period and rational consultation between all stakeholders, it is quite possible to craft a risk management framework that will properly protect institutions, and the system at large, from future calamities.

As the global economy moves forward, we can be quite certain that financial crises will continue to be part of the landscape, even though they can theoretically be prevented. We can also be relatively certain that the traditional approaches of managing risk we have grown accustomed to using will prove inadequate. Overreliance on flawed models, which is indicative of deeper flaws related to our way of thinking about crises, will continue to create idiosyncratic and systemic problems. If we are to succeed in managing through the next crisis, we must consider new ways of dealing with the challenges presented by the next financial catastrophe – which will happen sooner than we think.
1. This follows the inverse price/yield relationship, where a rising yield is equal to a falling price and vice versa.

2. This relates to a concept known as “ability to pay,” which we can contrast with “willingness to pay,” where a debtor may have the financial wherewithal to pay its obligations but may choose not to do so for legal reasons.

3. Contingent risk may also relate to underwriters’ liability, which is a unique exposure for banks involved in underwriting corporate securities.

4. The Law of Large Numbers is a statistical theorem indicating that, for any random variable with a finite expected value, repeated sampling will yield a value that approaches and stays near the expected value as the number of sampling observations increases.

5. In some cases societies willingly increase their vulnerabilities by developing at-risk areas. This tends to occur primarily in wealthier nations, where it may still be regarded as desirable to live and work in an area that is prone to peril (e.g., a scenic coastal area exposed to hurricanes or flooding, or a scenic mountain area prone to earthquakes and land mass movement). The same could be said for risky investing – though investors can theoretically place their funds in low-risk government securities, most voluntarily add a significant element of risk to their portfolios by investing in equities, corporate bonds, alternatives, and so on. Thus, despite knowledge of risk management and vulnerability reduction techniques, political, social, and economic forces foster expansion, development, and asset allocation in risky areas.

6. Note that an associated frequency measure is the recurrence interval, or the average time within which an event equal to, or greater than, a given severity occurs; this is simply the time-independent inverse of the occurrence frequency, that is, the recurrence interval of the 7.5 earthquake in a metro area is 200 years (1/200 years = 0.005%). Occurrence frequency and return period are typically held constant from year to year in analytical frameworks, apart from any condition changes owing to man-made influences. A related concept is the nonencounter probability, or the probability that no event greater than, or equal to, a given magnitude will occur over a particular period, and is given as (1– occurrence frequency), that is, there is a 99.95% annual nonencounter probability of a 7.5+ earthquake striking in a metro area.

7. Note that for purposes of this text we are dealing solely with the economic consequences of disasters, rather than the human or social elements. In no way do we wish to gloss over or trivialize the sometimes devastating human aspect of such events, but they are not the focus of our book.

8. Man-made disasters can also include other subclasses, including genocide (arguably a form of terrorism), as well as pandemics (e.g., HIV, SARS).

9. For instance, the first World Trade Center attack of 1993 led to the loss of six lives and created $725mm of insurable damages. The 9/11 attacks led to more than 3,000 deaths and $80b of direct damages (half of which was insured) plus additional secondary damages from loss of business due to an economic slowdown, while the 2008 Mumbai bombings cost nearly 200 lives and led to direct and indirect losses from property destruction, business interruption, and even sell-off in the financial markets.
10. For instance, in a credit asset bubble, where the value of credit assets reaches a level of overvaluation that becomes increasingly unsustainable, any dislocation can cause an immediate and marked reversal of trends that leads quickly to a true credit squeeze, particularly for lower rated companies. A sustained period of high credit spread levels can put tremendous pressure on lower rated companies, which may find it difficult to borrow on any terms. Banks may become increasingly unwilling to lend to such firms, prompting a rise in default experience. This can spread into other rated companies, which may find it difficult to borrow. This can become a self-fulfilling cycle that leads to a broader credit crunch. In general, an asset bubble is difficult to bring under control in an orderly fashion. In most cases the bubble simply bursts, leaving stakeholders with significant losses. This is especially true when an asset bubble burst leads to the liquidation of similar or associated assets, which creates broader ripple effects throughout the market.

11. Historical data suggest that in a typical recession cycle (which may or may not be explicitly driven by a financial crisis) defaults can increase from an average annual rate of 4% up to 10%. A crisis-driven economic dislocation may accelerate the speed at which the negative default experience is realized.

12. See Frankel and Rose (1996), for example.

13. Note that these examples are distinct from the collapses of Mexico (1994) and Turkey (2000–01), in which the sovereigns faced liquidity problems but remained solvent.

14. This would include the underlying assets and the associated derivatives written on such assets.

15. For instance, in the credit market we may argue that expected losses represent fair value, which can be derived as the probability of default \( \times (1 – \text{recovery rate}) \). This is true during normal market conditions, but it ignores the unexpected loss dimension of the process, which is certainly of interest to us in considering catastrophic risks. This needs to be captured through a “jump-to-default” component – whether the market appropriately captures this element is questionable.

16. For instance, amongst a population of financial crises, average annual credit growth as a percentage of GDP ranged from 8% to 34%. See Laeven and Valencia (2008), p. 19.

17. The creation of asset bubbles is a distinct and involved area of study, and well beyond the scope of this work. Nevertheless, it is useful to consider in brief some of the particular forces that go into the formation of asset bubbles. In the first instance, assets tend to be bid up in price through speculative forces that seek to profit through subsequent liquidation at a higher price. Successive months or years of bidding for real estate, equities, and other assets may create the illusion that further price increases are an inevitability. This self-fulfilling behavior may continue for some time. However, at some point during the cycle the relative value of the asset in comparison with its true worth will appear misbalanced, causing initial selling. Once selling occurs (either through voluntary or forced actions), the confidence in the sustainability of the asset’s value begins to erode – sometimes very rapidly. The unraveling can accelerate significantly as sellers face a dearth of buyers.

18. To wit Kindleberger’s comment that “speculative manias gather speed through expansion of money and credit or perhaps, in some cases, get started because of an initial expansion of money and credit” (Kindleberger, 1978, p. 54).

19. At least some warning signals may be evident during periods of excessive leverage. For instance, at the peak of the cycle borrowers may find themselves in the beneficial position of being able to dictate the terms of their borrowings, as banks and other lenders move into extreme competition for the business. These terms may relate not only to specific pricing (e.g., low fees and ongoing rates that create a risk-return misbalance for lending institutions), but also to liberal covenants (including, e.g., so-called covenant lite packages featuring very favorable terms related to interest and fixed asset coverage), and excessive leverage multiples (with total debt expressed as a multiple of earnings before interest depreciation and amortization, or EBITDA, ranging from 3 to 5 times during normal cycles up to 8+ times during excessive leverage cycles).

20. Similar theories also exist through the work of Clement Juglar, who posited the concept of the Juglar cycle, which was based on a strong growth period with significant prosperity, consumer confidence, and consumer demand. Following some peak and trigger event, consumer confidence would collapse, leading to economic contraction and significant devaluation of investments and other hard assets. In the extreme, periods of stagflation would follow.

21. Interestingly, Minsky also put forth some thoughts on ways of avoiding the collapse phase – in his view the ensuring disaster is not necessarily inevitable, though the highly fragile and unstable
state must be handled with extreme caution. Specifically, there are two broad paths that can be followed: (1) allowing inflation to increase in a gradual fashion so that the rising cost of goods and services results in spending restraint and (2) an endogenous decline in asset prices in a gradual fashion accompanied by a lower increase in interest rates. Such conceptual arguments may not, of course, work in a timely enough manner.

22. Knowing that asset bubbles, whether leveraged or unleveraged, can be dangerous, we must consider whether it is possible to identify the buildup of a bubble ex-ante rather than ex-post. Many models are available to explain the creation and expansion of bubbles. However, the interesting issue is whether there are practical dimensions to such models that indicate a bubble is in some stage of formation. For instance, a skewed risk/return profile for a lending institution may be indicative of the type of “irrational exuberance” that presages a collapse. A “herd mentality” that finds banking institutions pursuing the same business may also be a form of warning. However, transparency is often difficult to obtain, so a rigorous ex-ante analysis framework is still somewhat limited.

23. Resolution of debt problems must typically feature supranational, governmental and private sector solutions. In the case of the first two, emergency loan packages, liquidity facilities, and other guarantees may be made available to troubled countries, typically with significant conditions attached (including austerity programs and structural reforms). In addition, through a government and private sector partnership, the establishment of a framework for the orderly workout of debt obligations is necessary. This may include rescheduling, restrucrurings, or debt/equity swaps, or some combination of the three; indeed, this is the only practical way for debtor nations to ultimately return to the international capital and loan markets. Naturally, participating banks must typically be willing to sustain rather significant writedowns as part of the process (e.g., as in the debt reschedulings that accompanied the LDC debt crisis of the 1980s) – which of course brings with it the specter of concerns regarding the stability and health of the banking sector.

24. For example, in countries such as Thailand and Korea, finance companies have in the past been at the center of problems; similarly, in Jamaica, the insurance sector has been a cause of problems, while in the United States, monoline insurers and derivative product companies have compounded downward pressures.

25. Evidence suggests that while provision of additional liquidity may be a short-term phenomenon, the extension of deposit guarantees in excess of some insured level lasts between 4 and 5 years.

26. Recapitalizations impose the dramatic step of effectively eliminating most value from Tier 1 investors (e.g., holders of common equity and certain other qualifying instruments); in some cases it can also extend to Tier 2 capital investors. In either event, this can create difficulties in attracting future investors when the national authority seeks to “reprivatize” its holding.

27. In fact, we can easily go back to the 14th century and the creation of credit and early state loans/securities in the Italian regions to find the first instances of widespread speculation leading to asset bubbles and subsequent collapse. This type of activity was evident on a regular basis through the years, expanding into the money and credit markets of France and Flanders in the mid-16th century and from there to the increasingly sophisticated Dutch markets of the 17th century. In fact, the New Exchange of Amsterdam featured a wide array of financial instruments including shares in joint stock companies and early derivatives that promoted the use of leverage; each of these was the subject of speculative activity which was, in some cases, so significant as to cause temporary dislocation in the markets and local economies upon collapse. Such speculation also extended to commodities including, infamously, the tulip bulb – in the 1630s the leveraged purchase of tulip bulbs became so extensive and leveraged that when the bubble inevitably burst, the common person using personal credit notes to effect ill-advised purchases was damaged to some extent. Though there are varying accounts regarding the extent of the economic damage after the market collapsed in 1637 it was, by any measure, a crisis at the time. When London emerged as the financial successor to Amsterdam in the late 17th century, much of the speculative activity traveled there as well. In fact, the wider use of bills of exchange as a form of credit that became part of the London money markets fueled speculative activity. It was supplemented by the increasing use of the joint stock company organization to raise capital, sometimes for purposes which were of a questionable, if not fraudulent, nature. In fact, rampant and extended speculation in South Sea Company shares started in 1720 and expanded to other so-called bubble companies without legitimate operations (as well as several insurance companies that arguably had a legitimate
business), and enveloped individuals in all classes of society. Not until certain legislative decrees were passed and foreign interests began selling their shares did the South Sea Company collapse, leaving the public, politicians, and directors with significant losses. This triggered an economic recession, which was almost certainly prolonged by the inability of legitimate companies to raise further capital from a wary investing public. The speculative fever of the late 18th century ultimately shifted to other assets, including consols and government loans, followed by foreign government loans (and those of South America, in particular).

28. For instance, in 1825 the London financial markets introduced many new joint stock companies to the investing public, which renewed the speculative activity that had reached a fevered pitch during the 18th century. This culminated, ultimately, in a nasty crash and a significant economic downturn in England and on the Continent. Further episodes followed in the ensuing decades, with shares in canal companies and then railroads forming the nexus of interest. The bubble that formed in English railroad shares culminated in a spectacular burst in 1847 – which, when coupled with agricultural failures, bank failures, and depleted reserves at the Bank of England, spun the English and then Continental economies into collapse. As the pull of the US economy and the role of the United States in foreign trade increased, its own financial markets became increasingly vulnerable to speculative forces. For instance, in the mid-19th century, call loans (another term for margin loans) became increasingly popular in the purchase of stocks, which added greatly to volatility (and which would play out dramatically in 1929). Speculative markets developed in a range of commodities both before and after the American Civil War, while unsavory stock operators pushed shares in new mining and railroad companies in the latter part of the century. In fact, a massive speculative bubble that built through the late 1860s and the early 1870s (driven, in part, by Gould and Fisk and the “robber barons” that altered the landscape in railroad shares) burst in 1873, resulting in the first-ever closure of the New York Stock Exchange, for 10 days. The culmination of a decade of overinvestment that drove up asset prices took a heavy toll and resulted ultimately in a severe US economic dislocation that lasted nearly 10 years.

29. For instance, following on from the significant US dislocation of 1873, the US markets featured banking crises in 1884, 1890, 1896, and 1907 though all were significantly smaller than the episode of 1873.

30. While the root causes of the Panic of 1907 were varied and complex, the catalyst appears to have centered on a failed attempt by various institutions to put the stock of US Copper into play through leveraged positions. The decision by a number of New York banks to pull back on this lending sparked a series of bank runs that soon spread almost out of control. The collapse of the influential Knickerbocker Trust (itself part of the US Copper speculation) caused a plunge in share and commodity prices, precipitating a larger decline in the US stock market (which lost half of its market value by the time the debacle was done). The US Treasury attempted to inject liquidity into the banking system to avert further panic but lacked the influence and resources to do so (to recall, there was no effective US central banking mechanism at this point). While JP Morgan was ultimately able to organize a consortium of solvent banks to pump money back into the system, halt the bank runs, and stabilize the markets, the economy sustained damage and fell into recession. The Federal Reserve System was created in the aftermath of the crisis (1913) – though it was, in fact, a relatively ineffective mechanism and was at least one reason for the buildup of events that culminated in the Great Crash of 1929. The 12 Federal Reserve banks were only loosely coordinated, and lack of strong central leadership led to growth in speculative capital and insufficient oversight of the financial system. The entire central banking system was reorganized in 1934, becoming a much more effective regulatory body that helped contain major disasters – at least until the Credit Crisis of 2007.

31. See Laeven and Valencia (2008) for a comprehensive overview of major systemic financial crises. The authors present their findings based on extensive database of banking, currency, and debt crises around the world. While some of these crises are relatively small and self-contained and others are of greater systemic importance, the breadth helps reinforce the point that financial dislocations occur more frequently than we sometimes believe.

32. It is important to note that this represents perhaps the single most comprehensive compilation of data from the post–Bretton Woods area. It should not, of course, be interpreted as an indication of the sum total of all financial crises.

33. While there are many examples of this, a dramatic reminder came in late 2008 with the Madoff scandal: a $50b, multiyear Ponzi scheme run by a previously well-regarded financier caused
individuals and institutions that had invested all, or substantially all, of their assets through Madoff-sponsored funds to lose their entire fortunes. More than a few investors had concentrated 100% of their wealth with Madoff and were left with nothing.

34. Securitization has, in the past years, been a key element of the “originate and distribute” used by many financial institutions. Under this model, a bank originates a particular type of risk with an end goal of distributing the risk through a structural transformation into a tradable, securitized instrument. While this model worked successfully for quite a number of years (dating back to the early 1980s when the first mortgage-backed securities were developed), it encountered major problems in 2007. In fact, failure by originating banks to distribute all risk elements was a major reason for the very large losses they sustained in 2007 and 2008, as we will note in Chapter 6.

35. A firm can select from among a number of different derivative contracts to achieve its goal, including swaps, options, forwards, and futures. Each of these instruments has slightly different characteristics, costs, and payoff profiles, so a proper analysis is required.

36. It is worth noting that the approach and techniques described in this section are also applicable to a variety of investment fund and hedge fund management companies as well. Most funds take similar credit and market risks (though they are not, in the main, originators of products), and must, therefore, have in place a similar framework to evaluate and manage their risks. Most large funds have formal risk management functions.

37. Naturally, much depends on the nature of the hedge employed. Hedge transactions that are executed in the OTC market can result in the assumption of counterparty risk (depending on how collateral contracts are negotiated); those that are arranged through exchange-traded markets do not create counterparty risk but demand the posting of initial and variation margins, which represents a cost.

Actual hedging can occur through OTC contracts such as vanilla and exotic options, swaps, and forwards. Each of these creates a tailor-made solution that has the benefit of eliminating or reducing any potential basis risks. Exchange contracts can take the form of listed futures, options and futures options. What the bank may gain in terms of lack of counterparty risks, it loses in flexibility, as most exchange contracts (apart from so-called flex contracts) have very standardized features that remove a certain amount of flexibility and introduce basis risks.

38. For an insurance contract to be binding, it must include offer/acceptance and must be executed with knowledge and legal purpose. The contract itself is aleatory rather than commutative, meaning that values exchanged are unequal and uncertain. Insurance, therefore, represents the transfer of fortuitous losses from the cedant, which pays an economically fair premium to the insurer, who agrees to provide relevant indemnification (i.e., settlement of a claim that occurs as a result of a named peril or event).

Portions of the notes in this section draw on, and are adapted from, Banks (2005); a detailed discussion, with examples, can be found in that test. Within the general category of loss financing (risk retention/risk transfer), we note a spectrum of transferability that moves from minimum (e.g., significant retention via structural features in standard contracts, dedicated risk financing products, captives) to maximum (e.g., full transfer via structural features in standard products). These are, in fact, the very products that an insurer would offer to its ceding clients, including corporations (as discussed later in the chapter). By way of background, we can distinguish between full insurance and partial insurance: Full insurance is a maximum risk transfer contract designed to shift as much exposure as possible from cedant to insurer in exchange for a fair premium. A traditional contract is based on an upfront premium payment for one year of cover. Full insurance is generally characterized by a small deductible, large policy cap, limited (or no) copay/coinsurance, and limited exclusions. A cedant creating a full insurance maximizes its premium payment (cost) in exchange for what it perceives to be greater risk transfer advantages (benefit). Thus, a company with $1m of exposure to a particular risk that prefers minimal risk retention can purchase a policy with no deductible or exclusions and a $1m cap. This ensures it will receive a compensatory payment of any losses up to $1m if the named event occurs.

Partial insurance is a standard insurance contract that is altered so that the cedant retains more, and thus transfers less, exposure. This results in a lower premium payment from the cedant to the insurer, consistent with the cedant’s desired cost/benefit trade-off. In practice, full insurance can be converted to partial insurance by changing deductibles, policy caps, coinsurance, and/or...
exclusions. A deductible, which is the cedant’s first loss retention, can be set on an individual loss basis or in aggregate (i.e., the sum of all loss events occurring during the coverage period); the greater the deductible, the greater the retention and the smaller the transfer. Policy caps can also be used to define a level of risk retention by limiting the insurer’s settlement liability to the cedant: the smaller the cap, the greater the ultimate retention and the lower the transfer. Policy caps because they need not be as precise in estimating the tail of the curve and can cap their liabilities. Risk transfer can also be limited through coinsurance/copay features, where the cedant and insurer share in a certain amount of losses. The greater the cedant’s coinsurance percentage, the greater its retention and the lower the transfer. Policy coverage/exclusions are another form of risk retention. By specifically defining the scope of desired coverage the cedant indicates which risks it is willing to retain and which it prefers to transfer. As the number of exclusions increases – either as broad categories of risk (e.g., catastrophic P&C) or specific events (e.g., European windstorm) – the implicit level of risk retention increases and the amount of risk transfer decreases.

40. Reinsurance contracts can be written on a facultative or treaty basis. Facultative reinsurance is the term applied to any transaction that involves a case-by-case review of risks. Under a facultative contract, which is highly customizable, the primary insurer is not obligated to cede a particular risk, nor is the reinsurer required to accept it. Each risk that is ceded and accepted is analyzed on its own merits and governed by a separately negotiated contract (reflecting the bespoke nature of the process). Not surprisingly, a facultative agreement is often used when risks are very large and unique, or require special analysis and consideration. Facultative reinsurance is widely used to cover various risks in the P&C sector (including those with catastrophe characteristics). For instance, standard insurance lines in the property sector may be reinsured through a facultative agreement based on analysis of probable maximum loss and maximum foreseeable loss; a similar arrangement can be concluded in the casualty sector to cover general liability, automobile, workers’ compensation, excess liability, or umbrella covers. In general, the ceding insurer gives the reinsurer information on the specific exposure it seeks to cover. If the reinsurer agrees to accept the risk it provides a quote and written confirmation; if the insurer accepts the quote, the reinsurer then forwards confirmation of binder and receives a policy from the insurer, which it uses to prepare the final certificate of reinsurance.

Though facultative business gives both parties greater ability to specifically examine risks prior to commitment, it also means that there is no ex-ante guarantee of cession or coverage. Thus, if the reinsurer believes that a particular exposure generated by the primary insurer is inconsistent with its own risk tolerance, it can decline to write the cover. Or, if an insurer generates an especially profitable risk, it may choose to retain the entire exposure.

Treaty reinsurance, in contrast, is a contract where risks are automatically ceded and accepted (for that reason it is sometimes referred to as obligatory reinsurance). The primary insurer agrees to cede a portion of all risks conforming to preagreed guidelines under a treaty agreement; the reinsurer is similarly bound to accept all conforming risks. Underwriting criteria in the treaty must be delineated with enough specificity that there can be no doubt about the nature of risks to be ceded and accepted. Those that conform to established guidelines are automatically transferred; those that do not conform fall outside the scope of the treaty and must then be considered on a facultative basis. While the treaty process is efficient and economical (i.e., less expensive on a “per risk” basis than facultative cover), and provides comfort that coverage will be available when needed, it also reduces the reinsurer’s “underwriting power”; that is, the reinsurer agrees to absorb all conforming risks, up to a limit, without being able to inspect each one individually. In addition, some of the risks assumed by the reinsurer through the treaty may ultimately be unprofitable (though in the long run the reinsurer expects the relationship to be profitable). Similarly, while the ceding insurer gains comfort from having automatic capacity for conforming risks, it can no longer choose to retain selective exposures for its own book (i.e., very profitable ones, or those that help with its portfolio diversification efforts). A great deal of catastrophic and noncatastrophic reinsurance is written on a treaty basis.

Reinsurance risks, returns, and losses can be divided between the primary insurer and the reinsurer on a proportional (or pro-rata) basis or an excess of loss basis. This is true for both facultative and treaty risks.
Proportional agreements, such as the quota share and surplus share arrangements discussed immediately following, require the insurer and reinsurer to share premiums, exposures, losses, and loss adjustment expenses (LAEs) on the basis of a predefined formula, such as a fixed or variable percentage of policy limits. By way of contrast, excess of loss (XOL) agreements (sometimes known as nonproportional reinsurance agreements) call for the insurer and reinsurer to allocate risks and returns in specific horizontal or vertical layers; depending on the magnitude of losses and the sequence and level of attachment, a reinsurer may or may not face some cession and allocation of losses. The advantages to the insurer in using an XOL mechanism include greater protection against frequency or severity (though this depends on retention), increased retention of net premiums, and improved efficiencies in administration and premium allocation; XOL agreements also allow insurers to reduce peak exposures to retention levels they feel are more manageable. XOL protection can be arranged separately for each loss (e.g., loss per risk cover) or for each event (e.g., loss per event cover), and is generally designed to cover only a few large losses; if too many claims arise, the pricing may not be economical.

Under the proportional quota share (QS) structure the insurer and reinsurer agree to split premiums, risk, losses, and LAEs as a fixed percentage of the policy limit. The reinsurer, thus, pays the primary insurer a ceding commission for a share of the exposure and premium. A QS permits the ceding insurer to reduce its unearned premium reserves (through premiums ceded to the reinsurer) and increase its surplus (through commissions received from the reinsurer). The assets of the ceding insurer are reduced by the premium paid to the reinsurer, while liabilities (reserves) are reduced by the lower unearned premium reserve. Since the decrease in liabilities is greater than the decrease in assets (by the amount of ceding commission received) the ceding insurer’s surplus increases. The QS can also strengthen other financial ratios, such as premium to surplus; the more capital an insurer has on hand to support the premiums it is writing, the stronger its financial condition. A QS written with a creditworthy reinsurer provides the insurer with credit for reinsurance ceded, helping decrease the premium to surplus ratio.

Through a proportional surplus share (SS) structure the reinsurer agrees to accept risk on a variable percentage basis above the insurer’s retention limit, up to a defined maximum (known as a line), and pays the insurer a ceding commission for a share in the premium. Once the insurer’s retention limit has been exceeded, the reinsurer assumes the additional exposure, and resulting premiums, losses, and LAEs are shared between the two on a fractional basis. Since a separate dollar retention is set for each policy (or certain groups of policies) the sharing is variable in percentage terms across an entire portfolio.

41. A policy may be deemed to provide catastrophic cover if it provides for indemnification when a specific named catastrophe event occurs, or when an insurable event occurs and creates large losses for the cedant, for example, when amounts exceed a large deductible and the policy features a large cap – this is equivalent to the insurance providing the cedant with upper layer coverage.

42. For instance, P&C coverage is intended to provide postloss financing for any physical property that is damaged or destroyed by a catastrophic peril. Under many P&C contracts, insurers use actual cash value (replacement less depreciation) rather than replacement cost to determine postloss settlement if property is destroyed and not rebuilt or replaced. Most P&C contracts are written on an occurrence basis, where the full limits granted apply to each catastrophic event, without a maximum aggregate; any deviation from this practice must be specifically noted in the policy through the establishment of aggregate loss limits. Liability coverage, in turn, provides economic restitution from losses or injury sustained as a result of inadequate safety or protection measures that become evident in the aftermath of a disaster; building owners (e.g., third party property owners) are often required to provide tenant companies with liability coverage. Business interruption coverage is intended to provide compensation for revenues lost as a result of an inability to operate business in a normal fashion after a catastrophe strikes. In most policies the coverage is written on the basis of “actual losses sustained,” meaning that cedants and insurers must mutually agree on amounts lost. Workers’ compensation coverage relates to economic restitution for workers who are unable to continue working as a result a catastrophe-induced interruption that prohibits normal functions from being carried out, or injury that prevents workers from completing their assigned duties. Coverage can be seen as a replacement of lost income. Life coverage provides economic restitution to the beneficiaries of any individual that has lost his/her life as a
result of a particular catastrophic peril. Though insurers write such policies on an individual basis, they may also do so for an entire company on a group-wide basis; to minimize large losses from a single incident, an insurer may avoid writing group life cover for a single company that occupies a single at-risk location. Health coverage provides financial payments for any health-related injury or illness caused by a disaster; coverage often extends to medical consultations, hospitalization, and prescriptions.

43. For instance, providers of “financial disaster” coverage may themselves be susceptible to financial pressures during a dislocation.

44. Portions of the first two sections of this discussion are adapted from Banks (2005).

45. In practice, models often use Poisson processes to determine the number of catastrophic events that can occur in a given period, and individual probability loss distributions for each event are then developed and combined. If data are in the form of thousands of independent catastrophes, it is generally necessary to create separate frequency and severity curves. This can be done by applying certain assumptions (e.g., the sum of independent Poisson variables is itself Poisson, the severity distribution is discrete with probability equal to the Poisson frequency renormalized to 1) and allows practical computation of frequency and severity, for example, in $x\%$ of years there will be 0, 1, 2, 3, 4, etc., events; if an event occurs, $x\%$ will be less than $5x$ in size.

46. Drawing an example from the world of natural catastrophes, the spatial location and intensity of a hurricane can be modeled through a combination of meteorological data, physical/numerical weather prediction, meteorological equations, and expert opinion. Atmospheric pressure buildup, peak, and subsidence can be developed through input parameters. The resulting hurricane path can then be supplemented by wind-speed profile computations derived from meteorological data and local topography analysis. The spatial dimensions of earthquake events are based primarily on known fault lines, which are the source of most of the Earth’s seismic activity. Earthquake intensity can be modeled through regression, weighted by distance to the epicenter or hypocenter, or through attenuation functions and spectral ordinates (mathematical functions that describe a decrease in amplitude as seismic waves spread out from the rupture source). These processes may be supplemented by an examination of surrounding geological characteristics; soil composition, hydrological features, and potential for liquefaction all influence the speed and dispersion patterns of seismic waves. Regardless of the specific methodology and peril, event intensity is obviously critical to the process, as there is a high, though not perfect, degree of correlation between intensity and loss levels. This is particularly true in the region most immediately exposed to an event, as intensity tends to decline with dispersion or distance. The temporal aspects of an event can be estimated by understanding the effects of time on occurrence. For instance, we have indicated that Atlantic hurricanes occur from June to October, with a peak in August and September (the same is true for Pacific typhoons). This temporal relationship must be explicitly included in a hurricane hazard module. The temporal aspects of an earthquake can be modeled in one of two forms. Small or moderate events may be treated as a random process, where the probability of a future event is not influenced by the location or time of a previous event (e.g., time independent/Poisson variables). Large events can be modeled on a time-dependent basis, where the probability of an event is conditional on the time since the last event in the same region.

47. For instance, given a general loss distribution function $F(x) = P(\text{loss} \leq x)$, the exceedance probability $EP(x) = P(\text{loss} > x)$, or $(1 - F[x])$.

48. Ultimately, pricing of catastrophe risk requires high quality data so that loss distributions can be created. In such cases expected losses can be regarded as the fair value benchmark – but only if catastrophe risks can be diversified to some degree and exposure computations are unbiased; this reverts to our earlier point, where we noted that the Law of Large Number allows expected loss levels to be used with confidence when a large number of statistically independent events are included in the portfolio. In such instances we can examine the probability of a catastrophe of a certain minimum magnitude by estimating frequency/severity distributions. We can then use distribution information and market share to derive the probability distribution for a single risk, and then estimate expected losses. Unfortunately, pricing catastrophe risk is rarely this straightforward. When a catastrophe portfolio is not diversified enough, statistical assumptions break down, making it difficult to relate the variability of losses to the expected loss level. The variance of losses in the portfolio is much higher than in a noncatastrophic risk portfolio, meaning pricing has to be adjusted to a multiple of the expected loss benchmark to protect operations.
49. The primary difference between the distributions relates to the thickness of the tail, as defined by a shape parameter \( \varepsilon \). For the Gumbel distribution, \( \varepsilon = 0 \), for Frechet, \( \varepsilon > 0 \), and for Weibull, \( \varepsilon < 0 \). See Kotz and Nadarajah (2000) and Tsevas and Panaretos (1998) for additional background on the mathematical aspects of EVT construction.

50. Consider, for instance, in a VAR model that if \( X \) is a random variable representing the portfolio losses, we can calculate for some confidence level \( \alpha \) the level of \( U_\alpha \) so that the probability of \( X \) exceeding \( U_\alpha \) is simply

\[
P(X > U_\alpha) = 1 - F(U_\alpha) = \alpha.
\]

The mean excess loss conditional that a loss above \( U_\alpha \) (VAR) occurs is

\[
e(U_\alpha) = E(X - U_\alpha | X > U_\alpha).
\]

Given that \( F \) is a density function with excess distribution \( FU \), \( U \geq 0 \), then under reasonable conditions on \( F \) there is a class of density functions that can approximate the excess density function

\[
F_U(x) = P(X - U \leq X | X > U_\alpha), X \geq 0.
\]

51. Depending on the sophistication of the insurer this may be output from a proprietary catastrophe risk model, or it may be output supplied by one of the major commercial model providers, for example, RMS, AIR, EQE. It can also be supplemented by historic industry and insured loss data (where such exists). This output is, of course, essential in allowing an insurer to consider insurance and reinsurance pricing levels obtainable in the market, and whether it makes sense to retain or cede the risks.

52. For instance, this may take the form of \( x\% \) or loss probability of capital falling below \( 10x\% \) of stated minimum capital. It can also be defined in terms of \( \% \) of net written premiums, or some other metric.

53. Consider, for instance, that terrorist models make use of expert opinions that are exchanged and refined in multiple rounds (e.g., the Delphi method). Through this multiple questionnaire process, researchers can refine their views until a consensus is built. Typical focus questions relate to number of incidents per year, type of activity, form of attack and intensity/severity, primary and secondary targets, likelihood of target substitution in the event of visible protection or hardening, fallout impact in the event nonconventional weapons are used, etc. This process is not without shortcomings, of course – in particular, while each expert may be a specialist in some area of terrorism, the process may not be extendible to other areas of terrorism; in addition, there may also be a tendency to overstate threats in the aftermath of an event, for example, potential threats may have been perceived as larger after 9/11, or the July 2007 attacks in London, or the November 2008 attacks in Mumbai. Note that this general approach exists, in some sense, with regard to economic models – consensus building on growth, earnings, inflation, and so on is part of regular financial disclosure and analysis. However, such approaches tend to deal with normal expectations rather than disaster events. Adapting the framework for greater focus on the low frequency disaster events must be considered as an important future step.

54. Over the medium-term it is incumbent upon those dealing with disaster risks to champion the use of consistent data definitions and central data repositories, particularly those that have cross-border interest (and which are, therefore, more likely to be funded and maintained). Supranational organizations and industry groups, for instance, should consider development of databases with information related to assets, losses, replacement costs, and so forth. As part of any such exercise, data standardization is desirable so that inputs across countries are consistent. Importantly, such a repository must be based on a true assessment or estimate of findings, and not subject to manipulation for political or economic purposes.

55. During this episode a series of speculative pressures led to a market plunge and a bank run in the newly liberated United States. The Federal Government, already attempting to deal with the excessive debt burden of states such as Massachusetts and South Carolina, was thrust into the spotlight: speculators were moving rapidly to corner certain securities held at the Bank of New York Stock (including 6% government bonds), driving the value of the securities up to unrealistic levels. When the inevitable bursting of the bubble occurred – including a 25% decline in the value of securities in April of 1792 – a bank run commenced, fueling panic in the market. The Government, through the Treasury, borrowed money from the nascent banking system and used the funds to buy up securities and support the market. In a technique that would be replayed
In future years, banks were instructed to accept securities as collateral for loans to securities brokers, thereby ensuring an ample degree of liquidity in the system and a fair value for the government bonds.

56. In 1866, Overend Gurney, which functioned as a major City bill broker and discounter, collapsed after the Bank of England refused to provide a bailout, leaving in its wake debts of GBP11mm. The collapse of Overend quickly spread into the London money and banking markets, resulting ultimately in runs that put more than 200 institutions out of business. Apart from the economic damage that was wrought, the event created a sense of distrust in London’s financial markets that lasted for years.

57. For instance, from the 19th to the 21th centuries the United States has suffered significant financial disasters in 1819, 1837, 1873, 1884, 1890, 1896, 1907, 1929, 1987, 2001, and 2007. The United Kingdom has suffered repeatedly as well, as in 1825, 1847, 1866, 1929, 1973, 1987, and 2007. France, Holland, Germany, Scandinavia, Argentina, and many others have had their share of crises over the decades, too. All of these episodes form part of the broader database referenced in Chapter 3.


59. For instance, by 1926, 65% of all automobile purchases and 40% of all department store purchases were done through bank, auto, or retail credit.

60. Not only were trusts purchased by investors on a leveraged basis, but trust operators often leveraged their own bets as well, which increased systemic leverage even further.

61. There were approximately 2mm investors active in the market during this period, or nearly 2% of the population. This was, however, still a “wealthy man’s game” — 5% of the US population controlled 90% of the wealth-producing assets, meaning that when the crisis ultimately struck, the direct losses were borne primarily by wealthy individual investors (and institutions, of course); however, the secondary effects of the economic dislocation were borne by the entire population and, one might argue, even more heavily by day laborers and agricultural workers who found themselves unemployed.

62. Interestingly, the Federal Reserve, which ostensibly was responsible for constraining the balance of margin credit flowing into the stock market, had a difficult time of it as much of the funds were supplied either by foreign banks or by domestic nonfinancial corporations, neither of which was under the purview of the Fed.

63. US GDP contracted by 9% in 1930, 8% in 1931, and a further 13% in 1932.

64. The labor force shrank by 4.8% in 1930, 6.5% in 1931, and 7.1% in 1932.

65. To help resolve the problem, the US Government created the Home Owners Loan Corporation to prevent further foreclosure activity. Through the HOLC the Government purchased defaulted mortgages from banks, refinancing them at low fixed rates with 15-year terms and holding them until maturity. As a result of HOLC’s efforts, approximately 1mm foreclosures were averted, a significant relief for many homeowners. Similar mortgage relief would appear during the 2007 Credit Crisis.

66. In fact, many pools included company directors on their boards, to add a degree of “credibility” to their operations and lure in unwitting investors.

67. Indeed, the abuses and lack of transparency were so widespread that they led to the creation, in 1933, of the Glass-Steagall Act, which led to a separation of the securities and financing activities of banks (leading to the development of investment banks and commercial banks), the establishment of the Securities and Exchange Committee, the creation of the Securities Exchange Act (covering trading, disclosure, and so on), the short-selling uptick rule, and so on. Many, though not all, of these changes remain in place to the present time.

68. Indeed, many of these banks had begun to suffer considerable profit erosion as their traditional banking business was disintermediated. For instance, large, blue-chip corporate customers increasingly accessed the burgeoning US commercial paper market for their short-term funding, effectively bringing to an end the once-lucrative short-term working capital loans provided by banks. The same began to occur in medium- and long-term capital raising, where established companies could access the US bond markets and the very efficient and attractively priced Eurobond market, which had expanded rapidly throughout the late 1960s.

69. The Eurodollar markets refer to US dollar borrowing and lending that occurs outside of the United States. The rapid expansion of the Eurodollar markets occurred as a result of a favorable tax
and regulatory environment, which encouraged US banks to conduct significant portions of their international business from outside US borders.

70. As if to add to the woes of dollar borrowers in the emerging sector, the US dollar appreciated 11% in 1981 and 17% in 1982, meaning the effective cost of debt service for nondollar countries was even higher. Capital flight from many Latin American countries, in particular, added more pressure, as residents sold local currencies for dollars and exported their funds to perceived safe havens.

71. The specter of pure sovereign default had obviously increased in tandem. Though the secondary market for loan trading was still in its infancy, those willing to buy and sell syndicated loans of nations that had declared a moratorium could do so at discounts of 10%–25% in 1983; by the middle of the decade the discounts had increased to 50%.

72. There were, of course, a series of asset sales and capital raisings during this period, which helped shore up relatively low capital bases. However, the FDIC estimated that seven or eight of the ten largest US money center banks would have been technically insolvent had they been required to reserve against their LDC portfolios. In the event, the banks managed to retain public confidence, meaning funding proceeded uninterrupted throughout the crisis period.

73. Certain other solutions accompanied the restructuring talks, such as debt-equity swaps and asset sales; these, however, were quite opportunistic in nature.

74. In fact, this is precisely what occurred, as the Federal Funds rate moved from approximately 5% in 1970 to over 14% by 1980 as the Federal Reserve sought to combat oil-based inflation pressures. This followed 1980 legislation, the Depository Institutions Deregulation and Monetary Control Act (DIDMCA), which, among other things, permitted S&Ls to offer market-driven checking accounts.

75. While these activities were still subject to certain maximum limits, it was not long before management found creative ways of circumventing the letter of the law. Regulators, led by the Federal Home Loan Bank Board, allowed a loosening of controls, initially allowing thrifts to reduce their net worth requirements from 5% to 4% of deposits. In fact, this was just the beginning of similar such moves.

76. In fact, the underwriting standards for large loan commercial business were certainly much different than they were for small-ticket residential mortgages – many S&Ls were simply unprepared for the new wave of business and, in retrospect, made many poor loan decisions due to both their inexperience in the commercial sector and their reliance on bad property appraisals.

77. Another factor contributing to stress in the industry came from the conversion by many institutions from mutual to capital stock organizations. During the key period in question, a large number of large thrifts opted to demutualize their operations, converting from depositor-owned organizations to traditional publicly owned firms listed on a stock exchange. In making the conversion, the new stock companies had to face the reality of delivering earnings to a base of investors that did not want to be disappointed. This meant searching for new profit opportunities and taking on new risks, including those that may not have been thoroughly understood (e.g., mortgage derivatives). In more extreme situations, it may have also led to abusive behavior. In fact, by some estimates up to 20% of the S&L failures recorded during the crisis period were associated with some form of fraudulent activity (note that this applied to all S&Ls, not just those that had converted to joint stock status).

78. Indeed, by 1983 approximately 10% of S&Ls were technically insolvent on a GAAP basis.

79. For instance, between 1976 and 2000, US mortgage loans nearly doubled from $700b to $1.2t. History would eventually reveal that many of these loans were of dubious quality, not unlike the experience during the 2007 Credit Crisis.

80. Lincoln S&L became one of the largest failures, costing taxpayers over $2b.

81. The battle included a sharp tightening of interest rates to drive down crippling inflation, which culminated in a recession that lasted until 1982.

82. Portfolio insurance was a quantitative process based on submission of computerized trading orders that led to buying of stocks as the markets traded up, and selling as markets traded down. While the intent was to do so based on baskets of individual stocks, in some cases index contracts were used as convenient substitutes, particularly for asset managers benchmarked to specific index performance.
Interestingly, portfolio insurance proved to be a triggering factor in the dislocation much as the liquidation of margin loans had been during the October 1929 Crash, and just as structured product triggers would be in the Credit Crisis of 2007.

Standard option pricing frameworks require various inputs to generate a value – these include strike price, stock price, risk-free rate, time to maturity and volatility, which is generally implied from other traded options to generate an option value. The inability to obtain a credible implied volatility parameter made it impossible for market makers to quote prices with confidence, so most just pulled back.

EF Hutton’s operations were assumed by Shearson Lehman, which itself became part of American Express.

The junk-bond, or high yield, market, which grew aggressively during the mid-1980s as the LBO “frenzy” called for additional amounts of leverage through the capital markets, was subject to a range of speculative abuses that led ultimately to the collapse of pioneering junk-bond house Drexel Burnham Lambert, which filed for bankruptcy in June 1989. Just 4 months later the junk-bond financed LBO of United Airlines fell apart, causing broader dislocations in the junk-bond market. Subsequent defaults by major firms, such as Campeau and Integrated Resources, ushered in a wave of corporate defaults in 1990, which eventually reached 9% (or four times more than the average annual corporate bond default rate). The simultaneous collapse of the US S&L industry, which had also been active in the purchase of junk bonds, brought the market to a standstill.

The yen swap rate allowed some companies to issue Euromarket debt in Swiss francs, US dollars, or other currencies and swap back into yen for an effective zero cost, or even negative cost, of borrowing. This funding arbitrage meant that far too much cheap credit was circulating through the system, artificially boosting the prices of a range of assets.

An extreme example of this can be found in Hanwa Steel, a steel trading corporation that shifted its focus entirely to financial speculation, raising $30b in the Euromarkets to invest in a range of speculative assets. Hanwa’s strategy was ultimately unsustainable, and it ran aground. While this is an extreme example, many other companies followed the same path, raising lesser, but still significant, amounts of money for speculation.

During this frenzied period, stock valuations moved away from fundamental analysis and even basic discounted cash flow valuations to the point where the price levels of many stocks were clearly driven by buying forces alone. This type of behavior would be replayed during the “Dotcom” bubble of 2000–01, where unproven tech companies traded at unrealistic multiples of “anticipated future revenues.” This would ultimately prove unsustainable as well.

The scandals would eventually become far reaching, enveloping major firms such as Nomura, Nikko, Daiwa, Cosmo, Sumitomo, Fuji, and other blue-chip financial institutions.

To wit, the collapse of Toho Sogo, Toyo Shinkin, Hyogo, and others in 1992; this was followed by a wholesale bailout of nonbank financial institutions in 1995 (including $48b for housing loan companies).

For instance, in March 1998 the Top 20 banks featured JPY747T of assets, of which JPY50T were classified as bad loans; these were only backed by JPY11.2T of provisions, JPY2.7T of hidden reserves, and JPY13.6T of capital. A similar picture was in evidence for regional banks, shinkin banks, and credit cooperatives.

The currency stability exhibited in the Asian sphere was a result of both the pegging mechanisms in use as well as the general trend of dollar depreciation evident from 1985 to 1995 – making it easier for key countries to “disguise” the true value of their currencies. When the dollar began strengthening in the mid-1990s (and particularly in the early part of 1997), pressures began to mount.

Exceptions were found primarily in China, Taiwan, and India, which all required some form of government authorization.

Unfortunately, the impact of economic growth on the national exchange rate is not always immediately obvious, as the effects on the trade and capital accounts may be quite different. For instance, lower growth improves the trade account as imports decline versus exports and the currency temporarily strengthens. However, the opposite occurs on the capital account – slow growth creates lower profits for local companies and tends to be countered through lower interest rates – which has the effect of causing foreign capital to withdraw, resulting in a weakening of the currency. As a
result of such conflicting signals, detecting an impending currency crisis is not as straightforward as theory might suggest.

97. Current account can be defined simply as the balance of trade in imports and exports plus net income from foreign investments and transfer. Asian countries had trouble balancing their international accounts as exports became more costly to nondollar buyers, while imports from nondollar areas became cheaper.

98. At least six Asian countries relied heavily on short-term debt as part of their national liability programs. For instance, sub–1 year debt as a percentage of total debt was exceptionally large for Indonesia (62% of total), Korea (68%), Philippines (50%), Thailand (65%), and Taiwan (84%).

99. Malaysian Prime Minister Mahathir famously singled out hedge fund manager Soros for his speculative attacks on the Malaysian ringgit.

100. For instance, major international financial institutions providing regional analysis of their revenues noted substantial declines, including $250mm for Citibank, $450mm for Bank of America, and $600mm for JP Morgan, among others. While this still seems rather small in relation to the experience of 2007–08, it is important to remember that all of the banks were much smaller and had significantly lower earnings power at that time.

101. Interestingly, and in a replay of the margin lending that fueled the collapse of the stock market in 1929, US margin debt supporting securities purchases soared from $30b in 1990 to $154b on the eve of the crisis. The leverage inherent in equities added to systemic instabilities and was compounded by other forms of leverage delivered through derivatives, structured products, and other off–balance sheet activities.

102. Note that in a curious twist of fate, two institutions that chose not to participate in the $3.6b private sector bailout were Lehman and Bear Stearns, both of which would run aground during the 2007 Credit Crisis (as noted later in the chapter). Lehman would ultimately collapse, while Bear would be absorbed by JP Morgan.

103. Interestingly, the IMF’s Financial Stability Report of Spring 2007 featured a consensus opinion ranking credit risk as the lowest risk factor on its Global Financial Stability mapping. Even after the crisis started to unfold, there was a strong belief that the crisis would be contained to the subprime sector and would not pose any broader systemic threat. Of course, with the exception of a few prescient hedge funds, virtually all participants underestimated the ultimate depth and breadth of the crisis.

104. As an example of the degree of leverage coursing through the US system, debt increased from 255% of GDP in 1997 to 350% of GDP in 2007, with the household debt component accelerating most quickly. By early 2008 the US system alone featured $1.3t in subprime mortgage debt, $1t in credit card debt, and $700b in automobile debt. Homeowners were leveraged not only via their mortgages, but also through home equity loans, which they used for all manner of purposes. In fact, the role of the US consumer in the crisis is not to be underestimated, since US consumers drive 70% of the US GDP, and the housing price decline of 20%–30% erased an estimated $4–6t of household wealth. This, followed by job losses, caused many consumers to rein in their spending, exacerbating the economic slowdown.

105. The subprime mortgages that banks originated included loans requiring no downpayment, no income verification, and/or no documentation. Many of these loans were characterized by low initial teaser rates jumping to relatively high floating rates, which became problematic as rates rose in the middle of the decade. In many cases, banks actually outsourced the mortgage underwriting function to independent mortgage brokers, who were motivated through incentive schemes to focus on the quantity, rather than quality, of their production. This, of course, led to a misalignment of interests. As long as banks believed they could distribute mortgages of questionable quality through the securitization mechanism, they were quite happy to keep the machine going. By the early part of the 2000s, subprime mortgages accounted for approximately 20% of US mortgage origination; during the key period of 2005–07, 60% of loan originations had either a subprime component or structural features that made them risky. Total subprime mortgages increased from approximately $160b in 2001 to $600b by end 2006.

106. By the first quarter of 2008, approximately 10% of US homeowners suffered from negative equity, adding to foreclosure pressures. In fact, mortgages originated between 2005 and 2006 have proven to be the most vulnerable, as they were granted with valuations at the peak of the market; some 25% of such mortgages were expected to default or be included in a restructuring program.
107. This was particularly true of RMBS pools based on adjustable rate mortgages (ARMs), with high rate resets appearing in future time periods; these rate resets put more homeowners in financial jeopardy, leading to further instances of financial distress and lower valuations on the RMBS themselves.

108. Delinquencies and foreclosures in the US subprime market increased from 16% in 2007 (triple the level of 2005) and rose to 25% by May 2008.

109. The credit default swap, one of the key pillars of the OTC derivative market, experienced rapid and significant growth during the early part of the millennium (reaching $50t of notional contracts in 2008), far outpacing activity in equity and commodity derivatives, and reflecting growing rates that even the larger interest rate and currency derivative markets would envy. Being OTC in nature, their growth and control was not directly regulated by any formal authorities.

110. For instance, popular leveraged credit instruments included constant proportion debt obligations (CPDOs, an aggressive structure) and constant proportion portfolio insurance notes (CPPI, a defensive structure), where the arranger sold credit protection on indexes or baskets of credits with dynamic factors that leveraged or deleveraged based on the breaching of certain triggers. Another variation was the leveraged super senior (LSS) note, where an investor sold a bank credit protection in a senior tranche (either in the form of a credit index or a bespoke basket), gaining leverage through the internal subordination; the structure could be unwound through the breaching of a defined trigger, as was the case for many notes during the crisis — resulting in mark-to-market losses for the investors.

111. Industry and accounting rules distinguished between Level 1, Level 2, and Level 3 assets, with Level 1 defined as those with clear, transparent, and executable prices; Level 2 as those with prices driven primarily by strong proxies; and Level 3 as those with prices generated through models. As the crisis deepened, the percentage of bank balance sheets that migrated from Level 1 to Level 2 and Level 3 increased substantially, increasing opacity for outside stakeholders. In fact, Level 3 assets at major banks soon exceeded available capital, increasing concerns about systemic problems.

112. SIVs, which originated in 1988, are off–balance sheet vehicles that fund themselves primarily through the issuance of commercial paper; they use the proceeds to invest in a range of assets, establishing a typical “carry trade” (note that in some cases SIVs became a “dumping ground” for bank-sponsor assets that were difficult to sell to others — bringing to mind some of the unsavory techniques used in trusts prior to the October 1929 Crash). This structure tends to work in a stable, positive yield curve environment, when the cost of funds is cheaper than the yield on the purchased assets and short-term funding is readily available through rollovers. The off–balance sheet nature of the structure also provides the opportunity to take advantage of capital relief, meaning a classic regulatory arbitrage has fueled this activity since the late 1980s. To protect investors, SIVs typically feature certain structural triggers that lead to unwinding or deleveraging. If this occurs in an orderly fashion, investors may emerge relatively “whole.” If done under stressed conditions, as in 2007–08, losses invariably accrue, particularly to those ranking lower in the capital structure (e.g., the mezzanine note holders). In fact, there were approximately $340b of senior notes and $24b of mezzanine notes outstanding in the market when the crisis hit (suggesting leverage of 14X); the average mezzanine deteriorated in value from par to 50% and in some cases all the way down to 0. Note that a higher leverage, closed-end variant of the SIV, known as the SIV lite, featured another $19b of outstanding debt. SIVs effectively played the role of hedge funds in adding, in a rather opaque manner, leverage to the system. Banks that sponsored such vehicles (e.g., Citibank, Bank of Montreal, Standard Chartered, Deutsche Bank, HSBC, WestLB, among many others) eventually sustained incremental losses as they unwound or consolidated them back on their balance sheets.

113. Arbitrage conduits are similar to SIVs in that they are off–balance sheet vehicles that issue commercial paper and invest proceeds in a range of assets. However, some notable differences exist: conduits invest 100% of their assets in asset-backed securities, versus only about 60% by SIVs, and conduits fund themselves solely with commercial paper backed by liquidity lines while most SIVs feature a full capital structure. As the Credit Crisis unfolded, asset-backed CP investors refused to rollover their commitments, which caused conduits (and SIVs) to sell assets to meet redeeming liabilities. The sales of assets by these vehicles put substantial pressure on asset prices, helping fuel the downward spiral. Total asset-backed CP declined from a peak of $1.2t in
August 2007 to approximately $700b just 12 months later, meaning some $500b of assets were redeemed (or refinanced, though this was far more difficult to arrange).

114. This point comes as no particular surprise, as traditional VAR models built atop well-behaved distributions failed entirely to miss the very fat-tailed event represented by the crisis.


116. For example, in March 2008 the US Federal Reserve introduced the Term Securities Lending facility, a $200b program where primary dealers could borrow on a term basis through pledges of agency securities, agency MBS, and nonagency private label MBS. The Bank of England introduced its Special Liquidity Scheme a month later, permitting banks to swap MBS for government paper for up to 1 year to ease bank liquidity strains.

117. In fact, illiquidity was not confined to securitized structured credits but had by this time migrated to all types of vanilla credit assets, including high grade bonds issued by major multinational corporations. Even though the risk of default in such bonds was infinitesimal, investors were unwilling to hold any securities on a mark-to-market basis for fear of showing continued unrealized losses as spreads widened.

118. The bailout, a de facto nationalization, was accompanied by the creation of a new regulator, new management, and a new capital structure.

119. The largest commercial bank failure in the United States was Indy Mac, with $19b in deposits, which was intervened in July 2008. The impact of its collapse was, however, unremarkable compared with that of Lehman, which caused a tremendous ripple effect.

120. The insurer received a total of four different bailouts through the first quarter of 2009, including one in March 2009 after the insurer announced the largest quarterly loss in US corporate history, at $60b.

121. In fact, the United Kingdom supplemented its first bank bailout program in late 2008 with a second one in early 2009, which provided additional capital to the major banks in the country.

122. Monoline insurers had traditionally confined their business to “wrapping” municipal bond obligations, providing investors with payment guarantees in exchange for fees from the municipality; by 2007 total wraps amounted to $2.4t. In the late 1990s and early 2000s, most of the major monoliners, such as FSA, FGIC, Ambac, and others, began providing guarantees on asset-backed and other structured credit products. This new business model was predicated on their ability to retain AAA ratings atop a relatively thin base of capital; as the credit crisis unfolded, most lost their ratings and required significant capital injections. In fact, the credit spreads and financial standing of most monoliners grew worse than many of the underlying municipalities they were guaranteeing, suggesting that the business model may ultimately be doomed.

123. For instance, the Basel II framework directs national regulators to use a corporate bond rating methodology in establishing capital levels – even though such methodologies are not applicable for structured products.

124. In fact, a regular negative loop occurred during the crisis: from the initial ratings “overestimates” that resulted from bad models, a series of downgrades in structured credit assets occurred during the third and fourth quarters of 2007. The resulting losses posted by banks that were holding these assets led to downgrades in their own ratings at various points in 2007 and 2008. Bank downgrades put additional pressure on deleveraging, resulting in asset sales, including those underpinning the structured credit products in the markets (and on their balance sheets), leading to a new round of downgrades and lower valuations on such assets, and so forth.

125. Clearly the sum total of the “close-to-the-mean” risks is impacted when the financial dislocation occurs.

126. For instance, the move from Basel I to Basel II attempted to equalize the risks attributable to balance sheet and synthetic credit risks with the same risk profiles.

127. To be sure, the IMF packages were conditioned on each country fulfilling certain requirements; some of them based on economic austerity measures that were regarded by some as being particularly onerous. So it is fair to say that the decision to accept aid was not an easy one for most countries, thereby dampening slightly the moral hazard argument. For instance, in accepting the
1997-stabilization package Korea was required to reduce its current account deficit, cap its inflation, rebuild its international reserves, restructure its banking system, and upgrade its accounting standards.

128. These solutions can take different forms, from direct government acquisition of “damaged institutions” to purchase of troubled assets at a discount, or the acquisition of preferred shares or other portions of the capital structure; ultimately the taxpayer bears the cost.

129. For instance, in the United States the Automated Clearing House (ACH) processes credit, debit, and cash settlements, while the Fedwire and CHIPS settle payments between member banks; such clearing systems exist in many other national systems, and various cross-border systems, such as SWIFT, allow for similar effects.

130. For instance, in foreign exchange the Continuous Linked System (CLS) helps mitigate the effects of foreign exchange settlement risk through multilateral netting and a payment versus payment system using central bank funds. Settlement risk is, as noted in Chapter 1, a very real risk exposure that results from the time zone differences that exist between the payment and receipt of foreign currencies. Such settlement risk can result in true credit losses if a counterparty defaults after receiving, but before delivering, a currency payment. In fact, this has occurred on a regular basis in the financial markets over the past years, to wit Bank Herstatt, BCCI, and Lehman Brothers, among others.

131. In fact, the major agencies were forced to declare publicly that their models contained errors that impacted literally hundreds of billions of dollars worth of structured credit issues.

132. Even when restricted shares are granted, a prospective new employer often chooses to “cash out” a new recruit’s shares, so the retention aspect of such shares is not necessarily effective.

133. Catastrophe ILS are used by insurers and reinsurers as a substitute for reinsurance contracts and are typically employed when the cost of issuing a security is cheaper than the cost of entering into one of the reinsurance arrangements described in Chapter 4. In fact, a “hard” or expensive reinsurance appearing in the aftermath of one or more expensive disasters can lead to increased catastrophe ILS issuance – whose pricing tends to lag that of the reinsurance market.

134. For instance, a dislocation in the equity markets or foreign exchange markets has no bearing on whether or not a hurricane strikes Miami or an earthquake hits Jakarta. This lack of correlation makes the securities particularly attractive for portfolio managers seeking a greater level of diversification.

135. ILS structures may be structured with indemnity triggers (actual losses sustained), parametric triggers (losses sustained if an event of certain severity occurs), or index triggers (losses sustained based on the level of some correlated index). In fact, an index trigger could be a relevant trigger for a financial catastrophe structure.

136. A key point to consider is that the risks embedded in any potential financial catastrophe ILS are highly correlated with the movement of financial assets, meaning the diversification benefit that accrues to natural catastrophe ILS’ no longer exists – so a portion of the potential investor base disappears. In fact, the structure begins to look something like investors writing deep out-of-the-money puts on a basket of financial assets – whether such a basket can be sufficiently diversified and the premium earned sufficiently compelling is uncertain.

137. The Sarbanes-Oxley Act (SOX) was a legislative effort enacted in the wake of the corporate scandals of the early 2000s (e.g., Enron, Tyco, Worldcom, Parmalat, and others) designed to increase financial transparency/accounting, and strengthen corporate governance by increasing accountabilities for directors and corporate officers. SOX has become a rather complex (and some would say overly rigid and expensive) way of policing corporate activities. While SOX is a US initiative (applicable also to foreign companies listed on a US exchange), similar efforts exist in other countries (though most are less burdensome, and in some cases are structured as “recommended best practices” rather than mandatory requirements enacted through legislation).
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