CHAPTER 1

Moving Beyond Uncertainty

A BRIEF HISTORY OF RISK: WHAT EXACTLY IS RISK?

Since the beginning of recorded history, games of chance have been a popular pastime. Even in Biblical accounts, Roman soldiers cast lots for Christ's robes. In earlier times, chance was something that occurred in nature, and humans were simply subjected to it as a ship is to the capricious tosses of the waves in an ocean. Even up to the time of the Renaissance, the future was thought to be simply a chance occurrence of completely random events and beyond the control of humans. However, with the advent of games of chance, human greed has propelled the study of risk and chance to evermore closely mirror real-life events. Although these games initially were played with great enthusiasm, no one actually sat down and figured out the odds. Of course, the individual who understood and mastered the concept of chance was bound to be in a better position to profit from such games of chance. It was not until the mid-1600s that the concept of chance was properly studied, and the first such serious endeavor can be credited to Blaise Pascal, one of the fathers of modern choice, chance, and probability.[1] Fortunately for us, after many centuries of mathematical and statistical innovations from pioneers such as Pascal, Bernoulli, Bayes, Gauss, LaPlace, and Fermat, our modern world of uncertainty can be explained with much more elegance through methodological applications of risk and uncertainty.

To the people who lived centuries ago, risk was simply the inevitability of chance occurrence beyond the realm of human control. Nonetheless, many phony soothsayers profited from their ability to convincingly profess their clairvoyance by simply stating the obvious or reading the victims' body language and telling them what they wanted to hear. We modern-day humans, ignoring for the moment the occasional seers among us, with our fancy technological achievements, are still susceptible to risk and uncertainty. We may be able to predict the orbital paths of planets in our solar system with astounding accuracy or the escape velocity required to shoot a man from the Earth to the Moon, but when it comes to predicting a firm's revenues the following year, we are at a loss. Humans have been struggling with risk our entire existence but, through trial and error, and through the evolution of human knowledge and thought, have devised ways to describe, quantify, hedge, and take advantage of risk.

Clearly the entire realm of risk analysis is great and would most probably be intractable within the few chapters of a book. Therefore, this book is concerned with only a small niche of risk, namely *applied business risk modeling and analysis*. Even in the areas of applied business risk analysis, the diversity is great. For instance, business risk can be roughly divided into the areas of operational risk management and financial risk management. In financial risk, one can look at market risk, private risk, credit risk, default risk, maturity risk, liquidity risk, inflationary risk, interest rate risk, country risk, and so forth. This book focuses on the application of risk analysis in the sense of how to adequately apply the tools to identify, understand, quantify, and diversify risk such that it can be hedged and managed more effectively. These tools are generic enough that they can be applied across a whole spectrum of business conditions, industries, and needs.

Finally, understanding this text in its entirety together with *Real Options Analysis*, Second Edition (Wiley, 2005) and the associated Risk Simulator and Real Options SLS software are required prerequisites for the Certified Risk Analyst or CRA certification (see www.realoptionsvaluation.com for more details).

UNCERTAINTY VERSUS RISK

Risk and uncertainty are very different-looking animals, but they are of the same species; however, the lines of demarcation are often blurred. A distinction is critical at this juncture before proceeding and worthy of segue. Suppose I am senseless enough to take a skydiving trip with a good friend and we board a plane headed for the Palm Springs desert. While airborne at 10,000 feet and watching our lives flash before our eyes, we realize that in our haste we forgot to pack our parachutes on board. However, there is an old, dusty, and dilapidated emergency parachute on the plane. At that point, both my friend and I have the same level of uncertainty—the uncertainty of whether the old parachute will open, and if it does not, whether we will fall to our deaths. However, being the risk-adverse, nice guy I am, I decide to let my buddy take the plunge. Clearly, he is the one taking the plunge and the same person taking the risk. I bear no risk at this time while my friend bears all the risk.[2] However, we both have the same level of uncertainty as to whether the parachute will actually fail. In fact, we both have the same level of uncertainty as to the outcome of the day's trading on the New York Stock Exchange—which has absolutely no impact on whether we live or die that day. Only when he jumps and the parachute opens will the uncertainty become resolved through the passage of time, events, and action. However, even when the uncertainty is resolved with the opening of the parachute, the risk still exists as to whether he will land safely on the ground below.

Therefore, risk is something one bears and is the outcome of uncertainty. Just because there is uncertainty, there could very well be no risk. If the only thing that bothers a U.S.-based firm's CEO is the fluctuation in the foreign exchange market of the Zambian kwacha, then I might suggest shorting some kwachas and shifting his portfolio to U.S.-based debt. This uncertainty, if it does not affect the firm's bottom line in any way, is only uncertainty and not risk. This book is concerned with risk by performing uncertainty analysis—the same uncertainty that brings about risk by its mere existence as it impacts the value of a particular project. It is further assumed that the end user of this uncertainty analysis uses the results appropriately, whether the analysis is for identifying, adjusting, or selecting projects with respect to their risks, and so forth. Otherwise, running millions of fancy simulation trials and letting the results "marinate" will be useless. By running simulations on the foreign exchange market of the kwacha, an analyst sitting in a cubicle somewhere in downtown Denver will in no way reduce the risk of the kwacha in the market or the firm's exposure to the same. Only by using the results from an uncertainty simulation analysis and finding ways to hedge or mitigate the quantified fluctuation and downside risks of the firm's foreign exchange exposure through the derivatives market could the analyst be construed as having performed risk analysis and risk management.

To further illustrate the differences between risk and uncertainty, suppose we are attempting to forecast the stock price of Microsoft (MSFT). Suppose MSFT is currently priced at $25 per share, and historical prices place the stock at 21.89% volatility. Now suppose that for the next 5 years, MSFT does not engage in any risky ventures and stays exactly the way it is, and further suppose that the entire economic and financial world remains constant. This means that *risk* is fixed and unchanging; that is, volatility is unchanging for the next 5 years. However, the price uncertainty still increases over time; that is, the width of the forecast intervals will still increase over time. For instance, Year 0's forecast is known and is $25. However, as we progress one day, MSFT will most probably vary between $24 and $26. One year later, the uncertainty bounds may be between $20 and $30. Five years into the future, the boundaries might be between $10 and $50. So, in this example, *uncertainties increase* while *risks remain the same*. Therefore, risk is not equal to uncertainty. This idea is, of course, applicable to any forecasting approach whereby it becomes more and more difficult to forecast the future albeit the same risk. Now, if risk changes over time, the bounds of uncertainty get more complicated (e.g., uncertainty bounds of sinusoidal waves with discrete event jumps).

In other instances, risk and uncertainty are used interchangeably. For instance, suppose you play a coin-toss game—bet $0.50 and if heads come up you win $1, but you lose everything if tails appear. The risk here is you lose everything because the risk is that tails may appear. The uncertainty here is that tails may appear. Given that tails appear, you lose everything; hence, uncertainty brings with it risk. Uncertainty is the possibility of an event occurring and risk is the ramification of such an event occurring. People tend to use these two terms interchangeably.

In discussing uncertainty, there are three levels of uncertainties in the world: the *known*, the *unknown*, and the *unknowable*. The known is, of course, what we know will occur and are certain of its occurrence (contractual obligations or a guaranteed event); the unknown is what we do not know and can be simulated. These events will become known through the passage of time, events, and action (the uncertainty of whether a new drug or technology can be developed successfully will become known after spending years and millions on research programs—it will either work or not, and we will know this in the future), and these events carry with them risks, but these risks will be reduced or eliminated over time. However, unknowable events carry both uncertainty and risk that the totality of the risk and uncertainty may not change through the passage of time, events, or actions. These are events such as when the next tsunami or earthquake will hit, or when another act of terrorism will occur around the world. When an event occurs, uncertainty becomes resolved, but risk still remains (another one may or may not hit tomorrow). In traditional analysis, we care about the known factors. In risk analysis, we care about the unknown and unknowable factors. The unknowable factors are easy to hedge—get the appropriate insurance! That is, do not do business in a war-torn country, get away from politically unstable economies, buy hazard and business interruption insurance, and so forth. It is for the unknown factors that risk analysis will provide the most significant amount of value.

WHY IS RISK IMPORTANT IN MAKING DECISIONS?

Risk should be an important part of the decision-making process; otherwise bad decisions may be made without an assessment of risk. For instance, suppose projects are chosen based simply on an evaluation of returns; clearly the highest-return project will be chosen over lower-return projects. In financial theory, projects with higher returns will in most cases bear higher risks.[3] Therefore, instead of relying purely on bottom-line profits, a project should be evaluated based on its returns as well as its risks. Figures 1.1 and 1.2 illustrate the errors in judgment when risks are ignored.

> The concepts of risk and uncertainty are related but different. Uncertainty involves variables that are unknown and changing, but its uncertainty will become known and resolved through the passage of time, events, and action. Risk is something one bears and is the outcome of uncertainty. Sometimes, risk may remain constant while uncertainty increases over time.

Figure 1.1 lists three *mutually exclusive* projects with their respective-costs to implement, expected net returns (net of the costs to implement), and risk levels (all in present values).[4] Clearly, for the budget-constrained manager, the cheaper the project the better, resulting in the selection of Project X.[5] The returns-driven manager will choose Project Y with the highest returns, assuming that budget is not an issue. Project Z will be chosen by the risk-averse manager as it provides the least amount of risk while providing a positive net return. The upshot is that with three different projects and three different managers, three different decisions will be made. Which manager is correct and why?

Figure 1.2 shows that Project Z should be chosen. For illustration purposes, suppose all three projects are independent and mutually exclusive,[6] and that an unlimited number of projects from each category can be chosen but the budget is constrained at $1,000. Therefore, with this $1,000 budget, 20 project Xs can be chosen, yielding $1,000 in net returns and $500 risks, and so forth. It is clear from Figure 1.2 that project Z is the best project as for the same level of net returns ($1,000), the least amount of risk is undertaken ($100). Another way of viewing this selection is that for each $1 of returns obtained, only $0.1 amount of risk is involved on average, or that for each $1 of risk, $10 in returns are obtained on average. This example illustrates the concept of *bang for the buck* or getting the best value with the

Name of Project	Cost	Returns	Risk
Project X	$50	$50	$25
Project Y	$250	$200	$200
Project Z	$100	$100	$10

Project X for the cost- and budget-constrained manager
Project Y for the returns-driven and nonresource-constrained manager
Project Z for the risk-averse manager
Project Z for the smart manager

FIGURE 1.1 Why is risk important?

Looking at bang for the buck, X (2), Y (1), Z (10), Project Z should be chosen — with a $1,000 budget, the following can be obtained:

Project X: 20 Project Xs returning $1,000, with $500 risk
Project Y: 4 Project Xs returning $800, with $800 risk
Project Z: 10 Project Xs returning $1,000, with $100 risk

Project X: For each $1 return, $0.5 risk is taken
Project Y: For each $1 return, $1.0 risk is taken
Project Z: For each $1 return, $0.1 risk is taken

Project X: For each $1 of risk taken, $2 return is obtained
Project Y: For each $1 of risk taken, $1 return is obtained
Project Z: For each $1 of risk taken, $10 return is obtained

Conclusion: Risk is important. Ignoring risks results in making the wrong decision.

FIGURE 1.2 Adding an element of risk.

least amount of risk. An even more blatant example is if there are several different projects with identical single-point average net returns of $10 million each. Without risk analysis, a manager should in theory be indifferent in choosing any of the projects.[7] However, with risk analysis, a better decision can be made. For instance, suppose the first project has a 10 percent chance of exceeding $10 million, the second a 15 percent chance, and the third a 55 percent chance. The third project, therefore, is the best bet.

DEALING WITH RISK THE OLD-FASHIONED WAY

Businesses have been dealing with risk since the beginning of the history of commerce. In most cases, managers have looked at the risks of a particular project, acknowledged their existence, and moved on. Little quantification was performed in the past. In fact, most decision makers look only to single-point estimates of a project's profitability. Figure 1.3 shows an example of a single-point estimate. The estimated net revenue of $30 is simply that, a single point whose probability of occurrence is close to zero.[8] Even in the simple model shown in Figure 1.3, the effects of interdependencies are ignored, and in traditional modeling jargon, we have the problem of *garbage in, garbage out* (GIGO). As an example of interdependencies, the units sold are probably negatively correlated to the price of the product,[9] and positively correlated to the average variable cost;[10] ignoring these effects in a single-point estimate will yield grossly incorrect results. For instance, if the unit sales variable becomes 11 instead of 10, the resulting revenue may not

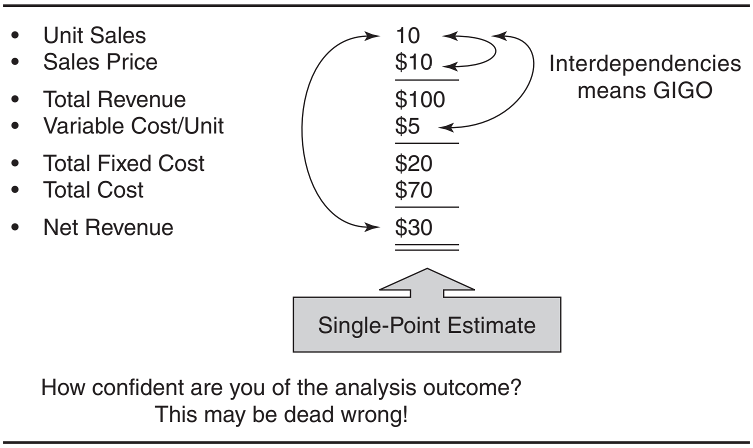


FIGURE 1.3 Single-point estimate.

simply be $35. The net revenue may actually decrease due to an increase in variable cost per unit while the sale price may actually be slightly lower to accommodate this increase in unit sales. Ignoring these interdependencies will reduce the accuracy of the model.

> A rational manager would choose projects based not only on returns but also on risks. The best projects tend to be those with the best bang for the buck, or the best returns subject to some specified risks.

One approach used to deal with risk and uncertainty is the application of scenario analysis, as seen in Figure 1.4. Suppose the worst-case, nominal-case, and best-case scenarios are applied to the unit sales; the resulting three scenarios' net revenues are obtained. As earlier, the problems of interdependencies are not addressed. The net revenues obtained are simply too variable, ranging from $5 to $55. Not much can be determined from this analysis.

A related approach is to perform *what-if* or *sensitivity* analysis as seen in Figure 1.5. Each variable is perturbed and varied a prespecified amount and the resulting change in net revenues is captured. This approach is great for understanding which variables drive or impact the bottom line the most. A related approach is the use of tornado and sensitivity charts as detailed in Chapter 6, Pandora's Toolbox, which looks at a series of simulation tools. These approaches were usually the extent to which risk and uncertainty

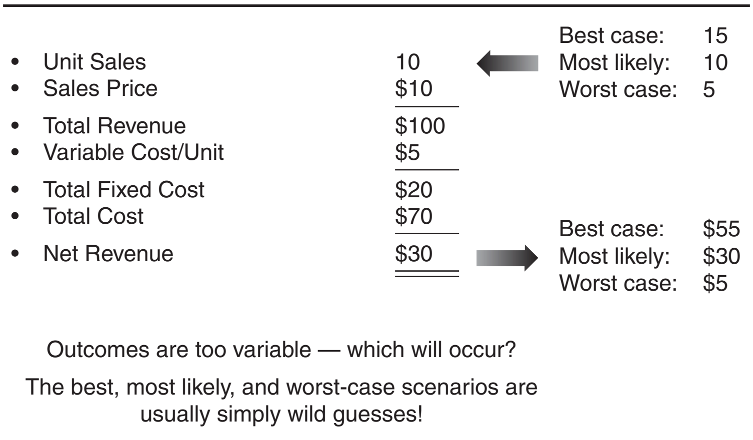


FIGURE 1.4 Scenario analysis.

analysis were traditionally performed. Clearly, a better and more robust approach is required.

This is the point where simulation comes in. Figure 1.6 shows how simulation can be viewed as simply an extension of the traditional approaches of sensitivity and scenario testing. The critical success drivers or the variables that affect the bottom-line net-revenue variable the most, which at the same time are uncertain, are simulated. In simulation, the interdependencies are accounted for by using correlations. The uncertain variables are then simulated thousands of times to emulate all potential permutations and combi-

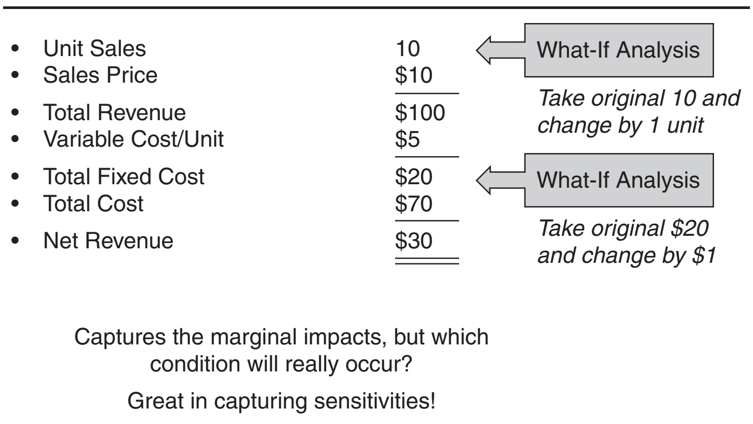


FIGURE 1.5 What-if sensitivity analysis.

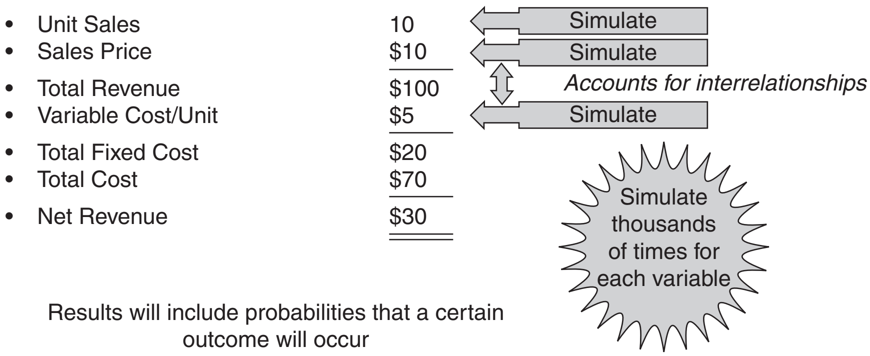


FIGURE 1.6 Simulation approach.

nations of outcomes. The resulting net revenues from these simulated potential outcomes are tabulated and analyzed. In essence, in its most basic form, simulation is simply an enhanced version of traditional approaches such as sensitivity and scenario analysis but automatically performed for thousands of times while accounting for all the dynamic interactions between the simulated variables. The resulting net revenues from simulation, as seen in Figure 1.7, show that there is a 90 percent probability that the net

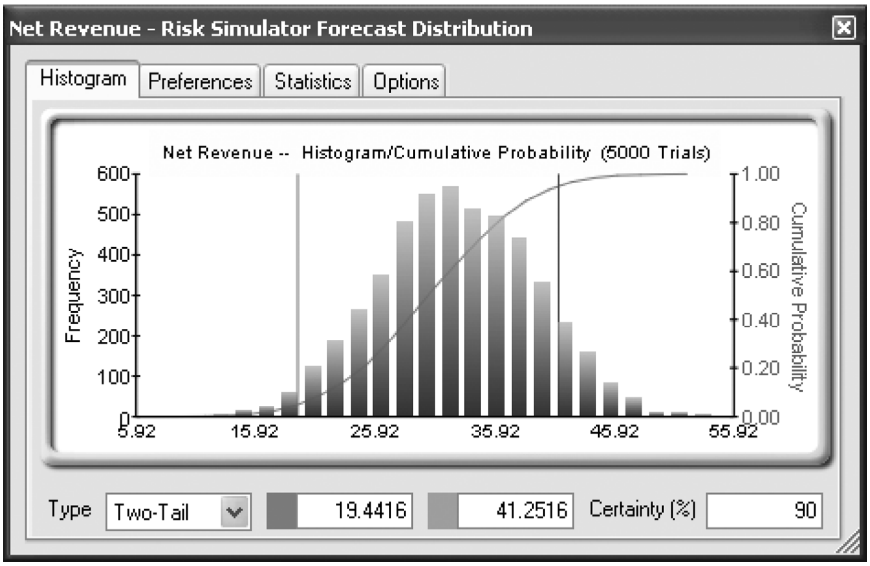


FIGURE 1.7 Simulation results.

revenues will fall between $19.44 and $41.25, with a 5 percent worst-case scenario of net revenues falling below $19.44. Rather than having only three scenarios, simulation created 5,000 scenarios, or trials, where multiple variables are simulated and changing simultaneously (unit sales, sale price, and variable cost per unit), while their respective relationships or correlations are maintained.

THE LOOK AND FEEL OF RISK AND UNCERTAINTY

In most financial risk analyses, the first step is to create a series of free cash flows (FCF), which can take the shape of an income statement or discounted cash-flow (DCF) model. The resulting deterministic free cash flows are depicted on a time line, akin to that shown in Figure 1.8. These cash-flow figures are in most cases forecasts of the unknown future. In this simple example, the cash flows are assumed to follow a straight-line growth curve (of course, other shaped curves also can be constructed). Similar forecasts

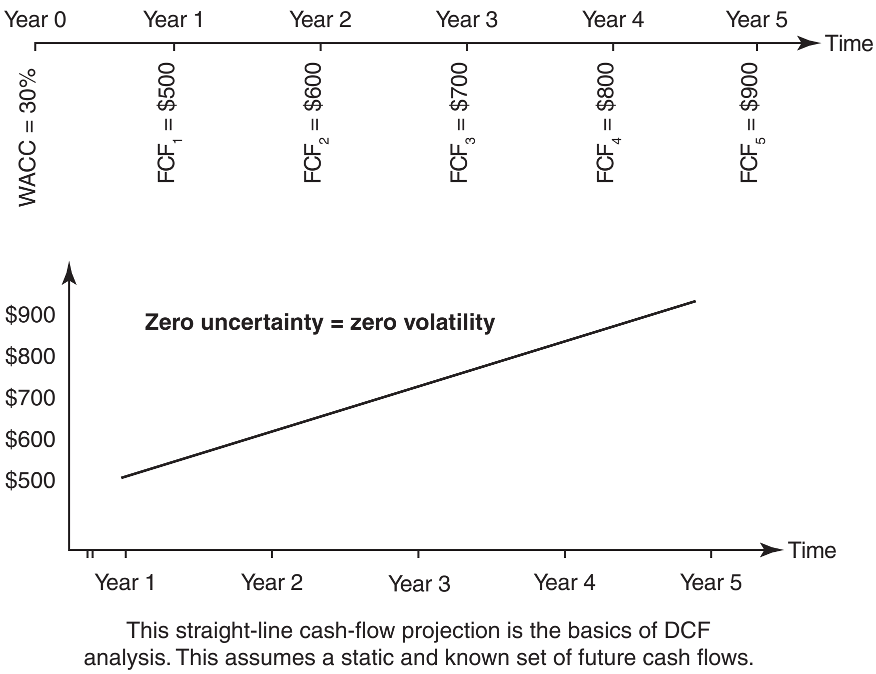
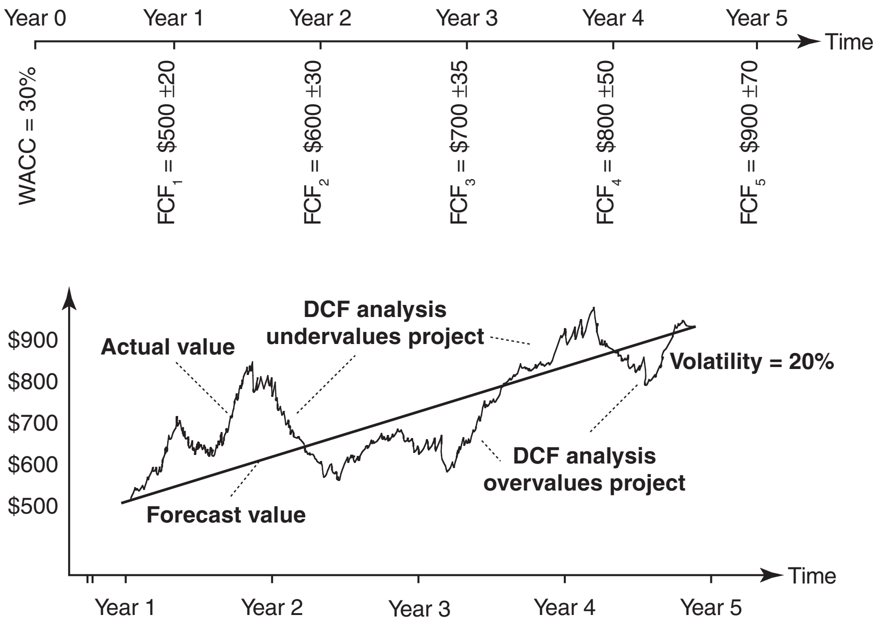


FIGURE 1.8 The intuition of risk—deterministic analysis.

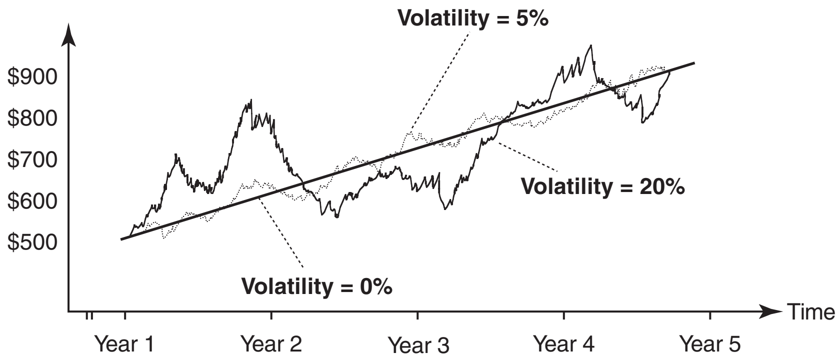
can be constructed using historical data and fitting these data to a time-series model or a regression analysis.[11] Whatever the method of obtaining said forecasts or the shape of the growth curve, these are point estimates of the unknown future. Performing a financial analysis on these static cash flows provides an accurate value of the project if and only if all the future cash flows are known with certainty—that is, no uncertainty exists.

However, in reality, business conditions are hard to forecast. Uncertainty exists, and the actual levels of future cash flows may look more like those in Figure 1.9; that is, at certain time periods, actual cash flows may be above, below, or at the forecast levels. For instance, at any time period, the actual cash flow may fall within a range of figures with a certain percent probability. As an example, the first year's cash flow may fall anywhere between \$480 and \$520. The actual values are shown to fluctuate around the forecast values at an average volatility of 20 percent.[12] (We use volatility here as a measure of uncertainty, i.e., the higher the volatility, the higher the level of uncertainty, where at zero uncertainty, the outcomes are 100 percent certain[13]). Certainly this example provides a much more accurate view of the



This graph shows that in reality, at different times, actual cash flows may be above, below, or at the forecast value line due to uncertainty and risk.

FIGURE 1.9 The intuition of risk—Monte Carlo simulation.



The higher the risk, the higher the volatility and the higher the fluctuation of actual cash flows around the forecast value. When volatility is zero, the values collapse to the forecast straight-line static value.

FIGURE 1.10 The intuition of risk—the face of risk.

true nature of business conditions, which are fairly difficult to predict with any amount of certainty.

Figure 1.10 shows two sample actual cash flows around the straight-line forecast value. The higher the uncertainty around the actual cash-flow levels, the higher the volatility. The darker line with 20 percent volatility fluctuates more wildly around the forecast values. These values can be quantified using Monte Carlo simulation fairly easily but cannot be properly accounted for using more simplistic traditional methods such as sensitivity or scenario analyses.

INTEGRATED RISK ANALYSIS FRAMEWORK

Before diving into the different risk analysis methods in the remaining chapters of the book, it is important to first understand the *integrated risk analysis framework* and how these different techniques are related in a risk analysis and risk management context. This framework comprises eight distinct phases of a successful and comprehensive risk analysis implementation, going from a qualitative management screening process to creating clear and concise reports for management. The process was developed by the author based on previous successful implementations of risk analysis, forecasting, real options, valuation, and optimization projects both in the consulting arena and in industry-specific problems. These phases can be performed either in isolation or together in sequence for a more robust integrated analysis.

Figure 1.11 shows the integrated risk analysis process up close. We can segregate the process into the following eight simple steps:

1. Qualitative management screening.
2. Time-series and regression forecasting.
3. Base case net present value analysis.
4. Monte Carlo simulation.
5. Real options problem framing.
6. Real options modeling and analysis.
7. Portfolio and resource optimization.
8. Reporting and update analysis.

1. Qualitative Management Screening

Qualitative management screening is the first step in any integrated risk analysis process. Management has to decide which projects, assets, initiatives, or strategies are viable for further analysis, in accordance with the firm's mission, vision, goal, or overall business strategy. The firm's mission, vision, goal, or overall business strategy may include market penetration strategies, competitive advantage, technical, acquisition, growth, synergistic, or globalization issues. That is, the initial list of projects should be qualified in terms of meeting management's agenda. Often at this point the most valuable insight is created as management frames the complete problem to be resolved and the various risks to the firm are identified and flushed out.

2. Time-Series and Regression Forecasting

The future is then forecasted using time-series analysis or multivariate regression analysis if historical or comparable data exist. Otherwise, other qualitative forecasting methods may be used (subjective guesses, growth rate assumptions, expert opinions, Delphi method, and so forth). In a financial context, this is the step where future revenues, sale price, quantity sold, volume, production, and other key revenue and cost drivers are forecasted. See Chapters 8 and 9 for details on forecasting and using the author's Risk Simulator software to run time-series, extrapolation, stochastic process, ARIMA, and regression forecasts.

3. Base Case Net Present Value Analysis

For each project that passes the initial qualitative screens, a discounted cash flow model is created. This model serves as the base case analysis where a net present value (NPV) is calculated for each project, using the forecasted values from the previous step. This step also applies if only a single project is under evaluation. This net present value is calculated using the traditional

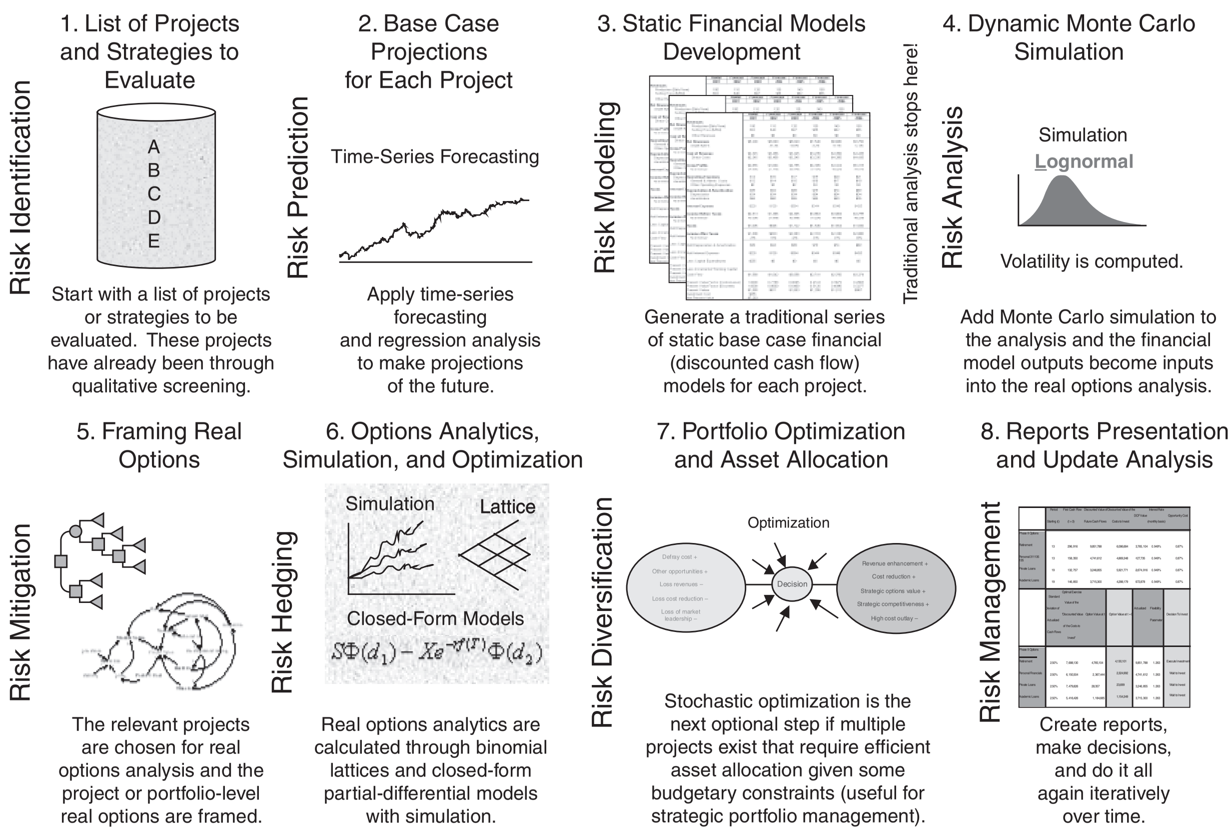


FIGURE 1.11 Integrated risk analysis process.

approach of using the forecast revenues and costs, and discounting the net of these revenues and costs at an appropriate risk-adjusted rate. The return on investment and other metrics are generated here.

4. Monte Carlo Simulation

Because the static discounted cash flow produces only a single-point estimate result, there is oftentimes little confidence in its accuracy given that future events that affect forecast cash flows are highly uncertain. To better estimate the actual value of a particular project, Monte Carlo simulation should be employed next. See Chapters 4 and 5 for details on running Monte Carlo simulations using the author's Risk Simulator software.

Usually, a sensitivity analysis is first performed on the discounted cash flow model; that is, setting the net present value as the resulting variable, we can change each of its precedent variables and note the change in the resulting variable. Precedent variables include revenues, costs, tax rates, discount rates, capital expenditures, depreciation, and so forth, which ultimately flow through the model to affect the net present value figure. By tracing back all these precedent variables, we can change each one by a preset amount and see the effect on the resulting net present value. A graphical representation can then be created, which is often called a tornado chart (see Chapter 6 on using Risk Simulator's simulation analysis tools such as tornado charts, spider charts, and sensitivity charts), because of its shape, where the most sensitive precedent variables are listed first, in descending order of magnitude. Armed with this information, the analyst can then decide which key variables are highly uncertain in the future and which are deterministic. The uncertain key variables that drive the net present value and, hence, the decision are called critical success drivers. These critical success drivers are prime candidates for Monte Carlo simulation. Because some of these critical success drivers may be correlated—for example, operating costs may increase in proportion to quantity sold of a particular product, or prices may be inversely correlated to quantity sold—a correlated Monte Carlo simulation may be required. Typically, these correlations can be obtained through historical data. Running correlated simulations provides a much closer approximation to the variables' real-life behaviors.

5. Real Options Problem Framing

The question now is that after quantifying risks in the previous step, what next? The risk information obtained somehow needs to be converted into *actionable intelligence*. Just because risk has been quantified to be such and such using Monte Carlo simulation, so what, and what do we do about it? The answer is to use real options analysis to hedge these risks, to value these risks, and to position yourself to take advantage of the risks. The first step in real options is to generate a strategic map through the process of framing the problem. Based on the overall problem identification occurring during the initial qualitative management screening process, certain strategic optionalities would have become apparent for each particular project. The strategic optionalities may include, among other things, the option to expand, contract, abandon, switch, choose, and so forth. Based on the identification of strategic optionalities that exist for each project or at each stage of the project, the analyst can then choose from a list of options to analyze in more detail. Real options are added to the projects to hedge downside risks and to take advantage of upside swings.

6. Real Options Modeling and Analysis

Through the use of Monte Carlo simulation, the resulting stochastic discounted cash flow model will have a distribution of values. Thus, simulation models, analyzes, and quantifies the various risks and uncertainties of each project. The result is a distribution of the NPVs and the project's volatility. In real options, we assume that the underlying variable is the future profitability of the project, which is the future cash flow series. An implied volatility of the future free cash flow or underlying variable can be calculated through the results of a Monte Carlo simulation previously performed. Usually, the volatility is measured as the standard deviation of the logarithmic returns on the free cash flow stream. In addition, the present value of future cash flows for the base case discounted cash flow model is used as the initial underlying asset value in real options modeling. Using these inputs, real options analysis is performed to obtain the projects' strategic option values—see Chapters 12 and 13 for details on understanding the basics of real options and on using the Real Options Super Lattice Solver software.

7. Portfolio and Resource Optimization

Portfolio optimization is an optional step in the analysis. If the analysis is done on multiple projects, management should view the results as a portfolio of rolled-up projects because the projects are in most cases correlated with one another, and viewing them individually will not present the true picture. As firms do not only have single projects, portfolio optimization is crucial. Given that certain projects are related to others, there are opportunities for hedging and diversifying risks through a portfolio. Because firms have limited budgets, have time and resource constraints, while at the same time have requirements for certain overall levels of returns, risk tolerances, and so forth, portfolio optimization takes into account all these to create an optimal portfolio mix. The analysis will provide the optimal allocation of investments across multiple projects. See Chapters 10 and 11 for details on using Risk Simulator to perform portfolio optimization.

8. Reporting and Update Analysis

The analysis is not complete until reports can be generated. Not only are results presented, but the process should also be shown. Clear, concise, and precise explanations transform a difficult black-box set of analytics into transparent steps. Management will never accept results coming from black boxes if they do not understand where the assumptions or data originate and what types of mathematical or financial massaging takes place.

Risk analysis assumes that the future is uncertain and that management has the right to make midcourse corrections when these uncertainties become resolved or risks become known; the analysis is usually done ahead of time and, thus, ahead of such uncertainty and risks. Therefore, when these risks become known, the analysis should be revisited to incorporate the decisions made or revising any input assumptions. Sometimes, for long-horizon projects, several iterations of the real options analysis should be performed, where future iterations are updated with the latest data and assumptions.

Understanding the steps required to undertake an integrated risk analysis is important because it provides insight not only into the methodology itself, but also into how it evolves from traditional analyses, showing where the traditional approach ends and where the new analytics start.

QUESTIONS

1. Why is risk important in making decisions?
2. Describe the concept of bang for the buck.
3. Compare and contrast risk and uncertainty.