CHAPTER FIVE

NEW VENTURE STRATEGY AND REAL OPTIONS

YOU MAY WONDER why, in a book on entrepreneurial finance, we would devote this chapter and the next to strategic planning. There are three key reasons. First, strategic planning is about choosing a course of action that is designed to achieve a particular objective. In business settings, the overarching objective is financial return. Even in not-for-profit settings where the primary objective may be philanthropic, adequacy of financial return must be an intermediate goal. Second, almost any strategic plan affords opportunities to change course after the initial direction has been selected. In financial terms, these choices are described as real options. Finance provides a means of valuing real options and taking account of those values in the initial strategic choice. Third, for new ventures, the ability even to pursue a particular strategy can depend on whether financing can be found.

This chapter establishes the basics of strategic planning in an entrepreneurial setting and develops a framework for evaluating alternative strategies.[1] The framework describes real options as decision trees and uses investment valuation to evaluate alternative strategies. The framework begins with identifying the objective and the strategic alternatives for achieving it. In general, we assume that the objective is maximum NPV for the entrepreneur. The alternatives are structures of real options that can be described and evaluated as the branches of a decision tree. We begin by highlighting the interconnected nature of product-market, financial, and organizational choices.

5.1 PRODUCT-MARKET, FINANCIAL, AND ORGANIZATIONAL STRATEGY

Especially for new ventures, financial strategic decisions must be determined jointly with product-market and organizational strategic decisions. The

potential for success is greatest when the decisions are in harmony. Financial strategy defines the type and timing of financing. Strategic financial decisions include the amount of outside financing, target capital structure, staging of cash infusions, and so on. Product-market strategy involves the targeted sales growth rate, product price, product quality, product differentiation, whether to produce multiple products, and the like. Organizational strategy concerns the horizontal and vertical boundaries of the firm and in whom decision-making authority resides.

As an illustration, suppose an entrepreneur were to conclude that rapid sales growth was the preferred strategy in the product market. The strategic choice to grow rapidly would commit the firm to a limited menu of financing options. Rapid growth usually requires external capital. The firm could choose to operate with high financial leverage, in which case it might sacrifice product-market and organizational flexibility and the entrepreneur would realize a residual return after debt service. Or, it might turn to equity capital, in which case the entrepreneur might have to secure agreement of other shareholders before acting and would have to share the total return with the outside investors.

It does not make sense to settle on a product-market strategy without considering how that choice restricts financing options. It also makes little sense to place product-market strategy ahead of financing in the decision hierarchy. While it may be possible to settle on a financing option that makes the choice of product-market strategy viable, sequencing the two decisions can lead to second-best outcomes. Even though rapid growth may appear to be attractive, the entrepreneur might be better off if the firm were to grow more slowly. Similarly, there are interactions between financial and organizational strategy and between product-market and organizational strategy.

Compared to new ventures, the interdependencies among product-market, organizational, and financial decisions can be less significant in large, well-established organizations. If a large company contemplates a strategy of rapid growth in a market that accounts for a small fraction of its total activity, that decision does not necessarily commit the company to a highly leveraged capital structure or the need to raise equity capital by selling stock. Thus, investors may not be harmed if the investment decision and financing decision are treated separately. In fact, this principle of separation is the hallmark of large public corporations and an important difference from entrepreneurial firms. Our point is that for new ventures, product-market, organizational, and financial decisions need to be viewed simultaneously. Simultaneous consideration helps guarantee that the first-best overall strategy is identified and selected.

Thinking about product-market, organizational, and financial strategies as simultaneous rather than sequential choices takes us beyond the limits of

intuitive decision making. Later in the chapter, we use decision trees as devices to capture the interplay between simultaneous and sequential decisions and to identify and evaluate alternative strategies.

5.2 THE INTERDEPENDENCE OF STRATEGIC CHOICES: AN EXAMPLE

To illustrate the interdependencies of strategic choices, consider the case of C2FO.com, one of several companies that have been established to arbitrage well-known inefficiencies in the management of working capital. In many industries, trade credit terms are established as industry norms to which suppliers must normally adhere. For example, net 30 is the standard term in some industries and means that customers have up to 30 days to pay for products they have purchased and received.

Traditionally, as discussed in Chapter 2, a supplier that was short of cash but had a significant balance of uncollected accounts receivable might be able to use the receivables as collateral for a bank loan or might be able to sell the receivables to a factor. At the same time, customers that were offered net 30 terms might be holding substantial cash balances that were invested at low rates of return. This traditional structure could often result in markets with cash-poor suppliers and cash-rich customers, suppliers resorting to expensive means of borrowing, and customers settling for low returns on cash holdings. The rigidities of the trade credit, bank lending, and factoring markets adversely affected the profitability of both customers and suppliers.

C2FO is one of the firms that saw this inefficiency as an opportunity that could be addressed with new technology that would match cash-rich customers with cash-poor suppliers and enable them to more efficiently negotiate with each other to transfer liquidity from customers to suppliers. Costco, for example, deals with multiple suppliers and has been a customer on the C2FO network since 2011. Using the C2FO marketplace, Costco can post an available cash balance. Suppliers to Costco, such as those that had sold on terms of net 30 and are in need of cash, can post offers of discounts on their receivables from Costco in order to collect their receivables more quickly. Costco can then decide which offers to accept.

The C2FO example illustrates how product-market, organizational, and financing strategies all work together. We can think of cash-short suppliers as potential borrowers that are willing to pay for cash if the loan terms are right. Rather than funding loans to these companies directly and raising its own capital to do so, C2FO effectively intermediates a lending operation (an organizational choice for C2FO that facilitated a new financing strategy for its customers). The

cash comes from purchasers of products supplied by the purchaser's vendors. C2FO earns a return by intermediating these exchanges in a way that is more efficient and more adaptable to specific needs than what a bank or factor might do. C2FO captures an intermediation spread related to transaction volume.[2]

5.3 WHAT MAKES A PLAN OR DECISION STRATEGIC?

It is useful to distinguish strategic decisions from other decisions along three dimensions. First, strategic decisions are consequential. Unlike the decision of which way to drive home from work, strategic decisions involve substantial commitments of time and resources. They are of sufficient magnitude and importance that they are rare, and little precedent exists on which to base them.

Second, strategic decisions are both active and reactive. The decision is made in a competitive setting, with regard to the possible actions and reactions of others who have competing or complementary objectives. In selecting among alternatives, the decision maker must consider the choices that may already have been made by others whose objectives overlap and must recognize that others may react to the decision. The decision of when, where, and how to locate a retail store is strategic in this sense.

Third, strategic decisions are costly to reverse. If a decision maker selects a wrong course of action, she cannot simply retract it. Investments made to pursue the first course of action are, to some extent, sunk. Sunk investments limit flexibility because the full cost of changing direction must be compared to only the incremental cost of continuing in the same direction. Consequently, an initial wrong strategic choice is one from which the decision maker may never fully recover.

5.4 FINANCIAL STRATEGY

Financial strategic choices have the same three elements. A financing choice can limit future financing options in a variety of ways. For example, contractual provisions of a debt agreement may restrict the firm's ability to redeem the debt and replace it with equity. Existing debt financing may limit the financing sources available for new projects. And debt service requirements may limit the firm's ability to undertake new projects that would generate negative cash flows in the short run.

Competitive interdependencies are also present. Financing choices that are costly to reverse or change involve sunk investments in arranging the financing. In such cases, a firm's financing choices may credibly commit the firm to a

particular course of action that is observable by competitors, suppliers, customers, employees, and stockholders. Such credible commitments can influence the actions of these groups. For example, securing project financing can discourage others from moving ahead with plans of their own. Conversely, announcement of intent to develop a new product, if not backed by a credible commitment, could touch off a scramble among rivals to be first in the market.

For example, when Airbus announced in 2000 that it was proceeding with the production of its super jumbo jet, the A380, Boeing immediately said that it too would introduce a new super jumbo jet to replace the aging 747. It was not until Airbus had secured financing and began investing in A380 production capacity that Boeing abandoned its plans for a 747 replacement and pursued the 787 Dreamliner.

The scope of financial strategy is quite broad. It goes beyond the simple debt-versus-equity financing decision and includes such considerations as the connections between financing choices and growth, flexibility, and control. In addition, financial strategy includes such choices as the use of financial contracts to address or overcome informational asymmetries between entrepreneurs and investors and to better align the incentives of entrepreneurs and employees with the interests of investors.

5.5 DECIDING ON THE OBJECTIVE

For many entrepreneurs, the decisions of whether to launch a new venture or continue in current employment and how to develop the venture are made by intuition. Yet these are not decisions where intuition is likely to lead to the best outcome. Also, some entrepreneurs place weight on qualitative considerations. They may, for example, take pride in having created something new or they may value self-employment.[3]

While subjective considerations can be important, our objective is to lay out an analytical framework that can help entrepreneurs and investors make better decisions. Here, we propose a two-step process: first, select the strategy that yields the highest estimated NPV; second, make qualitative adjustments to the NPV by assigning subjective values to the considerations that are important to the prospective entrepreneur. Our emphasis is on the first step, maximizing NPV. Generally, we examine NPV from the perspective of the entrepreneur by structuring the terms for outside investment to yield an NPV of zero and keeping the full residual for the entrepreneur.

More formally, the first step in developing the analytical framework for strategic planning is to clearly specify the objective. Making rational choices is a

forward-looking concept. Rationality does not mean that the choice is always right, *ex post*, only that it is expected to be right given the information available at the time of the decision. A prospective entrepreneur considers a variety of alternatives and selects the action that she expects will result in the highest level of satisfaction. A number of qualitative factors bear on the choice. A risk-tolerant person is more willing to abandon secure employment to pursue a venture than is a person who places a high value on security. A person who enjoys work-related challenges is more willing to start a venture than is one who values leisure time. These are the entrepreneur's personal choices, and we can do little in a formal way to assess such qualitative trade-offs. But we can provide an analytical approach to help the entrepreneur evaluate the trade-offs.

Strategic planning reduces the importance of intuition in the decision process so that entrepreneurs and investors can make better-informed decisions. To achieve this, we must begin with an objective that can be measured. We assume that the entrepreneur's objective is to maximize the value of the venture to herself. Thus, in purely financial terms, 40% ownership of a $5 million business is more valuable to the entrepreneur than 15% of a $10 million business. The value of the entrepreneur's interest is what should influence the strategic choice.[4]

This does not mean that the entrepreneur should substitute value maximization for utility maximization as the ultimate determinant of the choice. Once the quantitative value of the entrepreneur's interest is determined, it is easier for the entrepreneur to assess the qualitative trade-offs related to such factors as control and security. To illustrate, suppose, as an entrepreneur, you are offered two choices by a prospective investor. Under one you would retain control, and under the other you would not. In exchange for relinquishing control, however, you would receive additional compensation having a present value of $100,000. You can then assess whether you would be willing to relinquish control in exchange for a $100,000 increase in the expected value of your interest.[5]

The entrepreneur is likely to be concerned with the financial return, and risk is also an important consideration. Beyond this, entrepreneurial decisions are likely to be influenced by, among other things, liquidity, diversification, and flexibility; by transferability of ownership; and by the effects of the choice on the entrepreneur's control and accountability to others.

At a more fundamental level, the primary determinant of value is the trade-off between risk and expected return. Factors such as liquidity, diversification, transferability, and flexibility are taken into consideration through their effects on expected return and risk. The value of control is an additional qualitative factor that goes beyond the objective assessment of present value.

As a final note, value maximization does not mean that an entrepreneur is greedy or that a venture is exploitative of either consumers or employees. A vi-

able venture must offer a product or service that is attractive enough to draw consumers away from alternative purchases. Compensation packages offered to employees must be sufficient to attract them away from other positions.

5.6 STRATEGIC PLANNING FOR NEW VENTURES

New ventures are different from established businesses because their plans are unconstrained by previous decisions. Questions of financing, organizational design, and product-market strategy are all open. The planning process needs to reflect simultaneous consideration of all three components of the strategy.

The distinction between simultaneous and sequential consideration of strategic choices is fundamental. Suppose that on weekends while working in your current position you have perfected a technology for making calorie-free ice cream. You are trying to decide whether to resign and start a venture that will employ the technology. Should you decide to proceed, you must make a number of other decisions. To keep matters simple, in the product market you must choose either a high-margin, slow-growth approach or a low-margin, high-growth approach. With respect to organizational design, you must choose either to enter only at the manufacturing level and contract for distribution or to enter into both manufacturing and distribution.

Let's suppose that the nonintegrated option involves selling through grocery stores and the integrated approach involves creating a network of branded ice cream stores. Figure 5.1 illustrates the implications of the various product-market and organizational choices for the venture's financing needs. If you enter only manufacturing and pursue a slow-growth strategy, your own resources are sufficient to fund the initial investment. The growth rate is determined by the operating cash flows of the venture. With one-level entry and a plan of rapid growth, you must rely on outside financing to supplement the financing available through operating cash flow. If you decide to enter both manufacturing and distribution, even with slow growth the initial investment is too large for you alone, and additional start-up financing is required. With both vertical integration and rapid growth, outside financing is needed both for start-up and to sustain growth.

Figure 5.1 displays the two product-market alternatives, along with the two organizational structure alternatives. These choices have direct implications for the available financing options. Each cell in the table represents a combination of a product-market and organizational choices and describes the implied financing choice. The amount shown in the cell along with the financing description is the entrepreneur's expected NPV associated with that combination of choices. The

		Product Market Choice	
		Slow growth	**Rapid growth**
Organizational Choice	**One-level entry**	Initially financed by entrepreneur, growth financed with operating cash flows NPV = $40	Initially financed by entrepreneur, growth financed with operating cash flows and outside financing NPV = $120
	Integrated entry	Initial financing includes outside equity, growth financed with operating cash flows NPV = ($20)	Initial financing includes outside equity, growth financed with operating cash flows and outside financing NPV = $70

FIGURE 5.1

Financial implications of product-market and organizational strategic choices

Product-market and organizational strategic choices are interdependent with financing choices. One-level entry combined with slow growth minimizes immediate and ongoing needs for external financing. Integrated entry and rapid growth normally require higher levels of immediate and ongoing external financing. NPV reflects the expected value to the entrepreneur.

most valuable is a strategy of entering only at the manufacturing level (relying on contracting for distribution), pricing aggressively to foster rapid growth, and supporting the enterprise initially with your own resources followed by operating cash flows and outside financing. This choice provides the entrepreneur with an expected NPV of $120.

However, suppose you do not think through all of the alternatives and settle first on the integrated organizational strategy. In that case, no matter what the product-market strategy, you cannot expect to do better than $70. Moreover, if you choose a high-price/slow-growth strategy, then the expected NPV is negative.

Perhaps you can go back to the investors and try to change the deal. But even if the change is possible, it will require renegotiation, and your expected value can never be as high as if you had studied the alternatives first and planned accordingly. Even in this simple illustration, the product-market and organizational decisions limit the financing options. If entry is integrated, available outside financing is likely to be equity. You may have to sacrifice voting control or give other control rights to providers of financing. With rapid growth, financing needs to occur after the venture is established. In the early-growth stages, equity-like claims may still be required, but the fraction of ownership that must be relinquished per dollar raised is likely to be less than if funding is required at start-up.

As the venture grows and begins to generate taxable income, debt financing becomes a more realistic and attractive possibility. In addition, alternatives

such as franchising of distribution outlets and equipment leasing may have advantages over either equity or debt financing. A well-thought-out strategic plan takes such alternatives into consideration.

Of course, any commitment of resources to a particular strategy limits flexibility. If, for example, the entrepreneur builds the ice cream factory in California, it would be costly to change and decide that New York would be a better location. But here we are concerned with something more—a loss of flexibility that arises from reliance on outside financing. Almost any outside financing that the entrepreneur can raise comes with limitations on how it can be used and even on how the other resources of the venture can be used. Commonly, such limitations are tied to the strategy that was described in the business plan and was presented to the investors. Even if it were clear to the entrepreneur that a change of plans would be good for the venture, the change often cannot be made unless the investors are also convinced. Convincing them is likely to be difficult, particularly if they have not been heavily involved in the operation or if their interests conflict with those of the entrepreneur. The surest way to limit this problem is to methodically plan the venture before presenting it to investors.

5.7 RECOGNIZING REAL OPTIONS

Strategic planning is not a one-shot exercise. With the passage of time, original targets will be exceeded or missed, and new developments will render the initial plan obsolete. Rather than planning a single immutable course of action, it is more useful to select the strategy that offers the highest expected value in light of the flexibility that the strategy affords for dealing with surprises. Opportunities to abandon a venture, expand it, or change direction are real options. You can think of the focus of strategic planning as deciding which real options to acquire, retain, and abandon at key decision points.[6]

Option Basics

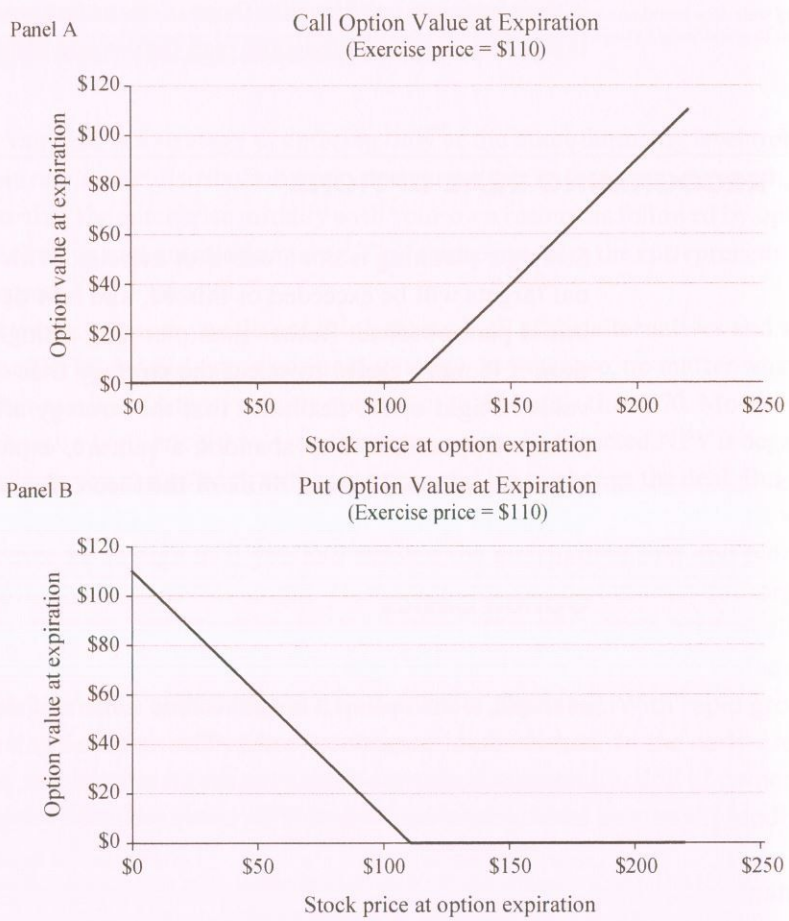
An option is the right to make a decision in the future. In the stock market, for example, a call option is a right to buy a share of stock at some future date for a price that is negotiated today. The right to buy a share of Spacely.com common stock anytime during the next 3 months at a price of $110 is a call option with an exercise price of $110, where the underlying asset is a share of Spacely common stock.

The value of the option depends on several factors. Most basically, a call option gains value the more uncertainty there is about the eventual value of

the underlying asset. It gains value if the market price of the underlying asset rises, and it loses value if the price of the asset falls. Suppose Spacely is selling at expiration for $118 per share. The $110 call option would yield an $8 payoff ($118 − $110). If the price of Spacely goes to $125, the value of the call option increases—in this example the payoff almost doubles to $15 ($125 − $110). It follows that call options with low exercise prices are more valuable than those with high exercise prices. The right to buy Spacely for $100 per share obviously is more valuable than the right to buy for $110.

Panel A of Figure 5.2 shows the payoffs for this call option with a $110 exercise price. The figure shows clearly that options limit downside risk. Since option risk is one-sided, the more volatile the underlying asset, the higher the value of an option on the asset. Suppose, over the next three months, Spacely is equally likely to increase in value to $140 or to decline in value to $100. If the price of Spacely stock increases to $140, a call option at $110 will be in the money and

FIGURE 5.2
Expiration date values of call and put options on Spacely.com stock



can be exercised to acquire the stock for a saving of $30 per share. If the price of Spacely falls to $100, the call option is out of the money and will not be exercised. Thus, buying a call option limits the downside risk of investing in Spacely but preserves the potential for gain. Because the exposure to risk is one-sided, an option is more valuable the higher the risk of the underlying asset. Because volatility increases with time to expiration, long-term options are more valuable. Similarly, because new ventures are very risky and can take years to harvest, real options on new ventures can be very valuable.

The time value of money affects option values because buying an option works like borrowing. If you buy a call, you do not have to come up with the money to exercise the option and purchase the shares until later, if and when you exercise the option. This is different from buying the stock outright, where you must pay the full price today. Accordingly, buying a call option is like borrowing the exercise price without having to pay interest. Since the value of not having to pay interest is greater the higher the interest rate for borrowing, call option value increases with increases in the cost of money.

A put option provides the right to sell an underlying asset during a specified period at a specified exercise price. If the owner of a put decides to exercise, he receives the exercise price. In contrast to calls, puts gain value when underlying asset values are low and when exercise prices are high. As can be seen in Panel B of Figure 5.2, a put on Spacely at $110 is more valuable if Spacely is selling for $80 than $90. Like call options, put options are more valuable when the underlying asset is riskier. Because the owner of a put is effectively lending the exercise price without charging interest, a put is less valuable if the cost of money is high (i.e., more interest income is forgone).

Calls and puts can be bought or sold. The price of an option contract is called the premium. The seller (or writer) of a call option is obligated to deliver the underlying asset in exchange for the exercise price if the call is exercised. The writer of a put is obligated to buy the underlying asset at the exercise price if the put is exercised. For agreeing to this obligation, option sellers collect the option premium. Puts and calls can be used to allocate the risk of investing in the underlying asset. For example, an investor in Amazon common stock who buys a put option has reallocated the downside risk to the writer of the option. In this case, the stockholder is hedged against the downside risk, and the put writer is acting as an insurer.

Comparisons Between Real and Financial Options

Puts and calls on shares of stock are financial options. The underlying asset is a financial asset, and exercising or not exercising the option does not affect the

value of the underlying asset. In several respects, real options are similar. As with financial options, the values of real options increase with the riskiness of the underlying asset and time to expiration. The values of real options are also affected similarly by the difference between the exercise price and the underlying asset value.[7]

Yet real options differ from financial options in important ways. First, the markets for financial options are often complete, meaning that calls and puts on a stock are available with the same exercise price and expiration date, the underlying asset is freely traded, and riskless borrowing is possible. If the market is complete, option value can be determined by appealing to the ability of investors to arbitrage risklessly any pricing disparities. In contrast, real option markets are not complete and simple arbitrages are not generally feasible.

Second, real options are often interdependent in ways that make the application of formal option pricing models inappropriate. Financial options can be bought, sold, and exercised separately, and the value of a portfolio of financial options is simply the sum of the values of the individual options. Real options, in contrast, are often interdependent, and the decision to exercise one may have implications for the values of others. Consequently, the value of a portfolio of real options often cannot be determined by simply adding up the values of the individual options. The term "real options" is used to stress their similarity to financial options while preserving the notion that there are important differences.

Returning to the calorie-free ice cream example, once you have developed the technology to manufacture the ice cream, you have options to exploit the technology in many ways. Some are reflected in Table 5.1. You also have the option to do none of those things and instead continue working in your existing position. In addition, you may have the option to delay and, for example, start the venture next year (though in a changed environment). Once you begin the venture, depending on contractual financing arrangements, you or the investor may have the option to abandon it if things do not work out as well as you hoped.

We can also intentionally incorporate real options into strategic choices to create additional flexibility. For example, the ice cream venture might acquire options to lease facilities in both California and New York.

Effective strategic planning takes account of the values of important real options. Because of the importance of real options to most new ventures, it is useful to incorporate formal decision analysis techniques into the strategic planning process.

The Real Option Premium

The cost of acquiring an option is called the option premium. Generally, financial options must be purchased from counterparties who consider the op-

TABLE 5.1 Examples of real options

Category of Option	Description	Examples
Option to wait	If it is possible to postpone an action, the decision maker has an option to wait. Decisions involve comparing the value of acting now with the expected value of waiting.	The owner of a forest can cut the trees today or wait until next year when the trees will have grown larger and lumber prices may have changed.
Option to learn	Learning options are similar to waiting options except that the focus is on the resolution of uncertainty. The option holder can either make the best choice in light of the uncertain future or wait until some important uncertainty is resolved.	A person who hopes to receive job offers from two different employers either could choose to minimize the expected commute today by buying a house located between the two or could wait for an offer and then locate near the ultimate employer.
Options to expand or contract	An entrepreneur who has the ability to increase the scale of a venture has an option to expand. One who has the ability to downsize has an option to contract.	An entrepreneur might decide to acquire an expansion option by purchasing a facility that is larger than the anticipated need. An entrepreneur might acquire an option to contract by closing down a production line if demand is less than anticipated. The option can be acquired by building a flexible production process.
Options to switch inputs or outputs	An entrepreneur has an option to switch inputs or outputs when she can alter the mix of a production process in response to market prices.	An entrepreneur who designs a facility to operate on either electricity or natural gas has the real option to switch between these two inputs. A refiner who can switch between producing heating oil and gasoline has the real option to switch outputs.
Option to abandon	An abandonment option is a right to discontinue an activity and redeploy the real assets to some other use.	Abandonment options include the options to discontinue a research project, close a store, or resign from current employment.

tion premium to be sufficient to compensate them for bearing the risk that the option will end up being in the money.

One important difference between real and financial options is that the real option premium bears no necessary relation to the value of the option. The value of an abandonment option, for example, depends on the highest alternative-use value of the assets. Automobiles, for example, have high option value since there is a well-functioning market for used cars. If the original purchaser no longer has a use for the car, it can be easily resold. Although the car has high option value, the new-car market has many competitors, so that the price of the new car is driven mainly by production and distribution costs. Because of the competitive new-car market and well-functioning used-car market, and because the new-car seller is not the counterparty in the used-car market, the new-car seller is not able to demand a price that reflects the option value to the buyer. Thus, the cost of acquiring a real option may have little to do with the option value.

It follows that the value of a strategy can be dramatically improved by making good choices about what real options to acquire and by using them effectively.

The terms of a new-car lease contract, in contrast, do reflect an important financial option premium. When a car is leased, the lessee acquires a financial option. At the end of the lease term, if the market value of the car is high, the lessee can purchase the car by paying a residual value that was negotiated at the time of the original lease transaction. Alternatively, if the market value is low, the lessee can return the car to the lessor so that the lessor bears the downside risk about the future value of the car. Although the underlying asset is real, the car lease contract is a financial option. It is effectively a bet about the future market value of the car, and not an instrument that redeploys the actual (real) use of the asset.

5.8 STRATEGIC PLANNING AND DECISION TREES

A decision tree is a useful way to conceptualize strategic alternatives that involve real options. Constructing a decision tree imposes discipline on the evaluation process and helps the entrepreneur identify relevant real options and the points at which critical decisions must be made. It also enables the entrepreneur to assess, in a structured way, the connections between decisions made today and the value of the venture in the future.

Building and Pruning Decision Trees

A decision tree incorporates both decisions and uncertain events that affect the value of the outcome. It identifies a sequence of decisions in which the range of available choices is limited by previous decisions, and the best decision depends on which state of the world is realized. The decision maker is uncertain about which state will be realized but knows or estimates the probabilities of the different states. In addition, the decision maker estimates the NPV of a choice conditional on which future state attains.

A few simple techniques can ensure that a decision tree accurately reflects the important choices and help to value them correctly.

- *Focus on the most important choices.* Because the number of branches expands geometrically, decision tree analyses can become intractable. Focusing on a few critical decisions and a few discrete choices is usually all that is needed.
- *Reason forward to construct the tree.* Sequencing is chronological. The tree should illustrate how each choice limits the options for subsequent

decisions. You can build the tree by first determining the important choices available today. For each of these, determine the choices that would be available at the next key decision point (node), and so on.

- *Keep track of what is known and unknown at each node.* If the decision on optimal scale of entry depends on the level of future demand (a state of the world that is uncertain today), you can only base the decision you make today on expected future demand.
- *Evaluate choices recursively.* Start with the last decision point (the terminal node) and compare the values of the alternatives that emanate from that node as if you had followed the branches up to that point. These are the payoffs conditional on having made the choices that are represented at the prior nodes.
- *Prune the tree.* Select the branch with the highest expected value, conditional on the earlier choices, and eliminate, or "prune," the inferior choices. For example, if conditional on high demand, you would choose to expand, then you can eliminate the other choices. Move backward to the next earlier decision point and evaluate the choices considering only the highest-valued branch from the subsequent node.
- *Select the branch of the tree with the highest expected value.* This process of backward induction, working from the best future decision conditional on choices made previously, leads to a set of valuations that reflect the values of the embedded options in the decision process.

An Illustration

Suppose an entrepreneur is considering investing in a retail venture such as a restaurant or a seller of Internet-of-Things (IoT) products. For simplicity, she assumes that demand for the venture's products could turn out to be any one of three states of nature: high, moderate, or low. She is considering building a Large Facility, building a Small Facility, or not entering the business at this time. The cost of the Large Facility is $750,000. The cost of the small one is $600,000. The entrepreneur has $400,000 to invest and plans to bring in an investor for the balance. The investor requires 1% of the equity for each $10,000 invested in the venture, resulting in a 35% interest in the Large Facility or a 20% interest in the small one. The entrepreneur retains the balance of ownership.

At this point, our focus is on strategic planning and our purpose is to demonstrate the use of decision trees for making strategic choices. To keep things simple, we assume (for now) that the entrepreneur has already estimated the present values (PVs) of the different facility sizes conditional on the different

states of nature and has already estimated the probabilities of the different states. We will relax these assumptions in the next chapter.

Naturally, the Large Facility has the potential to generate more revenue, but it also necessitates a larger investment and greater fixed operating expenses. The entrepreneur's estimates of the PVs in different states of the world reflect these economies. If the high-demand state occurs, the limited capacity of the Small Facility constrains its value. In the high-demand state, we assume that the entrepreneur expects the PV of the Large Facility to be $1.5 million and the PV of the small one to be $800,000. If the moderate-demand state occurs, the PV of future cash flows of both the Large and the Small Facility is expected to be $800,000. In the low-demand state, the PV of the Large Facility is $300,000 and that of the Small Facility is $400,000. The difference is due to the higher fixed cost of operating the Large Facility.[8]

Evaluating the Venture as an Accept/Reject Decision

To establish a baseline for evaluating the real options, consider the project as a simple accept/reject decision with mutually exclusive alternatives—the conventional way of evaluating simple capital investment projects. Figure 5.3 represents the choices in the form of a decision tree. The square in the figure represents the one decision point. The circles represent uncertain outcomes that are beyond the entrepreneur's control; they reflect states of the world with respect to demand. You can think of "nature" as choosing a state of the world.

Each state has an associated probability. In Figure 5.3, the entrepreneur has simplified the decision problem by thinking of it in terms of three states of demand and has estimated the probability of each. The probability of high demand is 30%, the probability of moderate demand is 50%, and the probability of low demand is 20%. In the accept/reject decision, the entrepreneur must decide which, if any, facility to open before the uncertainty about demand is resolved. Her investment is $400,000 regardless of which facility she chooses. Because we are examining the choice from the entrepreneur's perspective, the difference between the Large and the Small Facilities is shown as the fraction of the value that accrues to the entrepreneur.

The triangles in the figure are terminal nodes. Next to each is the NPV the entrepreneur expects if she selects the corresponding branch and the specified level of demand is realized. For example, if the Large Facility is built and the high-demand state is realized, the entrepreneur will invest $400,000 in return for 65% of a facility with a total PV of $1.5 million. The figure shows that $975,000 is the entrepreneur's 65% share of the PV, so that the resulting NPV of the entrepreneur's investment is $575,000. In our simple example, the entrepre-

neur decides how to invest by multiplying each state-contingent payoff by the probability of that state's occurrence and her fractional ownership interest (.65 or .80) and then subtracting her investment. The result of the calculation is the NPV of that choice to the entrepreneur. Thus, if the Large Facility is selected, her expected payoff is as follows:

$$\text{Expected Payoff} = .65\,(.3 \times \$1{,}500{,}000 + .5 \times \$800{,}000 + .2 \times \$300{,}000) = \$591{,}500$$

As this amount exceeds the entrepreneur's $400,000 investment by $191,500, it has a positive NPV, which means that it is better than not investing at all. The figure shows $191,500 as the NPV of selecting the Large Facility.

By a similar calculation, the entrepreneur's payoff from investing in the Small Facility is $576,000, an NPV of $176,000. Because both the Large and the Small

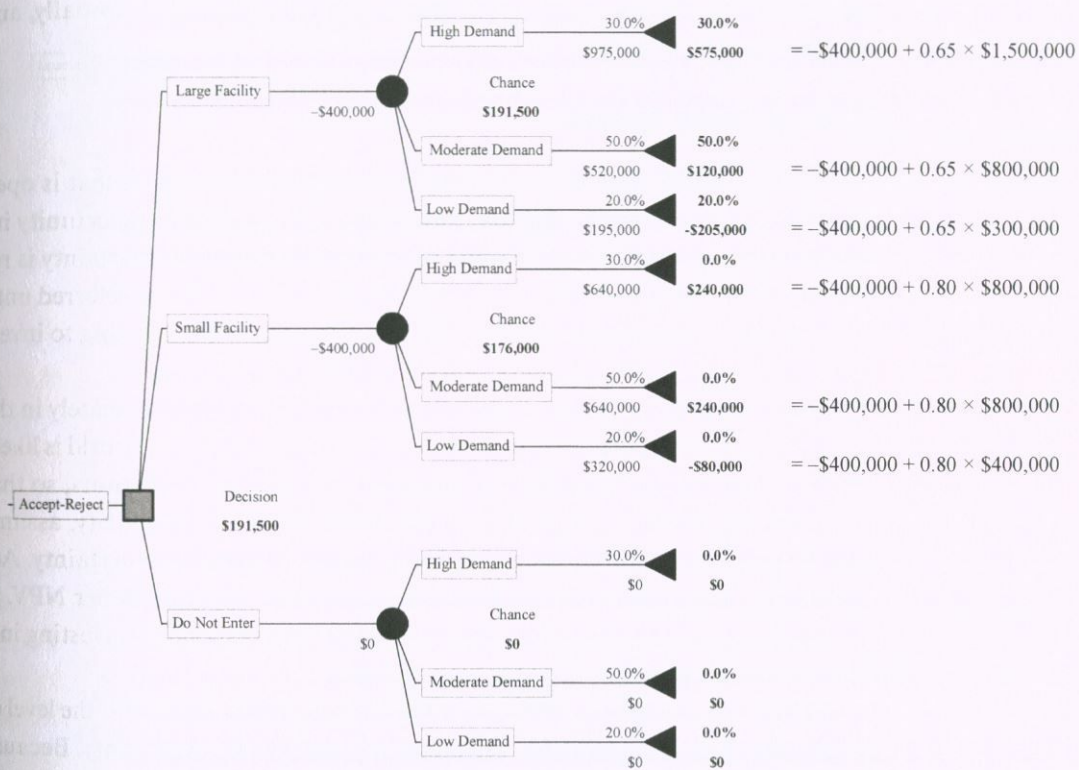


FIGURE 5.3

Decision tree for accept/reject decision to invest in the venture

Prepared using PrecisionTree™, Palisade Corporation.

With a one-time accept/reject decision, the entrepreneur cannot anticipate the level of demand that will be realized. The investment decision and choice of level of investment are made in light of existing uncertainty by maximizing expected NPV.

Facility have positive NPVs, either one is better than not investing. Because the Large Facility offers the entrepreneur a higher NPV, that choice is better than investing in the Small Facility. Thus, the entrepreneur would want to prune the alternatives of investing in the Small Facility or not investing.

Ex post, it may turn out that selecting the Large Facility was the wrong decision. If demand turns out to be intermediate, the Small Facility would have been a better choice. If demand turns out to be low, not entering would have been better than either of the other choices. At the time of the decision, however, the entrepreneur cannot know which state of the world will occur. Given what is known and the estimated probabilities of the different states, the Large Facility is the best alternative.

In Figure 5.3, the decision facing the entrepreneur is a one-shot choice. There are no real options reflected in the figure. This is the "base case," with an NPV of $191,500. We now want to expand the range of possibilities by considering three types of real options: (1) the option to wait and learn more about market demand, (2) the option to expand if the Small Facility is selected initially, and (3) the option to abandon.

The Learning Option

The ability to wait and learn more before acting is a call option that is open to most prospective entrepreneurs. Rarely does an investment opportunity involve a now-or-never choice. Waiting can add value because uncertainty is reduced, or technology advances, or expenditures of resources are deferred until they are more immediately needed. The offsetting cost is that waiting to invest may encourage others to enter or market conditions may change.[9]

Returning to our example, suppose that by not investing immediately in the venture, the entrepreneur can learn more about which state of the world is likely to occur, but waiting increases the likelihood of entry by competitors, so that the expected payoffs in the various states are reduced. For simplicity, assume that by waiting the entrepreneur can learn market demand with certainty. Accordingly, in each case she will build the facility that maximizes her NPV. If the good state of nature attains, the entrepreneur can respond by investing in a facility that is optimally sized for high demand.

As with any call option, the value of the learning option is higher if the level of uncertainty is high and if delay will materially reduce the uncertainty. Because of the delay and likelihood of competitive entry, we assume that the PV of the Large Facility declines (relative to the base case in Figure 5.3) to $1.3 million and the PV of the Small Facility declines to $700,000.

To examine the value of the learning option, we compare the NPV with delayed investment to the base case NPV. The difference is the value of the

learning option. Figure 5.4 modifies Figure 5.3 to reflect the learning option. Because waiting only affects the "Do Not Enter" branch of Figure 5.3, we have collapsed the two branches that involve investing today. For them, we show only the entrepreneur's NPV.

Under the learning option, conditional on the high-demand state, the entrepreneur's best course of action is to invest in the Large Facility. Her NPV of waiting and then investing in the Large Facility is $445,000 (net of the $400,000 investment). Because, in the event of high demand, the "Small Facility" and "Do Not Enter" choices have lower NPVs ($160,000 and $0, respectively), we will be able to prune those branches. Figure 5.4 shows that conditional on high demand, the entrepreneur chooses the Large Facility, and the resulting NPV is $445,000.

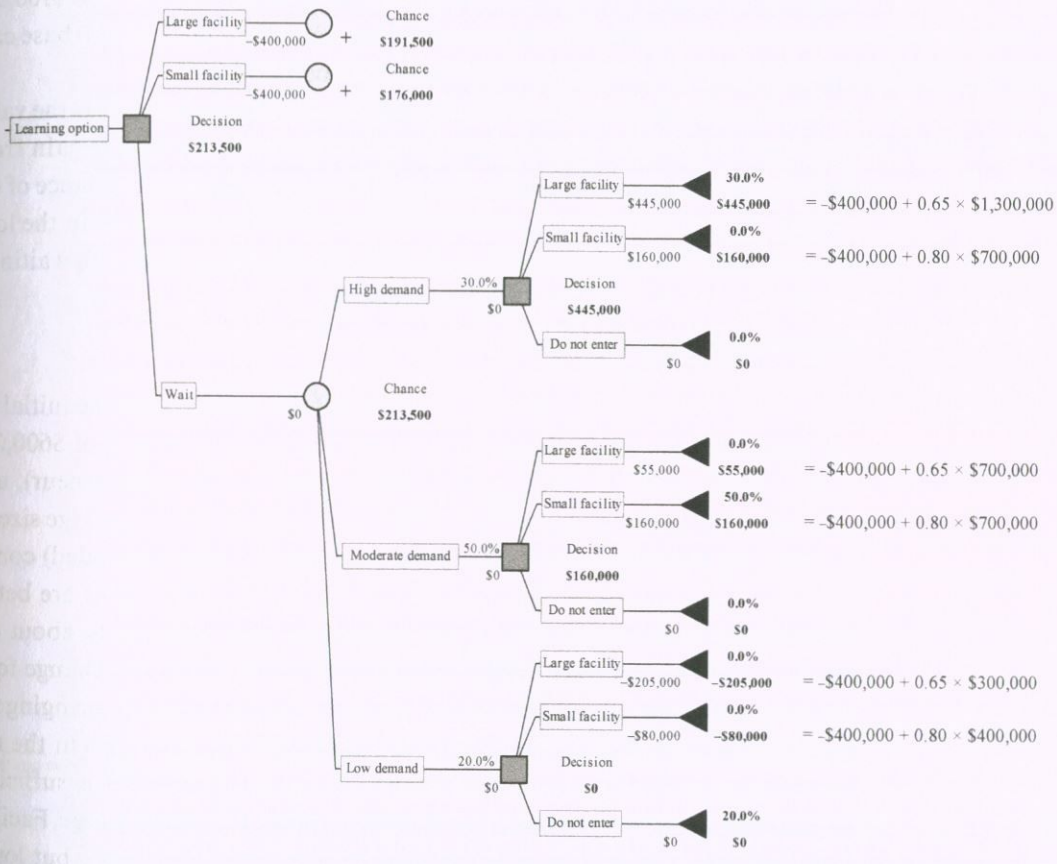


FIGURE 5.4

Decision tree for investing in a venture, with the option to delay investing until uncertainty about market demand is resolved

Prepared using PrecisionTree™, Palisade Corporation.

Not investing today may preserve an option to wait until more information is known about the true state of demand.

Similarly, the Small Facility is the best choice for the moderate-demand state. The NPV of investing in the Small Facility if the moderate-demand state occurs is $160,000. By waiting, the entrepreneur also avoids the potential mistake of investing only to learn that the low-demand state has been realized. If low-demand is realized, not entering is the best choice. Because, at present, we do not know which of the three states will be realized, we can only compare the expected value that would result from learning against the most favorable alternative available by choosing not to wait.

The immediate question facing the entrepreneur is whether to build now and face the uncertainty about demand or to wait for more information about demand. For this, we need to compare the NPV of investing now (and, as already established, building the Large Facility) against the NPV of waiting. The expected NPV conditional on using the learning option is simply the probability-weighted average of the three possible outcomes (.3 × $445,000 + .5 × $160,000 + .2 × $0), or $213,500. Because this value is greater than the $191,500 base case expected NPV of the best act-now choice, it is better to wait.

The learning option adds $22,000 to the value of the project; this is the value of the real option. The value comes from two sources: the upside gain from building the Large Facility when we know demand is high, and avoidance of the negative NPV outcome that occurs if we were to build any facility in the low-demand state. These two benefits outweigh the costs associated with waiting.

The Expansion Option

A second kind of option is the option to expand the venture after the initial investment has been made. Suppose that after an initial investment of $600,000 in the Small Facility (including $400,000 invested by the entrepreneur), and after learning market demand, the facility can be expanded to the large size by investing an additional $200,000. Assume that the $200,000 (if needed) comes from the outside investor, but on more favorable terms. The terms are better because the second investment is less risky given that uncertainty about demand is resolved. Specifically, the second $200,000 is raised in exchange for a 10% ownership share (1% of the equity for each $20,000 invested), bringing the investor's total to 30% in the event of expansion (rather than 35% in the no-waiting, Large-Facility scenario). Because the initial investment is sufficient to establish a market presence, we assume that the PV of the Large Facility is $1.4 million, higher than if no immediate investment were made but lower than if the Large Facility were built today.

What is the value of the expansion option? Figure 5.5 modifies Figure 5.3 to reflect this option. Here, we have ignored the learning option and have col-

lapsed the branches where the expansion option does not apply. As the problem is structured, if the Large Facility is chosen initially, the expansion option is implicitly forgone.

If the Small Facility is built, the entrepreneur can either expand or not. Expanding, if the high-demand state is realized, increases the entrepreneur's NPV to $580,000 ($980,000 minus the entrepreneur's original $400,000 investment). Not expanding leaves the NPV at $240,000, as in Figure 5.3. As this is below $580,000, we can prune the "High Demand/Do Not Expand" branch.

Figure 5.5 also compares the values of expanding to not expanding in the moderate- and low-demand states of the world. Expansion is not a good idea with moderate demand because investing reduces the entrepreneur's ownership share without increasing the value of the venture. So we can ignore the "Moderate Demand/Expand" branch. Not surprisingly, if demand is low, the best choice is "Do Not Expand."

Clearly, expansion is better if the high-demand state obtains. But is it a good idea to invest in the Small Facility first and wait to see what happens to demand?

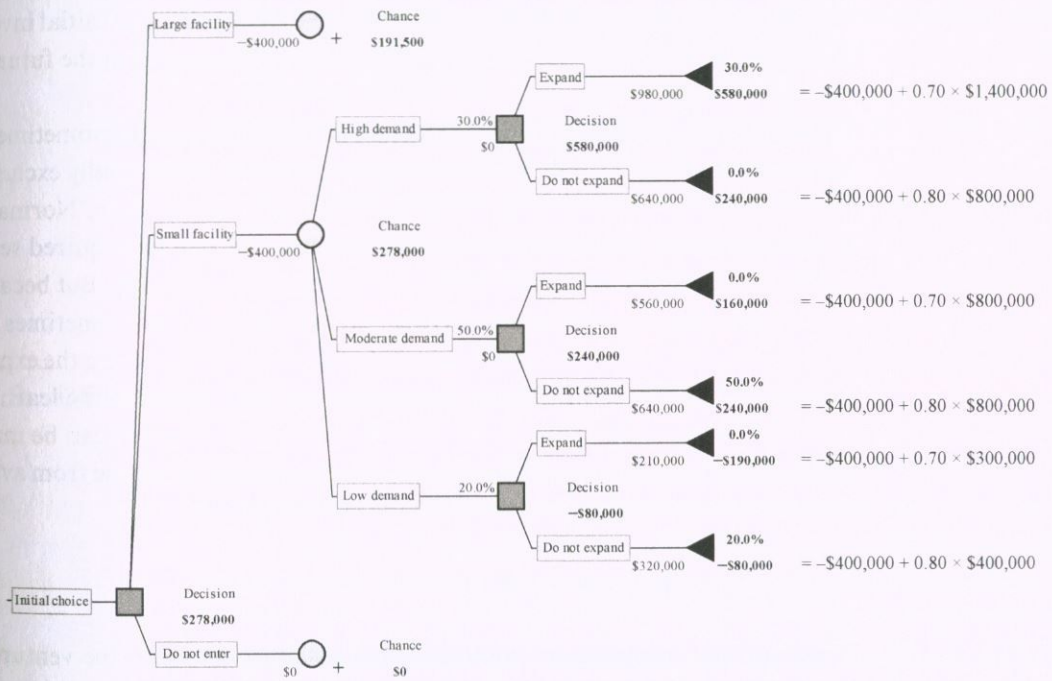


FIGURE 5.5

Decision tree for investing in a facility, with the option to expand the initial investment

Prepared using PrecisionTree™, Palisade Corporation.

The option to expand if demand turns out to be high is an example of the flexibility associated with real options.

The answer in this case is yes. As shown in Figure 5.5, the expected NPV from investing initially in the Small Facility and expanding only if the high-demand state is realized is as follows:

$$\text{NPV} = .3 \times \$580{,}000 + .5 \times \$240{,}000 + .2 \times (\$80{,}000) = \$278{,}000$$

where the parentheses indicate a negative value. Comparing this to the base case $191,500 expected NPV makes the expansion option worth $86,500. This is the value of the expansion option compared to the simple accept/reject decision.

In this case, we can compare the expansion option strategy that has a NPV of $278,000 with the $213,500 NPV of the learning option (Figure 5.4). According to these calculations, the NPV from investing immediately in a Small Facility (preserving the option to expand) is higher than from investing in a Large Facility ($278,000 > $191,500) and higher than from waiting to invest ($278,000 > $213,500). The incremental value of the expansion option compared to waiting is $64,500.

The key point of Figure 5.5 is that ignoring the option to expand would have led the entrepreneur to select a less valuable strategy. In some cases, a project may be passed up entirely because of the failure to recognize that initial investments sometimes create valuable options that can be exercised in the future if the environment is right.

Here we see a difference between real and financial options that sometimes is important: the waiting option and the expansion option are mutually exclusive ways to use the real asset. The entrepreneur cannot exercise both. Normally, financial options are independent of each other—they can be acquired separately and decisions to exercise them can be made independently. But because real options relate to how an underlying real asset is used, they sometimes are mutually exclusive. In this case, if the entrepreneur wants to acquire the expansion option, the investment must be made today, thus forgoing the learning option. That is, unlike financial options, where exercise choices can be made independently, sometimes the holder of a real option has to choose from available options—exercising one can preclude exercising others.

The Abandonment Option

The final type of option we consider is the option to abandon the venture if things do not work out as well as expected. Suppose the facility has an alternative use as office space. If converted to office space (for a negligible net expenditure), the PV of the Large Facility would be $600,000 and the value of the Small Facility would be $300,000.

You can see from the numbers that the option to abandon the Small Facility is worthless. This is because a Small Facility, even in the low-demand state, has a PV of $400,000, which is more than its PV as office space. But the option does have value for the Large Facility, because $600,000 is more than the $300,000 present value as a facility in the low-demand state.

The best strategy up to this point is to build small and then expand if demand turns out to be high. Is the value of the option to abandon the Large Facility enough to tip the balance in favor of building the Large Facility immediately? The "Large Facility/Low Demand/Abandon" path would mean a $390,000 payoff to the entrepreneur (.65 × $600,000). The entrepreneur's resulting NPV from investing immediately in the Large Facility with the option to abandon is as follows:

$$\text{NPV} = -\$400{,}000 + .3 \times \$975{,}000 + .5 \times \$520{,}000 + .2 \times \$390{,}000 = \$230{,}500$$

This is less than the $278,000 NPV of initially investing in the Small Facility with the option to expand but higher than any other alternative. If the option to expand did not exist, then investing in the Large Facility with the option to abandon would be the preferred strategy. It would exceed the NPV of the next best alternative—waiting until the state of the world is realized—by $17,000 ($230,500 − $213,500).

The option to abandon a venture that does not work out as well as expected can be critical to value and thus to the decision to launch the venture in the first place. It can also impact the willingness of investors to fund the venture. Test pilots of new aircraft normally take along parachutes in case something goes wrong; otherwise, they would be much less interested in testing new designs.

5.9 DECISION TREES AND CONTRACT NEGOTIATION

In the preceding example, we have assumed that the entrepreneur has found an investor who will agree to invest on the indicated terms (i.e., 1% of equity for each $10,000 invested in most cases). More realistically, the entrepreneur will need to negotiate and the terms will need to be mutually beneficial. In this illustration, we do not know whether the discount rate that would be used by the investor would be the same as that used by the entrepreneur. We also do not know whether the investor agrees about the probabilities of the different outcomes or the expected cash flows conditional on an outcome or real option choice. It could also be that the investor's equity claims have a preference relative to the entrepreneur's shares.

If we assume that the investor has the same expectations as the entrepreneur and uses the same discount rate, we can use the decision tree information to determine that the best option for the entrepreneur, build the Small Facility and expand if demand is high, would not be attractive to the investor. The investor's NPV from this strategy would be \$38,000.

$$NPV_{Investor} = [0.3 \times (-400 + 0.3 \times 1{,}400) + 0.5 \times (-200{,}000 + 0.2 \times 800) + 0.2 \times (-200 + 0.2 \times 400)] \times \$1{,}000$$

$$NPV_{Investor} = \$6{,}000 - \$20{,}000 - \$24{,}000 = -\$38{,}000$$

The NPV is positive if demand is high but negative otherwise. The willingness of the investor to accept the terms in the example indicates that the investor has a different perspective on the venture, such as a lower discount rate, lower perceived risk, or a higher probability that expansion would be warranted.

For example, as discussed in Chapter 1, the entrepreneur's valuations could be based on a high discount rate due to necessary underdiversification. A well-diversified investor could appropriately use a lower discount rate. If doing so were to double the present values of the cash flows under the expansion option strategy, the investor's NPV would be positive \$184,000 and would be positive in both the high- and moderate-demand outcomes.

While the details of discounting cash flows to present value is beyond the scope of this chapter, the point here is that the entrepreneur needs to think about the venture terms from both perspectives and seek to develop a financing strategy that would appeal to both parties. Examining the decision tree from both perspectives can enable the entrepreneur to assess this.

5.10 RIVAL REACTIONS AND GAME TREES

Decision trees do not explicitly incorporate the reactions of rivals or counterparties. For example, consider a venture that offers an innovative line of 3D-printed athletic shoes. Its entry strategy—of price, advertising expenditures, geographic scope, and so on—may depend critically on how it expects incumbent firms to react. The firm may decide to enter with an aggressive pricing strategy, assuming that incumbents will keep their prices constant. But if incumbents react by pricing aggressively, then the effectiveness of the new entrant's pricing strategy will be reduced and perhaps a toehold entry strategy would discourage rival reaction and be better for the entrepreneur in the long run.

Similarly, the terms of an agreement that is negotiated between a VC and an entrepreneur can have game-theoretic implications. For example, a VC might

be concerned that committing too much capital at an early stage might lead the entrepreneur to work less diligently on achieving the next important milestone, whereas investing a smaller amount might elevate the entrepreneur's concern about the difficulty of negotiating a fair valuation in the next round.

Rival (and counterparty) reactions are not an issue in perfectly competitive markets because other firms will not react specifically to the entry of a new rival and competition will mitigate the potential for holdup by an early investor (counterparty). For a small venture entering a large market or an entrepreneur who can deal with many potential investors, it may make sense to think of the market as nearly perfectly competitive. Furthermore, rival reactions are not an issue for a venture that offers a unique product and anticipates no entry, and therefore has market power. But planning for rival reactions can be important in settings where there are only a few actual or potential competitors. In such situations, the decisions of the competing firms and counterparties are highly interdependent.

One way to evaluate decision choices is to assign probabilities to rival reactions and use a decision tree to evaluate the choices. This approach is not likely to yield reliable results, however, because the probabilities effectively yield a weighted average reaction from among the various possibilities, whereas the actual reaction will be one choice or another.

There is a better way to think about the decision when rival reactions are important. The alternative is to explicitly assess what reaction would be in the best interest of each rival. The underlying reasoning is that a firm's actions and its rivals' are interdependent. Each firm is assumed to behave rationally by trying to select the strategy that maximizes value given what it believes its rival will do. Strategic interactions can be modeled by relying on the contributions of game theory. Game theory is concerned with analysis of optimal decision making when decision makers are aware that their actions affect each other's behavior and take these interactions into account.

To illustrate the uses of game theory in formulating strategy, we need to introduce some new terminology. A game consists of (1) a set of players, (2) an order of play, (3) the information set available to the players, (4) the set of actions available to each player, and (5) the payoff schedule that results from the actions. The players are simply the decision makers, such as an entrepreneur, a firm manager, a VC, or a rival.

The players make decisions at various points in a game (decision nodes). In a decision tree, the decisions are based on alternative states of the world, which are not strategic. In a game-theoretic setting, however, player actions are strategic and driven by rationality. The sequence in which decisions are made is the order of play. If all players make their decisions one at a time in a sequence, then the

game is a sequential-move game. If all decision makers act at the same time, then the game is a simultaneous-move game.

For an entrepreneur, it usually makes sense to think of the game as sequential, with the entrepreneur as the first mover. A sequential-move game can be analyzed with a game tree.[10] A game tree is a joint decision tree for the players and is composed of nodes and branches like a decision tree. Each node represents a decision point for one of the players. Each branch represents a possible action for a player at that point.

An Illustration

Consider a common problem of a prospective entrepreneur. Ethan would like to quit his bartending job and open his own establishment, Ethan's Bar. His options are (1) to enter the market with a large bar, (2) to enter with a small bar, and (3) to wait to see if the town's economy will support another bar. He has estimated the various costs and revenues associated with the two establishment sizes. His biggest concern is a rumor that a national chain, Naomi's Pub, is considering opening a bar in the same town. Naomi has two options: (1) enter the market or (2) do not enter. Ethan's decision depends on how Naomi might respond to Ethan's decision.

The decisions are illustrated as a game tree in Figure 5.6. The tree represents Ethan's perspective; both players' payoffs, shown in the two columns on the right, are expressed in terms of NPV. By acting quickly, Ethan can make the first move. Thus, the first decision node (working left to right) belongs to Ethan. The middle 3 decision nodes belong to Naomi. If Ethan chooses large-scale entry, then Naomi's Pub would make a loss of $100,000 if Naomi elected to enter and $0 if Naomi elected to stay out. In this case, the rational choice for Naomi is to stay out.

As with decision trees, we can ignore (or prune) the branches that represent inferior choices for the decision makers. Thus, we should assume that if Ethan opens a large bar, Naomi will choose not to enter. If Ethan chooses small-scale entry, then Naomi's Pub would earn a $200,000 NPV if Naomi were to enter and $0 if she decided to stay out. The rational decision for Naomi in this case is to enter, and we can prune the decision tree accordingly.

Finally, if Ethan decides to wait for the market to develop further, Naomi must decide between entering and staying out without knowing what Ethan is going to do. If Naomi enters, she would earn $100,000, $210,000, or $300,000, depending on Ethan's decision. If Ethan has decided to wait, then clearly Naomi would prefer to enter because all the choices associated with an entry strategy generate positive payoffs for Naomi's Pub. Hence, Ethan can prune the bottom branch of the game tree, "Naomi stays out." If Ethan decides to wait, he knows

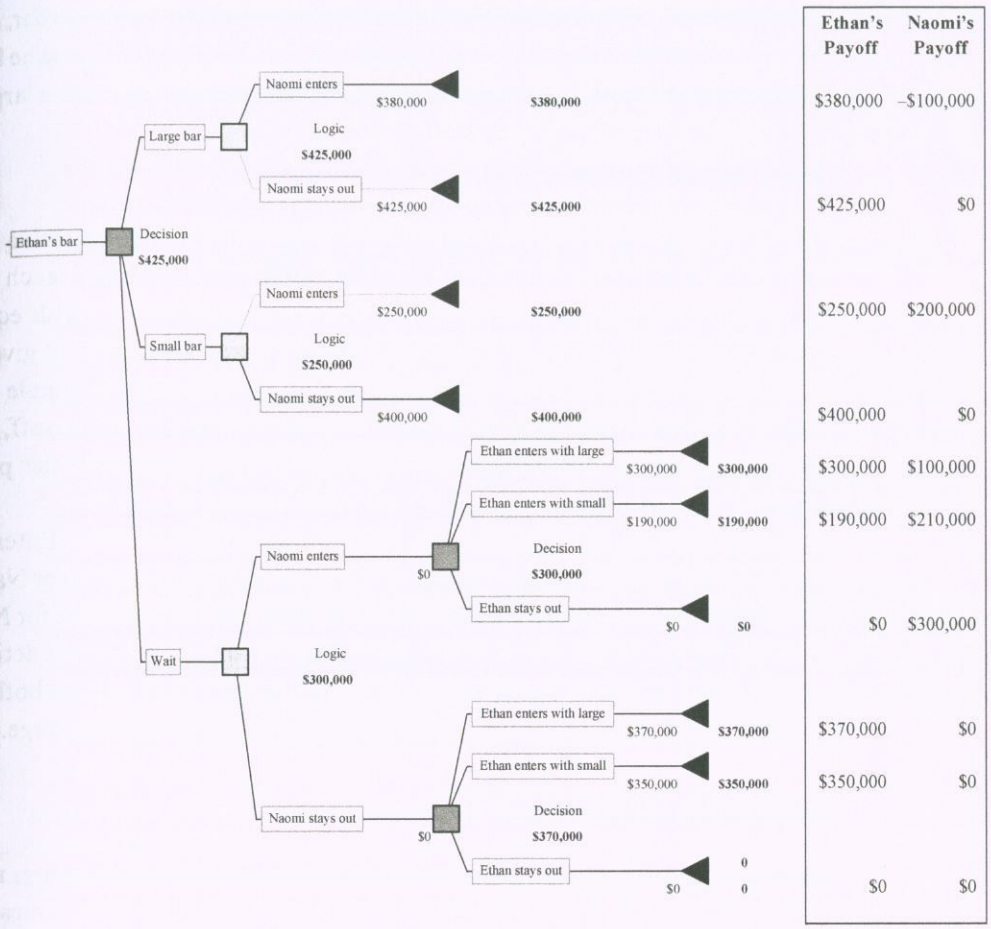


FIGURE 5.6

Entry decision game tree

Prepared using PrecisionTree™, Palisade Corporation.

In this sequential-move game, Ethan is the first mover. Ethan assumes Naomi will react rationally to Ethan's investment decision. Ethan can select the choice that maximizes value for him in light of Naomi's expected reaction.

Naomi will enter. Given that, the figure shows that Ethan's best response is to open the large bar, which gives Ethan a $300,000 NPV and leaves Naomi with $100,000. We can ignore the other branches, "Ethan enters with small" and "Ethan stays out," of this subtree.

Examining the remaining branches, we can adopt the same technique we used with the decision tree: backward induction. Start at the terminal decision nodes that display the NPVs of the various alternatives for the two parties. Beginning at the top, if Ethan enters with a large bar, Naomi will stay out (avoiding the $100,000 loss) and Ethan's payoff is $425,000. Moving down, if Ethan enters with a small bar, Naomi will also enter, making Ethan's payoff $250,000. Finally, if Ethan

waits, we know Naomi will enter. Ethan will then respond with a large bar, giving himself a $300,000 payoff. Since Ethan has the first move, and because he knows how Naomi will react, his optimal strategy is to enter immediately with a large bar.

Nash Equilibrium

The preceding example is a noncooperative game. In a noncooperative game, the players cannot enter into binding, enforceable agreements with each other. Any solution of the game must be a "Nash equilibrium."[11] A Nash equilibrium is a set of strategies such that each player's strategy is optimal given the strategy of the other player(s). The Nash equilibrium in our example is the pair of strategies such that (1) Ethan's strategy maximizes his payoff, given the strategy of Naomi's Pub, and (2) Naomi's strategy maximizes her payoff, given Ethan's strategy.

In the entry-decision game, the Nash equilibrium is (Ethan: "Enter with large"; Naomi: "Stay out"). That is, Ethan does not wait to see whether Naomi's Pub opens; instead, he enters first at a scale that makes it unprofitable for Naomi to open. Both parties maximize their profits given the other player's action. If each expects the other to choose its Nash equilibrium strategy, then both will. In other words, in equilibrium, expected and actual behaviors converge.

Games Entrepreneurs Play

Strategic "games" include a large class of activities in which a decision maker takes into account the actions and reactions of others. Strategic games commonly played by entrepreneurs include the following:

- **The business plan.** An entrepreneur must decide how much optimism to build into the projections that are included in the plan. Overoptimism can be dangerous. The investor may counter with a proposed deal that ties the entrepreneur's return to achieving the projections.
- **Strategic partnering.** An entrepreneur must decide whether to bring in a vertically integrated company as a distributor and strategic partner or risk the possibility that, if not invited to partner, the corporation will independently develop a competing product.
- **Control.** An entrepreneur must decide how much control to forsake in exchange for securing funding. If the entrepreneur is unwilling to give up control, a prospective investor might decide to forgo the opportunity.
- **Contract negotiation.** New venture contracting with investors is not a onetime event. Rather, it can involve several rounds with varying levels

of information and changing values. The dynamic nature of contract negotiation makes the process game theoretic.

- **Information disclosure.** A new venture's management must decide whether to patent an idea now and risk copycat entry of rivals or maintain the idea as a trade secret.

Strategic Flexibility Versus Strategic Commitment

Game theory forces the entrepreneur to think about a venture from the perspective of competitors, customers, suppliers, and investors. Decision trees and game trees are useful for assessing trade-offs between the value of maintaining flexibility (real options) and the value of committing to a more limited course of action. As in Figure 5.6, even though the waiting option has value, committing first to a large-scale bar may have an even greater NPV. In the figure, strategic commitment is the best choice, whereas in Figure 5.5, strategic flexibility (preserving the expansion option) was the best choice.

It is important for the founder of any new venture (and the investor) to systematically consider the values of the important embedded real options that it may have. However, early commitment to a course of action can preempt or limit rival reactions in the best interest of the new venture.

5.11 REAL OPTIONS WITH CONTINUOUS DISTRIBUTIONS

In the main example of this chapter, a retail facility, we limited uncertainty about demand to only three possible states of the world—high, moderate, and low demand. This, of course is artificial. In reality there are an infinite number of possibilities and the actual range is much broader than is reflected in the three that are examined. Artificially limiting the possibilities to a few discrete outcomes enabled us to use decision trees in a simple way to evaluate the strategic alternatives.

As long as the strategic choices are limited to a few discrete alternatives, we can still use decision trees to evaluate real options that involve continuous distributions of random outcomes (such as about demand). However, doing so requires more comprehensive descriptions of the uncertainty and the use of simulation software to evaluate the strategic choices. That is, in order to evaluate the strategic alternatives, we need to simulate the payoffs over the full range of possible outcomes.

The use of simulation to evaluate real options is the focus of Chapter 6. In this chapter, we use a few discrete scenarios to approximate the value we would

find by simulating a continuous distribution of scenarios. Doing so in a reliable way requires careful consideration of the strategic choices, including the use of simulation to identify the boundary conditions under which an option should be exercised.

To illustrate the use of discrete scenarios to evaluate real options involving continuous distributions, suppose we are considering a venture similar to the one described in Figure 5.5 and would like to evaluate the inclusion of expansion and abandonment options. At this point, suppose that based on an examination of similar ventures, instead of describing uncertainty about first-year demand as a single discrete outcome, we have determined that demand uncertainty can be approximated by a lognormal distribution with a mean of 1,000 units and standard deviation of 600 units. Based on the cost of expansion, we have also determined that if first-year demand turns out to be more than 1,500 units, it would be beneficial to expand. Conversely, if first-year demand is below 500 units, it would be beneficial to abandon the venture and liquidate the assets. Based on the parameters of the distribution, by simulating demand, we find that there is about a 15.7% probability that expansion will be warranted and a 16.5% probability that it would be best to abandon. This leaves 67.8% as the probability of continuing the venture without expanding.

Now that we have estimates of the probabilities of the three choices, we can use conditional expected values to evaluate the project including accounting for the real options. To do this, we will need to estimate the expected demand associated each of the three strategies. Simulation is a simple way to estimate the average demand associated with each. Using the simulation results, we estimate that the average demand from trials resulting in demand greater than 1,500 units is 2,073.4 units, the average for those with first-year demand below 500 units is 382.9, and the average over the trials where the venture would be continued without expansion is 901.6 units.

If we would like to value the project using a simple decision tree similar to the one in Figure 5.5, we would assign a 15.7% probability to expansion and an expected first-year unit sales volume of 2,073.4 units under expansion. Similarly, we would assign 16.5% as the probability of abandonment and an average first-year unit sales volume of 382.9.

The full analysis would require additional information, such as the contribution margin on each unit of sales, a model of how first-year sales relate to ultimate sales volume over time, and the level of fixed cost that is associated with each strategy. The main point here is that condensing the simulation data in this way makes it possible to evaluate the venture using a small number of discrete scenarios.

5.12 SUMMARY

Strategic decisions involve major commitments that limit the range of future actions. Comprehensive strategic planning involves product-market and organizational choices that are highly interrelated with financing choices. By considering all 3 simultaneously, the entrepreneur can be assured of identifying the alternative that yields the highest expected value.

A new venture can be thought of as a portfolio of real options, including, among others, the options to delay investing, to expand the size of the investment, and to abandon the investment. Strategic planning is a process of identifying these real options and comparing the values of alternative combinations of real options. Decision tree analysis provides a framework for identifying and describing strategic alternatives and for identifying and managing the real options that are embedded in any new venture. The different branches of the tree describe the interplay between alternative strategic choices and uncertain states of the world. By starting at the ends of the branches, determining the highest-valued choice at each stage, and eliminating the other branches from further consideration, it is possible to identify the strategic alternative today that is expected to result in the highest overall expected value of the project.

Game tree analysis is a useful extension of decision trees when the reactions of other parties to specific strategic choices are important. Game theory forces the entrepreneur to think about a decision from the perspectives of others who will be affected by it. In the context of a competitive game, it is important to consider the benefits of strategic flexibility relative to the benefits of strategic commitment.

REVIEW QUESTIONS

1. How are product-market, organizational, and financial strategies interdependent? Why, for new ventures, is it important to consider them simultaneously rather than sequentially? Give some examples.
2. What are the three aspects of a decision that make it strategic?
3. Why is it important for strategic planning to begin with a clear sense of the objective?
4. How might the objective for an entrepreneurial venture be different from that of a project pursued by a publicly held corporation?
5. How do embedded real options affect the values of investment opportunities? Why, when assessing investment alternatives, is it important to consider the embedded real options?

6. What are three important differences between real options and financial options?
7. Describe an investment opportunity that includes at least one real option. On what does the value of the option depend?
8. Explain how you would construct a decision tree that includes the real option(s) and uncertainty. How would you use the tree to decide on a course of action?
9. How are game trees different from decision trees? For what kinds of decisions would you want to use game trees instead of decision trees?
10. How is the business plan related to strategic planning?

NOTES

1. Background on the topic of strategy is provided by Porter (1998).

2. A more conventional example of these strategic interdependencies is the early growth of Ford Motor Company. Ford's product-market strategy emphasized high-volume, low-product-price marketing. Its complementary organizational strategy was to use assembly lines to build automobiles almost entirely from parts supplied by others, and to sell through non-integrated franchisee dealers. By focusing on final assembly, Ford reduced its need for early-stage capital. It could take advantage of vendor financing (trade credit) for the parts it purchased. By selling to dealers for cash, it shifted the burden of carrying finished-goods inventory to the dealers. It is unlikely that Ford's product-market strategy could have been achieved without the complementary financial and organizational strategies.

3. Moskowitz and Vissing-Jorgensen (2002) estimate returns to the private equity held by entrepreneurs and find a large public equity premium, and pose the following puzzle: why would entrepreneurs willingly invest in a single privately held firm with seemingly far worse returns than investing in the stock market? As noted in the text, qualitative considerations such as valuing being one's own boss could explain this. In an update to their study, Kartashova (2014) finds that the public equity premium puzzle does not survive in some subsets of the data. The difference between private and public equity returns is positive between 1999 and 2007, whereas in the 2008–2010 period, the returns are very similar.

4. Hammond, Keeney, and Raiffa (1998) offer a survey of the pitfalls of decision making that is guided by intuition or misapplication of more systematic approaches.

5. Bhide (1994) notes that a variety of factors in addition to NPV can influence the suitability of an investment.

6. Amram and Kulatilaka (1999) illustrate the application of real options approaches to new venture investing and other decisions. See Chen, Kensinger, and Conover (1998); Childs, Ott, and Triantis (1998); and Loch and Bode-Greuel (2001) for specific applications. Dixit and Pindyck (1995) provide perspective on valuing investment decisions as options. Luehrman (1998a) discusses strategic decision making in terms of real options.

7. Luehrman (1998b) describes how simple investment opportunities can be valued as real options using financial option valuation methods.

8. These values are from the perspective of the entrepreneur and are not necessarily the same as values to an investor. Because the focus in this chapter is on learning to recognize and compare real options, we are abstracting from other aspects of the strategic analysis.

9. As an aspect of a theory of entrepreneurship, Baumol (1993) studies the optimal rate of innovation using the trade-off between delaying introduction of new products as a means of improving their quality and the risk that a competitor will enter first.

10. Simultaneous-move games are usually analyzed using payoff matrices that display the players' outcomes for the simultaneous choices.

11. The Nash equilibrium concept is named in honor of John Nash, a Princeton mathematician who was a pioneer of game theory.

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