

CHAPTER 29

**THE OPTIONS TO EXPAND AND ABANDON: VALUATION
IMPLICATIONS**

In the last chapter, we noted that traditional discounted cash flow valuation does not consider the value of the option that many firms have to delay making an investment and consequently understates the value of these firms. In this chapter, we consider two other options that are often embedded in investments (and consequently in the values of the firms that possess them). The first of these is the option to expand an investment, not only in new markets but in new products, to take advantage of favorable conditions. We argue that this option may sometimes make young, start-up firms significantly more valuable than the present value of their expected cash flows. The second option is the option to abandon or scale down investments, which can reduce the risk and downside from large investments and therefore make them more valuable.

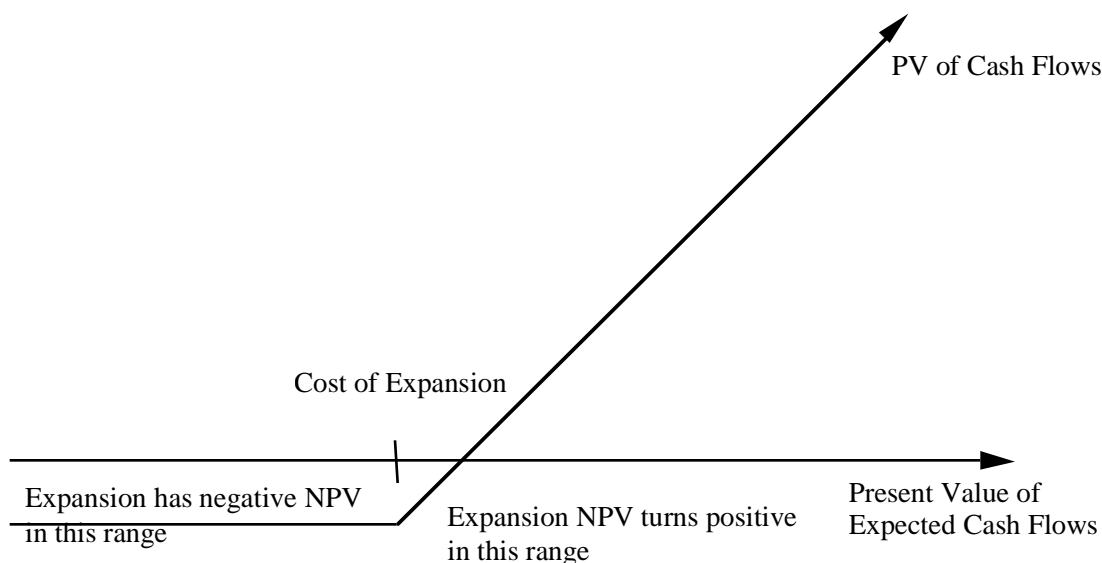
The Option to Expand

Firms sometimes invest in projects because the investments allow them either to make further investments or to enter other markets in the future. In such cases, we can view the initial projects as options allowing the firm to invest in other projects and we should therefore be willing to pay a price for such options. Put another way, a firm may accept a negative net present value on the initial project because of the possibility of high positive net present values on future projects.

The Payoff on the Option to Expand

The option to expand can be evaluated at the time the initial project is analyzed. Assume that this initial project will give the firm the right to expand and invest in a new project in the future. Assessed today, the expected present value of the cash flows from investing in the future project is V and the total investment needed for this project is X . The firm has a fixed time horizon, at the end of which it has to make the final decision on whether or not to make the future investment. Finally, the firm cannot move forward on this future investment if it does not take the initial project. This scenario implies the option payoffs shown in Figure 29.1.

Figure 29.1: The Option to Expand a Project



As you can see, at the expiration of the fixed time horizon, the firm will expand into the new project if the present value of the expected cash flows at that point in time exceeds the cost of expansion.

Inputs to value the option to expand

To understand how to estimate the value of the option to expand, let us begin by recognizing that there are two projects usually that drive this option. The first project generally has a negative net present value and is recognized as a poor investment, even by the firm investing in it. The second project is the potential to expand that comes with the first project. It is the second project that represents the underlying asset for the option. The inputs have to be defined accordingly.

- The present value of the cash flows that you would generate if you were to invest in the second project today (the expansion option) is the value of the underlying asset – S in the option pricing model.
- If there is substantial uncertainty about the expansion potential, the present value is likely to be volatile and change over time as circumstances change. It is the variance in this present value that you would want to use to value the expansion option. Since projects are not traded, you have to either estimate this variance

from simulations or use the variance in values of publicly traded firms in the business.

- The cost that you would incur up front, if you invest in the expansion today, is the equivalent of the strike price.
- The life of the option is fairly difficult to define, since there is usually no externally imposed exercise period. (This is in contrast to the patents we valued in the last chapter which have a legal life which can be used as the option life.) When valuing the option to expand, the life of the option will be an internal constraint imposed by the firm on itself. For instance, a firm that invests on a small scale in China might impose a constraint that it either will expand within 5 years or pull out of the market. Why might it do so? There may be considerable costs associated with maintaining the small presence or the firm may have scarce resources that have to be committed elsewhere.
- As with other real options, there may be a cost to waiting, once the expansion option becomes viable. That cost may take the form of cash flows that will be lost on the expansion project if it is not taken or a cost imposed on the firm until it makes its final decision. For instance, the firm may have to pay a fee every year until it makes its final decision.

Illustration 29.1: Valuing an Option to Expand: Ambev and Guarana

Guarana is a very popular caffeine-based soft drink in Brazil and Ambev is the Brazilian beverage manufacturer that is the largest producer of Guarana in the world. Assume that Ambev is considering introducing the drink into the United States and that it has decided to do so in two steps.

- Ambev will initially introduce Guarana in just the large metropolitan areas of the United States to gauge potential demand. The expected cost of this limited introduction is \$500 million and the estimated present value of the expected cash flows is only \$400 million. In other words, Ambev expects to have a negative net present value of \$100 million on this first investment.
- If the limited introduction turns out to be a success, Ambev expects to introduce Guarana to the rest of the U.S. market. At the moment, though, the firm is not

optimistic about this expansion potential and believes that while the cost of the full-scale introduction will be \$1 billion, the expected present value of the cash flows is only \$750 million (making this a negative net present value investment as well).

At first sight, investing in a poor project to get a chance to invest in an even poorer project may seem like a bad deal, but the second investment does have a redeeming feature. It is an option and Ambev will not make the second investment (of \$1 billion) if the expected present value of the cash flows stays below that number. Furthermore, there is considerable uncertainty about the size and potential for this market and the firm may well find itself with a lucrative investment.

To estimate the value of the second investment as an option, we begin by first identifying the underlying asset – the expansion project – and using the current estimate of expected value (\$750 million) as the value of the underlying asset. Since the investment needed for the investment of \$1 billion is the exercise price, this option is an out-of-the-money option. The two most problematic assumptions relate to the variance in the value of the underlying asset and the life of the option:

- We estimated the average standard deviation of 35% in firm values of small, publicly traded beverage companies in the United States and assumed that this would be a good proxy for the standard deviation in the value of the expansion option.
- We assumed that Ambev would have a five-year window to make their decision. We admit that this is an arbitrary constraint but, in the real world, it may be driven by any of the following.
 - financing constraints (loans coming due)
 - strategic prerogatives (you have to choose where your resources will be invested)
 - personnel decisions (management has to be hired and put in place).

Based upon these inputs, we had the following inputs to the option pricing model.

S = Present value of cash flows from expansion option today = \$750

K = Exercise Price = \$ 1000

t = 5 years

Standard deviation in value = 35%

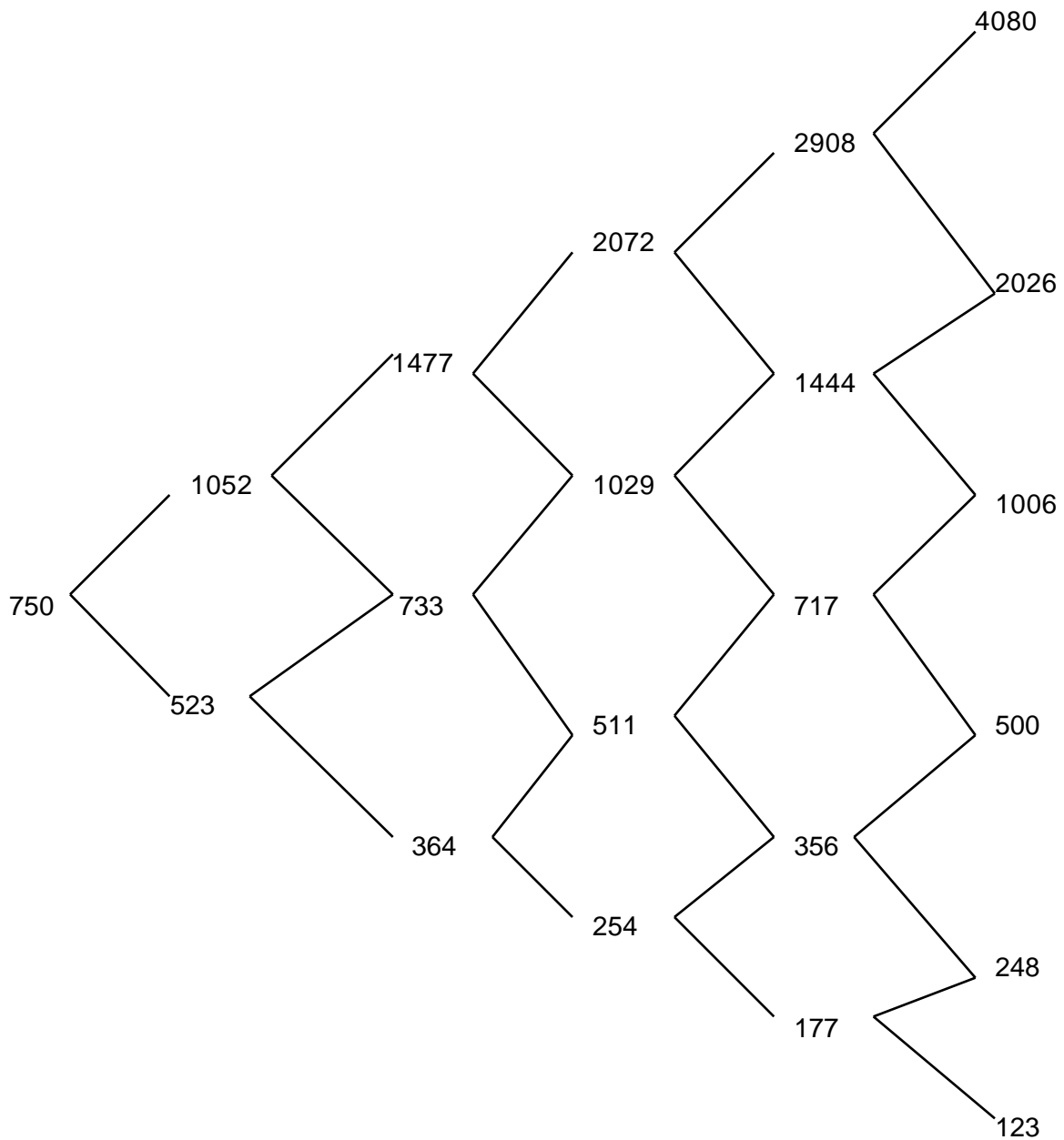
We used a riskless rate of 5% and derived the expected up and down movements from the standard deviation.

$u = 1.4032$

$d = 0.6968$

The binomial tree is presented in Figure 29.2.

Figure 29.2: Binomial Tree – Ambev Expansion Option



Using the replicating portfolio framework described in Chapter 5, we estimate the value of the expansion option to be \$203 million. This value can be added on to the net present value of the original project under consideration.

$$\text{NPV of limited introduction} = -500 + 400 = - \$ 100 \text{ million}$$

$$\text{Value of Option to Expand} = \$ 203 \text{ million}$$

$$\text{NPV with option to expand} = -\$ 100 \text{ million} + \$ 203 \text{ million} = \$ 103 \text{ million}$$

Ambev should go ahead with the limited introduction, even though it has a negative net present value, because it acquires an option of much greater value, as a consequence.

Estimating variances from Monte Carlo Simulations

We have suggested a couple of times in the last two chapters that the variances to be used in real option pricing models be derived from simulations. A Monte Carlo simulation requires the following steps.

1. You define probability distributions for each of the key inputs that underlie the cash flows and the parameters of the distributions – the average and the standard deviation, if it is a normal distribution, for instance.
2. In each simulation, you draw one outcome from each distribution and estimate the present value of the cash flows based upon these draws.
3. After repeated simulations, you should have a distribution of present values. The mean of this distribution should be the expected value of the project and the standard deviation of the distribution can be used as the variance in the value to value options on the project.

While the process of running these simulations is straight forward and there are a number of software packages¹ that exist that allow you to do this, we would add the following notes of caution.

- The most difficult step is estimating the probability distributions and parameters for the key variables. It is easier to do when a firm has had experience with similar projects in the past – a retail store considering a new store, for instance – than for a

¹ Crystal Ball and @Risk are both add-on packages to Excel that allow you to run simulations.

new product or a new market. If the distributions that feed into a simulation are random, the output, impressive though it might look on paper, is meaningless.

- The standard deviation or variance that you want to use in option pricing models is a variance in value over time and not at a point in time. What is the difference, you might ask? Market testing, for instance, provide a distribution for the market potential today and reflect estimation uncertainty. The market itself will evolve over time and it is the variance in that distribution that we would like to estimate.²
- You should estimate the standard deviation in the value of the project – the sum of the present value of the cash flows – rather than the standard deviation in annual income or annual cash flows.



expand.xls: This spreadsheet allows you to estimate the value of the option to expand a project to cover new markets or new products, using the Black-Scholes model.

Problems in valuing the Option to Expand

The practical considerations associated with estimating the value of the option to expand are similar to those associated with valuing the option to delay. In most cases, firms with options to expand have no specific time horizon by which they have to make an expansion decision, making these open-ended options, or, at best, options with arbitrary lives. Even in those cases where a life can be estimated for the option, neither the size nor the potential market for the product may be known and estimating either can be problematic. To illustrate, consider the Ambev example discussed above. While we adopted a period of five years, at the end of which the Ambev has to decide one way or another on its future expansion in United States, it is entirely possible that this time frame is not specified at the time the first store is opened. Furthermore, we have assumed that both the cost and the present value of expansion are known at the time of the initial investment. In reality, the firm may not have good estimates for either input before opening the first store, since it does not have much information on the underlying market.

Extensions and Implications of Expansion Options

The option to expand can be used by firms to rationalize investing in projects that have negative net present values but provide significant opportunities to enter new markets or to sell new products. The option pricing approach adds rigor to this argument by estimating the value of this option and it also provides insight into those occasions when it is most valuable. The option to expand is clearly more valuable for more volatile businesses with higher returns on projects (such as biotechnology or computer software) than it is for stable businesses with lower returns (such as automobile production). We will consider three cases where the expansion option may yield useful insights – strategic considerations in acquisitions, research and development expenses and multi-stage projects.

Strategic Considerations in Acquisitions

In many acquisitions or investments, the acquiring firm believes that the transaction will give it competitive advantages in the future. These competitive advantages include:

- *Entry into a Large or Growing Market:* An investment or acquisition may allow the firm to enter a large or potentially large market much sooner than it otherwise would have been able to do so. A good example of this is the acquisition of a Mexican retail firm by a US firm, with the intent of expanding into the Mexican market.
- *Technological Expertise:* In some cases, the acquisition is motivated by the desire to acquire a proprietary technology that will allow the acquirer to either expand its existing market or enter a new market.
- *Brand Name:* Firms sometimes pay large premiums over market price to acquire firms with valuable brand names, because they believe that these brand names can be used for expansion into new markets and products in the future.

While all these potential advantages may be used to justify large acquisition premiums, not all of them create valuable options. Even if these advantages can be viewed as valuable

² You could, for instance, be fairly certain about the size of the market today – the variance would be low or even zero – but be uncertain about what the market will look like a year from now or three years from now. It is the latter variance that determines the value of the option.

expansion options, the value has to be greater than the acquisition premium for stockholders to gain.

Research, Development and Test Market Expenses

Firms that spend considerable amounts of money on research and development and test marketing are often stymied when they try to evaluate these expenses, since the payoffs are in terms of future projects. At the same time, there is the very real possibility that after the money has been spent, the products or projects may turn out not to be viable; consequently, the expenditure must be treated as a sunk cost. In fact, R & D has the characteristics of a call option — the amount spent on the R&D is the cost of the call option and the projects or products that might emerge from the research provide the payoffs on the options. If these products are viable (i.e., the present value of the cash inflows exceeds the needed investment), the payoff is the difference between the two. If not, the project will not be accepted and the payoff will be zero.

Several logical implications emerge from this view of R & D. First, research expenditures should provide much higher value for firms that are in volatile businesses, since the variance in the product or project cash flows is positively correlated with the value of the call option. Thus, Minnesota Mining and Manufacturing (3M), which expends a substantial amount on R&D on basic office products, such as the Post-it pad, should receive less value³ for its dollar of research than does Amgen, whose research primarily concerns bio-technology products. Second, the value of research and the optimal amount to be spent on research will change over time as businesses mature. The best example is the pharmaceutical industry - pharmaceutical companies spent most of the 1980s investing substantial amounts in research and earning high returns on new products, as health care costs expanded. In the 1990s, however, as health care costs started leveling off and the business matured, many of these companies found that they were not getting the same payoffs on research and started cutting back. Some companies

³ This statement is based on the assumption that the quality of research is the same at both firm, though the research is in different businesses, and that the only difference is in the volatility of the underlying businesses.

moved research dollars from conventional drugs to bio-technology products, where uncertainty about future cash flows remains high.

Multi-Stage Projects/Investments

When entering new businesses or taking new investments, firms sometimes have the option to move in stages. While doing so may reduce potential upside, it also protects the firm against downside risk, by allowing it at each stage to gauge demand and decide whether to go on to the next stage. In other words, a standard project can be recast as a series of options to expand, with each option being dependent on the previous one. There are two propositions that follow.

- Some projects that are unattractive on a full investment basis may be value creating if the firm can invest in stages.
- Some projects that look attractive on a full investment basis may become even more attractive if taken in stages.

The gain in value from the options created by multi-stage investments has to be weighed against the cost. Taking investments in stages may allow competitors who decide to enter the market on a full scale to capture the market. It may also lead to higher costs at each stage, since the firm is not taking full advantage of economies of scale.

Several implications emerge from viewing this choice between multi-stage and one-time investments in an option framework. The projects where the gains will be largest from making the investment in multiple stages include:

- Projects where there are *significant barriers to entry to competitors* entering the market and taking advantage of delays in full-scale production: Thus, a firm with a patent on a product or other legal protection against competition pays a much smaller price for starting small and expanding as it learns more about the market.
- Projects where there is *uncertainty about the size of the market* and the eventual success of the project: Here, starting small and expanding in stages allows the firm to reduce its losses if the product does not sell as well as anticipated and to learn more about the market at each stage. This information can be useful in both product design and marketing in subsequent stages.

- Projects where there is a *substantial investment needed in infrastructure* and high operating leverage (fixed costs): Since the savings from doing a project in multiple stages can be traced to the investments needed at each stage, the benefit is likely to be greater in firms where those costs are large. Capital intensive projects as well as projects that require large initial marketing expenses (a new brand name product for a consumer product company), for example, will gain more from the options created by investing in the projects in multiple stages.

Sequential and Compound Options: Some Thoughts

A compound option is an option on an option. A simple example would be a call option on a small company that has only one asset – a patent. Last chapter, we argued that a patent could be viewed as an option and thus the call option on the company becomes a compound option. You can also have a sequence of options, where the value of each option is dependent upon whether the previous option is exercised or not. For instance, a five-stage project has sequential options. Whether you reach the fifth stage or not is obviously a function of whether you make it through the first four stages – the value of the fifth option in the sequence is determined by what happens to the first four options.

Needless to say, option pricing becomes more complicated when you have sequential and compound options. There are two choices. One is to value these options as simple options and accept the fact that the value that you obtain will be an approximation. The other is to modify the option pricing model to allow for the special characteristics of these options. While we do not consider these models in this book, you can modify both the Black Scholes and binomial models to allow them to price compound and sequential options.

When are expansion options valuable?

While the argument that some or many investments have valuable strategic or expansion options embedded in them has great allure, there is a danger that this argument can be used to justify poor investments. In fact, acquirers have long justified huge premiums on acquisitions on synergistic and strategic grounds. We need to be more

rigorous in our measurement of the value of real options and in our use of real options as justification for paying high prices or making poor investments.

Quantitative Estimation

When real options are used to justify a decision, the justification has to be in more than qualitative terms. In other words, managers who argue for investing in a project with poor returns or paying a premium on an acquisition on the basis of the real options generated by this investment should be required to value these real options and show that the economic benefits exceed the costs. There will be two arguments made against this requirement. The first is that real options cannot be easily valued, since the inputs are difficult to obtain and often noisy. The second is that the inputs to option pricing models can be easily manipulated to back up whatever the conclusion might be. While both arguments have some basis, an estimate is better than no estimate at all and the process of trying to estimate the value of a real option is, in fact, the first step to understanding what drives its value.

Tests for Expansion Option to have Value

Not all investments have options embedded in them and not all options, even if they do exist, have value. To assess whether an investment creates valuable options that need to be analyzed and valued, we need to understand three key questions.

1. *Is the first investment a pre-requisite for the later investment/expansion? If not, how necessary is the first investment for the later investment/expansion?* Consider our earlier analysis of the value of a patent or the value of an undeveloped oil reserve as options. A firm cannot generate patents without investing in research or paying another firm for the patents and it cannot get rights to an undeveloped oil reserve without bidding on it at a government auction or buying it from another oil company. Clearly, the initial investment here (spending on R&D, bidding at the auction) is required for the firm to have the second investment. Now consider the Ambev investment in a limited introduction and the option to expand into the U.S. market later. The initial investment provides Ambev with information about market potential, without which presumably it is unwilling to expand into the larger market. Unlike the patent and undeveloped reserves examples, the initial investment is not a pre-requisite

for the second, though management might view it as such. The connection gets even weaker and the option value lower when we look at one firm acquiring another to have the option to be able to enter a large market. Acquiring an internet service provider to have a foothold in the internet retailing market or buying a Chinese brewery to preserve the option to enter the Chinese beer market would be examples of less valuable options.

2. *Does the firm have an exclusive right to the later investment/expansion? If not, does the initial investment provide the firm with significant competitive advantages on subsequent investments?* The value of the option ultimately derives not from the cash flows generated by the second and subsequent investments, but from the excess returns generated by these cash flows. The greater the potential for excess returns on the second investment, the greater the value of the expansion option in the first investment. The potential for excess returns is closely tied to how much of a competitive advantage the first investment provides the firm when it takes subsequent investments. At one extreme, again, consider investing in research and development to acquire a patent. The patent gives the firm that owns it the exclusive rights to produce that product and, if the market potential is large, the right to the excess returns from the project. At the other extreme, the firm might get no competitive advantages on subsequent investments, in which case, it is questionable as to whether there can be any excess returns on these investments. In reality, most investments will fall in the continuum between these two extremes, with greater competitive advantages being associated with higher excess returns and larger option values.
3. *How sustainable are the competitive advantages?* In a competitive market place, excess returns attract competitors and competition drives out excess returns. The more sustainable the competitive advantages possessed by a firm, the greater will be the value of the options embedded in the initial investment. The sustainability of competitive advantages is a function of two forces. The first is the nature of the competition; other things remaining equal, competitive advantages fade much more quickly in sectors where there are aggressive competitors. The second is the nature of the competitive advantage. If the resource controlled by the firm is finite and scarce (as is the case with natural resource reserves and vacant land), the competitive

advantage is likely to be sustainable for longer periods. Alternatively, if the competitive advantage comes from being the first mover in a market or from having technological expertise, it will come under assault far sooner. The most direct way of reflecting this competitive advantage in the value of the option is its life; the life of the option can be set to the period of competitive advantage and only the excess returns earned over this period counts towards the value of the option.

If the answer is yes to all three questions, then the option to expand can be valuable. Applying the last two tests to the Ambev expansion option, you can see the potential problems. While Ambev is the largest producer of Guarana in the world, it does not have a patent on the product. If the initial introduction proves successful, it is entirely possible that Coke and Pepsi could produce their own versions of Guarana for the national market. If this occurs, Ambev will have expended \$100 million of its funds to provide market information to its competitors. Thus, if Ambev gets no competitive advantage in the expansion market because of its initial investment, the option to expand ceases to have value and cannot be used to justify the initial investment. Now consider two intermediate scenarios. If Ambev gets a lead time on the expansion investment because of its initial investment, you could build in higher cash flows for that lead time and a fading off to lower cashflows thereafter. This will lower the present value of the cash flows for the expansion and the value of the option. A simpler adjustment would be to cap the present value of the cash flows, the argument being that competition will restrict how large the net present value can become and value the option with the cap. For instance, if you assume that the present value of the cashflows from the expansion option cannot exceed \$2 billion, the value of the expansion option drops to \$142 million.⁴

Valuing a firm with the option to expand

Is there an option to expand embedded in some firms that can lead to these firms to trade at a premium over their discounted cash flow values? At least in theory, there is a

⁴ You can value the capped call by valuing the expansion option twice in the Black Scholes model, once with a strike price of \$1,000 (yielding the original expansion option value of \$218 million) and one with the strike price of \$2000 (yielding an option value of \$76 million). The difference between the two is the value of the expansion option with a cap on the present value. You could also value it explicitly in the

rationale for making this argument for a small, high-growth firm in a large and evolving market. The discounted cash flow valuation is based upon expected cash flows and expected growth and these expectations should reflect the probability that the firm could be hugely successful (or a huge failure). What the expectations might fail to consider is that, in the event of success, the firm could invest more, add new products or expand into new markets and augment this success. This is the real option that is creating the additional value.

Relationship to Discounted Cashflow Valuation

If the value of this option to expand is estimated, the value of a firm can be written as the sum of two components – a discounted cash flow value based upon expected cash flows and a value associated with the option to expand.

Value of firm = Discounted Cash flow Value + Option to Expand

The option pricing approach adds rigor to this argument by estimating the value of the option to expand and it also provides insight into those occasions when it is most valuable. In general, the option to expand is clearly more valuable for more volatile businesses with higher returns on projects (such as biotechnology or computer software) than in stable businesses with lower returns (such as housing, utilities or automobile production).

Again, though, you have to be careful not to double count the value of the option. If you use a higher growth rate than would be justified based upon expectations because of the option to expand, you have already counted the value of the option in the discounted cash flow valuation. Adding an additional component to reflect the value of the option would be double counting.

Inputs for valuing Expansion Option

To value a firm with the option to expand, you have to begin by defining the market that the firm has the option to enter and specify the competitive advantages that you believe will give it some degree of exclusivity to make this entry. Once you are

binomial by setting the value to \$2,000 whenever it exceeds that number in the binomial tree. [NOTE: The problem calls for a cap on the PV of cash flow or S, not the exercise price.]

convinced that there is this exclusivity, you should then estimate the expected cashflows you would get if you entered the market today and the cost of entering that market. Presumably, the costs will exceed the expected cash flows or you would have entered the market already. The cost of entering the market will become the exercise price of the option and the expected cashflows from entering the market today will become the value of the underlying asset.

To estimate the variance in the value, you can either run simulations on how the market will evolve over time or use the variances of publicly traded firms that service that market today and assume that this variance is a good proxy for the volatility in the underlying market. You also have to specify a period by which you have to make the decision of whether to enter the market or not – this will become the life of the option. You may tie this assumption to the assumptions you made about competitive advantages. For instance, if you have the exclusive license to enter a market for the next 10 years, you would use 10 years as your option life.

Illustration 29.2: Considering the value of the option to expand

Rediff.com is an internet portal serving the Indian sub-continent. In June 2000, the firm had only a few million in revenues, but had tremendous growth potential as a portal and electronic marketplace. Using a discounted cashflow model, we valued Rediff.com at \$474 million, based upon its expected cash flows in the internet portal business. Assume that in buying Rediff.com, you are in fact buying an option to expand in the online market in India. This market is a small one now, but could potentially be much larger in five or ten years.

In more specific terms, assume that Rediff.com has the option to enter the internet retailing business in India in the future. The cost of entering this business is expected to be \$1 billion and, based on current expectations, the present value of the cash flows that would be generated by entering this business today is only \$500 million. Based upon current expectations of the growth in the Indian e-commerce business, this investment clearly does not make sense.

There is substantial uncertainty about future growth in online retailing in India and the overall performance of the Indian economy. If the economy booms and the online

market grows faster than expected over the next 5 years, Rediff.com might be able to create value from entering this market. If you leave the cost of entering the online retailing business at \$1 billion, the present value of the cash flows would have to increase above this value for Rediff to enter this business and add value. The standard deviation in the present value of the expected cash flows (which is currently \$500 million) is assumed to be 50%.

The value of the option to expand into internet retailing can now be estimated using an option pricing model, with the following parameters.

S = Present Value of the expected cash flows from entering market today = \$ 500 million

K = Cost of entering the market today = \$ 1 billion

σ^2 = Variance in the present value of expected cash flows = $0.5^2 = 0.25$

r = 5.8% (This is a five year treasury bond rate: the analysis is being done in U.S dollar terms)

t = 5 years

The value of the option to expand can be estimated.


Option to Expand = $500(0.5786) - 1000e^{-(0.058)(5)}(0.1789) = \155.47 million

Why does the option expire in 5 years? If the online retail market in India expands beyond this point in time, it is assumed that there will be other potential entrants into this market and that Rediff.com will have no competitive advantages and hence no good reason for entering this market. If the online retail market in India expands sooner than expected, it is assumed that Rediff.com, as one of the few recognized names in the market, will be able to parlay its brand name and the visitors to its portal to establish competitive advantages.

The value of Rediff.com as a firm can now be estimated as the sum of the discounted cash flow value of \$474 million and the value of the option to expand into the retail market (\$155 million). It is true that the discounted cash flow valuation is based upon a high growth rate in revenues, but all of this growth is assumed to occur in the internet portal business and not in online retailing.

In fact, the option to enter online retailing is only one of several options available to Rediff. Another path it might embark is to become a development exchange for

resources - software developers and programmers in India looking for programming work in the United States and other developed markets. The value of this option can also be estimated using an approach similar to the one shown above.

 *expand.xls*: This spreadsheet allows you to estimate the value of the option to expand an investment or project.

Value of Financial Flexibility

When making financial decisions, managers consider the effects of such decisions on their capacity to make new investments or meet unanticipated contingencies in future periods. Practically, this translates into firms maintaining excess debt capacity or larger cash balances than are warranted by current needs to meet unexpected future requirements. While maintaining this financing flexibility has value to firms, it also has a cost; the large cash balances might earn below market returns and excess debt capacity implies that the firm is giving up some value and has a higher cost of capital.

Determinants of the Value of Financial Flexibility

One reason that a firm maintains large cash balances and excess debt capacity is to have the future option to take unexpected projects with high returns. To value financial flexibility as an option, assume that a firm has expectations about how much it will need to reinvest in future periods, based upon its own past history and current conditions in the industry. Assume also that a firm has expectations about how much it can raise from internal funds and its normal access to capital markets in future periods. There is uncertainty about future reinvestment needs; for simplicity, we will assume that the capacity to generate funds is known with certainty to the firm. The advantage (and value) of having excess debt capacity or large cash balances is that the firm can meet any reinvestment needs, in excess of funds available, using its debt capacity. The payoff from these projects, however, comes from the excess returns the firm expects to make on them. To value financial flexibility on an annualized basis, therefore, we will use the following measures.

<i>Input to Model</i>	<i>Measure</i>	<i>Estimation Approach</i>
S	Expected Annual	Use historical average of

	Reinvestment Needs as % Firm Value	$\frac{\text{Net Cap Ex} + \text{Non-cash WC}}{\text{Market Value of Firm}}$
K	Annual Reinvestment Needs as percent of firm value that can be raised without financing flexibility	<p>If firm does not want to or cannot use external financing:</p> $\frac{\text{Net Income} + \text{Dividend} + \text{Depreciation}}{\text{Market Value of Firm}}$ <p>If firm uses external capital (bank debt, bonds or equity) regularly:</p> $\frac{\text{Net Income} + \text{Depreciation} + \text{Net External Financing}}{\text{Market Value of Firm}}$
²	Variance in reinvestment needs	Variance in the reinvestment as percent of firm value (using historical data)
t	1 year	To get an annual estimate of the value of flexibility

Illustration 29.3: Valuing Financial Flexibility at the Home Depot

The Home Depot is a giant retail chain that sells home improvement products, primarily in the United States. This firm traditionally has not been a heavy user of leverage and has also grown at an extraordinary rate over the last decade. To estimate the value of financial flexibility for the Home Depot, we began by estimating reinvestments as a percent of firm value from 1989 to 1998 in Table 29.1.

Table 29.1: Reinvestment Needs as percent of firm value

<i>Year</i>	<i>Reinvestment Needs</i>	<i>Firm Value</i>	<i>Reinvestment Needs as percent of Firm Value</i>	<i>ln(Reinvestment Needs)</i>
1989	\$175	\$2,758	6.35%	-2.7574751
1990	\$374	\$3,815	9.80%	-2.3224401
1991	\$427	\$5,137	8.31%	-2.4874405
1992	\$456	\$7,148	6.38%	-2.7520951
1993	\$927	\$9,239	10.03%	-2.2992354
1994	\$1,176	\$12,477	9.43%	-2.3617681

1995	\$1,344	\$15,470	8.69%	-2.4432524
1996	\$1,086	\$19,535	5.56%	-2.8897065
1997	\$1,589	\$24,156	6.58%	-2.7214279
1998	\$1,817	\$30,219	6.01%	-2.8112841

Average Reinvestment needs as % of Firm Value = 7.71%

Standard Deviation in $\ln(\text{Reinvestment Needs}) = 22.36\%$

We followed up by estimating internal funds as a percent of firm value, using the sum of net income and depreciation as a measure of internal funds.

Table 29.2: Internal Funds as percent of firm value

<i>Year</i>	<i>Net Income</i>	<i>Depreciation</i>	<i>Firm Value</i>	<i>Internal Funds/Value</i>
1989	\$112	\$21	\$2,758	4.82%
1990	\$163	\$34	\$3,815	5.16%
1991	\$249	\$52	\$5,137	5.86%
1992	\$363	\$70	\$7,148	6.06%
1993	\$457	\$90	\$9,239	5.92%
1994	\$605	\$130	\$12,477	5.89%
1995	\$732	\$181	\$15,470	5.90%
1996	\$938	\$232	\$19,535	5.99%
1997	\$1,160	\$283	\$24,156	5.97%
1998	\$1,614	\$373	\$30,219	6.58%

Internal funds, on average, were 5.82% of firm value between 1989 and 1998. Since the firm uses almost no external debt, the firm made up the difference between its average reinvestment needs (7.71%) and the average internal fund generation (5.82%) by issuing equity. We will assume, looking forward, that the Home Depot will no longer issue new equity.

The Home Depot's current debt ratio is 4.55% and its current cost of capital is 9.51%. Using the cost of capital framework developed in Chapter 15, we estimated its optimal debt ratio to be 20%, and its cost of capital at that debt level is 9.17%. Finally, the Home Depot in 1998, earned a return on capital of 16.37% and we will assume that this is the expected return on new projects, as well.

S = Expected Reinvestment Needs as percent of Firm Value = 7.71%

K = Reinvestment needs that can be financed without flexibility = 5.82%

t = 1 year

$$\sigma^2 = \text{Variance in ln(Net Capital Expenditures)} = (.2237)^2 = .05$$


With a riskfree rate of 6%, the option value that we estimate using these inputs is 0.0228 or 2.28%. We then converted this option value into a measure of value over time by multiplying the value by the annual excess return and then assuming that the firm foregoes this excess returns forever⁵.

$$= 0.0228 \frac{\text{Return on Capital} - \text{Cost of Capital}}{\text{Cost of Capital}}$$

$$\begin{aligned} \text{Value of Flexibility} &= 0.0228 \frac{0.1637 - 0.0951}{0.0951} \\ &= 0.0164 = 1.64\% \end{aligned}$$

On an annual basis, the flexibility generated by the excess debt capacity is worth 1.64% of firm value at the Home Depot, which is well in excess of the savings (9.51% - 9.17% = 0.34%) in the cost of capital that would be accomplished, if it used up the excess debt capacity.

The one final consideration here is that this estimate does not consider the fact that the Home Depot does not have unlimited financial flexibility. In fact, assume that excess debt capacity of the Home Depot (which is 15.45%, the difference between the optimal debt ratio and the current debt ratio) is the upside limit on financial flexibility. We can value the effect of this limit, by valuing a call with the same parameters as the call described above, but with a strike price of 21.27% (15.45% + 5.82%). In this case, the effect of imposing this constraint on the value of flexibility is negligible.

 *finflex.xls*: This spreadsheet allows you to estimate the value of financial flexibility as an option.

⁵ We are assuming that the project that a firm is unable to take because it lacks financial flexibility is lost forever and that the excess returns on this project would also have lost forever. Both assumptions are strong and may result in overstatement of the lost value.

Implications of Financial Flexibility Option

Looking at financial flexibility as an option yields valuable insights on when financial flexibility is most valuable. Using the approach developed above, for instance, we would argue that:

- Other things remaining equal, firms operating in businesses where projects earn substantially higher returns than their hurdle rates should value flexibility more than those that operate in stable businesses where excess returns are small. This would imply that firms such as Microsoft and Dell, which earn large excess returns on their projects, can use the need for financial flexibility as justification for holding large cash balances and maintaining excess debt capacity.
- Since a firm's ability to fund these reinvestment needs is determined by its capacity to generate internal funds, other things remaining equal, financial flexibility should be worth less to firms with large and stable earnings, as a percent of firm value. Firms that have small or negative earnings, and therefore have much lower capacity to generate internal funds, will value flexibility more.
- Firms with limited internal funds can still get away with little or no financial flexibility if they can tap external markets for capital – bank debt, bonds and new equity issues. Other things remaining equal, the greater the capacity (and the willingness) of a firm to raise funds from external capital markets, the less should be the value of flexibility. This may explain why private or small firms, which have far less access to capital, will value financial flexibility more than larger firms. The existence of corporate bond markets can also make a difference in how much flexibility is valued. In markets where firms cannot issue bonds and have to depend entirely upon banks for financing, there is less access to capital and a greater need to maintain financial flexibility. In the Home Depot example above, a willingness to tap external funds – debt or equity – would reduce the value of flexibility substantially.
- The need for and the value of flexibility is a function of how uncertain a firm is about future reinvestment needs. Firms with predictable reinvestment needs should value flexibility less than firms in businesses where reinvestment needs are volatile on a period-to-period basis.

In our analysis of Home Depot, we considered the firm's gross debt ratio, which cannot be less than 0%. If we consider a firm's net debt ratio (gross debt minus cash), it is entirely possible for firms to have negative net debt ratios. Extending the financing flexibility argument, you could argue that in extreme circumstances – low or negative internal cash flows and no access to capital markets – firms will not only not use their debt capacity (thus driving the gross debt ratio to zero) but accumulate cash. This may explain why many emerging market firms and young technology firms use no debt and accumulate large cash balances.

The Option to Abandon

When investing in new projects, firms worry about the risk that the investment will not pay off and that actual cash flows will not measure up to expectations. Having the option to abandon a project that does not pay off can be valuable, especially on projects with a significant potential for losses. In this section, we examine the value of the option to abandon and its determinants.

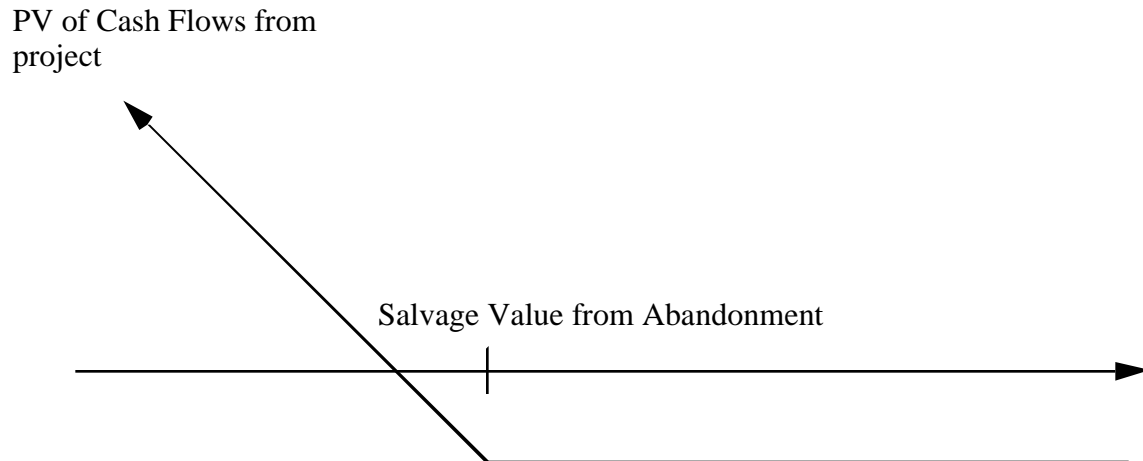
The Payoff on the Option to Abandon

The option pricing approach provides a general way of estimating and building in the value of abandonment. To illustrate, assume that V is the remaining value on a project if it continues to the end of its life and L is the liquidation or abandonment value for the same project at the same point in time. If the project has a remaining life of n years, the value of continuing the project can be compared to the liquidation (abandonment) value. If the value from continuing is higher, the project should be continued; if the value of abandonment is higher, the holder of the abandonment option could consider abandoning the project. The payoffs can be written as:

$$\begin{aligned} \text{Payoff from owning an abandonment option} &= 0 && \text{if } V > L \\ &= L - V && \text{if } V \leq L \end{aligned}$$

These payoffs are graphed in Figure 29.3, as a function of the expected stock price.

Figure 29.3: The Option to Abandon a Project



Unlike the prior two cases, the option to abandon takes on the characteristics of a put option.

Illustration 29.4: Valuing an Option to Abandon: Airbus and Lear Aircraft

Assume that Lear Aircraft is interested in building a small passenger plane and that it approaches Airbus with a proposal for a joint venture. Each firm will invest \$500 million in the joint venture and produce the planes. The investment is expected to have a 30-year life. Airbus works through a traditional investment analysis and concludes that their share of the present value of the expected cash flows would be only \$480 million. The net present value of the project would therefore be negative and Airbus would not want to be part of this joint venture.

On rejection of the joint venture, Lear approaches Airbus with a sweetener, offering to buy out Airbus's 50% share of the joint venture any time over the next 5 years for \$400 million. This is less than what Airbus will invest initially but it puts a floor on their losses and thus gives Airbus an abandonment option. To value this option to Airbus, note that the inputs are as follows.

S = Present value of the share of cash flows from the investment today = \$ 480 million

K = Abandonment value = \$ 400 million

T = Period for which abandonment option holds = 5 years

To estimate the variance, assume that Airbus employs a Monte Carlo simulation on the project analysis and estimates a standard deviation in project value of 25%. Finally, note


that since the project is a finite life project, the present value will decline over time, because there will be fewer years of cash flows left. For simplicity, we will assume that this will be proportional to the time left on the project:

$$\text{Dividend yield} = \frac{1}{\text{Remaining life of the project}} = \frac{1}{30} = 3.33\%$$

Inputting these values into the Black-Scholes model and using a 5% riskless rate, we value the put option.

$$\begin{aligned} \text{Value of abandonment option} &= 400e^{-(0.05)(5)}(1 - 0.5776) - 480e^{-(0.033)(5)}(1 - 0.7748) \\ &= \$40.09 \text{ million} \end{aligned}$$

Since this is greater than the negative net present value of the investment, Airbus should enter into this joint venture. On the other hand, Lear needs to be able to generate a positive net present value of at least \$40.09 million to compensate for giving up this option.⁶

 *abandon.xls*: This spreadsheet allows you to estimate the value of the option to abandon an investment.

Problems in valuing the Option to Abandon

In Illustration 29.4, we assumed, rather unrealistically, that the abandonment value was clearly specified and did not change during the life of the project. This may be true in some very specific cases, in which an abandonment option is built into the contract. More often, however, the firm has the option to abandon and the salvage value from abandonment can only be estimated. Further, the abandonment value may change over the life of the project, making it difficult to apply traditional option pricing techniques. Finally, it is entirely possible that abandoning a project may not bring in a liquidation value but may create costs instead; a manufacturing firm may have to pay severance to its workers, for instance. In such cases, it would not make sense to abandon, unless the cash flows on the project are even more negative.

⁶ The binomial model yields a value of \$34.74 million for this option.

Extensions and Implications of Abandonment Option

The fact that the option to abandon has value provides a rationale for firms to build the operating flexibility to scale back or terminate projects if they do not measure up to expectations. It also indicates that firms that try to generate more revenues by offering their customers the option to walk away from commitments will have to weigh the higher revenues against the cost of the options that have been granted to these customers.

Escape Clauses in Contracts

The first and most direct way of creating an abandonment option is to build operating flexibility contractually with other parties that are involved in a project. Thus, contracts with suppliers may be written on an annual basis rather than be long term and employees may be hired on a temporary basis rather than permanently. The physical plant used for a project may be leased on a short term basis rather than bought and the financial investment may be made in stages rather than as an initial lump sum. While there is a cost to building in this flexibility, the gains may be much larger, especially in volatile businesses.

Customer Incentives

On the other side of the transaction, offering abandonment options to customers and partners in joint ventures can have a negative impact on value. As an example, assume that a firm that sells its products on multi-year contracts offers customers the option to cancel the contract at any time. While this may increase sales, there is likely to be a substantial cost. In the event of a recession, firms that are unable to meet their obligations are likely to cancel their contracts. Any benefits gained by the initial sale (obtained by offering the inducement of cancellation by the buyer) may be offset by the cost of the option provided to customers.

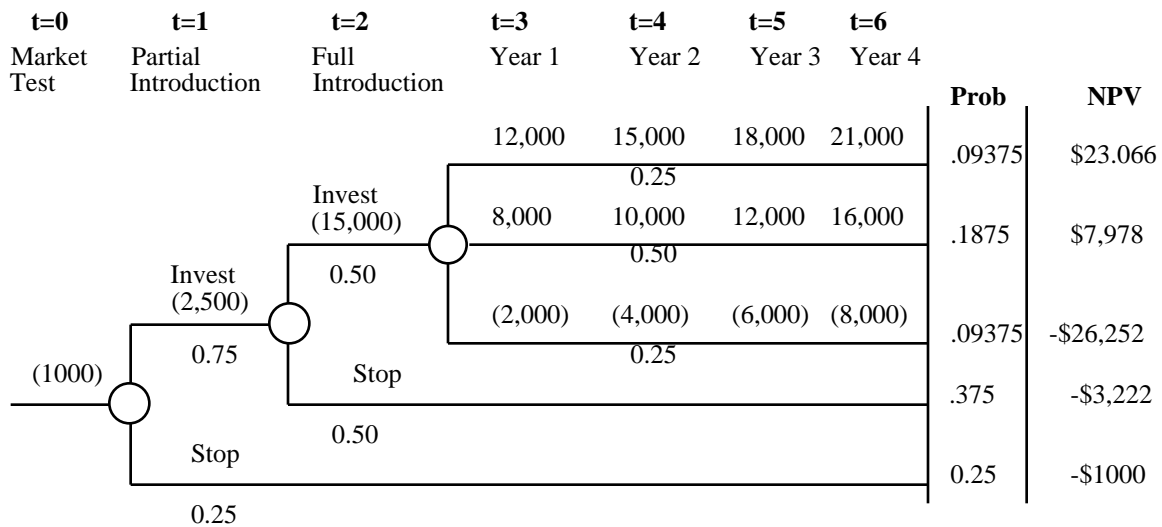
Reconciling net present value and real option valuations

Why does an investment sometimes have higher value when you value it using real option approaches than with traditional discounted cash flow models? The answer lies in the flexibility that firms have to change the way they invest in and run a project, based

upon what they observe in the market. Thus, an oil company will not produce the same amount of oil or drill as many new wells if oil prices go to \$15 a barrel as it would if oil prices go up to \$ 35 a barrel.

In traditional net present value, we consider the expected actions and the cash flow consequences of those actions to estimate the value of an investment. If there is a potential for further investments, expansion or abandonment down the road, all you can do is consider the probabilities of such actions and build it into your cash flows. Analysts often allow for flexibility by using decision trees and mapping out the optimal path, given each outcome. You can then estimate the value of a project today, using the probabilities of each branch and estimating the present value of the cash flows from each branch. For instance, you have a decision tree for a new investment for the Home Depot in the Figure 29.4.

Figure 10.9: Decision Tree for The Home Depot Home Shopping



This decision tree does bear a significant resemblance to the binomial tree approach that we use to value real options, but there are two differences. The first is that the probabilities of the outcomes are not used directly to value the real option and the second is that you have only two branches at each node in the binomial tree. Notwithstanding this, you might wonder why the two approaches will yield different values for the project. The answer is surprisingly simple. It lies in the discount rate assumptions we make to compute the value. In the real options approach, you use a replicating portfolio to compute value. In the decision tree above, you used the cost of capital for the project

as the discount rate all through the process. If the exposure to market risk, which is what determines the cost of capital, changes at each node, you can argue that using the same cost of capital all the way through is incorrect and that you should be modifying the discount rate as you move through time. If you do, you will obtain the same value with both approaches. The real options approach does allow for far more complexity and is simpler to employ with continuous distributions (as opposed to the discrete outcomes that we assume in decision trees).

Summary

In this chapter, we consider two options that are embedded in many investments – the option to expand an investment and the option to abandon it. When a firm has an option to expand an investment, the value of this expansion option may sometimes allow it to override the fact that the initial investment has a negative net present value. Extending this concept to firm valuation, you may sometimes add a premium to the value obtained from a discounted cash flow valuation for a firm that has the potential to enter new markets or create new products. This expansion option has maximum value when the firm has the exclusive right to make these investments and the value decreases as the competitive advantages enjoyed by the firm decline.

The option to abandon refers to the right that firms often possess to walk away from poor investments. To the extent that this reduces the firm's exposure to the worst outcomes, it can make the difference between investing in a new project and not.

Problems

1. NBC has the rights to televise the Winter Olympics in 2 years and is trying to estimate the value of these rights for possible sale to another network. NBC expects it to cost \$40 million (in present value terms) to televise the Olympics and based upon current assessments expects to have a Nielsen rating⁷ of 15 for the games. Each rating point is expected to yield net revenue of \$2 million to NBC (in present value terms). There is substantial variability in this estimate and the standard deviation in the expected net revenues is 30%. The riskless rate is 5%.
 - a. What is the net present value of these rights, based upon current assessments?
 - b. Estimate the value of these rights for sale to another network.

2. You are analyzing Skates Inc., a firm that manufactures skateboards. The firm is currently unlevered and has a cost of equity of 12%. You estimate that Skates would have a cost of capital of 11% at its optimal debt ratio of 40%. The management, however, insists that it will not borrow the money because of the value of maintaining financial flexibility and they have provided you with the following information.
 - Over the last 10 years, reinvestments (net capital expenditures + working capital investments) have amounted to 10% of firm value, on an annual basis. The standard deviation in this reinvestment has been 0.30.
 - The firm has traditionally used only internal funding (net income + depreciation) to meet these needs and these have amounted to 6% of firm value.
 - In the most recent year, the firm earned \$180 million in net income on a book value of equity of \$1 billion and it expects to earn these excess returns on new investments in the future.
 - The riskless rate is 5%.
 - a. Estimate the value of financial flexibility as a percent of firm value, on an annual basis.

⁷ There are 99.4 million households in the United States. Each rating point represents 1% of roughly 994,000 households.

- b. Based upon part a, would you recommend that Skates use its excess debt capacity?
3. Disney is considering entering into a joint venture to build condominiums in Vail, Colorado, with a local real estate developer. The development is expected to cost \$1 billion overall and, based on Disney's estimate of the cashflows, generate \$900 million in present value cash flows. Disney will have a 40% share of the joint venture (requiring it to put up \$400 million of the initial investment and entitling it to 40% of the cashflows) but it will have the right to sell its share of the venture back to the developer for \$300 million.
 - a. If the standard deviation in real estate values in Vail is 30% and the riskless rate is 5%, estimate the value of the abandonment option to Disney.
 - b. Would you advise Disney to enter into the joint venture?
 - c. If you were advising the developer, how much would he need to generate in present value cashflows from the investment to make this a good investment?
4. Quality Wireless is considering making an investment in China. While it knows that the investment will cost \$1 billion and generate only \$800 million in cashflows (in present value terms), the proponents of expansion are arguing that the potential market is huge and that Quality should go ahead with its investment.
 - a. Under what conditions will the expansion potential have option value?
 - b. Assume now that there is an option value to expansion that exactly offsets the negative net present value on the initial investment. If the cost of the subsequent expansion in 5 years is \$2.5 billion, what is your current estimate of the present value of the cash flows from expansion? (You can assume that the standard deviation in the present value of the cashflows is 25% and that the riskless rate is 6%.)
5. Reliable Machinery Inc. is considering expanding its operations in Thailand. The initial analysis of the projects yields the following results.
 - The project is expected to generate \$85 million in after-tax cash flows every year for the next 10 years.

- The initial investment in the project is expected to be \$750 million.
- The cost of capital for the project is 12%.

If the project generates much higher cash flows than anticipated, you will have the exclusive right for the next 10 years (from a manufacturing license) to expand operations into the rest of South East Asia. A current analysis suggests the following about the expansion opportunity.

- The expansion will cost \$2 billion (in current dollars).
- The expansion is expected to generate \$150 million in after tax cash flows each year for 15 years. There is substantial uncertainty about these cash flows and the standard deviation in the present value is 40%.
- The cost of capital for this investment is expected to be 12% as well. The riskfree rate is 6.5%.
 - a. Estimate the net present value of the initial investment.
 - b. Estimate the value of the expansion option.