How real options lead to better decisions.(SURVEY - MASTERING STRATEGY 5)

by Robert Gertner and Andrew Rosenfield

Summary

Managers frequently have to make decisions which involve high costs and

are fraught with uncertainty. According to Robert Gertner and Andrew Rosenfield they should consider real options. This denotes the explicit

valuation of opportunities associated with altering a decision in response to changing circumstances. The authors show how techniques for valuing

financial options are relevant and offer practical examples. They also explain why decision trees are sometimes a more transparent alternative. Real options help decide on investments that might be delayed, abandoned or expanded - employed well they will expose the flexibility embedded in a strategic

investment, improve analysis and lead to better decision making.

A newspaper publisher has to decide whether to give free access to its internet site or to try to continue to levy a subscriber fee; an integrated oil company has to decide whether to build a new refinery; a successful retailer has to decide how rapidly to expand; a chemical manufacturer that is losing money has to decide whether to shut down a plant or keep it operating; an aircraft manufacturer has to decide whether to expand its product line before its rivals. All these strategic decisions involve large costs and are fraught with uncertainty.

Traditionally, the way to evaluate investment projects and other similar strategic initiatives is to use discounted cash flow (DCF) analysis. Finance executives, strategy personnel, or line staff develop a model of the "project" and predict its costs and revenues. These are then discounted using the appropriate interest rate. The value of the project is summarised by a net present value (NPV) internal rate of return (IRR) or payback period. Sensitivity analysis may be incorporated by varying demand, cost or other parameters. If the company is choosing among several mutually exclusive alternatives the returns from the competing projects are compared.

In addition to financial modelling, a company will usually engage in strategic analysis that tries conceptually to capture some of the ambiguous, dynamic industry and competitive effects that may be difficult to incorporate in financial projections. Adjustments for the "strategic" effects not included in the model are usually done intuitively or heuristically. A difficult challenge is to incorporate some of the ambiguous parameters directly into the financial projections.

There has been a great deal of debate over the past 20 years among finance professionals and academics about how best to implement DCF analysis. There is controversy both about the choice of the appropriate interest rate at which to discount the future and even the different rules to apply to discounted flows.

More recently, academics, consultants and a growing number of corporate decision makers have realised there often can be fundamental problems in the use of simple DCF analyses to assess complex investment projects, especially those that are not inherently and completely "binary".

The problem is that DCF typically ignores that dynamic flexibility present in almost any investment project. Since there often is huge uncertainty in long-term projections, rarely do "ex ante" projected cash flows turn out to be precisely identical to actual "ex post" cash flows.

When things don’t work out exactly as expected, the company will often adjust its investment strategy or operation to take account of new information and the resolution of uncertainty.

It may expand more rapidly, enter a new, related market, abandon a project entirely, delay further investment, lay off workers, or divest some assets. A simple static DCF analysis does not incorporate the cash flow implications from responding in these and other ways, as uncertainty is resolved. Not only will valuations fail to reflect the value of flexibility; a company may make the incorrect choice among projects if they differ in the flexibility they allow.

For example, the choice between two technologies, one that involves large sunk costs and one that does not, may be incorrect if the analysis does not also value the different costs of shut down should the project fail.

Real options defined

Real options is the term used to denote the explicit

How real options lead to better decisions.(SURVEY - MASTERING STRATEGY 5)

valuation of the opportunities associated with changing decisions in response to the resolution of relevant uncertainty. The term derives from the link between methods to value real operating flexibility and methods to value financial options.

A financial option allows its owner to purchase or sell a specified security at a specified price and time. For example, a call option may allow its owner to buy one share of Exxon at $110 on or before January 15, 2000. The decisions to exercise that particular option or not depends on whether the Exxon share price exceeds $110 on the exercise date. This in turn depends on resolution of uncertainty about the Exxon stock price. Over the past 30 years, financial economists have developed sophisticated methods to value these and other more complex options.

Like financial option valuation, real option valuation involves incorporating into the valuation process today the opportunity the company enjoys later to take actions in response to new knowledge and the resolution of uncertainty.

Take the example of a company pondering whether it should it build a new $50m chemical plant. Suppose that of the total expected $50m in cost, there are initial expenditures of about $500,000 associated with plant planning and environmental permits. The company can analyse the entire project today in a static sense (performing a simple DCF) as if its only choice is to go forward and commit the entire $50m or not to proceed at all. But, it is far better to incorporate directly and expressly the fact that the company does not face an "all or nothing" choice. Instead it can invest the $500,000 now and then see about environmental approval. If so, it can go forward and invest $49.5m. If not, it can abandon the project without spending the $49.5m in "hard costs." Quite obviously, it can make a much better decision regarding its large investment once environmental risk has been resolved. Combining these risks in a simple DCF lead to below optimal decision making.

Decisions where real options may play an important role include all investments that can be delayed, sequential investments such as R&D stages, investments that may be abandoned, investments that may be expanded, and investments that may lead to new market opportunities.

Numerous books and articles have suggested applying the valuation methods used with financial options to real options. Although a full treatment of option valuation is beyond the scope of this article, we can demonstrate the basic ideas and the power of using this way of thinking about decision making under uncertainty. We will develop the concept sufficiently so that the reader can easily understand the trade offs between simple decision tree valuation and financial option valuation.

Consider again the call option on a share of stock in Exxon. Suppose the current price of a share of Exxon stock is $100 and that the risk free interest rate (between now and January 15, 2001) is 10 per cent. Assume (don't ask why) that somehow we know the price of Exxon on January 15, 2001 will be either $125 or $80. And to make the example even more structured, we also know the probability that Exxon will be worth $125 is 0.8 and the probability Exxon will be worth $80 is 0.2. (These probabilities are actually irrelevant to the option valuation). On January 15, 2000 the option will be worth $25 if Exxon is at $125 and $0 if Exxon is at $80. The question is how much is it worth today.

One might start by saying the expected value of the option is .8(25) = 20. The problem is we do not know at what rate to discount this. A key insight of option pricing is that we can construct a portfolio that consists of the stock and a bond bearing no risk, that exactly replicates the payoffs from the option. Since two portfolios with the same payoffs must trade at the same price to avoid arbitrage and since we know how to value each component of the portfolio, we can value the option.

In this example, a portfolio consisting of 5/9 shares of Exxon stock and borrowing $40.40 will give the same payoff as the option. If Exxon stock is $125, this portfolio is worth (5/9)*125 - 40.4*1.1 = 25, and if Exxon stock is $80, this portfolio is worth (5/9)*80 - 40.4*1.1 = 0. The cost of this is simply 5/9*100 - 40.4 = $15.15. This must also be the price of the option since the option and the security give identical returns. (The implied discount rate for the option is 32%. The reason why this discount rate is so high is that $1 invested in the call option is a good deal riskier than $1 invested in a share of Exxon. An option fluctuates in value by $25 while the stock fluctuates by $45; so the option is 5/9 as variable but the option costs 15 per cent of what a share costs, so the risk per dollar is greater).

Option pricing theory extends this method to derive pricing formulas when the uncertainty in the stock price is more complex than in this example. The Black-Scholes option pricing model formula gives the price of an American call option for a non-dividend paying stock whose returns satisfy a specific distributional assumption. The formula gives the option value as a function of the risk free interest rate, the current stock price, the exercise price of the option and the variability of the stock price.

Developing an oil field

How real options lead to better decisions.(SURVEY - MASTERING STRATEGY 5)

Some types of real options are closely analogous to simple financial options. An example is the decision of an oil company to develop an oil field. If the company does not develop the field today, it can do so in the future. The return from development depends on the price of oil while the cost of developing the field does not. The flexibility in timing is analogous to a call option to buy the returns from the oil field with the exercise price equalling the cost of development. So just like a financial call option, there is a fixed exercise price and a payoff on exercise that depends on the price of a traded asset - the price of oil. Thus, it is possible to use option pricing techniques to value the option and thereby determine the value of acquiring the oil field as well as determine if and when to exercise the option. A simple DCF analysis would ignore the possibility of delay; it would simply tell a decision-maker if it were better to develop today than to abandon development; it would undervalue the oil field if the option to delay were valuable.

In most settings, the analogy to financial options is less direct because the underlying uncertainty that drives the value of flexibility is not a traded asset and its distribution is neither known nor simple to estimate. It is only in rare circumstances where the decision to expand, contract, enter, or abandon depends on the value of a traded security or a variable with a known dynamic distribution.

Decision trees are an alternative to financial option pricing for modelling flexibility of strategic decisions. Decision trees have been around much longer than financial option analysis and allow for more general specifications of uncertainty than options pricing. A decision tree is a representation of decision-making under uncertainty in which decisions and outcomes of uncertainty are represented by branches. By attaching payoffs to end nodes and discounting optimal decisions back to the branch of the tree, one can value flexible strategic alternatives.

The main advantages of decision trees over option pricing methods derive from their greater transparency. The process of building a tree usually must involve communication among analysts and decision-makers that can result in a better model. The ability of a decision tree to incorporate different forms of uncertainty creates around statements such as "within one year we will know if the product is a flop, is okay, or a hit."

The results of the analysis can be presented in a way that makes the individual ultimately responsible for the decision, comfortable with the underlying assumptions and their implications. The black box of option pricing makes it seem easy but if the CEO doesn't understand how the model works and why it generates particular results, that person is unlikely to use it to make a decision.

Vast and unwieldy

decision trees

If a decision is complex with many different sources of uncertainty, decision trees can become vast and unwieldy. A number of techniques have been developed to simplify the process or its expositions. Influence diagrams are a way to describe the structure of complex decision problems in a more compact way than a tree. Scenario analysis helps hone the modelling of uncertainty to its most essential elements.

The main advantage of the option pricing approach is that it simplifies the process by using the market values of existing securities to substitute for assumptions about the environment and by using a parameterisation of uncertainty that is amenable to formulaic valuation. In particular, if there is a comparable traded security, the modeller does not have to worry about determining the appropriate risky discount rate and how it should vary at different points of time and for different realisations of uncertainty.

However, if there is no closely traded security, the relevant parameters must be estimated anyway and the information advantage of option pricing models evaporates. Simple option pricing models can give a quick estimate of the value of embedded real options that can be used to determine if more detailed analysis is justified.

The art of valuing real options comes from effective modelling of the relevant uncertainty and adopting appropriate tools to estimate value. Much of the existing literature uses stylised examples. In these settings, option pricing models may have an advantage because the stylisation tends to allow for a simple structure for the underlying uncertainty. Rather than focus on such a stylised example - where the link to financial options is strong - we will use an example of a typical investment decision that involves significant strategic flexibility in order to highlight the trade offs in various methods to incorporate the value of flexibility into the analysis.

Urban entertainment

destination

Sony, the consumer electronics and entertainment giant, recently opened Metreon, an innovative entertainment and retail complex in San Francisco. Sony calls it an "urban

How real options lead to better decisions.(SURVEY - MASTERING STRATEGY 5)

entertainment destination".

Metreon has interactive children's exhibits. These are based on Maurice Sendak's book, Where the Wild Things Are and David Macaulay's, The Way Things Work, a multiplex complex with a 3-D IMAX theatre, a state-of-the-art video arcade with interactive games unavailable elsewhere, stylish restaurants including outposts of several popular local restaurants, numerous stores, many selling Sony products and several one-of-a-kind stores.

Sony faced what is in many ways a typical strategic investment decision when it had to decide whether and when to move forward with Metreon, and how many centres to build initially.

A standard DCF analysis would include projections for revenues and costs for different possible locations. It would probably provide little guidance on how many locations to go forward with initially; it might have individual projections for different locations, so locations can be ranked.

This is not sufficient. Strategically, the decision of how many Metreons to build initially cannot be analysed effectively without considering the way in which different decisions affect the company as time passes and uncertainty is resolved.

Sony ought to have addressed the following questions (and it may well have done). What is the shutdown cost if the concept proves unsuccessful in the marketplace? How much will be learnt from the first locations that will help decide how aggressively to expand? Where to expand? How should later Metreons differ from the initial ones? What are the costs of delay given that consumer tastes may shift and competitors may beat them to market with a substitute in some target cities? (The authors have no knowledge of what processes Sony used in making these decisions).

All of these questions involve issues of how initial strategic choices affect future decisions as uncertainty about the market, demand and costs

of Sony's offering, and competitive responses

play out. This is exactly the domain of real option analysis.

Modelling the dynamic process

Advocates of the financial option pricing approach to real option analysis would have their hands full with this problem. A key step in the analysis is modelling the dynamic process for the relevant uncertainty in a way that is consistent with the assumptions of option pricing models.

The sources of uncertainty here are complex. They include uncertainty about demand, competitive responses, movements in real estate prices, stock market valuations, interest rates, and macroeconomic conditions.

A decision tree analysis of Sony's decision is also not simple. However, it does allow a decision-maker to focus on the main sources of uncertainty and key drivers in the decision of the number of companies.

The benefit of building more Metreons initially is that it increases the first-mover advantage over potential rivals, may deter competitive entry and provides more information about demand. The cost of building more Metreons initially is that if the entire concept fails the costs to Sony are greater. And if Sony learns that the optimal Metreon design is different from the initial design, it will be more costly to make the others conform to the optimal design than it would have been if more had been built only after Sony found out which worked best. The decision tree should incorporate all the elements of this trade off.

Key model choices include how long it takes to learn about demand; the likelihood of different demand realisations; how the likelihood and costs to Sony of competitive entry vary depending on the number of initial Metreons; and cost of abandonment or restructuring. Adding these features into a tree that incorporates the basic financial modelling will allow Sony to value the embedded flexibility in different choices.

In some cases, uncertainty may be too complex and the problem too ambiguous for formal modelling to add much value. Nonetheless, real option thinking can play an important role in strategic decision-making even when analytical attempts to value these choices or options expressly are absent. If analysts and decision-makers adopt a real options approach, that mode of thinking often will uncover the embedded flexibility in strategic investments. And that will greatly improve strategic analysis and lead to better decision making.