Real Options Reasoning as a Tool for Managerial Decision Making

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INTRODUCTION

An understanding of human decision making is a fundamental step toward the development of effective intelligent decision support systems (Newell & Simon, 1972; Pomerol, 1997). Many methods have been put forth by decision theory to provide us with an understanding of human decision making and to enable individuals to make better decisions such as in utility maximization (Savage, 1954), satisficing (Simon, 1983), statistical and regression analysis, case-based reasoning (Gilboa and Schmeidler, 1995, 2000), game theory (von Neumann & Morgenstern, 1947), decision trees (Yuan & Shaw, 1995), and so forth. This article focuses on a new approach, namely, real options analysis, as a tool for effective decision making by management when faced with uncertainty in its environment.

Real options reasoning materialised from insights that many managerial decisions share common characteristics with decisions resolved by buying or selling options traded in financial markets. Myers (1977), recognising the similarity of stock options and organisational resource investments, extended the option valuation process (Black & Scholes, 1973) to include investments in organisational resources. The latter form of option was referred to as a real option because typically it involved investments in real strategic assets (e.g., new technologies, a manufacturing plant, a distribution centre, or a firm's reputation). It provides the firm with the same kind of flexibility that a stock option provides someone investing in stock. The owners of real options have the right, but not the obligation, to expand or contract their investment in the real asset at some future date.

Though real options reasoning developed in the area of financial economics, it was extended in the management literature as a means of valuing strategic flexibility in managerial decision making (Bowman & Hurry, 1993; Luehrman, 1998; McGrath, 1997, 1999). Real options reasoning explains how the value of a new investment can be augmented by accounting for flexibility in the decision-making process, particularly in the face of uncertainty. For example, when faced with the opportunity to commercialise a new technology or to enter a new market, a firm may choose to maintain flexibility by holding the option to invest. Premature commitments (particularly irreversible investments) involve sacrificing flexibility and raising the firm's exposure to uncertainties in new markets. Flexibility, by allowing the firm to add value by building on good fortune or mitigating bad, increases the value of a project.

Many of the other methods for understanding human decision making referred to above fail to grapple sufficiently with the influence of uncertainty and assume that decisions are essentially reversible in nature (Pomerol, 1997). The real options approach encourages management to look ahead before committing resources to new projects in order to consider (a) their true value, (b) the timing of the investment given the underlying determinants of real option value (one of which is uncertainty), and (c) ways of increasing option value. It is hoped that the introduction to real options reasoning provided below may encourage the application of this approach in the development of intelligent decision support systems to aid managerial decision making in the face of uncertainty. Initially, the background section examines the determinants of real option value. Then, an application of the real options approach is provided to show how real option reasoning supports managerial decision making when faced with uncertainty. This is followed by some suggested directions for future research and some final conclusions.

BACKGROUND

In general terms, the value of a call option (C) or option to invest prior to the expiration of the option can be expressed as follows[1]:

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$$C=f(S, X, \sigma, T, r), \quad (1)$$

where S corresponds to the value of the investment including expected future cash flows and the option value of future growth opportunities. The exercise price, X, is the amount of money required to undertake the investment, and σ is the uncertainty of the value of the investment (S). The duration, T, is the length of time the investment decision may be deferred (i.e., the time to expiration). The risk-free rate of return is given by r, but its influence is weak and ambiguous for real options (Dixit & Pindyck, 1994). Prior to expiration, the option will only be exercised when the value of the underlying asset (S) exceeds the exercise price (X) by more than the value of holding the option (C). This condition can be expressed as follows:

$$S - X > C (S, X, \sigma, T, r). \quad (2)$$

Greater environmental uncertainty (σ) has been argued to increase the inducement to delay irreversible investments (McDonald & Siegel, 1986). Deferring sunk investments is sensible because preceding in this way limits the firm's downside risk. We expect managers to delay substantial investment decisions when uncertainty (σ) is high (Bowman & Hurry, 1993). It then pays to wait before committing resources until uncertainties are resolved (i.e., $S-X< C (S, X, \sigma, T, r)$). Effectively, the firm is adopting a wait-and-see approach. When uncertainty is low regarding future growth opportunities, the opposite is true. There are few enticements to delay the investment decision. However, investment will only occur when the real option is "in the money" ($S > X$). The value of waiting any longer in this instance is low. This wait-and-see approach underlies real options reasoning.

According to Bowman and Hurry (1993, p. 762), "options came into existence when existing resources and capabilities allow preferential access to future opportunities." Through an incremental choice process (see Figure 1), the firm makes an initial decision or recognises the existence of a shadow option and then adopts a wait-and-see policy until the option materialises. During this period, any uncertainties are hopefully resolved. The second decision, or strike, of the option often occurs when new information becomes available, reducing uncertainty about its future prospects. This decision often involves one, or more likely several, discretionary investments. Once the option is struck, new options, namely, embedded options, for future exercise arise. The firm limits downside risk through exercising these embedded options in an incremental fashion. In general, a pattern of staged investment emerges by (a) waiting until a real option is in the money (S>X) to exercise the option, (b) providing itself with the inbuilt flexibility to abandon options that are "out of the money" (S<X), (c) providing itself with the ability to revise its strategy by exercising a flexibility option, and (d) exercising embedded options when they are in the money (Bowman & Hurry, 1993; Luehrman, 1998). The exercise of embedded options can take place simultaneously or over time. The investment problem, according to Dixit and Pindyck (1994), essentially boils down to discovering a contingency plan for making these sequential (and irreversible) expenditures.

In short, real options reasoning holds that firms should seek, and hold, options with higher variance because the potential gains are greater while the cost to access them are the same. The firm should then contain the cost of these options by adopting strategies to minimise downside risk. In other words, the entrepreneur should hold options until uncertainties are resolved and the value of waiting is at its lowest. The manager should contain the costs of failure by staging investments, particularly investments that are irreversible in nature (Bowman & Hurry; Luehrman; McGrath, 1999). Making smaller investments initially and larger investments when the option matures facilitates project redirection (i.e., the exploitation of options to contract, expand, switch), advances learning, and allows investment to be discontinued at the earliest possible time (e.g., option to abandon) while simultaneously conserving the firm's resources. The manager should also monitor signals in its environment that alter the value of the option. He or she should actively try to influence the value of the option through shaping contingencies in its favour, and reduce uncertainty through making idiosyncratic investments to increase revenue streams or reduce the costs of commercialisation (McGrath, 1997). For example, the firm can attempt to find ways to reduce risks, or costs, to the customer related to trying a new product in order to increase the speed of adoption of the new product (e.g., free trial samples). By following these guiding principles, the flexibility of the firm is increased. In other words, the manager has the ability to revise its strategy based on new information at low cost, building on good news, and mitigating against

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