Real Options Analysis in Strategic Information Technology Adoption

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INTRODUCTION

Many information resource managers have learned to be proactive in today's highly competitive business environment. However, limited financial resources and many uncertainties require them to maximize their shareholders' equity while controlling the risks incurred at an acceptable level. As the unprecedented development in information technology continuously produces great opportunities that are usually associated with significant uncertainties, technology adoption and planning become more and more crucial to companies in the information era. In this study, we attempt to evaluate IT investment opportunities from a new perspective, namely, the real options theory. Its advantage over other capital budgeting methods like static discounted cash flow analysis has been widely recognized in analyzing the strategic investment decision under uncertainties (Amram & Kulatilaka, 1999; Luehrman, 1998a, 1998b). Smith and McCardle (1998, 1999) further show that option pricing approach can be integrated into standard decision analysis framework to get the best of the both worlds. In fact, some previous IS researches have recognized the fact that many IT investment projects in the uncertain world possess some option-like characteristics (Clemsons, 1991; Dos Santos, 1991; Kumar, 1996). Recently, Benaroth and Kauffman (1999) and Taudes, Feurstein and Mild (2000) have applied the real options theory to real-world business cases and evaluated this approach's merits as a tool for IT investment planning.

As all real options models inevitably depend on some specific assumptions, their appropriateness should be scrutinized under different scenarios. This study aims to provide a framework that will help IS researchers to better understand the real options models and to apply them more rigorously in IT investment evaluation. As the technology changes, the basic economic principles underlying the real options theory do not change. We do need to integrate the IT dimension into the real options based investment decision-making process. Using electronic brokerage's investment decision in wireless technology as a real-world example, we show the importance of adopting appropriate real options models in IT investment planning. By specifically focusing on the uncertainties caused by IT innovation and competition, our study also gives some intriguing results about the dynamics between IT adoption and the technology standard setting process.

REAL OPTIONS THEORY

It is generally believed that the real options approach will play a more important role in the highly uncertain and technology driven digital economy. Before reviewing the real options literature body that is growing very rapidly, we use an example to give readers an intuitive illustration of the values of real options and their significance in financial capital budgeting.

Pioneer Venture: The Value of a Growth Option

In this example, the management of a large pharmaceutical company wants to decide whether to acquire a young biomedical lab. If they decide to acquire it, they should provide $100,000 funding to cover the initial costs for the pioneer venture. Five years after the initial funding, the management will decide whether to stop the pioneer venture or to expand it significantly according to the market situation at that time. If they choose to expand it, additional $1,000,000 is needed. The cost of capital is assumed to be 15%. Five years after acquisition of the lab, the management will face two scenarios. The good scenario will occur with 60% likelihood, while the bad one will have 40% likelihood of happening. All expected future cash flows during the next 10 years are given in Table 1. Using standard capital budgeting method, we can find that the NPV for the pioneer venture is -$15,215. For the period of large-scale production, the NPV is -$71,873. As the NPVs for both periods are negative, it seems that the management should give up the acquisition. However, the acquisition will be a good investment if we consider the growth option associated with it. By acquiring the lab, the company also buys a growth option that enables it to expand the lab when the conditions are favorable 5 years later. In this case, the good scenario will occur with 60% likelihood. After simple calculation, it is easy to find that the growth option has a value of $28,965. Combining

Table 1. Projected cash flows in the example of pioneer venture project

Year	Pioneer Stage	Larger Scale Stage	Total Cash Flows	Discount Rate
0	-$100,000		-$100,000	15%
1	$10,000		$10,000	
2	$10,000		$10,000	
3	$50,000		$50,000	
4	$50,000		$50,000	
5	$20,000	-$1,000,000	-$980,000	
6		$100,000	$100,000	
7		$100,000	$100,000	
8		$500,000	$500,000	
9		$500,000	$500,000	
10		$200,000	$200,000	

	Large Scale Stage	Good Scenario	Bad Scenario	Prob (good)
5	-$1,000,000	-$1,000,000	-$1,000,000	0.6
6	$100,000	$130,000	$55,000	
7	$100,000	$130,000	$55,000	
8	$500,000	$650,000	$275,000	
9	$500,000	$650,000	$275,000	
10	$200,000	$260,000	$110,000	

NPV Pioneer Stage	-$15,215.42
NPV Large Scale Stage	-$71,872.54
NPV with Growth Option	$13,749.98
Value of the Option	$28,965.40

its value with the negative NPV during the pioneer venture period, the adjusted NPV of the acquisition is $13,750, which means this investment is strategically plausible.

Many researchers recognized the potential of this options pricing theory in capital budgeting because traditional DCF (discounted cash flows) technique has its inherent limitation in valuing investments with strategic options and many uncertainties. Table 2 gives a comparison between an American call option on a stock and a real option on an investment project. Despite the close analogy, some people may still question the applicability of option pricing theory on real options that are usually not traded in a market. However, Cox, Ingersoll and Ross (1985) and McDonald and Siegel (1984) suggest that a contingent claim on a non-traded asset can be priced by subtracting a dividend like risk premium from its growth rate.

Recent development in real option theory focuses on the valuation of more complicated real options like shared options, compounded options and strategic growth options. Dixit and Pindyck (1994) examine the dynamic equilibrium in a competitive industry. Their model suggests that a firm's option to wait is valuable when uncertainty is firm-specific. For industry-wide uncertainty, there is no value to wait because of the asymmetric effects of uncertainty.

FOUR CATEGORIES OF IT INVESTMENT OPPORTUNITIES

As shown in Figure 1, we have four types of IT investment opportunities based on the two criteria: (i). Shared opportunities with high IT switching costs; (ii). Shared opportunities with low IT switching costs; (iii). Proprietary opportunities with low IT switching costs; (iv). Proprietary opportunities with high IT switching costs. It is worth noting that each category has distinctive requirements on the application of real options models. We use the continuous-time model developed in McDonald and Siegel (1986) as a benchmark to show why we differentiate IT investment opportunities based on the two criteria. It basically suggests that the option to defer uncertain investment is very valuable and should be taken into account when a company makes investment decisions. A major assumption of this model is that there is no competitive erosion; in other words, the investment