

## **Much Ado About Options?**

Jim Smith

Fuqua School of Business

Duke University

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(jes9@mail.duke.edu)

There has been a great deal of buzz about "real options" lately. Recent articles in the *Harvard Business Review*, the *McKinsey Quarterly*, *USA Today* and *Business Week* tout real options as a "revolution in decision-making" and recent books make similar claims (see the references at the end of this note). Yet, if you read these articles and books, you may find it difficult to discern the differences between the real options approach and what decision analysts have been doing since the 1960s. This has led many decision analysts to wonder whether there is anything new in real options or whether real options is just decision analysis dressed in new clothes. As a decision analyst who has worked on the interface between these two fields, I have heard these questions many times and would like to take the time to address some of them.

### **Similarities in Purposes**

At the highest level, real options and decision analysis are both about modeling decisions and uncertainties related to investments. In real options the focus is on options, decisions that are made after some uncertainties have been resolved. The classic example of an option is a call option on a stock that gives its owner the right, but not the obligation, to purchase a stock at some future date at an agreed upon price. In real options, the options involve "real" assets as opposed to financial ones. For example, owning a power plant gives a utility the opportunity, but not the obligation, to produce electricity at some later date. Options (or "downstream decisions") have always been a part of decision analysis. For example, in Raiffa's classic wildcatter problem, one alternative allows you to gather information about a prospective oil field before deciding whether to "exercise your option" and drill the prospect.

So what is revolutionary about real options? In the books and articles touting real options as revolutionary, the revolution is against discounted cash flow or NPV analysis that boils all uncertainties and decisions down to a single scenario and then adjusts them for risk by using some inflated discount rate. The problem with this approach, they argue, is that by "boiling down all the possibilities for the future into a single scenario, NPV doesn't account for the ability of executives to react to new circumstances – for instance, spend a little up front, see how things develop, then either cancel or go full speed ahead" (*Business Week*). The key to valuing these options, they argue, is to consider the uncertainty or "volatility" associated with the investment in the same way that Black, Scholes, and Merton did in their Nobel Prize winning work on valuing financial options.

While decision analysts have long considered uncertainties associated with investments, unfortunately the vast majority of analyses done in corporate contexts are precisely the single-scenario cash flow analyses that are disparaged in the real options literature. Though decision analysis has had some impact on corporate decision making, the number of our clients and users is small compared to the number of people who make important corporate decisions and have never heard of and/or never used decision analysis. The real options buzz is clearly generating interest. A finance colleague at Duke recently told me that his students – particularly those in the executive programs – were clamoring to learn more about real options and that he was struggling to find good teaching materials to respond to this demand. I have heard of more than a few corporate decision analysts receiving inquiries from high-level executives asking, "Should we be using real options?" Are they asking for decision analysis in other words?

### **Differences of Style**

Despite the similarities in goals at the high level, the analyses done by real options and decision analysis practitioners differ in style. Real options analyses tend to draw heavily on analogies with financial options. In some applications, the analogy is taken literally and the analysis amounts to plugging numbers into the Black-Scholes formula for valuing put or call options. In other applications, projects are viewed as more exotic derivative securities – American options, compound options, or "rainbow" options – and valued using more complicated models. A common theme in these models is the use of continuous-time stochastic processes and frequent decision making. The models are often formulated using the language of stochastic differential equations and solved using binomial trees or lattices, which are, in essence, recombining decision trees or dynamic programs. Because of the difficulties in solving these models, real options analyses usually focus on the evolution of a few (one or two) stochastic factors that determine the value of the investment over time and the cash flows are usually simple functions of these factors. The models thus tend to focus on "dynamic complexity" at the expense of "detail complexity."

In contrast, corporate decision analysis models tend to consider great detail in the cash flow models and many uncertainties, but relatively little in the way of dynamic decision making or downstream decisions. Though downstream decisions are something decision analysts know about, they are frequently overlooked or oversimplified in our analyses. Too often, our decision models consider only a single decision made up front – e.g., what strategy should we choose – without considering the opportunities for later adjustments or changes in these strategies.

It would be foolish to argue that "dynamic complexity" is generally more important than "detail complexity" or *vice versa*; in some applications the insights may follow from the careful consideration of the details and in others they may come from careful consideration of the dynamics. But I believe that practitioners in each camp would benefit by learning to use the other's tools. Specifically, I think decision analysts would benefit from learning more about modeling stochastic processes and the use of lattices or dynamic programs to model dynamic decision problems. In framing problems, they should make a conscious effort to identify future decision making opportunities. Analogies with financial options may help in this effort. For example, one might ask what put or call options – options to expand or exit – may be associated with an investment. Conversely, real options practitioners would benefit from learning more about probability assessment to find more meaningful ways to assess and express the "volatilities" used in the option models. More generally, once real options practitioners get beyond plugging numbers into the Black-Scholes formula, I believe that they will find many of our tools and processes – including influence diagrams, tornado charts, "snaking" – very helpful.

### **Some Fundamental Differences**

There is, however, one area where the real options and decision analysis approaches differ rather fundamentally – how they value risky cash flows. In their classic work on valuing financial options, Black, Scholes, and Merton recognized that financial options could be valued by constructing portfolios that perfectly replicate the payoffs of the option. The value of this replicating portfolio determines a fair market price of the option; if the option traded at any other price, there would be an opportunity to earn a riskless profit. In modern implementations of this approach, these market values are calculated using "risk-adjusted" or "risk-neutral" probabilities. These probabilities reflect market beliefs and include any necessary risk premiums and the cash flows are then discounted at the market rate for risk-free borrowing and lending – no risk-adjusted discount rates or utility functions are required. This aspect of the real options approach is new and different from what decision analysts have traditionally done.

Decision analysts are quick to point out that few of the problems they work on allow the direct application of these no-arbitrage arguments. For example, technical risks and market shares for an early-phase pharmaceutical product cannot be perfectly hedged by trading existing securities. The temptation – and a

common reaction of decision analysts – is to dismiss this aspect of the option pricing techniques as impractical and/or irrelevant. This is, I believe, a mistake. If you dig deeper into the option pricing arguments, you will find that perfect hedges are not necessary to implement the option valuation approach; Merton makes this point emphatically in his Noble Prize address. The idea is to consider those hedging opportunities that do exist and recognize them and use market information to risk-adjust the probabilities associated with these risks. If there are no relevant markets, you make no adjustments and value investments at their expected value, discounting at the risk-free discount rate.

Fundamentally, this difference between the real options and decision analysis approaches reflects a difference in the definition of "values" being considered. In decision analysis, we have traditionally calculated values from the perspective of an individual or firm according to his or her or the firm's own beliefs and preferences. In real options and in corporate finance more generally, the definition of the value of an asset is taken to be the value that asset (or the cash flows generated by that asset) would have if it were traded in the marketplace. Finance theorists have long criticized decision analysis for failing to risk-adjust values appropriately from the market's perspective (see e.g., Brealey and Myers, *Principles of Corporate Finance*) and are consequently reluctant to suggest the use of decision analysis. I believe that this lack of support from finance theorists is a major reason that decision analysis techniques have not been used more often in corporate contexts. As a decision analyst, I am encouraged by the fact that the option valuation techniques – unlike some of the more sophisticated risk-adjusted discount rate methods – can be easily implemented using our tools and techniques.

### **Wrapping Up**

I have seen a wide variety of reactions to real options from decision analysts in addition to the "what's new?" or "so what?" reaction described earlier. Some decision analysts have enthusiastically embraced real options and now call what they do "real options analysis," even when there are no apparent changes in their modeling approach. Others have suggested "taking the offensive" in defending decision analysis against real options. My position is between these two extremes. While I do not think we should change the name of our field, I see the real options movement as an opportunity for decision analysis, rather than a threat. If the hype associated with real options gets executives thinking more about decisions and uncertainties, the desire for careful analysis of these issues should lead to a greater demand for decision analysis. Moreover, if we learn more about the ideas used in real options and incorporate them into our work, we may enjoy greater support from finance theorists and practitioners and this may ultimately lead to more widespread application of decision analysis in corporate settings. For these reasons, I think the real options movement is worth watching and supporting.

### **Some Recent References in Business Press:**

Amram, Martha and Nalin Kuatilka, "Disciplined Decisions: Aligning Strategy with the Financial Markets," *Harvard Business Review*, January-February 1999, pp. 95-104.

Copeland, Thomas E. and Philip T. Keenan, "How Much is Flexibility Worth?," *The McKinsey Quarterly*, 1998 Number 2, pp. 38-49.

Copeland, Thomas E. and Philip T. Keenan, "Making Real Options Real," *The McKinsey Quarterly*, 1998 Number 3, pp. 128-141.

Coy, Peter, "Exploiting Uncertainty: The 'Real Options' Revolution in Decision-making," *Business Week*, June 7, 1999, pp. 118-124.

Dixit, A. and R. Pindyck, "The Options Approach to Capital Investment," *Harvard Business Review*, September-October 1998, pp. 105-115.

Luehrman, Timothy A.; "Investment Opportunities as Real Options: Getting Started on the Numbers," *Harvard Business Review*, July-August 1998, pp. 51- 67.

Luehrman, Timothy A.; "Strategy as a Portfolio of Real Options," *Harvard Business Review*, September-October 1998, pp. 89-99.

Valdmanis, Thor, "Corporate Executives Examine Strategic Tool: A New Way to Assess Risk Arrives," *USA Today*, May 12, 1999.

### **Books/Academic Articles**

Amram, Martha and Nalin Kuatilka, *Real Options: Managing Strategic Investment in an Uncertain World*, Harvard Business School Press, 1999.

Dixit, Avinash K., and Robert S. Pindyck, *Investment under Uncertainty*. Princeton University Press, 1994.

Merton, Robert C., "Applications of Option-Pricing Theory: Twenty-Five Years Later" (Nobel Prize Address), *The American Economic Review*, June 1998 pp. 323-349.

Smith, James E. and Kevin F. McCardle, "Options in the Real World: Lessons Learned in Evaluating Oil and Gas Investments", *Operations Research*, January-February 1999, pp. 1-15.

Trigeorgis, Lenos, "Real Options: Managerial Flexibility and Strategy in Resource Allocations," *MIT Press*, 1996.