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Original Paper

The Application of Real Option in Corporate Investment

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1. Introduction

The term of "real option" was first put forward by Stewart Myers (1977) in his article who utilized the "option" way of thinking to evaluate corporates' future investment opportunities. Since then, this idea had aroused high recognition among the public: a survey shown that around 30% of interviewed CFO's used real option to evaluate investments (Graham & Campbell, 2001, p. 197), nearly 1000 papers had published for exploring real options topic up to the 1990s (Triantis, 2005).

However, since the late-1990s, real option theory has been increasingly criticized by market practitioners as the difficulties for putting into practices. Triantis (2005) collected four main critiques of real options and five key challenges for solving the practicability problems.

In this paper, I will first summarize the two articles covered by focusing on real options practicability issue, then evaluate the managerial behaviour issue addressed by Triantis (2005) and the effectiveness of the method introduced by Mathews, Datar and Johnson (2007); followed by the recommendations to firm management.

Summary

The main topic of the first article is to address the major obstacles and the challenges for solving each obstruction when putting real option theory into the corporate decision-making practice (Triantis, 2005).

Overall, Triantis (2005) holds a positive view of real option strategy because of its high implementation potentiality in management decision-making. On the one hand, Triantis (2005) believed that real options help managers capture economic values from dynamic environment, including the values of market uncertainties and risks. On the other hand, Triantis (2005) found that many studies had built and utilized various real option strategies for specific situations, for instance, valuing mines in exploration industries.

However, Triantis (2005) found only 9% of CFOs had used real options; 32% of practitioners gave up using real options in decision making from Bain & Co. survey in 2000. Subsequently, Triantis (2005) critically evaluated four main drawbacks raised by practitioners of real options. Firstly, criticisms

blamed the loose evaluation for growth real options with Internet Bubble exemplified. Secondly, criticisms argued the inappropriateness for real option strategy, especially for mis-combining of market and private risks (Triantis, 2005). Moreover, Triantis (2005) believed that the following two critiques are the major causes for the "distance" between theory and practice – first, some of the real option assumptions are not realistic, for instance, management perfect loyalty, projects independency; for another, many of the real option techniques are too complicated to be used for practitioners.

Based on those two critiques, Triantis (2005) figured out the main practicability issues for real options and addressed five types of difficulties for solving those problems.

Firstly, Triantis (2005) addressed that most of the real option models are too perfect to be implemented in technique aspect, including the liquidity risks of underlying real assets and the correlations between projects. Triantis (2005) found difficulties to use techniques to refine the models from three perspectives: specifying the non-standard future cash flows distributions and their proper discounting rates, but he found Monte Carlo Simulation useful in developing computational methods to model multiple uncertainties.

Secondly, most of the real options are jointly held by multi-parties on the market, practitioners need to split and evaluate option payoffs separately. For the growth option among competitors, Triantis (2005) addressed the complexity when incorporating game theory into real options analysis; for those options models linking industries value chain, a well-designed contract allocating appropriate remedies is always needed.

Thirdly, Triantis (2005) found that managerial flexibility can significantly undermine the effectiveness of real options, while the theory had no such risk-prevention mechanism. Managers can possibly make unintentional mistakes during decision-making, or they could deliberately modify decisions for their self-interests. Triantis (2005) suggested to incorporate management behaviours into real option models and to redesign compensation mechanisms or investment evaluation processes. For the latter suggestion, evaluating managers' performance based on industry level and delaying compensation corresponding with projects' durations can be of good use (Triantis, 2005).

Fourthly, Triantis (2005) stated that practitioners always facing a dilemma when implementing real option models, which is the trade-off between models' practicability and accuracy. Triantis (2005) noticed that managers prefer simpler model, but it is hard to balance the model complexity for accommodating to its highest practicability.

Lastly, companies always emphasize on their valuation, Triantis (2005) found it challenging for stakeholders to use real options in company's valuation because stakeholders need to consider many of uncertainties and complexities for valuation such as project interactions and timing of exercising growth options.

The main idea the second article is to demonstrate the major advantages and the practicability for Datar-Mathews real option method (DM method) by illustrating an implementation case in Boeing's unmanned aerial vehicle (UAV) project (Mathews, Datar, & Johnson, 2007).

Mathews, Datar, and Johnson (2007) pointed out that the complexities of implementing real options discouraged managers to adapt them into decision-making. They introduced DM model that can effectively overcome this practicability problem (Mathews, Datar, & Johnson, 2007).

DM model's first major advantages are its simplicity and transparency which facilitate managers to make investment decisions along with a deeper understanding for market complexities (Mathews et al., 2007).

For another advantage, Mathews et al. (2007) demonstrated DM model's high practicability in capturing values from dynamics, which incorporates NPV technique, scenario analysis and Monte Carlo simulation. Mathews et al. (2007) stated that DM method has the similar rationale in discounting future cash flows as NPV with attributes of simplicity and easy-understanding. Mathews et al. (2007) first conducted NPV analysis for UAV project and generated a negative result of -$19 million. However, NPV method is over-simplified and lacking considerations for cash flows distribution and discounting rates under dynamic environment (Mathews et al., 2007). Based on the drawbacks of NPV method, DM method developed based on scenario discussions for capturing values from market uncertainties (Mathews et al., 2007). Mathews et al. (2007) expanded UAV project case into three-scenario analysis (optimistic-most likely-pessimistic), generating a possible range for future cash flows that could happen.

Subsequently, Mathews et al. (2007) utilized Monte Carlo approach in DM model for simulating distribution of possible future cash flows and potential payoffs of UAV projects, which visualized market uncertainties into the project's price variability. Finally, as the trials increasing, the distribution of cash flows simulated by Monte Carlo technique successfully converged into its most-likely potential with a payoff of $23 million.

Discussion & Evaluation.

2. Managerial Behaviour Problem in Real Options Practicability Issues

I choose to state and justify the "distance" caused by managerial behaviour specified in Triantis (2005). The drawback and lacking solutions for managerial problem in Triantis (2005) both contribute to this "distance".

Triantis (2005) stated that mangers behaviours, either unintended errors or intended actions, can significantly undermine the effectiveness of real option strategy. The first behaviour is due to managers' cognitive imperfection (Triantis, 2005). Managers have cognitive limits in evaluating a large volume of information required When making investment decisions (Simon, 1979). Amrit et al. (2007) proved that those cognitive limits will cause mangers to over-or undervalue real options. The second behaviour is driven by misaligned incentives (Triantis, 2005). Triantis (2005) underpinned that the reasons are mainly aroused by short-term compensations and managers' future preferences. Empirical evidence revealed that flawed compensation mechanisms led to undesirable investment incentives (Reichelstein, 1997). Also, managers timing preferences can alter exercising time of real options (Baldenius, Nezlobin,

& Vaysman, 2016).

To find solutions, Triantis (2005) firstly specified that both researchers and practitioners should consider managerial behaviour into real option models especially for controlling management flexibilities. By constructing a goal-congruence real option model, Baldenius et al. (2016) proved that jointly considering real options and the interest divergence problem between principals and managers will significantly improve the practicability of real options. Also, Andalib, Tavakolan, and Gatmiri (2018) addressed to combine managers' risk aversion into real option strategy to mitigate the managerial flexibility influence.

Meanwhile, Triantis (2005) emphasized that a guidance is needed for redesigning managers' incentives mechanisms, or even the process for evaluating investment decisions. Reichelstein (1997) recommended that compensation mechanisms for managers should be designed based on the congruent goal for both principals and managers. Also, Baldenius et al. (2016) stated that investment opportunities must be evaluated based on dynamics with a combination of real options.

3. Evaluation for Mathews Approach

First of all, as many practitioners criticized the complexity of real options techniques when putting into practice, Mathews et al. (2007) addressed that one of the targets for designing DM approach is to solve the problem caused by the technique complexity – aiming to develop a simple and transparent real option approach for managers to adapt for their decision-making.

Secondly, Mathews et al. (2007) pointed out a primary critique aroused from the public is that real option strategies are typically difficult to be implemented in business realities. Triantis (2005) specified that one reason of this critique is originated from some unrealistic assumptions of real options. DM model addressed the practicability issue throughout the model building process. Triantis (2005) found that some model parameters or material information are too idealized to for managers to obtain in market realities. DM approach chose realistic parameters and achievable analysis for dynamics with an effective simulation method to generate essential information for managers to make decisions (Mathews et al., 2007). However, DM approach did not address the flawed assumptions of the perfect management loyalty nor the indirect effects of companies' activities, therefore, DM model partially solved the practicability problem criticized by major practitioners.

Regarding to Triantis (2005) five challenges, firstly, DM real option model illustrated its contribution to the challenge of "refining the models of perfection" through UAV project application. Firstly, Triantis (2005) addressed the difficulties in determining the future cash flows distribution. Without any predetermined distribution assumption, DM model forecasted cash flows first for each scenario analysis through company's due diligence; then it adapted Monte Carlo approach to simulate future cash flows distributions based on scenario forecasts and hundreds of trials (Mathews et al., 2007). The second difficulty is to provide guidance for estimating discounting rates under uncertainties (Triantis, 2005). DM model considered market and company risk separately for estimating cash inflows and

initial costs to avoid using a single bundled rate; also, DM model considered risk aversion factor (Mathews et al. (2007). However, according to UAV case, DM model did not estimate the risk variability for the same type of cash flows under different scenarios (Mathews et al., 2007). Thirdly, DM model proved the effectiveness of Monte Carlo simulation suggested by Triantis (2005), which accommodated multiple uncertainties for UAV project's price distributions prediction (Mathews et al., 2007).

Moreover, DM method made a significant contribution to the challenge of "developing heuristics". Triantis (2005) pointed that mangers prefer simple but accurate model; however, it is difficult to obtain an appropriate option model complexity. DM model is primarily built on the DCF models for capturing the advantage of simplicity, then it conducted scenario analysis to address the project's variability in cash flows and risks (Mathews et al., 2007). After that, DM model used Monte Carlo simulation to help managers deal with the complexities through incorporating those market uncertainties into distribution modelling process for cash flows (Mathews et al., 2007).

4. Recommendation

According to the discussion about real options in Triantis (2005) and Mathews et al. (2007), I provide recommendations for firm management from real options' advantages and further improvement aspects.

Firstly, according to the advantages of real options summarized in the first paper, I highly recommend firms to incorporate the real options into company-wide decision making, rather than merely projects-based evaluations. The company who utilized real options in an organizational manner links various management processes such as risk managing, internal controls together, which looks like managing a "company" portfolio (Triantis & Borison, 2001). Therefore, comparing with those companies utilizing real options for single projects, companies with deeper use of real options can obtain a better understanding of internal correlations under market uncertainties, which facilitates to achieve a comprehensive firm management.

Secondly, from the previous evaluation of DM model, it provided no solution for managers' intended bias. I recommend firms to find ways to manage the managerial flexibilities when using real option models to make decisions.

I first propose to treat each investment opportunity as a portfolio of real options. For project evaluation, a bundle of real options is usually discovered to analyse (McGrath, 1997). Managers cannot manipulate the real option model if it contains different options but with the same goal (Baldenius et al., 2016). For instance, Baldenius et al. (2016) developed a real option model by combining a wait option and a capacity maximization option. Managers must and only exercise this option when this model finds a maximum point for the set of real options, which successfully controlled the managerial flexibility (Baldenius et al., 2016).

Moreover, besides real option modelling, I recommend companies to appropriately design their

compensation mechanisms for managers. Reichelstein (1997) proved that performance evaluation system which reflects a congruent goal between managers and principals can effectively reduce the managers' undesirable investment incentives.

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