IT Project Selection using Fuzzy Real Option Optimization Model

Shashank Pushkar, Birla Institute of Technology, India
Prity Kumari, BBA Bihar University, India
Akhileshwar Mishra, National Institute of Technology, India

ABSTRACT

Optimal selection of interdependent IT and e-business projects for funding in multi-period has been challenging in the framework of Real Option analysis. This paper presents a mathematical model to optimize the fuzzy Option value for multi-stage portfolio of such projects. A fuzzy Option model is used to maximize the Option value of each project. The IT and e-service portfolio selection problem is formulated as a fuzzy zero–one integer programming model that can handle both uncertain and flexible parameters to determine the optimal project portfolio. The idea of optimizing the fuzzy real option value of the portfolio is to maximize the overall value and to minimize the downside risk of the selected portfolio for funding. A transformation method based on qualitative possibility theory is developed to convert the fuzzy portfolio selection model into a crisp mathematical model from the risk-averse perspective. The transformed model can be solved by an optimization technique. The optimization model and solution approach can help e-entrepreneurs and IT managers in optimal funding decision making for projects prioritization to implement e-business and other IT services.

Keywords: E-Business Model, E-Entrepreneurship, Financial Evaluation, Fuzzy Logic, Fuzzy Set Optimization, Information Technology Project Portfolio Management, Real Option

INTRODUCTION

Widely used DCF (Discounted Cash Flow) method for the appraisal of IT and e-business investment valuation forecasts future cash flow and discount them at risk adjusted rate, the opportunity cost of capital. This method assumes low market uncertainty. All opportunities are calculated based on current information and there is no possibility to make decision in future. The method does not capture flexibility as the investment decisions are fixed at the beginning.

Investment appraisal technique such as Net Present Value (NPV) have been widely criticized because of their inability to model uncertainty, a factor that is particularly relevant in the context of e-business investment decisions. Even when such investment appraisal yields a negative NPV (usually taken as a signal that the investment should not take place), an investment could still generate potentially valuable Options which is favourable. Circumstances could make the initial investment worthwhile e.g., infrastructure investments are often made without any immediate expectation of payback. They can act as a basis for follow-on investments like...
wireless technical infrastructure, investments in data warehouse etc. Their investment appraisal may yield a negative NPV, but they create value over time. Such investments create valuable follow-on contingent investment opportunities.

Real Option analysis has been an alternative approach that incorporates impact of flexibility while evaluating IT and e-business projects. The basic idea of the Real Options approach is to transfer the sophisticated Option pricing model used in the capital market theory to the valuation of risky projects. Real Option theory views investment activities as discretionary decisions in uncertain environment and thus is able to capture the value of decision flexibility ignored by existing net cash flow method. The initial investment of these projects is similar to purchase of an Option on a further dependent projects’ investment. The value of the project investment is not primarily determined by the initial investment but by the future investment opportunities provided by the initial investment. The NPV and the DCF based analysis are not suited well for risky IT and e-business projects as they are not able to estimate the managerial flexibility underlying such investments. Therefore, the value of the successful project is usually underestimated while the value of the failure is overestimated. In Real Option valuation approach, the initial investment of such project is similar to the purchase of an Option on the further dependent e-business project’s investment. Therefore, the basic idea is to add the call Option value of the dependent project to the initial project value. So, the total value of each project will be the addition of its own DCF value and the call Option value of the dependent projects to be implemented in the subsequent time period.

E-entrepreneurs and the companies that select IT projects to provide services for e-business purpose face an important problem of selecting a project portfolio for funding. The purpose of project portfolio decision is to allocate a limited set of resources to projects in a way that balances risk and reward. Since these project portfolio decision deals with future events and opportunities, much of the information required to make portfolio decisions is at best uncertain and at worst very unreliable. However, even with this doubtful information, the project portfolio decision still must be made. Moreover, resource or budget availability may be flexible because additional budget may be re-allocated from other budget categories.

Fuzzy set theory has been used to model imprecise and preference information in many applications. It can also be used to represent uncertain project information. Pereira and Junior (1988) formulated a simple fuzzy multi-criteria R&D portfolio selection problem that represented project appraisals for each criterion as fuzzy set and developed an algorithm to get non-dominated solutions. Machacha and Bhattacharya (2000) modelled uncertain critical factors involved in the information system project selection by fuzzy sets and developed a fuzzy logic approach to emulate the human reasoning process and make decisions based on vague or imprecise data. Mohamed and McCowan (2001) applied fuzzy set theory to handle the inherent uncertainty of both momentary and non-momentary aspects in construction projects and used a fuzzy ranking index to rank and select construction projects. Hsu et al. (2003) applied the fuzzy AHP approach to select government-sponsored frontier technology R&D projects and indicated the adequacy of fuzzy approach in selecting R&D projects. Fuzzy set theory is also applied to model uncertain and flexible project information. Wang (2004) has used fuzzy set theory to describe uncertain and flexible project information.

The prime idea here is to prioritize the IT and e-business projects such that the fuzzy real option value generated by projects in the portfolio is maximized. The maximization of the option value gives the optimal selection of the projects implementation. Since the Options created by the dependent projects reduce the downside risk, the maximization of the fuzzy Real Option value of the portfolio will eventually minimize the downside risk of the overall portfolio. Here the problem has been formulated as a mathematical model for the optimization.
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