Information Sciences 295 (2015) 544–557

Contents lists available at ScienceDirect

Information Sciences

journal homepage: www.elsevier.com/locate/ins

Facilitating risky project negotiation: An integrated approach using fuzzy real options, multicriteria analysis, and conflict analysis

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ARTICLE INFO

Article history:
Received 20 August 2013
Received in revised form 16 October 2014
Accepted 20 October 2014
Available online 28 October 2014

Keywords:
Fuzzy real options
Ordered weighted averaging (OWA)
Graph model conflict resolution (GMCR)
Private risk
Risky project evaluation

ABSTRACT

This paper proposes a risky project negotiation framework, comprising fuzzy real options, ordered weighted averaging (OWA), and the graph model of conflict resolution (GMCR). Fuzzy real options analysis is employed to evaluate risky projects where the value of managerial flexibility cannot be overlooked. For civil engineering project evaluation, OWA is used to estimate the parameters of the fuzzy real options model, such as initial values and volatilities, to reflect the risk preference of decision makers (DMs). Because it can take into account DMs' values and preferences for a risky project, GMCR is utilized to identify equilibria, or potential resolutions of the conflict, among all possible states, or combinations of DMs' choices. While an option pricing model is employed to estimate the values of decision makers (DMs) toward a risky project, all parts are integrated via fuzzy functions in this framework. A brownfield redevelopment case, the Ralgreen Community in Kitchener, Ontario, Canada, is used as a typical risky project to demonstrate how to apply this integrated approach. The main contribution of this paper is to demonstrate the comprehensive use of fuzzy methods to assess brownfield projects. For this purpose, stochastic methods face difficulties because risks cannot be fully reflected in market prices. Expert knowledge that is descriptive, multi-attribute, or subjective in nature can be effectively quantified using fuzzy representations.

1. Introduction

Conflicting decision makers' (DMs') values are the key factor determining a negotiation's outcome. For a risky project, profitability is perhaps the most important factor determining participants' values on the project, and hence the negotiation outcome.

When a project is highly uncertain on income or cost, traditional evaluation techniques, such as net present value (NPV), become incapable of providing meaningful suggestions, especially on the value of managerial flexibility [1,2]. Generally,

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http://dx.doi.org/10.1016/j.ins.2014.10.049
0020-0255/

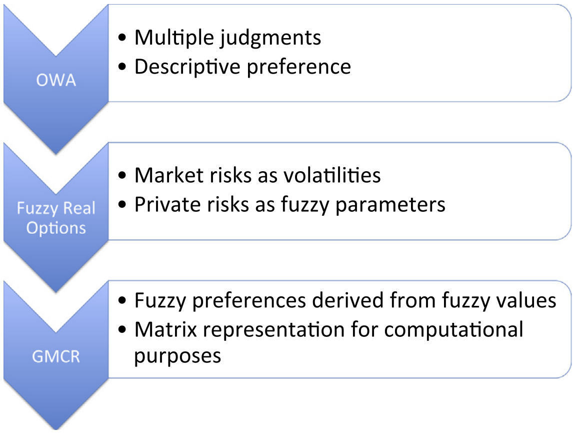

Fig. 1. The diagram of components in the proposed method.

risky projects can be evaluated more accurately using option pricing models, which describe uncertain future costs and income as stochastic processes. This approach is usually called real options analysis [3].

Unfortunately, option pricing models may be unrealistic in risky project evaluation, especially when uncertainties are complex. If some risks are not fully reflected in the market, parameter estimation on underlying stochastic processes cannot be accurate. Unless expert estimates are incorporated to assess private risk, which cannot be estimated using market data [2]. Second, in contrast to stochastic processes, information on private risk is often subjective and descriptive. Experts tend to make quantitatively-based multiple-criteria judgments. And the opinions of decision makers (DMs) may differ widely. To make option pricing models useful in the project risk assessment, all of this difficulties must be addressed.

Fuzziness is an alternative uncertainty representation that has been widely employed in expert systems, and has been especially successful in descriptive knowledge processing. To use fuzziness to deal with private risks. we apply real options with fuzzy parameters to produce fuzzy real options models [4,5]. Because aggregating multiple descriptive factors is critical in making human judgments, we develop a fuzzy multicriteria analysis technique to aggregate a DM's multiple descriptive judgments, using his or her preference to determine the parameters of a fuzzy real options model. Ordered weighted averaging (OWA) is employed due to its simplicity and capacity to deal with linguistic quantifiers [6]. A negotiation component is inserted to account for the conflicting opinions of DMs in joint efforts. Using a fuzzy preference framework, fuzzy real options can be input to the graph model for conflict resolution (GMCR), thereby converting DMs' fuzzy values to fuzzy relative preferences for states and permitting optimal negotiation results to be identified.

Components of the proposed method of facilitating risky project negotiation are summarized in Fig. 1. To tailor this framework for risky project evaluation to the civil engineering context, an intuitive interface to collect expert knowledge is obtained by using OWA to combine fuzzy boundaries. The core model to evaluate risky projects is then base on fuzzy real options, using graph models with fuzzy preferences to represent negotiation among the DMs. The application of the proposed method is illustrated using a typical risky project, the Ralgreen Community Redevelopment project in Kitchener, Ontario, Canada.

In the following sections, literature on each component of the proposed method is reviewed. Then the case study is introduced. The proposed approach is applied to study the case step by step. Insights on brownfield negotiation are discussed, based on this method. Conclusions for risky project negotiation using the proposed method are elaborated at the end.

2. Components of proposed integrated approach

2.1. Fuzzy real options

Fuzzy real options employ an integrated representation of fuzziness and randomness to tackle both market and private risks. Fuzzy real options modeling can be divided into three parts: real options analysis, fuzzy parameters and private risk, and a numerical method to determine the value. These will be briefly explained next.

2.1.1. Risky project evaluation and real options

The cash flow of a project is usually classified into income and cost. Both parts can be highly unpredictable and modeled as stochastic processes. A powerful way of evaluating risky projects, which originates from the financial market and explicitly considers risks, is real options analysis (Table 1).

The net present value (NPV) method treats the value of the cash flow (S) as growing exponentially at a certain rate (μ) over time (t). Future income (and costs) should therefore be discounted to determine present value [1]. As a deterministic