

REAL OPTIONS ANALYSIS BASED ON FUZZY RANDOM VARIABLES

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ABSTRACT. *The objective of this paper is to build a real options model under hybrid uncertain environment of randomness and fuzziness. In order to well describe the real uncertain situation, we utilize fuzzy random variable as a tool to characterize future cash flows, and propose a new real options analysis approach by combing binomial lattice-based model with fuzzy random variable, as named fuzzy random real options analysis (FR-ROA). Then the proposed FR-ROA is applied to an R&D project problem under fuzzy random environment, and the relations of FR-ROA with the classical ROA and the fuzzy ROA are explicitly discussed, respectively.*

Keywords: Fuzzy random variable, Real options analysis, Future cash flow, Binomial lattice-based model

1. **Introduction.** The term ‘real option’ was created by Myers [21] in 1977. In corporate finance, real options analysis (ROA) applies put option and call option valuation techniques to capital budgeting decisions [11]. This concept was made popular by Mauboussin [10]. A real options itself is the right - but not the obligation - to undertake some business decision [4]. Compared with traditional approaches such as discount cash flow (DCF) method, the ROA approach can better solve one project’s future uncertainty [11]. What’s more, Keswani et al. [1] presented two net present value (NPV) and seven option pricing models in a strict sequence of increasing flexibility and proved the excellence of ROA against traditional methods. Nowadays, many companies use ROA to evaluate their projects from the following two aspects: i) The utilization of ROA can take place in a conceptual manner as just applying ROA as a thought to provide a more holistic analysis from an options perspective. This is called real option reasoning (ROR). McGrath et al. [19] explored firms’ motivations to invest in a new option, after analyzing a large sample of patents by firms’ activities in the pharmaceutical industry, they reached the conclusion that: their investments in R&D are consistent with the logic of ROR. ii) Based on the options concept, it is possible to apply the real options methods for specific valuation procedures. There are mainly two popular techniques: One is Black-Scholes equation (B/S equation) [5] which offers an analytical and exact method. Furthermore, Geske [18] offers an extension solution of B/S equation for the valuation of option for continuous time. For more discussion on B/S equation, you may refer to [28]. The other method called Binomial Lattice-based model [9] is mainly proposed for discrete time analysis.

In the classical ROA, when forecasting the future return, most researchers use stochastic values from historical data. Recently, many researches on this topic are based on fuzzy set theory [14]. Wang et al. [12] employed fuzzy set to model uncertain and flexible project information and developed a fuzzy compound-options model to evaluate the value