



# Fuzzy Real Option Evaluation of Real Estate Project Based on Risk Analysis

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## Abstract

The initial investment decision-making of the real estate project is very important. It requires making the right assessment of engineering project risk, then judging the project potential value which is affected by the risk factors. Within this context, fuzzy mathematics is used to assess the levels of income risk and cost risk in the real estate investment, and then adjust the relevant parameters of fuzzy real option based on the above risk assessment of real estate project, which will improve the rationality and validity of the engineering potential value evaluation. Finally, this paper illustrates the assessment model with an example of a real estate investment project in Hangzhou.

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*Keywords:* real estate investment decision; risk assessment; fuzzy real option; evaluation

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## 1. Introduction

In the whole course of real estate investment and development, it comes along with long construction period, large capital flows, long payback period, many uncertainties, restriction and influence by policy, which determine the high risk in real estate investment. So, choosing the right investment project is far more important than managing. To make the correct choice, a reasonable assessment and measurement of the project risk and value is of great importance at the early stage in real estate investment. Establishing a set of scientific and effective assessment methods to identify and analyze the project risk factors to improve the judgment of the potential value, which plays an important role in ensuring the success of real estate investment.

## 2. Literature review

The traditional evaluation of real estate investment generally uses net present value (NPV), internal rate of return (IRR), etc. While these methods fails to take consideration of many uncertainties, and ignore the opportunity value that is brought by those uncertainties, as well as the flexibility of decision-making. In 1977, Professor Stewart Myers introduced the financial option theory into real asset areas. The concept of “real option” became popular in

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our country during the 1990s. Since then it has been widely discussed and successfully used in the theories of decision making in real estate investment at home and abroad [4-7]. Tang and Lu [4] elaborated the division of real option type of real estate projects according to the characteristics of real estate projects and real options, and explained the general framework of real option evaluation. Hou and Qian [5-6] proved the feasibility and rationality of real option approach applied to real estate project evaluation in connection with the flexible characteristics of project investment through analyzing some case of commercial and residential real estate using Black-Scholes pricing model. Compared with the traditional methods, the real options can objectively consider the uncertainties' effect to real estate potential value and make it more close to reality. But most Black-Scholes pricing model usually presumes that the cash flow present values of income and cost are definite values, which will affect the judgment about project values and final decisions if there is a big error in pricing model's parameters. According to this problem, Zhao and Tang [8] introduced a fuzzy real option method in which the Black-Scholes pricing model parameter is set to the fuzzy sets to enhance the accuracy of project assessment results.

Despite above real option pricing models take into account of several uncertain factors of the investment environment, but the investment income and cost are often obtained by cash flow statement, which can not analyze and assess the influence on relative parameters caused by risk factors quantitatively and may have a greater deviation on the overall value assessment of the project. Currently, the project risk assessment research is quite rich [10-15], produced a considerable amount of assessment tools, and widely used in real estate investment decisions, such as FAHP, Monte Carlo simulation, Neural network, probability statistics and so on. While these methods are still limited to risk factors' analysis and assessment about real estate investment, failed to analyze and quantify the risk impact on project potential value.

### **3. The Real Estate Fuzzy Option Evaluation Based on Risk Analysis**

In view of the above problem, the purpose of this study is to make a quantitative analysis on the influence of real estate potential value that caused by the investment risk factors about income and cost. The specific means is to combine the risk assessment with the relevant parameters of Black-Scholes pricing model of fuzzy real option to estimate the value of real estate investment project. This paper will identify the risks related to investment income and cost in the process of the real estate development and use fuzzy mathematic theory to assess these risk factors to get the corresponding risk level, then adjust the expected estimates of income and cost in the Black-Scholes pricing model, finally calculate the fuzzy option value of the project and combine the income and cost risk rating to make investment decision. This method can make the real estate investment evaluation more reasonable and effective that will provide investors with more feasible basis for decision-making.

#### *3.1. Assessment of Income Risk and Cost Risk*

##### *3.1.1. Risk Identification*

The most commonly used method for risk identification is risk list. Making the risk list on the basis of the potential risks of the specific investment project is the first step. There are a large number of researches on risk identification of real estate investment, and many researchers have classified and discussed the real estate investment risks. This paper mainly discusses the risk factors that affect the investment income and cost, which play an important role in real estate value assessment in the process of real estate development. So this paper needs to chose and analyze several economic risk factors, and select some key factors according to the environment of the specific project.

##### *3.1.2. Risk Assessment*

There are many risk assessment methods to chose. Firstly, this paper adopts expert scoring method to estimate the likelihood of occurrence of each risk factor and the severity of the consequences may be caused. Next step is to calculate the average of each risk factor by using fuzzy average operation. In the context, it quotes Ngai's [3] presentation about the linguistic term of likelihood and severity to evaluate the risk factors of investment income and cost. Here, likelihood means the changing probability of the risk factors in the period of investment project construction. And severity refers to the influence degree of the income fluctuation and cost fluctuation after the

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