# Investment project analysis under conditions of uncertainty

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**Abstract**

Investors today equipped with abundant amount of analysis tools to evaluate comprehensive financial data. However, an incompleteness of historical data or presence of data with probability nature of business financial states cannot be handled with existing approaches of investment analysis. This work examines methods of the game theory with nature for analyzing investment project scenarios under conditions of uncertainty. As the methods of game theory, the criteria of Maximax, Hurwitz, Laplace, Wald, Savage and Bayes were used to determine the most effective investments depending on investor's chosen strategies. As a result, an algorithm is proposed for selecting the most promising investment project based on the ranking and game theory methods.

*Keywords:* game theory, investment analysis, investment strategy

## 1 Introduction

When evaluating investments, investors often have to calculate the future values of certain, mainly financial, variables. The basis for predicting possible future results is mainly the historical data of current or similar projects. Also, in practice, to assess investments, one uses the most plausible option to calculate the behavioral model of the project. Using this method, analysts exclude the possibility of alternative results for each of the variables of the investment project and assume that the variables are accurate. [1]. But taking into account the realities of the business environment and the existence of uncertainties, the investment assessment is accompanied with analytical tools like scenario or sensitivity analysis. These analysis methods are designed to assess the economic benefits and feasibility of investment projects. In these methods, the level of price inflation, the level of currency devaluation and other uncertain attributes are reflected. But the likelihood of each of the proposed scenarios in many situations remains uncertain for investors. Even with the knowledge of the probability distribution of scenarios, a large number of scenarios and investment projects makes it difficult for an investor to make an effective decision. At this stage of the analysis, a mathematical theory of strategies called game theory comes to the rescue. There are a sufficient number of examples of classical decision rules under uncertainty, such as the Wald criterion [3], the Hurwitz criterion [4], the Savage criterion [5], the Laplace criterion [6], the Maximin criterion [7], the Maximax criterion and others. Although these criteria imply decision making under conditions of uncertainty, among them there are rules using probabilistic calculus [7], which helps to make a more accurate conclusion. The final step is to use the ranking method of investment projects for each of the described criteria. Of all the known ranking methods, the most practical is the Borda voting method [8].

## 2 Overview

This work describes methods of investment projects analysis:

- Game theory with nature
- Borda count method

As a result, proposes algorithm for investment project analysis under conditions of uncertainty.

## 3 Decision

The net present value (NPV) is one of the most commonly used financial indicator of investment effectiveness. For each of the project there are 3 scenarios of NPV has to be defined with basic, maximum and minimum values. [2] For every NPV value of every investment project the game theory methods with nature to be used to examine different investment strategies. Criteria of Maximax, Wald and Savage consider optimistic and pessimistic strategies, whereas Hurwitz, Laplace and Bayes requires distribution laws of financial attributes. For the effectiveness of considering all kinds of distribution of random variables, it is proposed to use the universal formula "gamma" distribution. Final step is to do scoring of investment criteria scenarios using the Borda count method. As a result, investor is provided by choice between one of the criteria of game theory methods with nature or aggregated value of all used methods to make effective investment decision.

## 4 Conclusion

Using standard methods of scenario analysis is not enough to make an effective choice of investment projects, since the investment strategy is limited to base selection approaches. Today, investors need a more complete approach with the ability to comprehensively analyze investment strategies due to the consideration of financial risks and heterogeneity

of the business environment. In this regard, the methods and rules associated with the decision under condition of uncertainty are come to help and the proposed algorithm opens up new perspectives for an in-depth analysis of investment projects.

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