UDC 372.881.1
DOI: 10.34671/SCH.HBR.2019.0304.0014

РАЗВИТИЕ ИНСТРУМЕНТАРИЯ ФИНАНСОВОГО АНАЛИЗА: ОЦЕНКА РИСКОВ В ПРОЦЕССЕ ИССЛЕДОВАНИЯ ЭФФЕКТИВНОСТИ ИНВЕСТИЦИОННЫХ ПРОЕКТОВ

SPIN-код: 4097-4269
AuthorID: 698812

Ефимова Ольга Владимировна, доктор экономических наук, профессор
Королева Дарья Александровна, магистрант департамента учета, анализа и аудита
Финансовый университет при Правительстве Российской Федерации
(125993, Россия, Москва, Ленинградский пр-т, д.51/1, e-mail: da.koroleva@mail.ru)

Аннотация. Принятие инвестиционных решений происходит в условиях неопределенности и рисков. Поэтому необходимо совершенствовать инструментарий оценки рисков при анализе эффективности инвестиционных проектов. В мировой практике накоплен большой опыт разработки и применения моделей оценки эффективности инвестиционных проектов, однако не все из них способны учитывать нефинансовые факторы, влияющие на инвестиционный проект и представляющие собой риски и неопределенность, которую важно учитывать в оценке эффективности инвестиционного проекта. Значимость и актуальность данной темы заключается в том, что своевременный и всесторонний анализ инвестиций, учитывающий факторы устойчивого развития, риски и неопределенность, в которой организации приходится функционировать, является основополагающим процессом стратегической деятельности организации и способствуют увеличению стоимости компании. Общим недостатком традиционных показателей эффективности инвестиционных проектов является требование определенности входных данных, что, приводит к получению значительно смещенных точечных оценок показателей эффективности и риска проекта. Наличие различных видов неопределенностей приводит к необходимости адаптации традиционных показателей оценки экономической эффективности инвестиционного проекта на основе применения математических методов, позволяющих формализовать и одновременно обрабатывать различные виды неопределенности. В условиях вышеуказанной неопределенности методологической основой для создания моделей сложных динамически развивающихся систем может служить регуляризирующий байесовский подход. Его преимущества состоят в его способности обеспечивать получение устойчивых оценок и моделей в условиях малых выборок, разнотипной информации, значительной неточности данных и нечеткости знаний об управляющей системе, объекте управления и среде. Использование байесовских интеллектуальных технологий для анализа эффективности инвестиционного проекта позволяют детально рассмотреть инвестиционный проект со всех возможных сторон в условиях значительной неопределенности, а также оценить вероятность наступления того или иного события в проекте, показать разбросы получаемых величин, что в дальнейшем способствует более обоснованному и обдуманному инвестиционному решению. В работе представлена модель оценки эффективности инвестиционного проекта с использованием интеллектуальных байесовских сетей.

Ключевые слова: инвестиционный проект, оценка эффективности, байесовские интеллектуальные технологии, регуляризирующий байесовский подход, риски устойчивого развития, технологии искусственного интеллекта, финансовый анализ, развитие инструментария, неопределенность, инфраструктурные инвестиции

DEVELOPMENT OF A FINANCIAL ANALYSIS TOOL: RISK ASSESSMENT IN THE PROCESS OF STUDYING THE INVESTMENT PROJECTS EFFICIENCY

Efimova Olga Vladimirovna, Doctor of Economics, Professor
Koroleva Darya Alexandrovna, graduate student of the Department of Accounting, Analysis and Audit
Financial University under the Government of the Russian Federation
(125993, Russia, Moscow, Leningradsky pr., 51/1, e-mail: da.koroleva@mail.ru)

Abstract. Investment decisions are made in conditions of uncertainty and risks. Therefore, it is necessary to improve the risk assessment tools in the analysis of the effectiveness of investment projects. In the world practice, a lot of experience has been accumulated in the development and application of models for assessing the effectiveness of investment projects, but not all of them are able to take into account non-financial factors that affect the investment project and represent risks and uncertainties that are important to consider in assessing the effectiveness of an investment project. The importance and relevance of this topic lies in the fact that timely and comprehensive analysis of investments, taking into account the factors of sustainable development, risks and uncertainties in which the organization has to operate, is a fundamental process of strategic activity of the organization and contribute to the increase in the value of the company. A common disadvantage of traditional performance indicators of investment projects is the requirement of certainty of input data, which leads to significantly biased point estimates of performance and risk of the project. The presence of different types of uncertainties leads to the need to adapt the traditional indicators for assessing the economic efficiency of an investment project on the basis of mathematical methods that allow formalizing and simultaneously processing different types of uncertainty. In the conditions of the above uncertainty, the regularizing Bayesian approach can serve as a methodological basis for creating models of complex dynamically developing systems. Its advantages consist in its ability to provide stable estimates and models in conditions of small samples, different types of information, significant inaccuracy of data and fuzzy knowledge about the control system, the control object and the environment. The use of Bayesian intelligent technologies to analyze the effectiveness of the investment project allows to consider in detail the investment project from all possible sides in conditions of significant uncertainty, as well as to assess the probability of occurrence of an event in the project, to show the dispersion of the resulting values, which further contributes to a more informed and deliberate investment decision. The paper presents a model for evaluating the effectiveness of an investment project using intelligent Bayesian networks.

Keywords: investment project, efficiency assessment, Bayesian intelligent technologies, regularizing Bayesian approach, sustainable development risks, artificial intelligence technologies, financial analysis, development of tools, uncertainty, infrastructure investments.

INTRODUCTION

Numerous scientific studies reflect the problem of taking into account the impact of sustainable development factors and the risks associated with them in the investment decision making the process. (EFFAS and DVFA, 2014; CFA Institute, 2015; A4S, 2019) In this case, the use of various

tools is possible. (Lam, 2012; Mooney, 1997; Pizzica, AJ, Penhagenco, LS, & LLC, P, 2014)

Efimova (2018) defines a system of critical factors and indicators of sustainable development necessary for a comprehensive assessment of the effectiveness of investment projects, justifies the selection of significant financial and non-financial decision-making criteria, and assesses the possibility of applying methods of integrating sustainable development aspects into the financial analysis mechanism. The article is theoretical and can be used as a methodological approach to the current practical study.

A structured classification of risks presented in the paper (Li, et al., 2017), but it should be revised given the researched project. The possibility of applying the theory of fuzzy sets in the analysis of risks of an investment project is considered, but according to the results of the study, only a risk assessment takes place, and not a comprehensive assessment of the effectiveness of the investment project taking into account risks.

Thus, it is necessary to consider the practical implementation of various risk assessment techniques in justifying investment decisions and identify the most effective ones.

The theoretical context includes traditional capital investment analysis (NPV, IRR) (Pizzica, AJ, Penhagenco, LS, & LLC, P 2014), Monte Carlo scenario analysis (Mooney, 1997), fuzzy set theory.

The practical context: the research will provide an example of the special economic zone investment project.

The currency of the research is that a timely and comprehensive analysis of investments, taking into account factors of sustainable development, risks, and uncertainty, determines the prospects for the company's development and competitiveness in the market.

METHODOLOGY

Research issue. How do non-financial factors integrate into the mechanism for substantiating investment decisions?

The aim is to study the ways of analysing the effectiveness and risk assessment of investment projects and suggest methods improving risk evaluation in investment decision making.

Objectives:

- consider methods for the integration of non-financial factors in the mechanism for substantiating investment decisions;
- provide the example and suggest ways improving the assessment of investment projects in the face of risk and uncertainty.

Type of investigation: an analytical study.

Data collection method: the study used the financial statements and other reports of the company.

Accessibility issues: investment project data is usually closed information. It is possible to create a financial model of an investment project using the information from financial statements and other analytical reports provided by the Bloomberg database.

Ethical issues: the research uses only open resources.

Data analysis plan:

1. Create a financial model of investment based on financial statements.
2. Identify the risks corresponding to the investment project.
3. Evaluate the effectiveness of the investment project based on traditional capital investment analysis (NPV, IRR).
4. Investigate the effectiveness of investment project and its risk according to Monte Carlo scenario analysis.
5. Develop the model for evaluation of the effectiveness of the investment project, including the non-financial information based on fuzzy set theory.

Research limitations: there is uncertainty in the risk assessment of investment projects in connection with the subjective perception of the analyst.

Results

In the last few years, there has been an industrial upsurge in Russia. The economic sanctions imposed against Russia and the adopted state policy in the field of import substitution served as an impetus for the revival of Russian industry. In this regard, investment processes are being activated, since the results of the enterprise's economic activity, the prospects for its development and competitiveness in the market are determined by the scale, structure and effectiveness of the investments made.

The significance and relevance of this topic lie in the fact that a timely and comprehensive investment analysis, taking into account the factors of sustainable development, risks and uncertainty in which the organisation has to operate, is a fundamental process of the organisation's strategic activities and contribute to increasing the value of the company.

This work aims to study the problematic aspects of the theory and practice of analysing the effectiveness and risk assessment of investment projects and suggest ways to analyse the effectiveness of the investment project in the face of uncertainty and risk in order to improve such an assessment.

Risks of sustainable development can be classified into regulatory, operational, social, environmental, corporate governance, reputational. For developing an investment model, it is necessary to identify factors of sustainable development that are essential for the implementation of an investment project; assess the influence of factors in the process of project implementation; integrate sustainable development factors into the model for evaluating the effectiveness of an investment project. [8]

Efimova O.V. points out that "in order to identify factors of sustainable development that can have a significant impact on cash flows, key risks and, as a result, the success of the investment project, the following areas of analysis can be proposed:

- Identification of significant factors in the context of individual aspects of sustainable development: economic, social, environmental;
- Assessment of the influence of SD factors on the company's business model: resources, business processes, products, results;
- Analysis of the significance of SD factors at certain stages of the implementation of an investment project (investment, operational, liquidation);
- Analysis of the impact of SD factors on the value chain: supply chain, production, marketing and sales. " [1]

Sustainable development factors in the analysis of investment decisions can be taken into account by the following methods:

Qualitative - a description of sustainable development factors and the risks associated with it; qualitative assessment and characterisation of the degree of influence of SD factors, for example, low, medium, high.

Quantitative (non-financial) - the development of the KPI system, including performance indicators, for example, the level of staff satisfaction, the number of jobs created, as well as various kinds of indices and ratings.

Financial - inclusion in the traditional methods of project evaluation, for example, NPV or IRR of additional cash flows related to SD factors, adjustment of CAPEX and OPEX, as well as adjustment of the discount rate taking into account additional social or environmental risks. [9]

Integrated (multicriteria) - comprehensively taking into account the financial and non-financial aspects of the investment project.

At the next stage, it is necessary to develop criteria for making investment decisions taking into account sustainable development factors, while it is necessary to develop a system of financial and non-financial criteria for evaluating investment projects (along with the traditional criteria NPV, IRR, MIRR non-financial criteria are used, for example, the level of emissions is not higher ..., level load on the environment no more and others. The composition of the indicators used is determined to take into account the

industry. It suggests the development of an assessment of the weight of the significance of a particular criterion. To make a project selection taking into account non-financial criteria in the analysis of alternative projects. The assessment of the contribution of the project to the achievement of sustainable development goals based on the specific organisation strategy.

It is necessary to highlight the following approaches to the integration of SD factors in financial analysis:

1. Valuation of sustainable development factors in the form of additional income and expenses in developing a financial model.

2. Accounting for risks of SD in the form of adjustment of the discount rate.

3. A combined approach based on the use of financial and non-financial factors and their rating to form an integrated assessment of the effectiveness of the solution. [2]

Thus, it is necessary to conduct a comprehensive assessment of the factors of sustainable development that are significant for a particular investment project, using a flexible mechanism for their accounting and integration into the process of preparing and substantiating investment decisions, including the formation of the necessary information base, recommendations on the use of economic analysis tools, and development of evaluation criteria. It will provide an opportunity to compare the private interests of investors and the requirements of stakeholders to identify inconsistencies in the early stages of decision-making and the fair distribution of costs and benefits between the various parties affected by the project.

Using the theory of fuzzy sets is possible to determine the permissible parameters of interrelated changes, pre-setting verified rules for the formation of judgments on an integrated assessment of economic changes. An objective assessment is made on-the-fly from non-financial information about the expansion of the market, the use of new key competencies, the emergence of competitive advantages - an increasing strategic development potential, and with a digital display of interval values of the membership function, which represents the degree of completion of organizational and technical measures that determine the growth of strategic potential, after the full implementation of development processes. [5]

Under the conditions of the above uncertainty, the regularising Bayesian approach can serve as a methodological basis for creating models of complex dynamically developing systems. Its advantages are its ability to provide stable estimates and models in small samples, heterogeneous information, significant inaccuracy of data and fuzzy knowledge about the control system, control object and environment. As a rule, in the problems of mathematical modelling of complex systems of a priori knowledge is not enough, and the available experimental information and data are attracted.

The regularizing properties of the Bayesian approach are provided by the introduction of the mathematical apparatus for creating, transforming and transmitting scales with dynamic constraints, on which the acquisition, storage, transformation, transmission and interpretation of data and knowledge necessary for the formation of models of control objects, control systems and the environment takes place. Moreover, with each new piece of information, there is a transformation and its integration on the appropriate scales with dynamic constraints, and the models are refined. Thus, as a result of such transformations on scales with dynamic constraints, state assessments, decisions on compliance with criteria, model representations of processes and situations, conclusions, recommendations, tables and risk maps can be obtained as solutions. [3]

The practical value of the Bayesian theorem is the creation of Bayesian networks, which allow a graphical interpretation to represent the probability distribution of features with a causal relationship. It is allowed changing the perception and approaches to the assessment of expert opinions and statistical modelling.

When making evaluative and managerial decisions, tools are needed that allow, based on the generated request, to find the most complete, objective and reliable decisions in an acceptable time interval.

The use of Bayesian intelligent technologies designed to work in conditions of significant uncertainty allows us to solve the above problems. The Bayesian intelligent technology methodology is used in the concept of object management as the basis for the generation of management decisions and technologies for their implementation. In this case, the "InfoAnalytics" software package becomes a tool with which it is possible to work with data of this nature. The concept of a model with dynamic constraints and scales with dynamic constraints of Bayesian smart measurements is key to the InfoAnalytic system. Scales with dynamic restrictions are measuring scales, the benchmarks of which can be different in elements, values, ratings, shapes. They suggest the presence of alternative estimates with varying degrees of probability and are characterised by the variability of their characteristics, such as range, number of benchmarks, norms, and control.

To build a model with dynamic constraints, the controlled and measured properties of the object and the environment, as well as the relationships between them, are determined. A priori uncertainty of the initial information can be considered as a measuring situation of restoration of the measured characteristics from incomplete information. The problems of modelling an object from incomplete initial information can be presented as incorrect inverse problems of restoring the model dependence (causes) from experimental data (their consequences), and the solutions obtained are unstable. To ensure a sustainable solution, such problems require the use of regularising schemes. Regularisation is ensured by replacing the likelihood function with the hypothesis distribution function and by introducing the mathematical apparatus for creating, transforming and transmitting scales with dynamic constraints, on which the acquisition, storage, transformation, transfer and interpretation of data and knowledge necessary for the formation of models takes place.

Thus, the main idea of the regularising approach is to use scaling that measuring the solution space.

Let analyse the investment project in the software environment "Infoanalitik". In the program, it is possible to develop and simulate any situation by creating a tree of factors that describe the project or the current situation. Therefore, to analyse the investment project of DDP LLC, it is initially necessary to develop this tree of factors that describes the presented investment project. To do this, we will use the forecast report on financial results and the forecast report on cash flows; we will also display the calculated financial efficiency of the investment project in a separate block.

From the data point of view, we distinguish the following blocks of factors: - a forward-looking report on financial results, where "Retained earnings" is highlighted as the main factor; - a forward-looking statement of cash flows, where the main factor highlighted is "Cumulative cash flow at the end of the period" with the allocation of operating, investment and financial activities; - financial efficiency of the investment project with the primary factor "cumulative discounted cash flow for investment capital on an accrual basis" The described solution looks in the program as shown in Figures 1. The data are presented on 12/31/2017, i.e. for the first year of the project.

After creating this tree of factors, it is necessary to enter statistical information describing each factor. Such unloading occurs through the import function from Microsoft Excel.

After loading information and scaling each indicator, the audit of factors is displayed in the left pane, i.e. in a graphical interpretation, the characteristics of this factor (below or above the norm) at a certain point in time are reported.

The green value indicates a satisfactory state of the factor, the red value indicates an unsatisfactory state of the factor, and the violet value indicates an extremely favourable state. The analysis of indicators shows that at the beginning of the project, its indicators are in critical values, the investment phase of the project is actively ongoing, attracting significant amounts of funding.

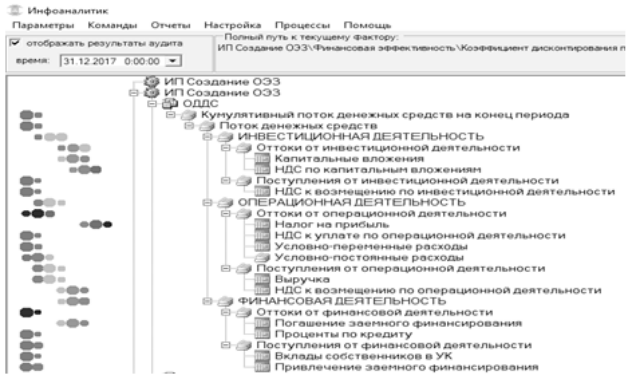

Figure 1 - Tree of cash flow statement factors (Source: developed by the author)

Such an interpretation of indicators allows to comprehensively analyse the investment project and assess the likelihood of receiving the expected income at any given time. So, for example, the probability that the NPV for the project of DDP LLC by the middle of the project will be below the norm and fluctuate within 600 million rubles is 75%, while the probability that this value will be within the norm 10 %.

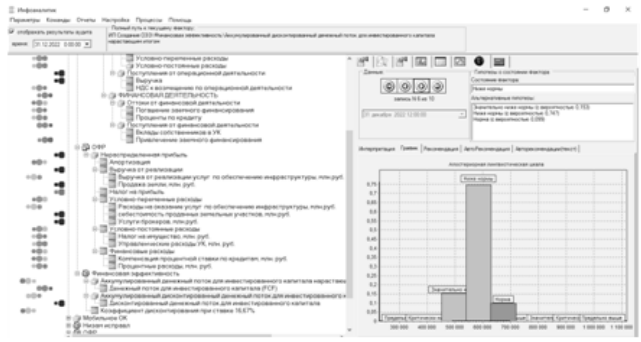

Figure 2 - Accumulated discounted cash flow for the investment project of LLC DDP for 2022 (Source: developed by the author)

The InfoAnalytic program also allows for dynamic analysis of the presented indicators. The following figures show the dynamics of cash flows and the discount coefficient of the most probable model (red line), as well as the upper and lower levels.

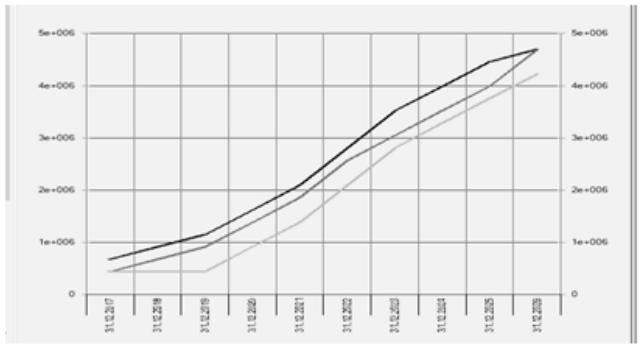

Figure 3 - Cumulative cash flow dynamics (Source: developed by the author)

Cumulative cash flow shows the amount of cash available at a given point in time. According to the above data, it is clear that by the end of the project, the amount of available funds reaches 4.5 billion rubles.

CONCLUSION

Thus, the use of Bayesian intellectual technologies for analyzing the effectiveness of an investment project allows us to examine in detail the investment project from all possible sides under significant uncertainty, as well as to assess the likelihood of a particular event in the project, to show the scatter of the obtained values, which further contributes to a more reasonable and deliberate investment decision. Evaluation of an investment project by this method is possible if there is a particular software package “Infoanalitik”.

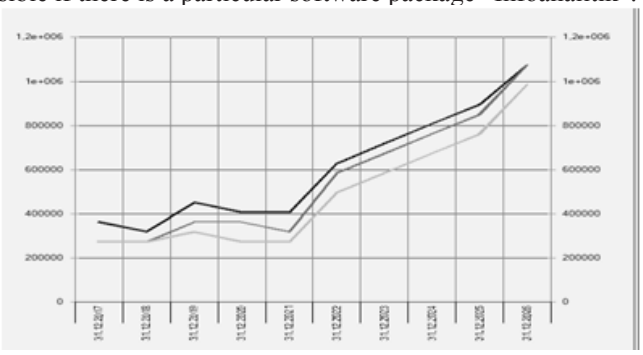

Figure 4 - Cumulative discounted cash flow dynamics for investment capital on an accrual basis (Source: developed by the author)

Timely and comprehensive investment analysis, taking into account the factors of sustainable development, risks and uncertainty in which the organisation has to operate, is a fundamental process of the organisation’s strategic activities and contribute to increasing the value of the company. A common drawback of traditional investment project performance indicators is the requirement of certainty of input data, which leads to obtaining significantly biased point estimates of project performance and risk indicators.

Under the conditions of the above uncertainty, the regularising Bayesian approach can serve as a methodological basis for creating models of complex dynamically developing systems. Its advantages are its ability to provide stable estimates and models in small samples, heterogeneous information, significant inaccuracy of data and fuzzy knowledge about the control system, control object and environment. As a rule, in the problems of mathematical modelling of complex systems of a priori knowledge is not enough, and the available experimental information and data are attracted. Thus, the use of Bayesian intellectual technologies for analyzing the effectiveness of an investment project allows us to examine in detail the investment project from all possible sides under significant uncertainty, as well as to assess the likelihood of a particular event in the project, to show the scatter of the obtained values, which further contributes to a more reasonable and deliberate investment decision.

REFERENCES:

1. Efimova OV Financial analysis: modern tools for making economic decisions: textbook / O.V. Efimova - 4th ed., Rev. and add. –M .: Omega-L Publishing House, 2013. - 350 p.

2. Efimova OV Integration of sustainable development processes into the process of substantiating investment decisions // Economic analysis: theory and practice - M .: 2018. - No. 1 T.17 - P. 48-65

3. Zvyagin L. S. Management systems for the adoption of managerial decisions based on Bayesian Intellectual Technologies (BIT) // Young scientist. - 2011. - No. 12. T.1. - S. 151-154.

4. Koroleva D.A. Bayesian approach in strategic management accounting and auditing // International Conference on Soft Computing and Measurements. - 2017. No. 3 - P. 324-327

5. Prokopchina S.V., Vetrov A.N., Nesterov A.O. Management of investment risks of construction organisations based on Bayesian information technologies / // Software products and systems. - 2014. - No. 1. - S. 212-216.

6. Prokopchina S.V. Development of methods and means of Bayesian measurement intellectualisation in monitoring tasks of complex objects: the dissertation of a doctor of technical sciences: 05.11.16 / Prokopchina Svetlana Vasilievna. - St. Petersburg, 1995 .-- 450 p.

7. Infrastructure investments. [Electronic resource]: - URL: http://www.ey.com/Publication/vwLU-Assets/EY-infrastructure-investments-for-insurers/%24FILE/EY-infrastructure-investments-for-insurers.pdf

8. ISO 21500: 2012. Guidance on project management [Electronic resource]: - URL: https://www.iso.org/en/standard/50003.html

9. Project Management Body of Knowledge [Electronic resource]: - URL: http: // fbs. dinus.edu/repository/docs/ajar/PMBOKGuide_5th_Ed.pdf (accessed March 9, 19)

10. Sustainability and enterprise risk management: The first step towards integration. World Business Council for Sustainable Development, WBCSD, January 2017