Methodological Approaches to the Evaluation of Investment Efficiency Taking into Account Environmental Factors

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Abstract. A huge scale of the industry connected with mining mostly non-renewable natural resources and increasing negative impact of the industrial activity on the environment result in an increasing number of environmental catastrophes and disturbance of the natural environmental balance. The global community must design an effective model of "sustainable development" to balance economy, nature and mankind. This issue is especially urgent for the Far East, its northern part, as the nature there is highly vulnerable, the environment has a long recovery period; it is also characterized by permafrost and more expensive resources. At the same time, the number of natural resource mining projects is on the rise. They inflict permanent damage on the environment. Therefore, selection of investment projects and evaluation of their effectiveness from the point of view of not only commercialization, but also of minimization of consequences for the environment is the most urgent issue. The purpose of this article is to develop approaches to the evaluation of investment efficiency taking into account environmental factors. Various methods were used throughout the study, such as comparison, methods of mathematical modelling in economics, induction, and generalization. The article describes three stages of evaluation of how investment projects affect the environment to evaluate projects from the point of view of their impact on the environment. This allows classifying projects by their impact on the nature and determine economic effect with or without consideration of environmental impact. A clarified method based on classification features of investment projects for analyzing investment efficiency was proposed. The author proposed a method of calculating indicators of environmental-economic effectiveness taking into account inflicted (or possible) environmental damage.

1. Introduction

The methods to evaluate investment efficiency have been appealing to scientists for decades. Numerous researchers address issues of environmental sustainability of economic entities focusing on the issue of developing a system of interconnected indicators of environmental sustainability affecting effectiveness of a company's economic activity [19]. There is a large number of various approaches to the evaluation of project effectiveness satisfying various purposes of investors [12, 13, 16, 20]. In our view, all evaluations must be complex, and one of the tasks for investment researches is the search for a universal indicator to answer the following question: are investments efficient? Do they serve the interests of the generation to come? Does a project meet requirements of sustainable development? The article provides results of a study of environmental-ecological evaluation of investment efficiency based on a study of current methods of investment analysis.
2. Urgency
Investments are resources of the future. In that sense, the most important part of any investment decision is to take into account the environmental factor, especially in the sphere of mining of natural resources. Sustainable (harmonious, balanced) development is a strategic goal of all countries across the world. Sustainable development involves environmentally sound development based on the regard to future needs. In foreign countries, analysis of environmental aspects of investment projects is considered a regular practice for investors. In the Russian Federation this approach is only just gaining popularity, and there is no uniform method yet.

3. Problem setting
For a complex evaluation of investment projects from the point of view of not only economic, but also of environmental effectiveness, it is necessary to develop a universal method, the indicators whereof could be introduced in business planning as obligatory components. This norm follows the principles of environmental protection captured in the Federal Law "On the Environmental Protection." One of such principles is a compulsory review of projects and other documents for compliance with requirements of standards and recommended practices in the sphere of environmental protection according to the legislation of the Russian Federation to substantiate commercial and other activities that may negatively affect the environment, create a threat to life, health and property of citizens [2]. Investment efficiency analysis is the crucial stage investment decision-making. The most important factor is the analysis of the rate of return, i.e. the comparison of project costs and benefits. However, there are two approaches, too: economic and financial. An economic approach to the determination of effectiveness of investment projects includes analysis and evaluation of project feasibility and effectiveness from the point of view of a country's economic interests and demonstrates whether the benefits the society obtains as a result of execution of the project outweighs the costs that the society incurs in the process of execution and operation of the project. Financial analysis helps to ascertain advantage of investing in a specific project. In our view, the combination of approaches will help to ensure rational decision-making.

4. Theory
In our view, it is necessary to study classification of investment projects in order to determine environmental-economic effectiveness of projects [7]. In that sense, a decision to invest is directed either at profit-making or at achieving other effects.

Capital investment in a specific case or project is based on the attachment of invested assets to a specific created, modernized, or expanded economic entity or a group of entities or processes required to achieve the set goals and resolving new issues. Interpreting the economic sense of the word "project" (from the point of view of capital investment), we may assume that a project is a program of measures for practical implementation of a specific socioeconomic design (construction of objects, modernization of processes, resolution of social and environmental issues).

The earlier studies conducted by the author dedicated to the issues of investments in environmental protection activities described a classification of investment projects by impact on the environment:
- projects providing environmental-economic effect;
- projects aimed at preventing damage;
- purely commercial projects (impact on the environment difficult to determine).

Therefore, by convention, any project may belong to industrial, environment-oriented, or commercial investment projects.

Projects of the first type negatively affect the environment, projects of the second type positively affect the environment, projects of the third type have an indirect impact. The impact on the environment may be permanent or accidental (as a result of accidents). For instance, natural resources mining projects and construction of plants have permanent negative impact on the environment. Nuclear station projects will be classified as the projects characterized by the risk of accidents with negative environmental consequences. Water treatment plant projects will be classified as the projects...
preventing permanent negative impact on the environment. IT adoption projects will be classified as the projects that do not have any damaging effect.

Depending on the purpose of an investment project, we propose using different calculation methods to determine economic effectiveness.

Effectiveness of economic impact is determined by a ratio of costs and results. The quantitative evaluation of effectiveness directly depends on the definition of costs and results. From the environmental point of view, an economic impact is a performance of actions in order to reduce damaging impact of commercial activity on the environment. The issues connected with costs of such actions are relatively simple; definition of results of an environment-oriented action is far more difficult, because environmental actions may pursue additional profit along with purely environment protection.

Numerous leading economists have analyzed issues of effectiveness of environment-oriented actions, worked over the methodology of evaluating investment efficacy, costs of environment protection, and damage evaluation. There are several guidance papers for determining economic effectiveness of costs of environment protection and the damage inflicted to the environment in different spheres of economy.

One of the first state-of-the-art methods is a model method of determining capital investment efficacy developed under the guidance of Academician T.S. Khachaturov. It is a basis for most branch methods.

This method is unique in that it helps to determine capital investment efficacy over the whole investment cycle on the basis of the indicators reflecting impact of separate factors. Absolute economic effectiveness is the general indicator of effectiveness [10]. The method is based on two criteria: either maximum effect, or minimum incurred costs. This, in our opinion, is not sufficient to make an informed decision about a project.

This method does not consider the issues associated with uncertainty and investment risk, cash flow analysis, and profit and loss statements. We may assume that these issues were not on the list of analyzed problems. However, this approach to determining economic effectiveness of investment projects is state-of-the-art and default for many branches of economy. Furthermore, there is a concept of "comparative economic effectiveness."

The method proposed by Professor A.V. Vorontsovskii involves a different classification of methods to substantiate investment projects. According to this method, all investment calculation methods may be divided into two groups:

- methods of substantiating investment projects in the circumstances of uncertainty and risk;
- methods of determining the best investment in the circumstances of guaranteed future profit.

The first group of methods is based on the assumption of multivariance of future consequences of made decisions, and also takes into account subjective estimates of probability of such consequences, as well as subjective attitude of each investor to risks and risky decisions. The second group of methods does not take into account factors of uncertainty and risk (the assumption is that future profit and investor's costs are definite) [9].

This method is oriented at determining relevant parameters of substantiating decisions on investment projects; however, it does not consider issues of environmental consequences of projects. Therefore, this method qualifies for determining economic benefit, i.e. characterizes the quantitative side of investors' purposes.

Therefore, we may assert that there is a wide variety of methodological approaches to the determination of economic effectiveness of investments. However, not all of them consider the environmental component of projects.

5. Practical relevance
Throughout previous studies, we managed to arrange methods to determine effectiveness of investment projects. As a result, we obtained an algorithm for an environmental-economic analysis:
calculation of costs - calculation of results - calculation of economic effectiveness - calculation of environmental damage - calculation of environmental-economic effectiveness.

On the basis of this algorithm we have proposed methods to calculate indicators of environmental-economic effectiveness of investment projects taking into account inflicted (possible) environmental damage. These indicators include:

1. Net present value involving the environmental component (NPVe) characterizing the excess of integral results over integral costs.
2. Profitability index involving environmental damage (PIe) characterizing the ratio of the total current discounted income and the total discounted capital investment.
3. Pay-back period

The second and the third indicators may be classified as auxiliary indicators for the evaluation of effectiveness of investment projects taking into consideration their environmental impact. At the same time, we propose using the net present value (NPVe) as the primary evaluation indicator.

Given the proposed classification of investment projects (Figure 1), the author suggests calculating the net present value as follows:

- for industrial projects with negative permanent environmental impact, the net present value involving the environmental component must be corrected by the total damage inflicted by the project to the environment;
- for industrial projects characterized by the risk of accidents with negative environmental consequences, the net present value must be corrected by the amount of economic damage that may be inflicted on the environment by the project;
- for environment-oriented projects intended to prevent negative impact to the environment, the regulated value of the net present value gained from investments into environment protection must tend to the maximum level;
- for projects intended to control damage inflicted by natural disasters, the regulated value of the net present value gained from the implementation of a specific environment-oriented action (prevented damage) must tend to the maximum level;
- for commercial projects, the impact whereof on the environment is understudied, the net present value may be determined without regard to the environmental component.

Therefore, this indicator may serve as an indicator of project effectiveness in the sense of eco-friendliness, as it provides an indication of prevented damage, reflects the effect of activities aimed at environmental protection and takes into account the factor of time.

6. Conclusions
The approach to the evaluation of project effectiveness proposed by the author is unique in that it combines two approaches to the evaluation of project effectiveness: the economic approach and the environmental approach. Therefore, the use of the study results obtained by the author will help to significantly improve quality of environmental protection activity planning, as well as investment appeal of environment-oriented projects. It is also important that this method provides a way to conduct a complex economic analysis of effectiveness of use of investment resources for environmental protection not only on the company level, but also on the regional level.

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