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RISK ASSESSMENT METHODS IN INNOVATIVE PROJECTS

The article describes the advantages and disadvantages of the method of correction of the discount rate and the method of equivalent annuities, the concept of «risk of innovation», identified the causes of the risk and the methods of eliminating of negative manifestations of the risk situations in innovative projects, the methodical approach in assessing of the expected effect of the innovative project based on the concept of probability-interval uncertainty is proposed in the article. It was established that the analyzed approaches can be used for the accounting of the risk of innovative projects. Project manager makes his choice of using of any method of risk assessment individually, depending on the extent and characteristics of the project, the degree of novelty and scale introduction of innovative products, the number of participants and the level of requirements of foundation of project efficiency and other factors.

Keywords: *innovation project, risk, method of equivalent annuities, discount rate correction.*

У статті вказані переваги і недоліки методу коригування норми дисконту, методу еквівалентних ануїтетів, розглянуто поняття «ризик інноваційної діяльності», визначені причини появи ризику та методи усунення негативних проявів настання ситуацій ризику при інноваційному проектуванні, запропоновано методичний підхід при оцінці очікуваного ефекту інноваційного проекту на базі концепції інтервально-ймовірнісної невизначеності. Встановлено, що проаналізовані підходи можуть використовуватись для обліку ризику в інноваційних проектах.

Ключові слова: *інноваційний проект, ризик, метод еквівалентних ануїтетів, метод коригування норми дисконту.*

В статье указаны преимущества и недостатки метода корректировки нормы дисконта, метода эквивалентных аннуитетов, рассмотрено понятие «риск инновационной деятельности», определены причины появления риска и методы устранения негативных проявлений наступления ситуаций риска при инновационном проектировании, предложен методический подход при оценке ожидаемого эффекта инновационного проекта на базе концепции интервально-вероятностной неопределенности. Установлено, что проанализированные подходы могут использоваться для учета риска в инновационных проектах.

Ключевые слова: *инновационный проект, риск, метод эквивалентных аннуитетов, метод корректировки нормы дисконта.*

Introduction. Numerous risk analysis methods outlined in ISO 31010 do not allow taking into account the features of innovative project.

The problem of risk analysis plays an important role in the research that preceded the development of innovation projects. The results of risk assessment should be taken into account when making business decisions on choosing the strategy and tactics of innovation development, planning of scientific and technical, production, marketing and financial activities. In deciding on the implementation of an innovation project, it is necessary to analyze the possible consequences of the impact of both internal, subjective risk factors and external, objective factors beyond the competence of project managers, and in the domestic environment, the impact of the latter is particularly significant.

Analysis of the main achievements and literature. The potential causes of risk in the innovation business include temporary uncertainty, that is, the impossibility of assessing with high accuracy of the duration of development of innovation and the period of time during which it will be in demand on the market; uncertainty of the market situation, that is, the impossibility of accurately predicting the values of the parameters of the market environment surrounding the innovation project; behavioral uncertainty, that is, the unpredictability of the behavior of participants in the innovation process, that depends on the creative potential and coordinated work of the team of innovation managers; target uncertainty, that is, the danger of the wrong choice of purpose or failure to achieve the predicted result, since, the innovation activity is often interpreted as activity with an unknown previously known result; information uncertainty, since any actions associated with the creation of a new product, technology or service inevitably encounter the inability to obtain sufficient and relevant information.

The risk of an innovation project should be understood as a marginal category and focus on the future, rather than on the past experience of innovation. Thus, the concept of «risk of an innovation project» implies how much the firm's financial situation will be affected by the implementation of a particular innovation project, that is, how much the company's overall risk as a result of investing financial resources in the development and organization of a specific venture capital will change. Therefore, when assessing the risk of an innovative project, only risks that are directly related to this project, and not to other activities of the entity, should be taken into account, although it relates to innovation.

The main types of risks that arise in the process of creating and implementing innovative projects, systematized on the basis of generalization of the views of domestic and foreign scientists, are reflected in [1-4]. There are various kinds of losses in innovative projects, in particular: financial (direct cash losses: over-spending of money, unforeseen payments, fines, payment of additional taxes, loss of securities, lack of funds in case of non-payment of debts, non-payment of delivered products by customers, decrease of revenues as a result of lower prices for innovative products); technological (loss of

technological advantage due to aging of technology or the appearance of its legal or illegal imitation of competitors); social (the growth of social tension in society, the change in the demographic situation, the complication of the political situation); time (time losses caused by accidental circumstances or violation of the schedule of implementation of the innovation project); environmental (harm to the environment); material (losses of material resources: property, products, raw materials, materials, fuel, spare parts, equipment, etc.); image (loss of company image, loss of credibility in the market, loss of customers, deterioration of relations with suppliers, change in the attitude of real or potential buyers to the innovation made by the company towards the benefits of other products); moral and psychological (losses caused by the deterioration of the psychological climate in the team of innovative managers, the turnover of personnel); labor (labor losses, personnel problems, labor migration).

Research aim and task. The investigation of the feasibility of applying risk-taking methods in assessing of the effectiveness of innovative projects is the purpose of the article. The definition of the advantages and disadvantages of risk assessment methods in innovative projects and proposing of effective solutions to minimize uncertainty in the management of innovative projects is the task of the article.

Materials of research. Leading economists distinguish the following risk assessment methods in assessing of the effectiveness of innovative projects: the method of adjusting of the discount rate, the method of estimating of the expected efficiency, the method of reliable equivalents. The variety of forms of manifestation of the risk of introducing innovations, the frequency and severity of the consequences of its manifestation, the impossibility of absolute elimination necessitate the study of causal relationships and ways of reducing of the consequences of occurring risk events. Under the discount rate, taking into account the risk, it is accepted to understand the maximum of such discount rates, at which at least one alternative or available investor to the direction of investment, having the same risk as the given project, will provide him with the inherent integral discounted effect [5].

The application of the method of adjusting of discount rate to determine the effectiveness of an innovation project does not always seem possible for the following reasons. The application of the risk value to the discount rate will lead to absurd results in cases where the project's cash flows are unconventional (the dependence of the net present value (NPV) on the discount rate is non-monotonous). Risk taking into account by adjusting of the discount rate is incompatible with the free choice of the moment of reduction, in this case, only the moment of completion of the calculation of the efficiency can be selected as the calculation period in the discounting procedure.. Adjustment of the discount rate to a risk valueis justified only if the risks taken into account in this way are accidental and can lead to the project being terminated at a certain stage of the life cycle. The risk value for a certain step of the calculation period should be interpreted as a subjective probability of termination of the project at this stage. Adjustment of the discount rate for a risk premium is justified only if

the value of the risk premium is not too large. Adjustment of the discount rate to a risk value only is consistent with the risk-taking methodology, when for negative cash flows (investments, losses during the period of exploitation, liquidation expenses, etc.) this premium is deducted from the risk-free discount rate, and for positive cash flows − add to it. The risk premium should be variable in time and its size at each specific stage of the calculation period should depend on the set of risks that may arise precisely at a given time. The use of the discount rate adjustment method is unreasonable in cases where the types of risks accounted for in a risk value may lead not to the termination of the project at any stage, but to the occurrence of additional costs.

The method of adjusting of the discount rate is to adjust some basic risk-free rate of return on the so-called «risk premium», which reflects the integral assessment of all types of risks of the project. The value of the risk premium can be determined using any risk assessment method acceptable for these purposes, but most often statistical or expert estimates are used for these purposes. This value is determined for each project participant, taking into account his functions, obligations to partners and obligations of other participants before him. A project participant may not take into account the risk value in his discount rate, if the receipt of his part of the income from the project is insured or there are guarantees of payment for his performed work. Under this method, it is assumed that the discount rate can serve as an aggregate indicator to take into account all types and types of risk that may arise when implementing an innovation project. The advantages of the method are as follows: the opportunity to evaluate the real value of the cash flow is not nominal; ease of calculation, accessibility for a wide range of users. There are some disadvantages of the method: the discount rate is often determined on the basis of past experience, internal conviction of managers or even arbitrary, and therefore can not always act as an adequate indicator of the level of risk of a project; the method does not allow to take into account all possible results when implementing the project; the existence of a very large number of restrictions when using this method; the method does not provide information about probabilistic distributions of future cash flows, that is, it does not take into account the probability with which the cash flow of each year will change in one direction or another; if a permanent risk premium is used instead of a variable risk premium, then the likelihood of receiving false estimates increases, as in most projects the risk level is significantly reduced as it approaches the end of the lifecycle; the method restricts the possibilities for modeling innovative projects, as it involves an analysis of the dependence of the final criteria of the project's efficiency only on one factor − the discount rate; taking into account simultaneously all possible risks in the norm of the discount leads to the least probable and most pessimistic option of the project, due to which artificially narrowing the decision-making framework; the lack of scientifically sound methodological approaches to calculating the quantitative risk premium (in most cases, it is determined expertly for each specific project, which introduces additional requirements to the level of expertise of experts).

Within the framework of the reliable equivalents method, for the purpose of taking into account risk, adjustments are made not to the discount rate, but to the expected values of cash flows by multiplying them by special reduction coefficients (coefficients of reliability or coefficients of certainty). The most common approach of calculating of the reliability coefficients is their expert definition of lowering coefficients that reflect the degree of confidence of experts in the existence of this cash flow, that is, the reliability of its value. In other words, the coefficients of reliability within this approach correspond to the value of subjective probability.

However, in [6] it is noted that such an interpretation of the reliability coefficients does not correspond to the economic substance of the risk assessment, makes the process of making managerial decisions arbitrary and may lead to serious errors in the formal approach. Another method of implementing the true equivalence method is the better-state method, which is to take into account all alternative event variants (in fact, in the construction of decision trees), each of which uses its risk-adjusted discount rate [6-8]. There are some advantages of the method: ease of calculation and availability for a wide range of users; in contrast to the discount rate method, this method does not involve an increase in risk with a constant coefficient, that is, it allows the risk to be taken into account more correctly. There are some disadvantages of the method: the lack of a unified approach to calculating the reliability coefficients; the method does not allow for probabilistic analysis distribution of key project parameters; calculating the coefficients of reliability, adequate to the level of risk at each stage of the project implementation, presents certain difficulties.

In the framework of this method, for measuring the outcome of the project, new, specific estimators should be used that characterize the instability of the parameters and the distribution of possible effects values. On the one hand, they should reflect all possible conditions for the implementation of the project, on the other − the degree of their capabilities, ie probability.

This function is performed by the so-called «expected» values of net current value (NPV), profitability index (PI), discounted payback period (DPP) and internal rate of return (IRR). The method of estimating of the expected efficiency implies that the analyst has information about all possible scenarios of the project implementation, their feasibility and the significance of the main technical and economic indicators of the project in each of the scenarios.

In [7; 8] the following sequence of the implementation of this method is described: all possible scenarios of the project implementation are being compiled; the organizational and economic mechanism of project realization under each scenario is investigated (each project scenario is calculated by the end of the project, cash flows, additional expenses are taken into account when various «unusual» situations occur for each scenario); the availability of a reserve of financial feasibility of the project is checked; quantitatively evaluates the possibility of an offensive scenario (in the form of objective or subjective probabilities or intervals of their changes) for each of the project participants; the risk of non-implementation of the project is measured, measured by

the probability of occurrence of those scenarios in which the project ceases to be financially implemented; for each scenario, the net present value is determined, and the discount is made at the risk-free discount rate, which reflects the maximum profitability of alternative and available risk-free investment directions; the risk of inefficiency of the project is estimated, that is, the overall probability of occurrence of scenarios in which the net present value is negative, as well as the average loss from the project implementation in case of its ineffectiveness; on the basis of the indicators of the integral effect of individual scenarios, a summary indicator of the expected net present value is determined, on the basis of which a decision is made on the implementation of this project.

Despite the unconditional theoretical advantages of this method (consistency, consistency, logical transparency), its practical implementation is often quite complex and cumbersome.

In particular, attempts to detect the relationship between individual components of a cash flow (for example, between revenue and operating expenses) or between the values of elements of a cash flow at different stages are revealed rather difficultly realized. In addition, the scripting process may be complicated by the possible presence of trends, as well as some restrictions, for example, on the return and maintenance of loans.

Expected effect (R) in the case of interval uncertainty is taken to calculate according to the formula proposed in [9], which is called the criterion of optimism-pessimism

$$R = (1-\lambda)\cdot R_{\min} + \lambda \cdot R_{\max}, \qquad (1)$$

where $R_{\min}, R_{\max}$ – the largest and smallest integral effects of the scenarios under consideration;

λ – a special standard to take into account the risk of obtaining of the effect.

The concept of interval uncertainty, in principle, excludes the possibility of taking into account in calculations additional information about the probabilities of certain values of the effect, assuming that nothing is known about them until the project begins to be implemented.

However, when compiling scenarios of an innovative project, an analyst can usually predict with a large degree of accuracy, at least three or four scenarios, based on expert estimates in forecasting market trends. In this situation, the criterion [9], which takes into account only the extreme value of the effect, may give less accurate estimates than those that could be obtained, based on available forecast data from the scenarios. In addition, the Gurvic formula in [9] is appropriate only for those projects in which the uncertainty of the effect is mainly due to the project itself, but not the external environment.

With a certain combination of external parameters, which may arise with some subjective probability, the project effect may take one of the possible values of a given range, the probability of which is unknown.

Expected effect within the framework of this concept is calculated according to the formula, which is a modification of the Gurvic formula and includes the minimum and maximum value of the mathematical expectations of the effect, calculated by all allowable probabilistic distributions

$$R = (1-\lambda)\cdot \min_{(p_1,p_2)} \sum_i R_i \cdot p_i + \lambda \cdot \max_{(p_1,p_2)} \sum_i R_i \cdot p_i, \qquad (2)$$

where R_i – integral effect on the i project scenario;

p_i – subjective probability of the i scenario of the project.

The effect of the project is a random variable, but the information available in the analytics on the peculiarities of the implementation of this project may correspond not to one, but to several types of laws of probability distribution, but unknown to which particular one.

The coefficient λ lies within the limits $0 \le \lambda \le 1$. If $\lambda = 1$ under the formula $R = R_{\max}$, that is, we have the opposite situation and evaluate the project too optimistic, focusing only on the best of possible scenarios. If $\lambda = 0$ under the formula $R = R_{\min}$, we estimate the project's effectiveness too cautiously (pessimistically), namely, in its worst case scenario, which can be justified only when assessing large and global projects or in case of absolute risk aversion by the decision maker. We would not recommend such an approach in any circumstances.

In [10], the indicator λ is called the coefficient of pessimism and it is noted that the closer the value λ to zero, the more cautious is considered the type of behavior of the decision maker. Let there is a project that requires an investment of one-time investments in size of S and provides for obtaining uncertain results that lie within the range from $P_{\min}$ to $P_{\max}$, and moreover $P_{\min} < S < P_{\max}$. The uncertainty of the results of this project is characterized by the difference $P_{\max} - P_{\min}$, and the maximum size of the possible damage is $P_{\min} - S$. If the risk level of the project is determined as the size of the maximum loss per unit of uncertainty, practical determination of the coefficient λ for a particular project can be recommended to pre-calculate its degree of risk and set the standard of λ in such a way that it does not exceed the obtained value.

Conclusions. It should be noted that exogenous factors, which strongly influence the success or failure of the introduction of innovations, in the framework of the considered approaches are practically not taken into account. Both approaches can be used to take risk into account when evaluating the effectiveness of innovative projects, although the method for assessing expected efficiencies is more reasonable. However, in practice, it involves the need to compile and process a large number of project scenarios.

The question of choosing one of them should be decided by each project manager individually, depending on the scale and features of the project, the degree of novelty and scale of the introduction of innovative products, the number of participants and their level of requirements to justify project efficiency and other factors. It is therefore appropriate to use a mixed approach that assumes that a significant part of the effect depends on the internal uncertainty of the innovation project, and would also combine the two types of uncertainties discussed above and relate the effect of the project to a particular situation in the external environ-ment.

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