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ECONOMIC ANALYSIS OF INVESTMENT PROJECTS AT THE CONDITIONS OF UNCERTAINTY

Abstract: *The article proposes a fuzzy-interval approach for solving the problems of forming an optimal portfolio of investment projects. Although to solve the problem of forming an optimal portfolio of an investment portfolio, a large number of models have been developed that differ from each other in the type of objective functions, the properties of variables used by mathematical methods, and taking into account the uncertainty, where the linear mathematical programming apparatus is used under the conditions of certainty of the initial information.*

Key words:*economic, math, project.*

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Introduction

As it is known, investment process plays an important role in economy of any country. Investment substantially defines economic growth of the state, employment of the population and makes a base essential element on which economic development of a society is based. Therefore the problem connected with effective realization of investment, deserves a close attention.

Investment activity represents one of most prominent aspects of functioning of any commercial organization. The reasons causing necessity of investments, updating of available material base, escalating of volumes of output, development of new kinds of activity are. Value of the analysis for planning and realization of investment activity is very important. Thus the preliminary analysis which is spent at a stage of working out of investment projects has special importance and promotes acceptance of reasonable and well-founded administrative decisions.

Rather often the enterprise comes up against a situation when there is a number of an alternative (mutually exclusive) investment project. Naturally, there is a necessity for comparison of these projects and a choice of most attractive of them by any criteria. In investment activity essential value has risk factor. Investment is always connected with an immobilization of financial resources of the enterprise and usually carried out in the conditions of the uncertainty which degree can vary considerably.

Results of research.

Research shows that, extensive practice of carrying out of real look-ahead calculations of investment projects (IP) testifies to necessity of the all-round account of various kinds of uncertainty at an estimation, planning and management of investment projects. The validity is that that influence of factors of uncertainty on IP leads to occurrence of the unforeseen situations leading to unexpected losses, losses, even in those projects which are originally recognized by economically expedient for the enterprise as not considered in IP negative scenarios of succession of events, let and A little expected, nevertheless, can occur and break realization of the investment project [1,2]. The account of uncertainty of the information and its efficiency directly depend on a choice of the mathematical apparatus defined by the mathematical theory. The stage of a substantiation and choice of the mathematical apparatus providing comprehensible formalization of uncertainty and the

adequate decision of problems, arising at management of real investments, is the extremely important. Unreasonable and as, a consequence, not the correct choice of mathematical apparatus, basically, leads to inadequacy of the created mathematical models, reception of incorrect results in the course of their application and, accordingly, there is a mistrust to the received results, and conclusions to their basis are ignored.

Above carried out analysis of methods of a quantitative estimation of efficiency IP in the conditions of uncertainty allows to draw a conclusion that existing methods, or eliminate uncertainty from model IP that is wrongful as uncertainty is the integral characteristic of any forecast, or are incapable to describe formally, and to consider all possible variety of kinds of uncertainty. The overwhelming majority of methods formalize uncertainty only as distributions of the probabilities constructed on the basis of subjective expert estimations that in very considerable quantity of cases are obviously idealized. Thus, in the given methods uncertainty, irrespective of its nature, is identified with accident and consequently they do not allow considering all possible variety of kinds of uncertainties influencing on IP [2]. As it was already marked, use of the likelihood approach in the investment analysis is at a loss the reasons connected with absence of the statistical information or the small (insufficient) size of sample on some of parameters IP that is caused by uniqueness of everyone IP. Besides, accuracy of an estimation of probabilities (objective and subjective) depends on set of factors, beginning from quality of the statistical information and finishing quality of expert estimations, therefore and quality of a resultant of an estimation of efficiency and risk IP too strongly depends on them that has served mistrust growth to look-ahead estimations received on their basis and decisions. In this connection among top-managers, bankers, financiers there was an opinion that the overwhelming majority of look-ahead calculations too идеализированы and are far from practice. Many prefer to work on the basis of experience and intuition. It is caused, including following principal causes [3]:

- Specificity of subject domain of research as it is on a joint of modern applied mathematics, economy and psychology;

Relative novelty and insufficient sophistication mathematical methods of analysis IP in the conditions of uncertainty;

- Low awareness of top-managers of the enterprises and experts in the field of the finance about new mathematical approaches of formalization and simultaneous processing of the diverse information (determined, interval, linguistic, statistical) and about possibilities of construction on the basis of these approaches of specialized techniques.

Extensive experience of researchers convincingly testifies that the likelihood approach cannot be recognized by the reliable and adequate tool of the decision poorly structured problems to which management problems real investments belong also [4]. Basically, any attempt of use of statistical methods for the decision of such problems is not that other as the reduction to well structured (well formalized) problems, at this reduction essentially deforms initial statement of a problem. Restrictions and lacks of application of "classical" formal methods at the decision of poorly structured problems are a consequence formulated by the founder of the theory of indistinct sets L.A. Zade [5] «of an incompatibility principle": "The more close we approach to the decision of problems of the real world, the more obviously that at increase in complexity of system our ability to do the exact and confident conclusions about its behavior decrease to a certain threshold behind which accuracy and confidence become almost mutually exclusive concepts»[6].

Therefore some researchers develop methods of an estimation of efficiency and risk of investment projects on the basis of the device of the theory of indistinct sets (TIS) [6]. In the given methods instead of probability distribution the distribution of possibility described by function of an accessory of indistinct number is applied.

The methods which are based on the theory of indistinct sets, concern methods of an estimation and decision-making in the conditions of uncertainty. Their use assumes formalization of initial parameters and target indicators of efficiency IP in the form of a vector of interval values (an indistinct interval), hit in which each interval, and is characterized by some degree of uncertainty. Carrying out arithmetic, etc. operations with such indistinct intervals by rules of indistinct mathematics, experts and persons of accepted decisions receive результирующий an indistinct interval for a target indicator. On the basis of the initial information, experience, and intuition experts often can to characterize quantitatively confidently enough borders (intervals) of possible (admissible) values of parameters and area of their most possible (preferable) values.

Also to the methods, indistinct sets based on the theory, it is possible, as a special case, to carry for a long time and widely known interval method [4]. The given method corresponds to situations when borders of values of the analyzed parameter in which limits it can change are precisely enough known only, but thus there is no quantitative or qualitative information on possibilities or probabilities of realization of its various values in the set interval. According to the given method, entrance variables IP are set in the form of the intervals which functions of an accessory, are classical characteristic functions of set, therefore further probably direct application of rules of indistinct mathematics for reception результирующего an indicator of efficiency IP in an interval kind. In an interval method for level (degree)

of risk it is offered to accept the size of the maximum damage having on unit of uncertainty, i.e.:

$$P = \frac{q_N - q_{\min}}{q_{\max} - q_{\min}} \qquad (1)$$

$$P = \frac{q_{\max} - q_N}{q_{\max} - q_{\min}} \qquad (2)$$

Where q_n - demanded value of parameter;

$q_{\min}$ -minimum value of parameter;

$q_{\max}$ - maximum value of parameter;

P - level (degree) of risk, or the relation of distance from the demanded size to its minimum (maximum) value to an interval between its maximum and minimum values.

The concrete variant of expression (1) - (2) depends on used criterion of efficiency. For example, for an estimation of risk IP criterion the Pure resulted cost, pure current cost, the pure discounted income, Net present value, accepted in the international practice for the analysis of investment projects reduction - NPV) is the sum of the discounted values of a stream of the payments led to today is necessary to use expression (1), by criterion Direct Participation Program (DPP-program of direct participation) - (2). Such way of definition of risk will completely be co-ordinated with geometrical definition of probability, however at the assumption that all events in a piece are equal probable. It is obvious that it is impossible to name the given assumption reflecting $[q_{\min} : q_{\max}]$ reality. In the presence of the additional information on values of parameter in an interval when, for example, it is known that value and is more possible, than b, mathematical formalization неопределенностей can be adequately realized by means of the indistinct-interval approach. At use of mathematical apparatus theories of fuzzy sets it is necessary for experts to formalize the representations about possible values of the estimated parameter IP in terms of the task of characteristic function (accessory function) sets of values which it can accept. Thus from experts it is required to specify set of those values which, in their opinion, the estimated size cannot accept (for them characteristic function it is equal 0), and then, rank set of possible values on possibility degree (an accessory to the given indistinct set). After formalization of input parameters of the investment project is made, it is possible to calculate distribution of possibility $\mu_{\tilde{Y}}(y)$ of target parameter (an indicator of efficiency I) on «α -equation to a generalization principle» or «to a principle of generalization Back» [6]:

$$\mu_{\tilde{Y}}(y^*) = \sup_{\substack{f(x_1^*, x_2^*, \ldots, x_n^*) = y^* \\ x_i^* \in supp(\tilde{X}_i),\ i=\overline{1,n}}} \left\{ \min \left\{ \mu_{\tilde{X}_1}(x_1^*), \mu_{\tilde{X}_2}(x_2^*), \ldots, \mu_{\tilde{X}_n}(x_n^*) \right\} \right\}$$

Where $\mu_{\tilde{X}_i}(x_i^*)$- possibility of that the indistinct size $\tilde{X}_i$ will accept value;

x_i^*; $f(x_1^*, x_2^*, \ldots x_n^*) = y^*$ - functional dependence of target parameter IP on input parameters.

The basic advantages of the is indistinct-interval approach to an estimation of efficiency and risk of investment projects in comparison with the methods set forth above [4] are more low listed:

1. The Given approach allows to formalize in the uniform form and to use all accessible non-uniform information (determined, interval, statistical, linguistic) that raises reliability and quality of accepted strategic decisions;

2. Unlike an interval method, the is indistinct-interval method to similarly method of Monte-Carlo, forms a full spectrum of possible scenarios of development IP, and not just the bottom and top borders, thus, the investment decision is accepted not on the basis of two estimations of efficiency IP, and on all set of estimations.

3. The is indistinct-interval method allows to receive expected efficiency IP both in the form of dot value, and in the form of set of interval values with the distribution of possibilities characterized by function of an accessory of corresponding indistinct number that allows to estimate an integrated measure of possibility of reception of negative results from IP, i.e. degree of risk IP.

4. The is indistinct-interval method does not demand absolutely exact task of functions of an accessory as unlike likelihood methods, the result received on the basis of an is indistinct-interval method, is characterized by low sensitivity (high robustness (stability)) to change of a kind of functions of an accessory of initial indistinct numbers that in actual practice poor quality of the initial information does application of the given method more attractive;

5. Calculation of estimations of indicators IP on the basis of an is indistinct-interval method appears effective in situations when the initial information, is based on small statistical samples, i.e. in cases when likelihood estimations cannot be received that always takes place at a tentative estimation of long-term investments and is frequent enough - at the subsequent perspective analysis spent in the absence of sufficient information base;

6. Realization of an is indistinct-interval method on the basis of interval arithmetic's, gives ample opportunities for application of the given method in the investment analysis that is caused

actually by absence of competitive approaches to creation reliable (in sense assurance) and transportability (on inclusion) tool means for the decision of numerical problems.

7. It is characterized by simplicity of revealing of expert knowledge.

Also is indistinct-interval approach has advantages in the decision of problems of formation of an optimum portfolio of investment projects. A considerable quantity of models of formation of the optimum portfolio IP is developed for the decision of a problem of formation of optimum portfolio IP, criterion functions different from each other by a kind, the properties of variables used by mathematical methods, the uncertainty account. As a rule, for the decision of the given problem the device of linear mathematical programming (LMP) in the conditions of definiteness of the initial information is used: the problem is formulated usually as a maximization problem (or minimization) the set function on the set of admissible alternatives which is described by system of equalities or inequalities [6]. For example, $f(x) \to \max$, using the limitation **(**under restrictions) $\varphi_i(x) \le 0$, $i = 1, \ldots, m$, $x \in X$

Where X - a given set of alternatives $f : X \to R^1$ и $\varphi : X \to R^1$ - predefined functions.

As parameters of criterion function $f(x)$ for a problem of formation of optimum portfolio IP various integrated indicators of efficiency IP, however, despite certain advantages and lacks of each of the indicators are used, many researchers tend to that use NPV as criterion function parameters [5] is represented to the most preferable[6] first of all NPV possesses property of additively that gives the chance to estimate profitableness of all portfolio IP as the sum of profitableness's separate IP, forming the given portfolio. Various variants of statement of a problem of formation of optimum portfolio IP are possible. More often, the economic sense of criterion function $f(x)$ consists in maximizations of economic benefit of investment activity, and sense $\varphi_i(x) \le 0$ of the restrictions imposed on set of admissible decisions of a problem, reflects limitation of money resources taking into account possibility of various budgetary restrictions for each of time pieces of action of the project.

As strategic decisions, including connected with formation of an optimum portfolio of investment projects, is directed on long-term prospect and, hence, by the nature is interfaced to considerable uncertainty, and also has a considerable subjective component; therefore application of indistinct mathematical programming to the decision of a problem of formation of optimum portfolio IP possesses many advantages [6-10].

As an example it is possible to consider a situation in which the set of admissible alternatives (investment projects) represents set of every possible ways of distribution of resources which LMP is going to enclose for the purpose of formation of an optimum investment portfolio. It is obvious that, in this case, is inexpedient to enter in advance a clear boundary for set of admissible alternatives (for example, accurate restrictions on the size of the investment budget of the enterprise into the period) as can happen so that distributions of resources (investment projects), slightly lying behind this border (i.e. out of restrictions), will give the effect "outweighing" smaller desirability (for example, on the size of investment expenses) these distributions for LMP. Thus, the indistinct description appears more adequate to a reality, than in a sense any way accepted accurate description of a problem.

Conclusions.

Thus, the comparative analysis of traditional methods of an estimation of efficiency of the long-term investments, existing methods of formation of optimum portfolio IP and an is indistinct-interval method has shown that theories of fuzzy sets is one of the most effective mathematical theories directed on formalization and processing of the uncertain information and in many respects integrating known approaches and methods of theories of fuzzy sets once again confirms true widely known to researchers: the applied formal device by the potential possibilities and accuracy should be adequate to semantics, and correspond to accuracy of the used initial data. Therefore methods of the mathematical analysis are effectively applied at the exact initial data. The mathematical statistics and probability theory use the experimental data possessing strictly certain accuracy and reliability. The theory of indistinct sets allows processing the diverse information, characteristic for real problems of the investment analysis.

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