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THE METHODS OF MODELLING AND THE EFFICIENCY FACTORS IN INVESTMENT PROJECTS*

In this research we have classified the methods of investment project modeling, made a comparative analysis of the given methods, and studied their advantages, disadvantages, and the directions of application. The efficiency factors of the investment project are displayed, based on the developed of enterprise net profit algorithm calculation.

Keywords: investment project, estimation and the analysis of efficiency, modeling of the project.

Viewing the development of investment resources activities (which are necessary for any enterprise) we see a constant struggle increase in conditions of a growing competition. Naturally, the need for an exact substantiation of development projects and the most effective utilization of the involved investments increases. It is impossible to achieve the goals without use of the toolkit, which allows the modeling of the investment process and detailed representation of the influence mechanism for various factors rendering direct or indirect influence on the investment project efficiency.

The classifications of parameters, methods, the used approaches are the important elements when selecting a toolkit, by the consideration and negotiation of the investment project at an enterprise.

The most widespread toolkits are decision-making support systems in the field of investment financing. Any software product used by the consideration of investment projects, is based on a mathematical model. Now we shall investigate the expedient to allocate three methods of the investment modeling process (investment projects):

– simulation;
– optimization;
– optimization-simulation.

The software products based on simulation mathematical models correspond to the simulation method; the applied programs constructed on the basis of models of the optimization correspond to optimization; the applied programs which are based in combined mathematical models, combining elements of the optimization and simulation methods. A more detailed comparison of the given methods is shown in table 1.

The most widespread method of investment projects modeling is the simulation method. Within the limits of this method such software products, as *Project Expert*, *Alt-Invest*, *Comfar*, and others are widely used for the estimation and the analysis of investment projects [1]. The specified software products are convenient in means of project efficiency substantiation to the potential investor as they enable to plan the investment project in detail and to forecast financial reporting.

Solving the problem of enterprise monetary streams and parameters of IE calculation efficiency in the optimization mode is a more complicated task; it is directed on the formation of optimal monetary streams formation, which leads to the maximal value of the investment project efficiency parameter.

It is necessary to say that when using the optimization method, the mathematical complexity of the modeling imposes essential restrictions on a refinement level of elaborating calculations and their conformity to legislative techniques. In this case it is advised to use the optimization-simulating method which combines features of optimization and simulating methods, thus the priority is given to the optimization method.

The expediency of the optimization-simulation method application to consider the investment projects is shown as following:

1. The System of decision-making support, constructed on the basis of the optimization-simulation method sustains an optimization wholeness character. Hence, it allows to compute the optimal parameters of the investment project efficiency at a preliminary analysis stage and to define the best script of project development.

2. A combination of the two methods makes it possible to calculate the techniques, reducing the conformity of enterprise activity financial parameters and legislative techniques. Therefore the calculation of project efficiency parameters becomes more exact and adequate to the validity.

3. The optimization-simulation method allows reducing dimension of the optimization models that makes the wider horizon of planning and a higher level of detailed elaboration of initial data possible.

In use of the optimization-simulation method the concept of the aggregated basic production asset (ABPA) as it is a link between two methods. Under ABPA the minimal set of objects of the basic production assets (BPA), including quantity of the different kinds of BPA necessary for the beginning of production is meant. Thus, at least one unit of ABPA is necessary to start the project.

For the definition of by means of what factors the management of investment project efficiency is possible at the stage of its planning and during realization, is necessary to define the criteria of the project efficiency and the algorithm of enterprise monetary streams formation.

As the main criterion of efficiency it is expedient to use a parameter of net present value NPV which can be presented in the following equation:

$$\mathrm{NPV} = \frac{W_r + Am}{1 + r} - I ,$$

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where W_r – net profit on results of realization of the investment project; Am – the amortization calculated for whole period; r – the rate of discounting considering risks of the project for whole period; I – volume of investment investments for whole term of realization of the project.

The expediency of use of parameter NPV accounts for by the following, that it:

1. An additive parameter that allows considering the cost of investment projects set as the costs is the sum of each of them.
2. Through the rate of profitableness the risks of activity connected with the project are considered.
3. It is an unequivocal parameter (in difference, for example, from internal rate of return).
4. The absolute parameter expressed in the monetary uniform influences all the monetary stream elements from the given investment project on its efficiency (unlike dimensional time of a payback period or such relative parameters as internal rate of return, return of investment index, etc.) and answers to the basic purposes of enterprise activity – the increase of additional cost.
5. Defines the majority of other parameters, rather then vice versa.

To find a pure current cost it is necessary to settle an invoice net profit Wr and amortization Am, considering thus the features of accounting and tax accounts. In this case the following calculation of net profit algorithm which is a basic element of the offered decision-making support system is offered.

1. Proceeds from the realization, equal to total cost of all kinds of realized production:

$$R = \sum_{k=1}^{K} M_k \cdot V_k \cdot P_k ,$$

where M_k – quantity of ABPA of k-th kind, necessary for realization of the project; V_k – productivity of unit ABPA of k-th kind; P_k – cost of the unit of production made on ABPA of k-th kind.

Each kind of ABPA corresponds to a kind of production made within the limits of investment project realization.

2. Amortization is calculated on the basis of data of the previous stage:

$$Am = \sum_{k=1}^{K} Am_k \cdot M_k ,$$

where Am_k – the sum of amortization for the period of project realization of the on unit ABPA of k-th kind, calculated at a preliminary stage.

3. Expenses for turnaround actives will be calculated under the following formula:

$$z = \sum_{k=1}^{K} z_k \cdot V_k \cdot M_k ,$$

where z – total expenses for turnaround actives for whole period of realization of the project; z_k – expenses for current assets for a unit of production, made at ABPA of k-th kind.

4. Calculation of the VAT is made as follows:

$$N_1 = \alpha_1 \cdot (R - \sum_{k=1}^{K} C_k \cdot M_k - z_k) ,$$

where N_1 – the sum of the VAT; C_k – cost of unit ABPA of k-th kind; α_1 – the rate of the VAT.

5. The tax to property is calculated under the formula:

$$N_2 = \sum_{k=1}^{K} N_{2_k} \cdot M_k ,$$

where N_2 – the total wealth tax for whole period of project realization; N_{2_k} – the wealth tax to unit of ABPA of k-th kind for the period, calculated at a preliminary stage.

6. Fund of a payment (FP). As the estimation of the project is carried out “by an incremental method”, we shall consider only FP for the personnel, employed in addition in connection with realization of the project:

$$F = \sum_{k=1}^{K} F_k \cdot M_k ,$$

where F – the general FP for whole period of realization of

The comparative characteristic of investment projects modeling methods

Method	Advantages	Disadvantages	Way of use
Simulation	– the high level of detailed elaboration at calculation of enterprise activity parameters ; – opportunity to estimate projects both in structure of the enterprise, and by the «increment method» [2]	– absence of an opportunity to reception of project optimum efficiency parameters; – absence of an opportunity to find an optimal way of project development	– estimation and the analysis of investment projects; – tactical planning of enterprise activity
Optimization	– allows to consider a mode formation of monetary streams of the enterprise during the project realization in an optimization procedure; – allows to see the optimal script of project development	– a low level of detailed enterprise elaboration in activity parameters calculation; – the difficulty of modeling leads to the simplification of calculating techniques and their deviation from accounting and tax accounts	– estimation and the analysis of investment projects; – strategic planning of enterprise activity
Optimization-simulation	– allows to consider a mode formation of monetary streams of the enterprise during the project realization in the optimization procedure; – allows to see the optimal script of project development. – techniques of the enterprise activity financial parameters calculations correspond to accounting and tax accounts	– the level of detailed elaboration is higher, than when using the optimization method, but nevertheless it concedes to simulating	– estimation and the analysis of investment projects; – strategic planning of enterprise activity (when using the dynamic model, the application for tactical planning is also possible)

the project; F_k – FP on unit of *k*-th ABPA, calculated at the preliminary stage.

7. Consolidated social tax, calculated in view of a descending scale:

$$N_4 = \sum_{k=1}^{K} N_{4_k} \cdot M_k,$$

where N_4 – total consolidated social tax for whole period of realization of the project; N_{4_k} – consolidated social tax on unit ABPA of *k*-th kind for the period counted at a preliminary stage.

8. The general expenses are all expenses, including taxes (except for PT), i. e. the sum of amortization, FP, material and investment expenses, the VAT, the wealth tax and consolidated social tax:

$$Z = Am + F + N_1 + N_2 + N_4 + z\ .$$

9. The balance profit is a difference between proceeds from realization and the general expenses:

$$W_b = R - Z\ ,$$

where W_b – balance profit on results of the project.

10. PT, equal to product of PT rate on balance profit:

$$N_3 = \alpha_3 W_b\ ,$$

where α_3 – the rate of the profit tax.

11. The pure profit is a part of proceeds from the realization, remaining at the disposal of the enterprise after the account of all expenses and payment of all taxes, equal to a difference between balance profit and PT:

$$W_r = W_b - N_3\ ,$$

where W_r – net profit by results of the project.

It is necessary to note, that in the calculation of net profit the taxes, making the basic tax load of any enterprise independent on a field of activity: the value-added tax, the wealth tax, the consolidated social tax and the profit tax, are considered in the algorithm. Also, it is necessary to pay attention on the fact that when using the optimization-simulation method of investment process modeling the received model will have a two-level structure and will consist of simulation and optimization stages. Calculation of parameters which are problematic to calculate at the optimization, a stage is prepared on simulation stage. Cost ABPA, the wealth tax, consolidated social tax, amortization concern to such parameters.

On the basis of the described algorithm the decision-making support system in the field of investment projects financing [3] is constructed.

Based on the offered criterion of efficiency and algorithm it is possible to allocate the major factors having impact on efficiency of the investment project:

– norms of an expenditure of the surplus earnings, received during realization of the project, on project development;

– the price of ready product;

– a way of amortization.

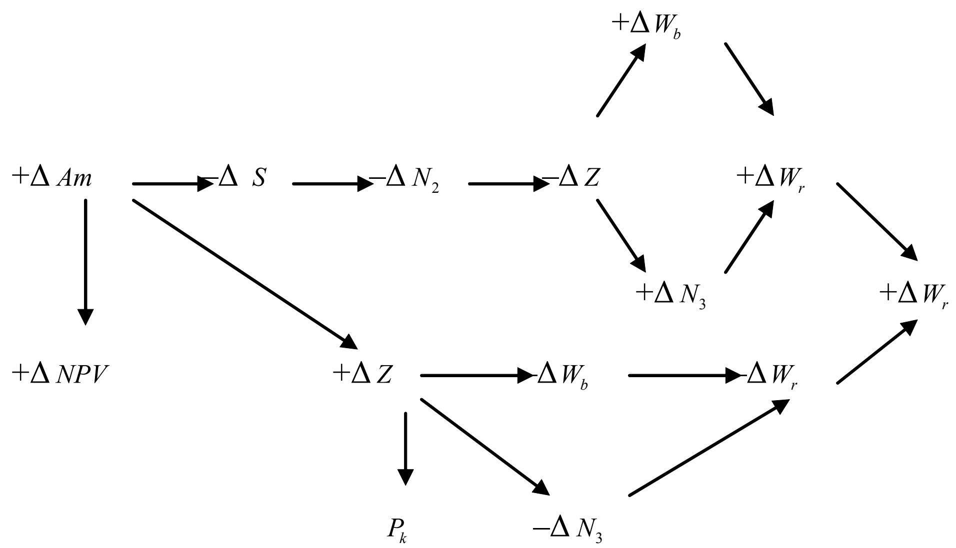
It is necessary to note, that not only the listed factors are capable to influence the investment project efficiency. It will vary also in case of tax rates, the discount rates, turnaround expenses, production demand changes. Features of the given factors show that the enterprise realizing the project has an opportunity to influence them prior to the beginning of the project or operatively during its realization.

The enterprise realizing the project has an opportunity to change the norm of expenditure of surplus earnings on project development, i. e. to define, what percent of surplus earnings will be invested in the project during its realization. The increase in norm of an expenditure of surplus earnings will increase the project efficiency, in case of if it allows to make a demand restraint for made production.

The influence of such factor as the price for made production on the project efficiency is ambiguously, as the production price change influences demand, therefore the influence of the production price on efficiency will depend on elasticity of demand for an exact production, competitive enterprise position in the market.

The use of the nonlinear method of amortization for those objects of the basic means, for which it is possible, also raises the efficiency of the project. In the figure it is shown in detail, how the given effect is reached.

Apparently from the figure, the use of the nonlinear method will entail not only change of the tax to property N_2 that has been described above, but also increase in amortization Am which doubly influences on NPV. On one



Influence of amortization on the investment project efficiency hand, the increase in the savings amortization leads to increase of cumulative expenses Z, that reduces balance profit W_b, cumulative profit tax N_3 and, finally, net profit W_r and reducing efficiency of the project.

On the other hand, the amortization directly influences the parameter NPV aside its increase. Thus, the size change of amortization Am influences the NPV in three directions at the same time. Therefore during the use of the nonlinear method the efficiency of the project will increase, as negative influence of amortization on expenses will be compensated, first, by the positive influence of reduction of the wealth tax, and, secondly, direct influence of amortization on NPV.

Due to the fact that the size increase of amortization Am will lead to increase in general expenses *Z*, it will be reflected in the price of production P_k aside its increase, that, in turn, will influence the demand again. Therefore the problem of how much the parameter NPV will finally change after a change in the amortization charge method will depend on elasticity of demand for an exact production, a competitive position of the enterprise in the market.

An account of considered factors during the preparation of this project and during its realization makes the management of its efficiency possible. Thus it is necessary to consider interaction of factors and change of production demand.

In conclusion we can say that the offered classification of investment projects modeling methods and the lead comparative analysis allows the choosing of toolkit which will correspond to purposes of the user. The investment project efficiency factors, allocated on the basis of the net profit calculation algorithm enable to operate the project efficiency at the stage of planning and during its realization.

Bibliography

1. Zimin, I. A. Real investment / I. A. Zimin. M. : Tandem, 2000. 304 p. (in Russian).

2. Starik, D. E. The estimation of investment projects efficiency / D. E. Starik // Financy. 2006. № 10. C. 70–72. (in Russian).

3. The Designer and solver of discrete optimum control tasks (“Karma”) : The Computer program : The certificate on the state registration in Rospatent № 2008614387 from 11.09.2008 / Legal owners: A. V. Medvedev, P. N. Pobedash, A. V. Smoljaninov, M. A. Gorbunov. (in Russian).

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A MODIFIED PROBABILISTIC GENETIC ALGORITHM FOR THE SOLUTION OF COMPLEX CONSTRAINED OPTIMIZATION PROBLEMS*

A new algorithm for the solution of complex constrained optimization problems based on the probabilistic genetic algorithm with optimal solution prediction is proposed. The efficiency investigation results in comparison with standard genetic algorithm are presented.

Keywords: probabilistic genetic algorithm, constrained optimization.

The necessity to develop complex system models appears in different fields of science and technology such as mathematics, economics, medicine, spacecraft control and so on. In the process of modeling there emerge many optimization problems which are multiextremal, multiobjective and have implicit formalized functions, complex feasible area structure, many types of variables etc. There is no possibility to solve such problems using classical optimization procedures thus we have to design and implement more effective and universal methods such as genetic algorithms (GAs). GAs proved their efficiency in the process of solving of many complex optimization problems [1; 2].

The GAs efficiency depends on fine tuning and control of their parameters. If an untrained user sets arbitrary parameters values, the GA efficiency may vary from very low to very high. The recent trends in a field of GAs are adaptive GAs based on complex hybrid structures and efficient GAs with reduced parameters set.

A known approach to GA parameters set reduction is probabilistic genetic algorithms (pGAs) [3; 4]. The essential difference between pGA and standard GA is that pGA has no crossover operator and new solutions are generated according to statistical information about search space. Thus, collecting and processing such kind of information, pGAs can adapt to the problems they solve.

PGAs demonstrated their efficiency with many complex optimization problems and their further investigation and improvement are promising. There are actual problems of the pGA’s features analysis for wide-range optimization problems

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