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Assessment effectiveness of investment projects based on fuzzy logic

Investment project is the study of economic feasibility, the volume and timing of capital expenditures. Investment projects should be checked for efficient use of allocated funds.

There are five methods for evaluating the effectiveness of the investment project that are combined into two groups [1].

The first group includes methods based on the use of discounting principle. This group consists of the following methods:

- by determining the net present value;
- by calculating the return on investment and internal rate of return.

The second group comprises the three methods. They are called the traditional or simple as they do not use the concept of discounting. This group includes the following methods:

- method based on the calculation of the payback period;
- method of annual (design. calculation. average) rate of profit;
- an approach in which there is a break-even point.

However this method of evaluating the effectiveness of the investment project is subjective. It makes impossible to get a reliable estimate of the effectiveness due to uncontrolled variations in the external environment, inaccuracies obtain primary data necessary to calculate, ambiguous interpretation of the characteristics used. In this situation the use methods of fuzzy logic (FL) is the most reasonable thing.

Calculations on the basis of the FL refer to Soft Computing that focused on adaptation to malfunctioning of the real world [2]. The guiding principle of these calculations is the tolerance for inaccuracy, uncertainty and partial truth to achieve the manipulation convenience, robustness, low cost solutions and better agreement with reality. Soft computing is a set of computational methodologies that collectively provide a basis for understanding the design and development of intelligent systems. The main components are fuzzy logic, neural networks, evolutionary computation in this union.

Analysis of using techniques of the FL for assessing the effectiveness of investment project considered in [3-5]. For example, in [3] indicated that the standard financial approaches to solving this problem is neglected changing environment and do not reflect the actual situation. Alternative fuzzy approach helps to eliminate some assumptions about the behavior of the market. In [4] points to the

risk of investment decisions. A method of estimating this risk is directly related to the description of information uncertainty of initial project data. However, this technique leads to the weak justification of the use of any type of probability in the investment analysis. The article [5] describes the benefits of using the FL compared with other approaches in the development of evaluation method of the investment project.

The purpose of this work is not only to demonstrate the FL possibilities for solving the problem of estimating the efficiency of the investment project, but also in the formation of a more simple evaluation based on a regression equation.

Selection of input and output variables often made on the basis of common sense, developer experience, the availability of regulatory documents. In this problem as input parameters assume the following: cost of project, equipment and technology, experience of staff, competition in the external environment. The output parameter is the efficiency of investment project.

Construction of fuzzy inference model is made in a software module Fuzzy Logic of Matlab. The above parameters are the inputs and output of fuzzy inference system which is shown in Fig.1.

Fig.1 Fuzzy inference system

For each input and output variable is necessary to set a ranges of changes, the type of membership function (MF) and the number of gradations. Selected values of these quantities are shown in Table 1.

Table 1

Characteristics of variables

Variable	Range	MF	Gradations		
Finance	10-100mln. rub.	Triangular	Small	Middle	Large
Equipment	0 -10 years	Trapezoid	New	-	Old
Staff	0-10 years	Gaussian	Small	Middle	Large
Competition	0 - 10 point	Trapezoid	Small	-	Large
Efficiency	0 - 100 point	Triangular	Small	Middle	Large

As an example Fig. 2 shows the MF of the first input variable.

The number of rules determined by multiplying the number of gradations of input variables so in this case the base of rules consists of 36 rules.

Fig.2 Membership functions of variable finance

The results of fuzzy inference system are shown in Figure 3 in the form of three-dimensional dependency of the output variable (effectiveness of the investment project) from a pair of input variables: finance and staff.

Fig.3 Effectiveness of the investment project

Quantitative values effectiveness of investment project obtained through fuzzy inference system are shown in Fig. 4. When we apply to the input of fuzzy inference model the values of the input parameters, the value of efficiency of investment project is formed on the output of fuzzy inference system. Note that the boundaries of the selected 100-point scale efficiency correspond to the cases of extremely low (0 points) and maximum possible efficiency (100 points).

Fig. 4 Value of efficiency of the investment project

Almost all papers on the use of the FL in such a problem is finished on this point. However, you can continue the solution of the problem as follows:

- play the values of the input variables;
- alternately enter each input vector in fuzzy inference system;
- evaluate the effectiveness of investment project obtained with FL;
- derive the regression equation relating the output variable with the input parameters;
- assess the adequacy of equation;
- compare the results of effectiveness evaluations obtained in two ways.

Table 2. illustrates this algorithm.

Table 2

Data for regression equation					
X1	X2	X3	X4	Y(FL)	Y(RE)
1	2	3	4	5	6
57	4	5	6	66	61
91	1.8	6.1	4.7	80	83
21.6	8.2	1.9	8.1	29.2	31
38	4.4	8.4	8.1	54.4	55
79	1.5	1.7	9	50	49
35.2	2.4	2.5	7.8	38.5	39

The first four columns of Table 2 shows the values of the simulated input variables; the fifth column is the assessment of efficiency of investment project received by FL. Five columns of Table 2 are used to derive the regression equation. Table 3 shows the values of the coefficients of this equation.

Table 3

<i>Coefficients of the regression equation</i>		
	Coefficients	Standard error
Y- intersection	50.62212737	27.57923967
Variable X 1	0.379685217	0.171608136
Variable X 2	-0.167481057	1.660541332
Variable X 3	2.682092153	1.068234909
Variable X 4	-3.95291072	2.116443286

The resulting equation is:

$$Y = 50.6 + 0.38 * X1 - 0.17 * X2 + 2.68 * X3 - 3.95 * X4.$$

The adequacy of the equation and the used data is confirmed by the value of the coefficient determination (Table 4).

Table 4

<i>Testing the adequacy</i>	
The regression statistics	
Multiple R	0.990301961
R- squared	0.980697974
Normalized	
R-squared	0.903489872
Standard	
error	5.704071118
Observations	6

As can be seen from Table 4, the coefficient determination is close to unity, which does not reject the resulting regression equation. Negative signs of variables X2 and X4 is quite understandable: the greater the age of the equipment, the lower efficiency; the greater the competition, the lower the efficiency.

Now return to the Table 2: in the sixth column shows the values of efficiency obtained by the regression equation. As can be seen from a comparison of the last two columns, evaluations found the two methods differ slightly, so for the rapid assessment efficiency of the investment project can be used the regression equation.

References

1. Kossov VV Livshits VN. Shakhnazarov AG Methodical recommendations according to efficiency of investment projects. - M.: Economics, 2000. - 421s.
2. Zadeh LA The role of soft computing and fuzzy logic in understanding the design and development of intelligent information systems. - News Artificial Intelligence, 2001. № 2-3. p.7 - 11.
3. Serguieva A., J. Hunter. T. Kalganova. Soft Computing in Investment Appraisal. Proc. of the International Conference in Fuzzy Logic and Technology. De Monfort University Leicester. UK, 2001, p. 214-219.
4. Tomaszewski E.J., Mityashin N.P. Fuzzy model for evaluating the effectiveness of regional investment process. Bulletin of Saratov State Technical University, 2011, № 2 (58), v.3, s.335-339.
5. Doskočil R. An evaluation of total project risk based on fuzzy logic. Business: Theory and Practice, 2016, 17 (1), p. 23-31.