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Integral Assessment of the Effectiveness of Investment Projects on the Basis of Econometric Methods

E.G. Moskaleva[1], L.A. Chelmakina[2]

Abstract:

The objective of the article is the solution of the problem of theoretical foundation and methodical support of the formation of an integrated evaluation of investment projects on the basis of econometric methods.
The result of the study is the development of the recommendations for the evaluation of the effectiveness of investment projects with the use of econometric methods that help to influence the value of the net present impact, profitability index, internal rate of return, payback period of the most significant factors that are crucial for the project both at the stage of development and at the stage of implementation. These factors have been determined on the basis of multifactorial regression models.
In the following paper we present a novel approach to unstructured data processing by imposing a hierarchical graph-based structure on the data and decomposing it into separate subgraphs according to optimization criteria. In the scope of the paper we also consider the problem of automatic classification of textual data for the synthesizing the hierarchical data structure. The proposed approach uses textual information on the first stage to classify ideas, innovations, and objects of intellectual property (OIPs) to construct a multilayered graph. Numerical criteria are used to decompose constructed graph into separate subgraphs. In the scope of the research we apply the developed approach to the innovative ideas in a management case study.

Key Words: *Investments, investment project, evaluation methods, econometric methods, efficiency*

[1] PhD (Law), Associate Professor, Department of Accounting, Analysis and Audit, Ogarev Mordovia State University, Saransk, Russian Federation, ch.analiz@econom.mrsu.ru
[2] PhD (Law), Associate Professor, Department of Accounting, Analysis and Audit, Ogarev Mordovia State University, Saransk, Russian Federation, lchel@mail.ru

1. Introduction

1.1 Introduction to the Problem

The crisis phenomena and instability in the global economy lead to a decrease in the efficiency of investments directed to different areas of the world economy. This in its turn undermines the value of the gross domestic product, labor productivity and society standard of living. In this situation, it is necessary not just to increase the volume of investments but also to perform commercially reasonable actions to attract and invest funds exactly in those investment projects that will stimulate the growth of manufacturing and will provide a positive economic and social impact.

1.2 Importance of the Problem

Ongoing reorganizations in the Russian Federation, defining the conditions for the investment activity of economic entities are characterized by a high degree of variability and uncertainty, which leads to a significant increase in the interest for studying this area. Fundamental changes in the social and economic environment, limited financial resources, concentrated on the support of the most effective investment projects determine new rules for the functioning of economic entities and require a selective approach to the choice of the most efficient investment projects. According to that, there is a problem of selection of such projects and, above all, the criteria for the assessment of their effectiveness.

1.3 Relevant Scientists

Problems of formation of assessment system for the effectiveness of investment projects of economic entities are widely studied by the Russian and foreign economists. At various times, this problem was studied in the works of such well-known Western economists as Behrens (1991) and Hawranek (1991), Bierman (2007), Smidt (2007), Sharpe (1997), Friedman (1992), Ordway (1992), Alan (2004), Pinto (2007) and others.

To the problem of efficiency of capital investments as an independent direction of research studies the works of such scientists as Bogachev (1966), Novozhilov (1995), Kantorovich (1959), Lurie (1948), Khachaturov (1979) are devoted.

The problem of selection and assessment of investment projects due to its special significance became the object of attention for the leading Russian economists: Balabanov (1995), Vilenskiy (2002), Kovalev (2003), Idrisov (1995), Lipsits (2014), Livshits (1994), Smolyak (2002), Kaltynyuk (1995), Kossov (2014), Igonina (2013) and others. However, in the existing studies insufficient attention is paid to the questions of economic feasibility of technology selection and evaluation of investment projects, development of appropriate criteria, including with the use of econometric methods.

2. Methods

2.1 Method of Statistical Monitoring

To assess the effectiveness of investment projects in the economic literature two groups of methods are used: based on valuation prices payback period (Payback Period-PP), the average rate of profit, and based on discounted estimates profitability index (profitability index - PI), internal rate of return (profitability) - (Internal Rate of Return - IRR), net present value (Net Present Value -NPV) and other. (Northcott, 1997) (Chelmakina, 2007, 2009). Having agreed with the above mentioned classification, we note that during the preparation and evaluation of the investment project not only the used methods are important, because each of them has certain advantages and disadvantages, but also the factors affecting future results.

As the most frequently used methods for assessment of the effectiveness of investment projects are the payback period, the average rate of return, profitability index, internal rate of return, net present value, we consider it necessary to form the criteria for evaluating the effectiveness of investment projects on the basis of these methods and specialized program complex for econometric modeling regarding the influence factors. We explain the appeal to econometric methods by the fact that they have different methods for assessment of the parameters of economic models on the basis of the available statistics, as well as using the results of the estimated model for economic forecasting and for good economic policy. In addition, econometric methods allow selecting models, appropriate for available data in a situation where the influence of both external and internal factors is not predictable.
The algorithm of the study consists of the following steps:

1. Construction of the regression models of productive attributes of dependence of payback period, profitability index, internal rate of return, net present value on the factors causing the efficiency of investment projects;

2. The selection of the most significant factors affecting the indicators of the effectiveness of investment projects;

3. Construction using the automated complex "EKM-3" of pair coefficients matrice and its multicollinearity study;

4. Exception of factor variables with statistically insignificant coefficients in the regression models with Student's test;

5. Choice of criteria of optimum dependency according to the attributes, that have the most significant impact on the payback period, the average rate of return, internal rate of return, net present value, with the use of elasticity coefficients and β - coefficients.

To construct the regression models we selected time series of factor and efficient features for 2006 -2010 years and evaluated 19 investment projects of industrial enterprises of the Republic of Mordovia.

To select the criteria of assessment of the investment projects effectiveness the regression model of the system of interrelated attributes was developed, that is, the regression equation, which includes the main factor attributes affecting the variation of the resultant attribute. As a sign of resultative attributes (the dependent variables) of the model the following variables were examined: Y_1 – payback period per months; Y_2 – profitability index, %; Y_3 – internal rate of return, %; Y_4 – net present value, thousand $.

As the independent variables the indicators completely or partially affecting them were chosen: X_1 – number of workers, people; X_2 – number of new workplaces, people; X_3 – payment to the federal budget, mln. $.; X_4 – sum of profits, mln. $.; X_5 – project net present value, mln. $.; X_6 – payments to the republican budget, mln. $.; X_7 – yearly income, mln.$.; X_8 – social effect, mln. $.; X_9 - total amount of financing, mln. $; X_{10} – capital base, mln. $; X_{11} – undistributed profit, mln. $.; X_{12} – capital depreciation, mln. $; X_{13} – credits, mln. $.

2.2 Method of Analysis and Measurement
At the simulation of multifactor correlation models for the validity of the final results, we took into account the requirement of probably less dependence between the factors (lack of multicollinearity). If the value of the pair coefficient, considering the degree of tightness in the connection between the two factor attributes is equal to 0.8 and more, then such factors are deemed collinear.

Inclusion in the model of multicollinear factors is undesirable due to the following effects:

- the interpretation of the model parameters as the characteristics of "pure" form becomes complicated, since the factors are correlated; linear regression parameters become meaningless;
- assessments of the parameters are unreliable, they show large standard errors and calter with the change of volume of observations (not only in value but also in the sign), that makes the model unsuitable for analysis and forecasting.

Constructing the matrics of paired correlation coefficients using program complex "EKM-3"

Rij	1	2	3	4	5	6	7	8	9	10	11	12	13
01 0.244	1	0.99144	-0.38640	-0.32243	-0.30319	-0.34997	-0.33552	0.40903	-0.43654	-0.42720	-0.30204	-0.29010	-0.44541
02 0.292		1	-0.38806	-0.32660	-0.30806	-0.34208	-0.33954	0.45683	-0.43132	-0.42321	-0.30666	-0.29552	-0.43896
03 -0.367			1	0.95685	0.93678	0.53561	0.96961	-0.38340	0.86839	0.86988	0.93399	0.91952	0.86577
04 -0.526				1	0.99802	0.26731	0.99883	-0.33896	0.68824	0.68936	0.99750	0.99401	0.68624
05 -0.556					1	0.20633	0.99390	-0.32386	0.64128	0.64252	0.99992	0.99891	0.63922
06 0.323						1	0.31275	-0.29351	0.88165	0.88218	0.19895	0.16064	0.88000
07 -0.506							1	-0.34728	0.72151	0.72292	0.99293	0.98774	0.71916
08 0.024								1	-0.39983	-0.39018	-0.32444	-0.31280	-0.40907
09 0.001									1	0.99937	0.63589	0.60495	0.99936
10 -0.011										1	0.63677	0.60625	0.99746
11 -0.556											1	0.99914	0.63418
12 -0.577												1	0.60286
13 0.014													1

Figure 1. The matrice of paired correlation coefficients

Having analyzed the matrice of paired correlation coefficients, we found the variables responsible for multicollinearity: pairs $X_1 – X_2$, X_3-X_4, X_3-X_5, X_3-X_5, X_3-X_7, X_3-X_7, X_3-X_9, X_3-X_{10}, X_3-X_{11},X_3-X_{12}, X_3-X_{13}, *X4*-X_{11}, X_4-X_{12}, X_5-X_7, X_5-X_{11}, X_5-X_{12}, X_6-X_9, X_6-X_{10}, X_6-X_{13}, X_7-X_{11}, X_7-X_{12}, X_9-X_{10}, X_9-X_{13}, X_{10}-X_{13}, X_{11}-X_{12} (1)

During the construction of the model, we eliminated one of each pair of factor attributes. Order of elimination of the dependent variables from the study is determined by the total correlation coefficient as follows:

- firstly, it is necessary to calculate all the total correlation coefficients for all dependent factors;
- secondly, to determine the coefficient of determination by these total correlation coefficients;
- thirdly, to compare the values of the coefficients of determination with 90%, and if there are the coefficients that exceed this number, the corresponding factors should be eliminated from the study primarily.

With the program complex "EKM-3" multiple regression equations (multiple models) for payback period were constructed and therewith 2 solution options were obtained, according to the method of multicollinearity eliminating:

1) eliminated factors X_1, X_3, X_4 X_5 X_6 X_7, X_9, X_{10} and X_{11},

2) eliminated factors X_2, X_4, X_5 X_7 X_9 X_{10}, X_{11}, X_{12} and X_{13}

As a result, we concluded that the best model to determine the factors on the payback period (2) is the regression equation:

$$Y_1 = 3{,}439 \cdot e^{0{,}0001 X_1} \cdot e^{-0{,}088 X_3} \cdot X_6^{0{,}0003} \qquad (2)$$

Comparison of the coefficient of neighboring relationship η = 0,908 with Chaddock table showed the presence of high connection, close to a functional; comparative analysis of the confidence coefficient to the Student table (14,625>2,310) showed that tф> tt – this means that the coefficient of neighboring relationship is valid; confidence coefficients of model parameters are, respectively t_{a1} = 24,197; t_{a3} = 5,272; t_{a3} = 6,375; t_{a6} = 8,387, because they exceed the critical value of Student's t test t_t = 2,31, the coefficients of the regression equation are statistically significant at the significance level α = 0,05; average approximation error ε=2,17 <4 % – the regression equation can be used for the index forecasting; Fф >Ft (4,142>3,310) – the regression equation is reliable by the Fisher test at the significance level α = 0,05 and therefore useful for the study. Thus, the constructed model 2 can be used for the forecasting.

From the model (2) we see that the payback period of the investment project is most affected by the following factors:

X_1 – number of workers, people;
X_3 – payments to the federal budget, mln. $;
X_6 – payments to the regional budget, mln. $;

Next, we investigate the effect of the following factors X_1, X_3, X_6 , on the payback period by coefficient of elasticity and β – coefficients (Table 1).

Table 1. The impact of factors on the payback period

#	***aj***–coefficients of values of the equation	***Ej*** – coefficients of elasticity		***βj*** – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_1 = 0,0001	0,065	2	0,781	3	6	3
2	a_3 = -0,088	-0,109	1	-0,946	2	3	1
3	a_6= 0,009	0,034	3	1,264	1	4	2

Analysis of the data in Table 1 shows that the most significant effect on Y_1 – the payback period have the following factors:

X_3 – payments to the federal budget, mln. $;
X_6 – payments to the regional budget, mln. $;

For the second variant of the solution of multicollinearity elimination we have the best regression equation in the form

$$Y_1 = 3{,}169 \cdot X_{12}^{-0{,}00005} \cdot e^{0{,}089 X_{13}} \quad (3)$$

Comparison of the neighboring relationship coefficient η = 0,907 with Chaddock table showed the presence of high connection, close to a functional; comparative analysis of the confidence coefficient to the Student table (14,625>2,310) showed that tф> tt – this means that the coefficient of neighboring relationship is valid; confidence coefficients of model parameters are, respectively t_{a1} = 24,197; t_{a3} = 5,272; t_{a3} = 6,375; t_{a6} = 8,387, because they exceed the critical value of Student's t test t_t = 2,31, the coefficients of the regression equation are statistically significant at the significance level α = 0,05; average approximation error ε=2,17 <4 % – the regression equation can be used for the index forecasting; Fф >Ft (4,142>3,310) – the regression equation is reliable by the Fisher test at the significance level α = 0,05 and therefore useful for the study. Thus, the constructed model 3 can be used for the forecasting.

From the model (3) we see that the payback period of the investment project is also affected by the following factors:

X_{12} – capital depreciation, mln. $;
X_{13} – credits, mln. $;

Then we construct a regression equation of dependence of the profitability index (Y_2) on the below stated factors.

X_1 - X_2, X_3 - X_6, X_4 - X_5, X_4 - X_7, X_4 - X_{11}, X_5 - X_7, X_5 - X_{11}, X_7 - X_{11}, X_9 - X_{10}

In case of elimination of factors: X_1, X_3, X_4, X_5, X_7, X_9, and on Student's test – X_2, we have the following model (4)

$$\tilde{Y}_2 = 3{,}140 \cdot X_6^{0,016} \cdot X_8^{0,241} \cdot X_{10}^{-0,008} \cdot e^{-0,088 X_{11}} \quad (4)$$

Coefficient of neighboring relationship is R=0,982 , that means tight relation. Determination coefficient D=96,44. Consistency of coefficient of neighboring relationship t_η =61,679 > 2,570, consistency of the coefficients of the regression equation t_{a6} = 85,067; t_{a8} = 4,405; t_{a10} = 70,256; t_{a11} = 2,901. The average relative error of approximation e=2.580% < 4% Fisher test Fp=15,604 > 4,780 – the regression equation reliable at the significance level α = 0,05. Thus, the constructed model 4 can be used for the forecasting.

Let's have a comparative assessment of the impact of variables X_6, X_8, X_{10}, X_{11} on the profitability index by a coefficient of elasticity and β – coefficients (Table 2).

Table 2. The impact of factors on the profitability index

#	aj– coefficients of values of the equation	***Ej*** – coefficients of elasticity		βj – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_6 = 0,01648	0,557	1	7,178	1	2	1
2	a_8 = 0,24140	0,147	3	0,372	3	6	3
3	a_{10} = -0,00825	-0,399	2	-5,928	2	4	2
4	a_{11} = -0,08849	-0,120	4	-0,245	4	8	4

Analysis of the data in Table 2 shows that X_6 and X_{10} have the most significant effect.

Second model of dependence of X_8 and X_{11} on the profitability index looks as follows:

$$\tilde{Y}_2 = 3{,}201 \cdot 0{,}0215^{X_8} \cdot 0{,}00009^{X_{11}} \quad (5)$$

Coefficient of neighboring relationship R=0,982 – very tight relation. Determination coefficient D=96,41 %. Consistency of coefficient of neighboring relationship on the Student's test t_r =77,332 > 2,310, consistency of the coefficients of the regression equation t_{a8} = 5,613; t_{a11} = 15,539. The average relative error of approximation e=2,557% < 4%. Fisher test Fp = 22,277 > 3,340 - the regression equation is reliable. Thus, the constructed model 5 can be used for the forecasting.

Using the coefficient of elasticity and ß – coefficient (Table 3) we'll analyze the effect of X_8, X_{11} on the profitability index.

Table 3. The impact of profit and sum of capital base on the profitability index

#	*aj*– coefficients of values of the equation	*Ej* – coefficients of elasticity		*βj* – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_8 = 0,02145	0,074	1	0,376	2	3	1-2
2	a_{11} = 0,00009	0,067	2	1,041	1	3	1-2

To construct the third model of the influence of factors on the profitability index we choose an option of factors elimination: X2, X5, X6, X7, X10, X11, on Student's test – X1, X3, X9.

$$\tilde{Y}_2 = 3{,}187 \cdot 0{,}00004^{X_4} \cdot 0{,}0221^{X_8} \quad (6)$$

Coefficient of neighboring relationship R=0,986. Determination coefficient D=97.14 % - variation of the variables in the model. Consistency of coefficient of neighboring relationship t_r = 97,365 > t_{kp}=2,310, consistency of the coefficients of the regression equation t_{a4}=17,52, t_{a8}=6,467. The average relative error of approximation e=1,951% < 4% . Fisher test Fp=27,942 > 3,340 - the regression equation reliable. Thus, the constructed model 6 can be used for the forecasting.

The impact of factors X_4, X_8, on the profitability index with using the coefficient of elasticity and ß – coefficient is shown in Table 4.

Table 4. The impact of factors «payments to federal budget» and «profit» on the profitability index

# п/п	aj– coefficients of values of the equation	Ej – coefficients of elasticity		βj – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_4 =0,00004	0,068	2	1,048	1	3	1-2
2	a_8 = 0,02207	0,076	1	0,387	2	3	1-2

Assessing the fourth model of the dependency of index of profitability on factors (payments to federal budget and profit) we eliminate factors: X2, X5, X6, X7, X10, X11, on Student's test – X8.

As a result we have the following model:

$$\widetilde{Y}_2 = -2{,}819 \cdot X_1^{0{,}422} \cdot X_3^{-0{,}00001} \cdot e^{0{,}648 X_4} \cdot X_9^{-0{,}0003} \quad (7)$$

Coefficient of neighboring relationship R=0,968. Determination coefficient D=93,65 %. Consistency of coefficient of neighboring relationship (Student's test). t_r=45,741 > t_{kp}=2,260; consistency of the coefficients of the regression equation t_{a1}=10,539, t_{a3}=7,935, t_{a4}=23,365, t_{a9}=8,300. The average relative error of approximation e=3,186% < 4% . Fisher test Fp=10,908 > 2,930 - the regression equation is reliable.
Comparative assessment of the impact of factors X_1, X_3, X_4, X_9, on the index of profitability using the coefficient of elasticity and β - coefficient is shown in Table 5.

Table 5. The impact of factors payback period, number of workplaces and social effect on the profitability index

#	aj– coefficients of values of the equation	Ej – coefficients of elasticity		βj – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_4 =0,42157	0,775	2	0,885	2	4	2

2	a_3 =-0,00001	-0,035	4	-0,666	4	8	4
3	a_4 =0,64810	1,039	1	1,962	1	2	1
4	a_9 = -0,00034	-0,065	3	-0,697	3	6	3

Then, we have constructed regression equations for the dependency of internal rate of return (Y_3) on the following factors: X_1 - X_2, X_3 - X_6, X_4 - X_5, X_4 - X_7, X_4 - X_{11}, X_5 - X_7, X_5 - X_{11}, X_7 - X_{11}, X_9 - X_{10}

When forming the dependency model of the internal rate of return (1 option) the following factors were eliminated: X_2, X_5, X_6, X_7, X_{10}, X_{11}, and on Student's test – X_1, X_9. As a result we‘ve obtained the following model:

$$Y_3 = 3{,}171 \cdot 0{,}000001^{X_3} \cdot 0{,}00003^{X_4} \cdot 0{,}0273^{X_8} \quad (8)$$

Coefficient of neighboring relationship R=0,979 - very tight relation. Determination coefficient D=95,89 % . Consistency of coefficient of neighboring relationship t_r =53,210 > t_{kp} = 2,570, consistency of the coefficients of the regression equation t_{a3}=3,942, t_{a4}=11,419, t_{a8}=5,225. The average relative error of approximation e=2,536% < 4% . Fisher test Fp=15,188 > 4,820 - the regression equation is reliable. Thus, the constructed model 8 can be used for the forecasting.

Let's check the impact of factors X_3,X_4, X_8, on the internal rate of return using the coefficient of elasticity and β - coefficient (Table 6)

Table 6. The impact of factors of number of new workplaces, payments to federal budget and profit on the internal rate of return

#	aj– coefficients of values of the equation	Ej – coefficients of elasticity		βj – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_3 =0,000001	0,023	3	0,358	3	6	3
2	a_4 =0,00003	0,069	2	1,036	1	3	1-2
3	a_8 =0,02730	0,082	1	0,474	2	3	1-2

When forming the second model of dependency of factors on the internal rate of return we eliminated the following factors: X_2, X_5, X_6, X_7, X_{10}, X_{11}.

$$Y_3 = 4{,}697 \cdot X_1^{-0{,}159} \cdot X_3^{0{,}00001} \cdot e^{0{,}855 X_4} \cdot e^{0{,}006 X_8} \cdot X_9^{-1{,}085} \quad (9)$$

Coefficient of neighboring relationship R=0,997 - very tight relation. Determination coefficient D=99,33 %. Consistency of coefficient of neighboring relationship t_r =

331,283 > t_{kp}=2,570, consistency of the coefficients of the regression equation t_{a1}=12,600, t_{a3}=27.464, t_{a4}=53,680, t_{a8} =2,679, t_{a9}=72,368. The average relative error of approximation e =1,251% < 4% . Fisher test Fp=74,328 > 4,740 – the regression equation is reliable. Thus, the constructed model 9 can be used for the forecasting.
Having analyzed the model 9 we can conclude that the internal rate of return of the investment project have a greater impact of factors:

X_1 – number of workers, people
X_3– payments to federal budget, mln.$;
X_9 – total funding, mln.$;

Then we'll determine the impact of the following factors X_1, X_3, X_4, X_8, X_{10} on the internal rate of return using the coefficient of elasticity and β - coefficient (Table 7).

Table 7. The impact of factors "number of new workplaces", "number of workers", "profit" and "payments to federal budget" and "social effect" on the internal rate of return

#	aj– coefficients of values of the equation	Ej – coefficients of elasticity		βj – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_1 =-0,15925	-0,279	3	-0,462	4	7	3-4
2	a_3 =0,00001	0,055	4	1,007	3	7	3-4
3	a_4 =0,85501	1,198	2	1,969	2	4	2
4	a_8 = 0,00551	0,022	5	0,098	5	10	5
5	a_9 = -1,08471	-1,221	1	-2,654	1	2	1

Then we'll eliminate factors: X_1, X_6, X_4, X_7, X_5, X_{11}, X_9 and build the third model of dependency of factors on the internal rate of return:

$$Y_3 = 3{,}701 \cdot X_2^{-0{,}0001} \cdot e^{0{,}488 X_3} \cdot X_8^{0{,}011} \cdot X_{10}^{-0{,}599} \quad (10)$$

Coefficient of neighboring relationship R=0,955 - very tight relation. Determination coefficient D=91,29 %. Consistency of coefficient of neighboring relationship t_r =31,043 > t_{kp} = 2,310, consistency of the coefficients of the regression equation t_{a2} =4,743, t_{a3} =18,626, t_{a10} =2,465, t_{a10} =18,330. The average relative error of approximation e=3,585% < 4% . Fisher test Fp=7,658 > 3,280 - the regression equation is reliable. Thus, the constructed model 10 can be used for the forecasting.
From this model we can see, that the internal rate of return have a greater impact of factors:

X_2 – number of new workplaces, people
X_8– social effect, mln. $.;

X_{10} – capital base, mln. $
Impact of factors X_2, X_3, X_8, X_{10} on the internal rate of return is shown in Table 8.

Table 8. The impact of factors “number of new workplaces”, “number of workers”, “profit” and “total funding” on the internal rate of return

#	aj– coefficients of values of the equation	Ej – coefficients of elasticity		βj – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_2 =-0,00013	-0,069	3	-0,495	3	6	3
2	a_3 =0,48824	0,530	1	1,943	1	2	1
3	a_8 =0,01133	0,041	4	0,257	4	8	4
4	a_{10} = -0,59850	-0,497	2	-1,912	2	4	2

Then, we have constructed regression equations for the impact on the net present value (Y_4) of the following factors – X_1- X_2, X_1- X_3, X_1- X_6, X_1- X_7, X_2- X_3, X_2- X_6, X_2- X_7, X_3- X_6, X_3- X_7, X_4- X_5, X_4- X_8, X_5- X_8, X_6- X_7.
In case of elimination of factors: X_1, X_2, X_3 ,X_4 ,X_5 ,X_6 we'll get the following model of factors dependency on the net present value

$$Y_4 = 2{,}571 * X_7^{0{,}554} * e^{0{,}001 X_8} \quad (11)$$

Coefficient of neighboring relationship R =0,931 very tight relation, determination coefficient D=86,63 % variation of model variables. Corrected index of multiple determination is 84,57%, consistency of coefficient of neighboring relationship t_r =61,679 > t_{kp} 2,570, the average relative error of approximation e =17,190 % >12 % – above normal (the results of model calculations can’t be used). Fisher test F_p =6,460 > 2,460 – that proves that the regression equation is reliable, and model 11.

Thus, the constructed model 11 can be used for studying and forecasting.

Having analyzed model 11 we can conclude that the net present value of the investment project have a greater impact of factors:
X_7 – yearly profit, mln. $;
X_8 – social effect, mln. $;
Then, we’ll find out the impact of factors X_7 , X_8 on the net present value using the coefficient of elasticity and β - coefficient (Table 9).

Table 9. Impact of factors on the net present value

#	***aj***– coefficients of values of the	***Ej*** – coefficients of elasticity	***βj*** – beta-coefficients	Sum	# of significance

	equation	values	# in a row	values	# in a row		
1	a_7 =0,46331	0,30597	2	0,49207	1	3	1
2	a_8 =0,56415	0,49687	1	0,47682	2	3	1

According to Table 9 we can see that the net present value is impacted equally by social effect and profit.

In constructing of the next model the impact of the following factors on the net present value, were chosen (multicollinearity): X_1- X_2, X_1- X_3, X_1- X_6, X_1- X_7, X_2- X_3, X_2- X_6, X_2- X_7, X_3- X_6, X_3- X_7, X_4- X_5, X_4- X_8, X_5- X_8, X_6- X_7. In case of eliminating the following factors: X_2, X_3 ,X_5 ,X_6 ,X_7, X_8. We've obtained the following model:

$$Y_4 = -0{,}981 \cdot X_4^{1,347} \cdot X_9^{-0,420} \quad , (12)$$

Coefficient of neighboring relationship R =0,995 very tight relation, determination coefficient D=99,04 % variation of model variables. Corrected index of multiple determination is 98,85 %, consistency of coefficient of neighboring relationship t_r =327,296 > t_{kp} 2,230, the average relative error of approximation e =3,502 % >12 % – normal. Fisher test Fp =86,668 > 2,910 – that proves that the regression equation is reliable. Thus, the constructed model 12 can be used for forecasting.
Analysis of impact of factors X_4, X_9 on the net present value using the coefficient of elasticity and β - coefficient is shown in Table 10.

Table 10. Impact of profits and total funding on the net present value

#	aj– coefficients of values of the equation	Ej – coefficients of elasticity		βj – beta-coefficients		Sum	# of significance
		values	# in a row	values	# in a row		
1	a_4 =1,34746	1,57083	1	1,36074	1	2	1
2	a_9 = =-0,42001	-0,38849	2	-0,40284	2	4	2

The data in Table 10 shows that the profit has the most significant impact on the net present value and total funding has less impact.

3. Results and Discussion

On the basis of made calculations regression models were constructed for the dependency of the payback period, profitability index, internal rate of return, net present value on the contributing factors (Table 11).

Table 11. Regression models for the analysis and forecasting of the payback period, profitability index, internal rate of return, net present value

Indicator of efficiency	Type of regression dependence
Payback period, months	$Y_1 = 3{,}439 \cdot e^{0{,}0001X_1} \cdot e^{-0{,}088X_3} \cdot X_6^{0{,}0003}$
	$Y_1 = 3{,}169 \cdot X_{12}^{-0{,}00005} \cdot e^{0{,}089X_{13}}$
Profitability index, %	$\tilde{Y}_2 = 3{,}140 \cdot X_6^{0{,}016} \cdot X_8^{0{,}241} \cdot X_{10}^{-0{,}008} \cdot e^{-0{,}088X_{11}}$
	$\tilde{Y}_2 = 3{,}201 \cdot 0{,}0215^{X_8} \cdot 0{,}00009^{X_{11}}$
	$\tilde{Y}_2 = 3{,}187 \cdot 0{,}00004^{X_4} \cdot 0{,}0221^{X_8}$
	$\tilde{Y}_2 = -2{,}819 \cdot X_1^{0{,}422} \cdot X_3^{-0{,}00001} \cdot e^{0{,}648X_4} \cdot X_9^{-0{,}0003}$
Internal rate of return, %	$Y_3 = 3{,}171 \cdot 0{,}000001^{X_3} \cdot 0{,}00003^{X_4} \cdot 0{,}0273^{X^8}$
	$Y_3 = 4{,}697 \cdot X_1^{-0{,}159} \cdot X_3^{0{,}00001} \cdot e^{0{,}855X_4} \cdot e^{0{,}006X_8} \cdot X_9^{-1{,}085}$
	$Y_3 = 3{,}701 \cdot X_2^{-0{,}0001} \cdot e^{0{,}488X_3} \cdot X_8^{0{,}011} \cdot X_{10}^{-0{,}599}$
Net present value, thousands $.	$Y_4 = 2{,}571 * X_7^{0{,}554} * e^{0{,}001X_8}$
	$Y_4 = -0{,}981 \cdot X_4^{1{,}347} \cdot X_9^{-0{,}420}$

The factors the most significantly influencing the indicators of efficiency of investment projects are identified, which is confirmed by calculating the coefficient of elasticity and β – coefficient.

Construction of multifactorial regression models to assess the effectiveness of investment projects allows forecasting the payback period, profitability index, internal rate of return, net present value including the expected values of the influencing factors, and determining the most efficient investment project not only at the stage of its development but also at the implementation stage.

The above stated approach to the formation of criteria for evaluating the investment projects will greatly facilitate the decision making process in the projects analysis and will help to reduce the risks of investment projects. The tests of the proposed method have proved its viability, as it was used in the competitive selection of investment projects in the Republic of Mordovia.

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