UNBIASED INVESTMENT RISK ASSESSMENT FOR ENERGY GENERATING COMPANIES: RATING APPROACH

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ABSTRACT

This article presents a proprietary methodological approach to the ranking of investment risks by severity level and assessment of risk impact on the investment decision-making process. Use was made of the multivariable data analysis mathematical tool, which allows the bias problem to be solved in the efforts to attain the objectives aimed at improvement of investment potential for energy generating companies.
Keywords: Bayesian treatment, electric power industry, energy business, energy company, investment, investment potential, investment risk, risk classification, threshold values.

1 INTRODUCTION

It is common knowledge that the electric power industry as one of the most important sectors of economy exerts versatile and profound effect on socioeconomic development and the environment [1, 2]. This is because of the high significance of the sector's product i.e. electric and thermal energy [2] that directly affect the competitiveness of industrial corporations and the comfort level of households.

It should be noted that as a rule, the electric energy sector development process is accompanied by the energy business-specific risks which relate to the project engineering reliability and capital intensity [3].

When the complex methodological problem of nonpartisanship enhancement of investment risk assessment is solved, the investor gets armed with up-to-date analytical tools which will enable the investor to acquire more information on the risks inherent to the project, including those of latent nature. Thus, more accurate assessment of risks will enable ranking of the projects with proper consideration for sectorial specificity (high level of environmental interaction, technology interchangeability, capital intensity etc.). Furthermore, the proposed technique of investment risk assessment can have an investment yield augmenting impact on the investor's sectorial portfolio due to an unbiased assessment of the risks [4, 5].

2 THE STEPS OF INVESTOR ATTRACTIVENESS RISKS ASSESSMENT

Implementation of the objectives set underlies the development of a mathematical tool that will allow the significance of expert opinions to be minimized [6, 7]. Figure 1 gives a stepwise presentation of such tool [5].

3 RISKS OF INVESTOR ATTRACTIVENESS

Within the framework of the undertaken study, two groups of interrelated investment potential risks were considered: exogenous and endogenous. Such grouping of risks arises from the specifics of risk origin, effects of internal and external environment on the project, and specifics of risk level leverages.

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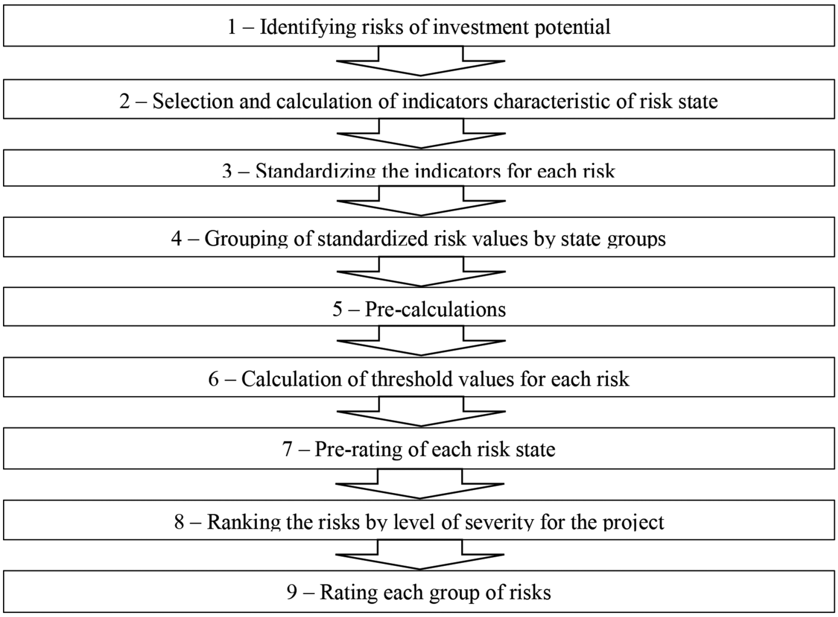

Figure 1: Steps of investment potential risk assessment.

3.1 Exogenous risks of investor attractiveness

Exogenous risks are independent of operations conducted by the energy generating company and are beyond its control. The selection of exogenous risks for their evaluation is random from an existing set of factors. In this study, the following risks are considered as:

1. Gross regional product (GRP) (X_1): cumulative indicator of regional economic activity inclusive of production of goods and services. The related risk implies that any reduction in GRP will adversely affect the regional investment climate. The estimated indicator is total GRP for the period.
2. Risk related to the development of regional specialization sectors (X_2) is based on the availability or lack, present and future, of primary outfits being the main consumers of electric and thermal energy within the territory of interest. The risk assessment estimated indicator is the regional product output expressed in rubles.
3. Regional capital investment behavior (X_3) reflects the enhancement of capabilities for business development, aggregate cost coverage etc. The estimated indicator is the regional investment amount by year.

3.2 Endogenous risks of investor attractiveness

The second-group risks under study, i.e. endogenous risks are the outcome of assessment and analysis into all spheres of operations and financial activities undertaken by the company and related outfits. Within the framework of this study the following risks are considered as:

1. Contingent financial losses (X_4): the likelihood of financial pressures that may occur in an energy generating company, such as reduction in revenues, loss of capital, increasing reliance on raised funds etc. The risk assessment estimated indicator is the revenue trend for the period.
2. Risk related to the company's standing on the stock market (X_5) is based on the fact that the stock quotation indices are of paramount importance for investors and are indicative of the company's dependence on the events at the international energy market etc. For comprehensive risk assessment, the indicator of stock quotation trend (forecasts considered) is used.
3. Risk related to the reliance of the energy generating company on imported equipment (X_6). On top of everything else, this implies the assessment of dependence of the company's future period expenditures for maintenance, repair, and the provision of consulting services related to such equipment. The risk calculation is based on the determination of the import content in the total plant and equipment of the company.

4 EVALUATION OF INVESTOR ATTRACTIVENESS RISKS VALUES

This stage includes 2nd – 4th steps of methodology (Fig. 1):

- Selection and calculation of indicators characteristic of risk state.
- Standardizing the indicators for each risk.
- Grouping of standardized risk values by state groups.

4.1 Initial data for evaluation

The source data for risk assessment are given below in Tables 1 and 2 [2]. Mentioned in Tables 1 and 2 data represent standardized values of the actual value (in accordance with paragraph three of methodical).

Table 1: Standardized statistical values for exogenous risk indicators.

	Periods								
Indicators	1	2	3	4	5	6	7	8	9
X_1	0.46	0.23	0.65	0.59	0.32	0.02	0.77	0.85	0.15
X_2	0.53	0.36	0.79	0.61	0.49	0.13	0.83	0.95	0.28
X_3	0.51	0.31	0.59	0.56	0.43	0.11	0.71	0.82	0.24

Table 2: Standardized statistical values for endogenous risk indicators.

	Periods								
Indicators	1	2	3	4	5	6	7	8	9
X_4	0.35	0.73	0.84	0.61	0.22	0.52	0.48	0.87	0.14
X_5	0.28	0.54	0.71	0.49	0.25	0.41	0.33	0.89	0.15
X_6	0.26	0.73	0.85	0.61	0.23	0.45	0.34	0.97	0.12

4.2 Distribution of the normalized risks facts to the status groups

The standardized statistical data are grouped into three possible states specified in the methodology: minimum, maximum permissible, and unacceptably high level of risk effect on the project respectively. The principle of direct relationship between the increasing risk level (from the first group to the third group) and the increase in the risk indicator value underlies the grouping of risks.

The results of the aforesaid grouping for the exogenous and endogenous risk values are shown in Tables 3 and 4, respectively.

5 PRELIMINARY AND THRESHOLD VALUES CALCULATIONS

This stage includes 5th (Pre-calculations) and 6th (Calculation of threshold values for each risk) steps of the methodology (Fig. 1):

5.1 The theory of threshold value calculation

Generally, the threshold values for each investment potential risk are calculated by eqn (1) based on the Bayesian treatment [8]. According to Bayes's rule, for a set of objects behaving as normally distributed, the object characterized by variable vector *X* should be referred to the first-state set, if:

$$ln\left(c_i q_i\right) - 0.5*\left(\left(X - M_i\right)^T * S_i^{-1} * \left(X - M_i\right) - ln\left|S_i\right|\right) - \left(ln\left(c_{i+1} q_{i+1}\right) - 0.5*\left(\left(X - M_{i+1}\right)^T * S_{i+1}^{-1} * \left(X - M_{i+1}\right) - ln\left|S_{i+1}\right|\right)\right) = 0, \quad (1)$$

Table 3: Exogenous risk values by project-affecting group.

Indicators	States								
	Minimal level (1)			Maximum permissible level (2)			Unacceptably high level (3)		
X_1	0.02	0.15	0.23	0.32	0.46	0.59	0.65	0.77	0.85
X_2	0.13	0.28	0.36	0.49	0.53	0.61	0.79	0.83	0.95
X_3	0.11	0.24	0.31	0.43	0.51	0.56	0.59	0.71	0.82

Table 4: Endogenous risk values by project-affecting group.

Indicators	States								
	Minimal level (1)			Maximum permissible level (2)			Unacceptably high level (3)		
X_4	0.14	0.22	0.35	0.48	0.52	0.61	0.73	0.84	0.87
X_5	0.15	0.25	0.28	0.33	0.41	0.49	0.54	0.71	0.89
X_6	0.12	0.23	0.26	0.34	0.45	0.61	0.73	0.85	0.97

where X – variable vector in the space of risks under study; M_i, M_{i+1}– expectations; S_i, S_{i+1} – covariance matrixes; q_i, q_{i+1} – a priori probability of objects appearance from i or (i+1) areas; c_i, c_{i+1} – the values of objects erroneous labelling to i or (i+1) areas.

However, the implementation of this step shall follow the fifth step of pre-calculations.

5.2 Preliminary calculation to threshold values

First, the expectancy, M_n, for each risk in each of the three possible states shall be computed, and the unit vectors for boundary state expectancy differences ($M_{i+1} - M_i$) shall be formed. Furthermore, it is necessary to calculate the unit vector values for the differences between each risk in the current state and the respective expectancy by year ($X_i - M_n$).

Pre-calculation results are used at a later stage when covariance matrices (S_n) are computed; generally, such computation is based on common mathematical tools.

5.3 Threshold value calculation

Since this technique implies that investment potential risk threshold values for the three possible states are to be calculated, the further study will be split into two parts. The first part implies the threshold value analysis, where the threshold value demarcates the minimum (1) effect level state from the maximum tolerable (2) effect level state. Accordingly, in the second part, the maximum tolerable (2) effect level state is demarcated from the unacceptably high (3) effect level state.

As it was noted above, the first part of the study that follows comprises the determination of threshold values for all risks; these threshold values shall demarcate the first and second states of risk.

The line that goes through semicenters of the first and second states with the coordinates M_1, M_2 is described by the eqn (2):

$$X = b^*\left(M_2 - M_1\right) + M_1, \tag{2}$$

where b – the line parameter.

5.3.1 The results of threshold value calculation

Using the data acquired during pre-calculations, after solving eqn (1) and applying the derived results to eqn (2), the following threshold values demarcating the first and the second states are obtained:

- For exogenous risks: $X_1 = 0.24,\ X_2 = 0.36,\ X_3 = 0.32.$
- For endogenous risks: $X_4 = 0.38, X_5 = 0.31,\ X_6 = 0.32.$

From similar calculations, the threshold values demarcating the second and the third states are determined:

- For exogenous risks: $X_1' = 0.63,\ X_2' = 0.72,\ X_3' = 0.62.$
- For endogenous risks: $X_4' = 0.59,\ X_5' = 0.47,\ X_6' = 0.55.$

6 BEFORE-RATING EVERY RISKS STATUS ASSESSMENT

Pre-rating for the state of each risk shall be made by referring each risk actual value to the respective project-affecting a group and the calculation of the degree of effect for each of the risks. The latter will be used directly in analysis of the project level of riskiness. The examples of state pre-rating for each risk are shown in Figs 2 and 3.

Thus, the most severe risks for the project are those referred to the third group characterized by the unacceptably high level of effect: development of regional specialization sectors (X_2) and contingent financial costs (X_4). The least severe risks for the project are those referred to the first group characterized by the minimum level of effect: capital investment (X_3) and standing on the stock market (X_5).

However, these ratings are of preliminary nature; they only consider the group of effect to which the risk is referred.

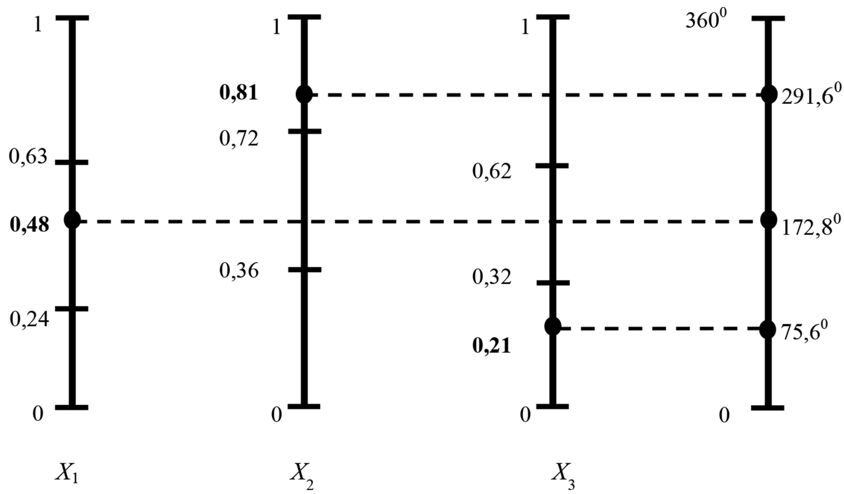

Figure 2: State rating for exogenous risks.

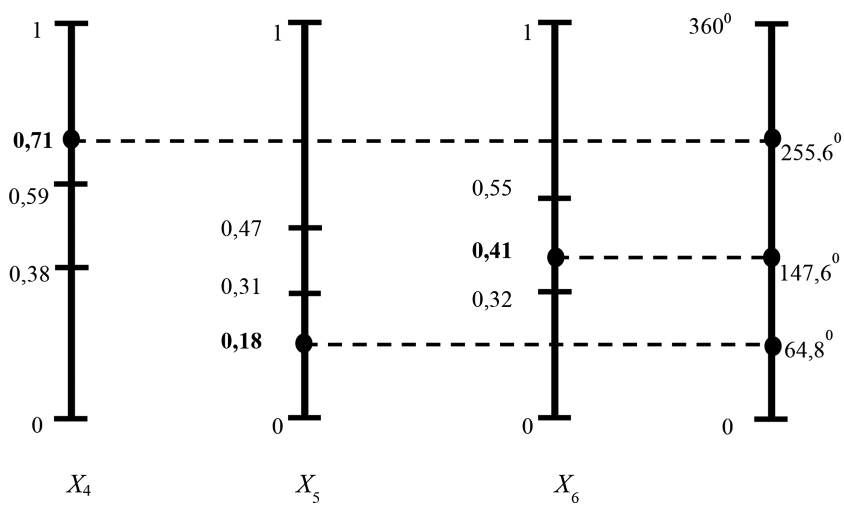

Figure 3: State rating for endogenous risks.

7 RISKS RANKING BY THE LEVEL OF THEIR THREAT TO THE PROJECT

This 8th stage of investor attractiveness risk evaluation supposes the calculating the final amount of the risks place in the rating.

7.1 Calculating the rating risk amount

The final rating of investment potential risk is made out with account for the actual and threshold standardized values characteristic of each risk and the related group.

The estimated indicator underlying the risk ranking procedure is determined by eqn (3):

$$Y_i = \frac{X_i}{X_{up\ threshold}}, \tag{3}$$

where Y_i – final amount to make the risk ranking; X_i – actual normalized magnitude of every risk; $X_{up\ threshold}$ –the every risk status group top threshold value.

7.2 Ranking risks assessment

Based on the initial data (Tables 1 and 2) and the use of eqn (3) there is need to compute the final risk rating value. Calculation-based general rating of risks by level of effect on the project with account for the estimated indicator is shown in Table 5.

7.2.1 Conclusions

According to Table 5 and based on the above calculations, the most severe risk is the exogenous risk associated with the development of regional specialization sectors. Of the endogenous risks, the most severe one is that related to the contingent financial losses (second place in the general rating of risks).

8 RATING EVALUATION OF EVERY GROUP OF RISKS

Rating of risk groups is based on determination of the most severe project-affecting risk groups. Such rating is more accurate as, in addition to the use of standardized values, it also contemplates the use of risk occurrence probabilities. This step is implemented by calculation of the overall level of riskiness for each group of risks according to the plots shown in Figs 4 and 5.

Table 5: Rating of investment potential risks for the project.

№	Risks designation	Nature of risk	Y_i	X_i	State groups
1	X_2	Exogenous	0.81	0.81	3
2	X_4	Endogenous	0.71	0.71	3
3	X_1	Exogenous	0.76	0.48	2
4	X_6	Endogenous	0.75	0.41	2
5	X_3	Exogenous	0.66	0.21	1
6	X_5	Endogenous	0.58	0.18	1

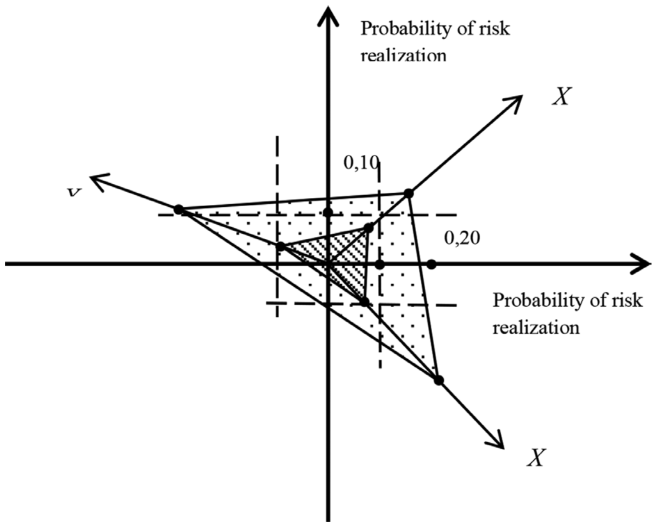

Figure 4: Overall exogenous risk level – Graphic presentation.

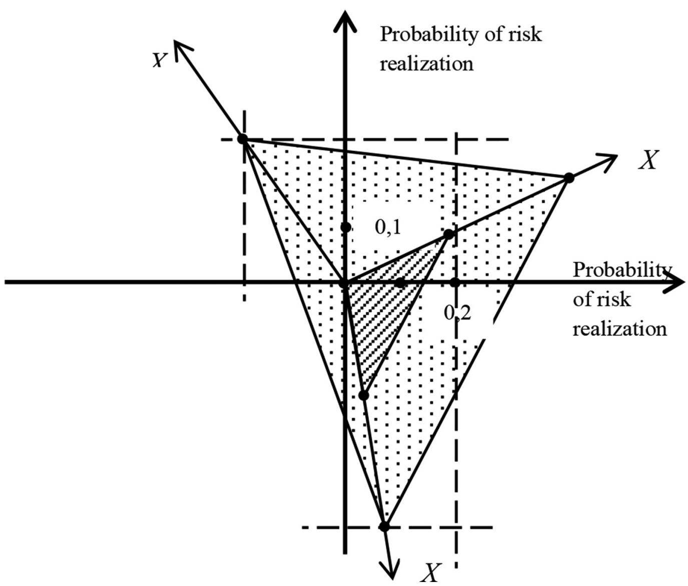

Figure 5: Overall endogenous risk level – Graphic presentation.

8.1 Initial data to assessment

The initial data to the risk group evaluation are presented in Table 6 below.

8.2 Graphical presentation of the total group risks

The graphic presentation of the overall risk level for exogenous and endogenous risk groups is shown in Figs 4 and 5, respectively.

Table 6: Maximal and minimal probabilities of risk implementation.

Risk designation	Risk effect on project	Probabilities values	
		Maximal	Minimal
X_1	0.48	0.33	0.11
X_2	0.81	0.33	0.11
X_3	0.21	0.22	0.11
X_4	0.71	0.33	0
X_5	0.18	0.44	0.22
X_6	0.41	0.44	0.22

8.3 Quantitative group risks assessment

The overall risk for each group is calculated according to the total risk equation [9] and makes the following values: For exogenous risks: $R_{exog} = 0.0439$. For endogenous risks: $R_{end} = 0.1094$.

Thus, the endogenous risks rank first in the general rating of groups by level of severity, while the exogenous risks rank second. In practice, when assessing the investment potential, five to six groups of risks are distinguished.

Although the rating of individual risks has shown that the most severe risk is the exogenous risk of region's sectorial specialization, however, due to higher values of occurrence probabilities, it is endogenous risks that are the most severe for the project.

9 CONCLUSIONS

The proposed technique of investment risk rating allows a significantly more unbiased assessment and solving of the problem of the strong dependence of financial decision-making on experts' opinion. In particular, such technique can be used as a routine in a computerized investment decision-making system. The result was attained by application of multivariable data analysis mathematical tool, as well as by using the actual statistical risk data [10, 11].

The development of this theory involves the creation of an integrated approach which involves not only the ranking of the risks, but also the calculation and evaluation of the indicator, which will give the unique solution about the possibility of financing the project.

Along with the attained methodological results, the proposed rating approach from a practical point of view enables the investor to qualify the potential risks including those of latent nature. This allows a correct investment policy to be selected. Thus, the enhancement of risk assessment quality level provides an opportunity to attain a dual effect: as a rule, consistent risk reduction and yield increase.

The findings allow the formulation of a new hypothesis on the interrelation between risk and yield and, probably to add an exception to the financial market fundamental assumption of the risk-yield relationship. However, such statement should currently be referred to a yet outstanding problem requiring additional investigation.

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