Borodin, Alex; Mityushina, Irina; Harputlu, Mustafa et al.

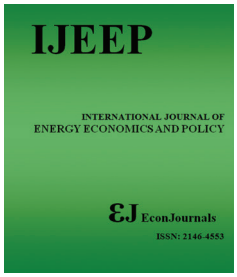
Article

Factor analysis of the efficiency of Russian oil and gas companies

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Borodin, Alex/Mityushina, Irina et. al. (2023). Factor analysis of the efficiency of Russian oil and gas companies. In: International Journal of Energy Economics and Policy 13 (1), S. 172 - 188. https://econjournals.com/index.php/ijeep/article/download/13763/7127/32076. doi:10.32479/ijeep.13763.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(1), 172-188.

Factor Analysis of the Efficiency of Russian Oil and Gas Companies

Alex Borodin[1]*, Irina Mityushina[2], Mustafa Harputlu[3], Natalia Kiseleva[4], Andrey Kulikov[5]

[1]Department of Sustainable Development Finance, Plekhanov Russian University of Economics, Moscow, Russia, [2]Department of Innovative Economics and Finance, Belgorod National Research University, Belgorod, Russia, [3]Governor of Antakya, Antakya, Turkey, [4]Department of State and Municipal Administration and Law, Russian Presidential Academy of National Economy and Public Administration, Pyatigorsk, Russia, [5] Department of Organization of Medical Provision and Pharmacoeconomics, I.M. Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russia
*Email: aib-2004@yandex.ru

Received: 05 October 2022 **Accepted:** 03 January 2023 **DOI:** https://doi.org/10.32479/ijeep.13763

ABSTRACT

The purpose of the study is to develop theoretical and methodological foundations for the development of tools for assessing the level of financial and technical efficiency of oil and gas companies and identifying reserves for improving efficiency based on the influence of external and internal factors. The theoretical basis of the research consists of the authors' works devoted to the problems of assessing financial efficiency, technical efficiency, innovation, market and environmental efficiency of companies. Modeling was carried out on the basis of tools for building DEA models, logistic regression, methods of correlation and regression analysis using the functionality of the software product R. The data of 7 companies with the largest revenue in the oil and gas industry by the end of 2020 and macroeconomic indicators of the financial and economic market of the Russian Federation are also components of the information base of the study. The scientific novelty of the research lies in the development of theoretical provisions and methodological tools for evaluating the effectiveness of companies in effective identification by assessing financial and technical efficiency, developing models of the phenomenon and forecasting the effectiveness of companies in the oil and gas industry.

Keywords: Oil and Gas Companies, DEA Model, External Environment, Internal Environment, Factor Analysis
JEL Classifications: O20, Q43, Q48

1. INTRODUCTION

Currently, the processes taking place in the world economy are leading to the onset of a new economic crisis. In Russian realities, the most tangible blow is to the oil and gas industry. Starting in January 2020, the price of Brent crude oil futures began to decline, the strongest decline occurred since mid-February, and the price reached its lowest value in several years. The reaction of oil and gas companies to the current situation and their further actions remain not obvious to external users of information. The share price of companies in the oil and gas sector shows the dynamics of decline, for this reason, in the short term they become unattractive to investors.

The assessment of the economic efficiency of the company is relevant within the framework of the economy, which is in a stable state, and during the economic crisis, both for the companies themselves when taking further development paths both at the internal and external level. Suppliers of raw materials, customers and investors are also interested in assessing the economic efficiency of the company. Under modern conditions, investors are most interested in the most accurate assessment of the company's performance, as they strive to make investments that will not only save money, but also bring significant income with the lowest level of risk (Fedorova et al., 2021; Stepanova et al., 2013; Mahmood et al., 2022).

The oil and gas industry remains the leading sector of the economy in Russia (according to the Ministry of Finance of the Russian Federation for 2019, it is 40% of GDP), on which the well-being of other industries and the overall economic climate in the country depend. The relevance of the topic is due to the fact that in the current conditions, the most accurate assessment of the effectiveness of oil and gas companies is needed, which will serve as a starting point for decision-making both for the companies themselves and for other economic entities.

The concept of company efficiency, its essence and methods of evaluation in the modern world are considered by research scientists, companies themselves, their suppliers, buyers and clients, investors, and also appear in educational literature and in every-day life, in particular in the media. However, the effectiveness of a company's activities often means not the same thing at all. Often, the efficiency of a company is called a relative characteristic of the use of individual resources. There is also a widespread approach to determining efficiency from the point of view of the general characteristics of the quality of the company's work, research in the field of management considers such an aspect of the concept, which as a result leads to its identification with the effectiveness of the company's management.

The overwhelming number of researchers define the company's performance as a multi-criteria system based on various systems of indicators. Depending on the systems of indicators and the goals of determining efficiency, it can exist in various forms: Financial and economic efficiency, technical efficiency, market efficiency, innovation efficiency and environmental efficiency. The main types of efficiency of the company's activities are listed, but there are others, for example, the strategic efficiency of the company, which is characterized by three categories: operational efficiency, investment efficiency and financial efficiency. Operational efficiency is determined on the basis of such indicators as: sales volume, sales price, volume and share of costs, productivity. The effectiveness of in-vestment activity is characterized by the following indicators: the volume and return on investment in production, the volume and return on investment in mergers and acquisi-tions, in research and development, in the brand. In order to assess the effectiveness of financial activities, they turn to liquidity indicators, the interest rate on loans, and financial leverage. The strategic effectiveness of the company shows the success of raising capital and the effectiveness of its use in conjunction with the effectiveness of strategy implementation (Streltsova et al., 2022; Aleinikova and Mileta, 2019; Trunova and Gubarenko, 2013).

Economic efficiency is a characteristic of the success of the company's economic activity, its viability both for the management sector and for other stakeholders (Mahmood et al., 2020). The over-all economic efficiency of the company is revealed through the concept of financial efficiency. In the study of financial (economic) efficiency in educational and scientific literature, the most common approach is focused on the analysis of the financial condition of the company, attention is paid to indicators of business activity (turnover) and profitability (profitability) (Moiseeva and Tormyshev, 2018; Borodin et al., 2022). Financial efficiency implies a complex characteristic, since it can be considered from various positions: Planning production volumes, cost formation, deter-mining prices and assortment, investment attractiveness and competitiveness (Nifontov et al., 2019). Nifontov and his co-authors also consider economic efficiency in many ways as an economic category providing for cost management in the entire production process, taking into account the interests of the supplier and the consumer, as well as responsible for the effectiveness of resource use.

Researchers mostly agree on the conditions for achieving financial efficiency. The achievement of economic efficiency, according to (Alkhateeb and Mahmood, 2020; Smirnova and Matrosova, 2018), is possible with an increase in labor productivity, advanced training of employees, automation of processes, saving resources and reducing the number of employees, due to which an in-crease in the volume of goods will follow with a constant volume of costs or with a constant output of goods, a reduction in costs. (Moiseeva and Tormyshev, 2018) believe that the growth of the company's financial efficiency is possible with an increase in the efficiency of the use of fixed assets, an increase in the turnover of working capital and labor productivity. In order to more comprehensively assess the impact of factors on the efficiency of oil and gas companies, the following research hypotheses are put forward in the article:

Hypothesis 1. Natural indicators reflecting the production volumes of oil and gas companies have a direct impact on the efficiency of companies. Under such indicators, the article accepts the volumes of oil and gas production by the companies under study. These indicators should not be ignored in the framework of efficiency analysis, they are often primary or secondary key performance indicators (Elhuni and Ahmad, 2017).

Hypothesis 2. Increasing the attractiveness of oil and gas companies' shares on the stock market depends on increasing the efficiency of their activities. Among the main indicators characterizing the position of the company's shares on the stock market, the dividend payment, the dividend and the yield of the stock are highlighted (Yudkina and Berlin, 2009).

Hypothesis 3. Relative financial ratios with growth stimulate an increase in the efficiency of the company. Most of the coefficients in question are accepted in the form of full-fledged performance characteristics of companies, in this paper, they act as components of efficiency, therefore, the relevance of their research is preserved as factors influencing the result. These indicators are: return on equity, return on assets, return on sales, current liquidity ratio, autonomy coefficient. Researchers also consider these parameters in the context of their impact on the efficiency of companies (Ajemyan et al., 2016; Lysenkova and Makludova, 2018; Polunina, 2017).

Hypothesis 4. In times of crisis in the Russian economy, the efficiency of oil and gas companies is changing. The difficult economic situation following the results of certain periods can be illustrated by such indicators as: GDP, the key rate of the Central Bank, the inflation rate, the consumer price index. (Troyanova, 2015), in a study aimed at developing a methodology for evaluating

the effectiveness of companies taking into account the market situation, also highlights inflation and the consumer price index among the indicators of the market situation. The price level in general and other mandatory characteristics of the current economic situation are important, as they affect the solvency of the population, the labor market in the country, resource attraction and development, therefore it is important to take into account when forming directions for improving the efficiency of companies. Economic factors and factors of the banking system. (Polunina, 2017) evaluates as environmental factors affecting the economic efficiency of companies.

Hypothesis 5. The growth of the dollar against the ruble affects the efficiency of oil and gas companies in Russia. In the current situation, this hypothesis is similar in nature to hypothesis 4. When assessing external factors that can potentially affect the effective-ness of companies, it is necessary to pay attention to the dependence of the result on the exchange rate. (Postnikov and Timirova, 2019) examined the dependence of the investment activity of oil and gas companies on the dollar exchange rate and oil prices. (Filimonova and Komarova, 2019) revealed that the profitability of sales has the greatest impact on the efficiency of oil and gas companies due to revenue growth caused by favorable oil prices and positive exchange rate differences. These studies also allow us to formulate the following hypothesis.

Hypothesis 6. The increase in oil and gas prices leads to a change in the efficiency of Russian oil and gas companies. Verification of this hypothesis is necessary, since manipulations with prices for an object, which on the one hand acts as a product, and on the other as a raw material, can in theory be interpreted for companies not only as losses, but also as opportunities. The study will allow us to see the presence of any kind of interconnection in this context. This hypothesis was considered not only by domestic, but also by foreign researchers (Nasreen et al., 2020; Bagirov and Mateus, 2019).

2. LITERATURE REVIEW

The analysis of the financial efficiency of companies is also relevant in foreign literature. In the study aimed at assessing the financial performance of national and international oil companies (Al-Mana et al., 2020; Mamedov et al., 2022), much attention was paid to relative financial indicators (profitability indicators), which served as the main database for analyzing the financial performance of these companies. Chinese researchers (Lin and Hong, 2020) chose the data from the annual reports of companies as the basis for analyzing the financial efficiency of airlines. (Lan et al., 2019) also pay great attention to the financial performance of companies in the analysis of reporting data, saying that the rational use of available resources will allow companies to become more efficient. Foreign re-searchers are united by the search for ways to optimize resources and increase efficiency through the performance indicators of companies, thus the financial efficiency of companies is identified with their financial results.

The production capabilities of companies in terms of the volume of products (services provided) are evaluated through technical efficiency. In a generalized form, technical efficiency exists when a company has the opportunity to increase the volume of products without involving additional resources for this. The evaluation of the technical efficiency of companies is an actual direction in the research of Russian and foreign authors. Trifonov and his co-authors conducted a study of the technical efficiency of metallurgical enterprises, the researchers note that in the microeconomics, the analysis of technical efficiency consists in choosing a production function and finding technological optima (Trifonov et al., 2018). (Byk and Myshkina, 2018) also note that technical efficiency illustrates the company's ability to produce a certain volume of products with available resources. In addition, the re-searchers note that only if there is a high level of technical efficiency, innovative activity is expedient and distinguish its properties such as technical safety, technical reliability, and technical productivity. Technical security implies a company's ability to use new technologies while remaining resilient to internal and external threats. Technical reliability indicates the operability of the object despite various impacts. Technical performance characterizes the ability of a company to provide high-quality output or provide services to the maximum based on available resources.

Foreign researchers are paying more and more attention to the analysis of technical efficiency and the assessment of the impact of various factors on it. Therefore, it is often possible to find in the studies of foreign authors the identification of the effectiveness of companies as a whole and their technical efficiency. It is also worth noting that when analyzing technical efficiency, it is mainly not individual companies that are considered, but aggregates of companies of the same industry selected on some basis (for example: Size, participation of the state or foreign sector in the number of owners). The interpretation of the concept of technical efficiency in foreign literature is identical to the previously described definitions of domestic authors. (Coto-Millan et al., 2018) note that technical efficiency is expressed in relation to the actual production of the company to the production boundary (that is, maximum technical efficiency with available resources). The evaluation of technical efficiency can be applied in order to find a more appropriate production method. (Chao et al., 2018) calculated in which case the production efficiency of shipping companies-carriers will be higher when conducting a single process of providing services or when dividing transportation into periods. (Altoe et al., 2017) of the study note that in most research papers, technical efficiency is evaluated in two directions: Determining maximum productivity with available resources or determining a given productivity with minimal resources.

Technical efficiency is interrelated with innovation efficiency, since an increase in technical efficiency can be achieved through the introduction of the latest equipment, more productive production methods, computerization and other things, as well as technical efficiency is a condition for the expedient introduction of innovations. The contribution of innovation to the economic growth of companies is undeniable, and relevant in the age of digital technologies. Innovative efficiency may otherwise be called the economic efficiency of the use of innovative technologies (Konstantinova, 2018). The assessment of innovation efficiency

is carried out not only for individual organizations, but also for countries. The rating of the Global Innovation Index provides an innovation efficiency coefficient calculated as the ratio of the sub-index of innovative costs to the sub-index of innovative results. In scientific research, the direction of assessing the development of innovations and problems associated with the introduction of innovations is relevant, this proves that 24532 peer-reviewed articles have been identified in the ABI ProQuest database, in the title of which the term "innovations" is present; of these, 13,933 were published after 2010 (Calof, 2018). (Rybin et al., 2019) propose to determine the effectiveness of the innovative development of the company by the ratio of profit and corresponding costs. The results of innovative efficiency can manifest themselves in four forms (effects): technical, resource, economic and social.

In foreign studies, the question is widespread not only about the assessment of innovative efficiency, but also about determining the influence of various factors on the innovative efficiency of the company. Chinese researchers note the importance of innovative efficiency as a prerequisite for sustainable and rapid development of companies (Xu et al., 2020). They note the impact of innovation efficiency on the technological efficiency of companies, thereby highlighting the unidirectional relationship of these categories. (Cardinal and Opler, 1995) in their study, they described that innovative efficiency plays an important role in the development of the company and in order to increase it, they calculated the de-pendence on the diversification of production. (Kaya et al., 2020) noted that in modern times, a necessary condition for the growth of innovation efficiency is communication between companies related to both general production activities and, in particular, related to the direct exchange of experience in the field of innovation.

The next type of company efficiency that should be distinguished is market efficiency, which generally consists in investment attractiveness in the stock market. This characteristic is most important for public joint-stock companies whose shares are in circulation on the securities market. In modern research, the definition of market efficiency can consist both in the calculation of individual indicators characterizing stocks, and in the complex calculation of values reflecting investment attractiveness as a whole. (Bushueva et al., 2018) find the level of market efficiency of the company through the EVA economic value-added model and propose the use of the model for the purpose of making managerial decisions. In the course of determining market efficiency, they often resort to assessing the investment attractiveness of companies, in this case, together with the characteristics of shares on the stock market, a financial and economic analysis of the compa-ny is carried out (Shevtsov et al., 2017). When analyzing the investment attractiveness, researchers note the variety of approaches and compare them with each other (Butorina and Shishkina, 2017) com-pared fifteen methods for determining the investment attractiveness of companies. Thus, the market efficiency of a company can be assessed in various ways, the choice of which should depend on the person involved in the assessment and his goals. In the studies of foreign authors, market efficiency is often determined for energy and oil and gas companies.

Environmental efficiency stands out among the previously considered types of efficiency in that it has a more pronounced interaction with external uncontrolled factors. In addition, the environmental efficiency assessment is developed not only by research scientists in Russia and abroad, but is also regulated in GOST R ISO 14031-2016. The environmental efficiency of an enterprise implies the results of managing environmental aspects of activities that can be measured in relation to the organization's policy, its goals and objectives in the field of environmental protection. In general, the definition of environmental efficiency can be expressed by the ratio of net profit and environmental costs (Kuramshina and Dyrdonova, 2018). (Merzlikina, 2019) in her study developed an indicator of environmental efficiency based on indicators-results and resources. The overwhelming number of studies in the field of environmental efficiency analysis belong to Chinese scientists who have considered environmental efficiency taking into account corporate social responsibility (Wang et al., 2019), established the relationship between environmental impact and economic growth (Yang and Yang, 2019) and also proposed the optimization of the environmental industry chain (Wang et al., 2017).

Thus, the article notes the importance of not only the direct choice of the method of evaluating the effectiveness of the company and its application, but also the study of factors influencing performance indicators, which is a prerequisite for the success of companies.

3. MATERIALS AND METHOD

The study examined methods for evaluating the effectiveness of the company's activities depending on the types of efficiency under study. Based on the considered theoretical aspects and methodological approaches, it can be concluded that it is necessary to analyze two types of efficiency within the framework of the study: financial and technical for oil and gas companies in Russia. Financial efficiency will reflect the general economic component of the company, also predetermining the prospects of investment attractive-ness, technical efficiency will reveal the level of organization of production, productivity of the company.

The DEA method (analysis of the functioning environment) is being improved by re-searchers, its relevance remains for various organizations: government agencies, airlines, hospitals, financial institutions, manufacturing companies, educational institutions. One of the specific features of the methodology is that the most complete analysis is possible when taking into account all possible companies that are characterized by one feature. When a company appears that is not part of the previously studied array, it is necessary to recalculate the DEA model, since the performance indicators of each individual company are influenced by the indicators of the state of other companies. Despite the simplicity of conducting DEA analysis using computer programs, there are aspects that require special attention when using the method (Borodin and Mityushina, 2020).

The rule of the DEA method, through which the effectiveness of a company is deter-mined, is formulated as follows: A company

is considered absolutely effective (the result obtained during the analysis is 1) only when the results of the activities of other companies do not show that some of its parameters can be improved without worsening others. That is, the method is completely focused on finding the relative efficiency of companies, which on the one hand can introduce some subjectivity, and on the other hand has applied significance, since for the management of companies and their suppliers, consumers and investors, the position among other companies within the industry, a certain segment, the sales market, etc. is important.

In the DEA analysis, there is no need to determine the form of the production function before conducting the study, which is an indisputable advantage of it. The task of optimizing functional parameters is implemented for each evaluation object separately. The DEA methodology, which is based on linear programming, was originally created for the purpose of evaluating the performance of organizations, but in the process of a number of modifications has also shown successful applicability for assessing the relative effective-ness of companies. The results of the DEA are informative for the management of companies for the purposes of subsequent changes in the expenditure of resources, the use of technologies and other things. The scope of DEA analysis is becoming more and more broad, researchers use it not only to assess traditional technical or economic efficiency, but also to assess social processes, the development of individual operating units (among which may be representatives of a department in a company or profession, students), etc. (Chernov and Kolkova, 2019).

The efficiency of the DEA method is determined by the ratio of the weighted sum of the output data to the weighted sum of the input data. DEA analysis forms an efficiency boundary, and when independent economic units (DMUs) are located at this boundary, their effectiveness is recognized. Modern tools for assessing the technical efficiency of a company (in particular, DEA analysis) allow us to take into account both absolute and relative indicators as the data under study, which also partially reflects financial efficiency. Within the framework of the analysis of the effectiveness of companies by the DEA method, there are several approaches consisting in the selection of data for input and output parameters (Alimkhanova and Mizel, 2019).

With the help of this model, several parameters can be estimated together at the input and output. DEA analysis assumes a system of flexible weights, due to which subjective evaluation of parameters is excluded.

Thus, the advantages of the DEA method are in the following aspects:

1. There is no need to make a mathematical expression of the production function
2. It is possible to analyze several input and output parameters
3. Data can be used in different dimensions
4. It is possible to analyze the sources of inefficiency and quantify them
5. Based on the results of the analysis, a comparative characteristic of companies is obtained, and their ranking is also possible, since the result of efficiency is expressed by values in the range from 0 to 1.

The methodology also has its drawbacks:

1. The results of the model strongly depend on the choice of parameters at the input and output of the model
2. High efficiency of the company can be obtained with a certain combination of in-puts and outputs
3. The greater the number of variables, the more likely it is to overestimate the effectiveness of companies.

The presence of these shortcomings in the DEA method suggests that the main difficulty in implementing models is the choice of indicators at the input and output of the model, since the adequacy of the model and its practical significance will depend on this.

At the beginning of the construction of the DEA model, first of all, it is necessary to determine its specification. To do this, you need to pay attention to the very essence of the model and its properties. Input-oriented models reveal efficiency by minimizing resources or other values taken at the input. Output-oriented models are calculated by maximizing outputs (more often than the results of companies' activities). Within the framework of the article, a result-oriented model is adopted. The result of the output-oriented DEA model is expressed in the issuance of recommendations aimed at increasing the values of the output vector y(j) without increasing the values of the vector x(j), where j – number of the independent decision-making unit (DMU). The output variables will be calculated using the formula:

$$y(j)\ \text{recommended} = \upsilon \times y(j), \quad (1)$$

where υ - the performance indicator of the j - object,
y(j) – vector of values of output variables for j- object.

The output -oriented DEA model has the following form:

$$f(\upsilon, L) = \upsilon + L \times 0 \rightarrow \max, \quad (2)$$

$$-\upsilon \times y(j) + Y \times L \geq 0,$$
$$x(j) - X \times L \geq 0,$$
$$Li \geq 0,\ i = 1,2,\ldots,n.$$

A measure of the effectiveness of a company's activities can be the value of:

$$Tout = \exp(-(\upsilon-1)). \quad (3)$$

This expression shows that companies that are on the edge of efficiency (υ=1), corresponds to the value Tout = 1. For companies that are not efficient, the value is Tout < 1.

Models focused on both input and output are divided into types, the most common of them: VRS – variable scale and CRS-constant scale. In practice, the VRS model is more applicable, since it does not imply a constant return on scale, which means that if the use of resource X increases by k times, then this will not be

a prerequisite for increasing product Y by k times. Turning to economic theory, it can be noted that this provision is reflected in the form of the concept of decreasing marginal productivity. This fact should not be ignored when evaluating the comparative effectiveness of companies.

Initially, the task of evaluating efficiency by the DEA method can be expressed as an optimization problem of mathematical programming. Conditionally, there are data: W input and Z output indicators for each n economic entity, for the nth object of evaluation they will be expressed by vectors xwn (w=1.,W) and yzn (z=1.,Z). The input matrix X, whose dimension is W × N, and the matrix Y with dimension Z × N at the output display data for all analyzed objects. The optimization problem is reduced to the following form:

$$\theta = \frac{\sum_z u_z y_{z0}}{\sum_w v_w x_{w0}} \to \max \quad (4)$$

$$\theta = \frac{\sum_z u_z y_{zn}}{\sum_w v_w x_{wn}} \le 1 (\mathrm{n} = 1,..., \mathrm{N}),$$

$$u_z \ge 0 \left(\mathrm{z} = 1,\ldots, \mathrm{Z}\right), v_w \ge 0 \left(\mathrm{w} = 1,\ldots, \mathrm{W}\right),$$

Where u_z, v_w – unknown weighting factors for input and output indicators,

Index 0 – an index indicating the object of evaluation, the effectiveness of which is analyzed from the entire set n.

The fractional-linear expression of the optimization problem creates difficulties in solving it, therefore, due to the model with variable scale effect, it was reduced to a linear programming model aimed at maximizing the weighted sum of output indicators at fixed values of input indicators:

$$\theta = \sum_z u_z y_{zn} + u_0 \to \max \quad (5)$$

$$\sum_w v_w x_{wn} = 1,$$

$$\sum_Z u_z y_{zn} - \sum_w v_w x_{wn} + u_0 \le 0 (\mathrm{n} = 1,...., \mathrm{N}),$$

$$u_z \ge 0 \left(\mathrm{z} = 1,\ldots, \mathrm{Z}\right), v_w \ge 0 \left(\mathrm{w} = 1,\ldots, \mathrm{W}\right), u_0 \in R,$$

Where u_0- the scale effect variable.

The scale effect variable is exactly the element of the mathematical function that allows you to display a variable effect in an optimization problem. The increasing effect of scale will be when $u_0 > 0$, decreasing at $u_0 < 0$ and a constant return on scale at the value of $u_0 = 0$.

Based on the features of the DEA method, it was decided to use a generalized DEA model with standard input and output indicators BCC (VRS) output, an output-oriented model, for the purposes of this study.

4. RESULTS

The DEA model was built using the R programming language, designed for statistical data processing, in the R Studio Desktop program. R Studio is written in the general purpose programming language C++, which is widely used in software development. The construction of models was based on a number of developed algorithms supported by the program.

Before starting work in R Studio, data on companies were collected in the MS Excel program, so that each indicator existed for each company. The analysis in this paper was carried out over 5 years, the effectiveness for each year was calculated separately. In general, the data for analysis for 1 year are presented in the form of a table (Table 1).

The input and output parameters are entered into the table in equivalent columns, there is no need to separate them in a specialized way. Since the values of the indicators can vary greatly, already when calculating the model, the natural logarithm should be used for parameters that differ greatly in magnitude.

Then the available data is entered into the R program. The calculation of performance indicators is implemented through a form that can be generally represented as follows:

DEA (x, y, rts= “vrs”, orientation=”input”, slack=TRUE, dual=FALSE, second=”none”, z=0, round=FALSE, debug=1).

Table 2 shows the transcript of this entry.

At the first stage of the study, the return on assets of the companies studied was calculated, the results are presented in Table 3.

The return on assets of oil and gas companies for 2016-2020 does not have a single trend or any patterns. All indicators for the companies for the period under review are positive, with the exception of the return on assets of Surgutneftegaz in 2016 and Gazprom in 2020. A stable trend of changing indicators while maintaining high values is observed in the companies: Lukoil, Tatneft and Novatek. Based on the data in the table, it can be seen that it is impossible to say about the company’s efficiency based on data from 1 year. So, in 2018 and 2020. The return on assets of PJSC Surgutneftegaz was the highest in the sample, but in 2016 the indicator turned negative. It is also impossible to draw a conclusion based on this about the inefficiency of the company, since in 2017 the profitability value became positive. Thus, we see that the obtained indicators of return on assets do not allow us to make full-fledged conclusions about the effectiveness of the companies under study. The dynamics of return on assets for the period under review by companies is heterogeneous, that is, it is not related to external factors occurring in the world and in the industry, but is due to decisions made in the companies themselves.

The next step was to calculate the return on equity, the results are presented in the Table 4.

Table 1: Data set for conducting DEA analysis of companies' performance in 2014

Company	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13
Gazprom	43.5	445	3990	189	933	7.2	9089	2.08	1.6	23.1	2.3	0.74	3085
Lukoil	97.2	4	242	372	131	154	1134	37	24.4	83.5	1.5	0.65	1892
Rosneft	191	56.7	4284	501	87	8.21	1356	37	7.9	3.6	1.3	0.17	2075
Surgutneftegaz	61.4	9.45	863	892	86	0.65	2824	37	34.8	20.5	7.5	0.94	1067
Transneft	526	0	717	12	2.3	0	155	8	1.1	1.7	0.6	0.14	895
Tatneft	26.5	0.88	392	82	24.6	10.58	485	18	14.8	23.4	4	0.84	498
Novatek	6	62.1	318	42	31.2	10.3	236	18	9.2	26.1	2.5	0.47	1320

Table 2: Arguments used when conducting DEA analysis in R studio

Arguments	Meaning
x	Input parameters relevant to each analyzed company, there may be several
y	Parameters at the output of the model relevant to each analyzed company, there may also be several
rts	Scaling of the model, one of the following types can be specified: • vrs-variable returns on scale • drs-diminishing returns on scale • crs-constant returns to scale • irs-increasing returns to scale
orientation	Orientation of the model, when minimizing inputs (input-oriented model), when maximizing outputs (output-oriented model)
slack	Optional argument (TRUE), which indicates a secondary objective function for identifying objects weak in efficiency
dual	Additional argument (TRUE), which indicates double weights for parameters as at the input and output of the model
round	Optional argument (TRUE) that allows rounding efficiency values to 0 or 1
second	An optional argument that includes an alternative secondary objective function in the model with λ and the argument z. None-by default. When maximizing or minimizing λ×z, max and min are used, respectively
z	An optional argument, required only for second=max or second=min, represents a matrix with one column and the same number of objects as in the main model (with the same x and y)
debug	An optional argument that may be useful for debugging the model

Table 3: Return on assets of oil and gas companies for 2016-2020, %

Company/year	2016	2017	2018	2019	2020
Gazprom	3.1	0.7	6.2	4.6	1
Lukoil	9.2	10.1	10.3	24.1	21.6
Rosneft	1	1.3	3.9	6.2	1.2
Surgutneftegaz	−2.9	4.1	20.1	2.3	13.9
Transneft	2.6	5.4	1	7	6.1
Tatneft	15.3	13.5	24.8	19.1	9.7
Novatek	24.8	19.6	22.9	26.3	29.2
Average	7.59	7.81	12.74	12.8	12.3

Table 4: Return on equity of oil and gas companies for 2016-2020, %

Company/year	2016	2017	2018	2019	2020
Gazprom	4	1	9	6.7	1
Lukoil	14	15	19	38.5	32
Rosneft	7	9	25	15.6	3
Surgutneftegaz	−3	4	21	2.5	14.6
Transneft	18	32	5	41	40
Tatneft	18	16	31	27	13
Novatek	44	28	30	33	37
Average	14.57	15.0	20.0	23.5	18.9

The values of return on equity for the studied companies for 2016-2020 are similar to the previously considered indicators of return on assets, which indicates changes in profitability indicators due to changes in net profit. High values indicate a significant pre-dominance of net profit over the equity of companies. Based on the obtained indicators, it can be concluded that all companies effectively use their own capital, which is an important result for their owners. Consistently high coefficients are observed for companies: Novatek, Tatneft and Lukoil, whose return on equity has been at least 14% for 5 years. PJSC Gazprom is characterized by the lowest return on equity indicators, despite the fact that the company is one of the most attractive companies in Russia for owners, in 2020 it has a negative indicator.

Thus, the calculated indicators of return on assets and equity of companies do not allow us to draw full conclusions about the effectiveness of companies. In general, we can talk about the effectiveness of all the companies studied.

In order to obtain more concrete results, a DEA model was implemented based on relative indicators and revenue at the output (Table 5).

The data in Table 5 are interpreted unambiguously: Over the 5 years studied, three companies were effective: Gazprom, Rosneft and Transneft. The efficiency of PJSC Lukoil has steadily grown and peaked in the last 2 years under review. PJSC Surgutneftegaz is the most inefficient company in the sample, whose growth from 2016 to 2017 was re-placed by a sharp drop in 2018. The companies of PJSC Tatneft and PJSC Novatek, in accordance with the proposed model, are characterized by indicators below 0.5, which indicates the inefficiency of the companies. Important in this model is the result of the arithmetic mean of performance indicators for all companies in the sample. It can be seen that in 2018, the efficiency is the lowest, but in general, oil and gas companies adapted to economic trends and the crisis in 2014, and their performance indicators began to increase. When assessing the effectiveness of a company related to investment attractive-ness, special attention should be paid to the size of the company's capitalization, the following model was focused on it (Table 6).

The constructed model with the capitalization of companies at the output showed that the following companies are effective: Rosneft, Transneft, Novatek. PJSC Gazprom can also be called an efficient company, in the years when the indicators did not take the absolute value of efficiency, they were close to one, but due to the pandemic in 2020, the indicator turned negative. PJSC Lukoil, based on the results of two models, is absolutely effective in 2017 and 2018 and is characterized by high efficiency during the rest of the study period. Surgutneftegaz PJSC has the lowest efficiency in the sample.

There are similar trends among the two DEA models considered. For the complete-ness of the study, the last step is proposed to conduct a DEA analysis with a focus on a natural indicator, namely, the volume of oil production (Table 7).

The DEA model. focused on the volume of oil production, as a result showed the effectiveness of all the companies studied. There are minor deviations for a number of companies in different years. Invariably, maximum efficiency is characteristic of PJSC Lukoil and PJSC Transneft. The maximum efficiency of all companies in the sample for 2017 indicates the success of the industry as a whole in oil production during this period.

Table 5: The effectiveness of the DEA analysis based on relative indicators for 2016-2020

Company/year	2016	2017	2018	2019	2020
Gazprom	1	1	1	1	1
Lukoil	0.69	1	1	1	1
Rosneft	1	1	1	1	1
Surgutneftegaz	0.31	0.65	0.35	0.42	0.45
Transneft	1	1	1	1	1
Tatneft	0.39	0.41	0.26	0.31	0.38
Novatek	0.40	0.48	0.29	0.32	0.37
Average	0.78	0.79	0.70	0.72	0.74

Table 6: The effectiveness of DEA analysis with the capitalization of companies at the exit for 2016-2020

Company/year	2016	2017	2018	2019	2020
Gazprom	0.76	1	0.81	1	0.21
Lukoil	0.91	1	1	1	1
Rosneft	1	1	1	1	1
Surgutneftegaz	0.50	0.86	0.65	0.71	0.82
Transneft	1	1	1	1	1
Tatneft	0.81	0.89	0.85	0.86	0.89
Novatek	1	1	1	1	1
Average	0.85	0.96	0.90	0.95	0.79

Table 7: The effectiveness of the DEA analysis with the amount of oil produced at the out-let for 2016-2020

Company/year	2016	2017	2018	2019	2020
Gazprom	0.81	1	0.78	1	0.71
Lukoil	1	1	1	1	1
Rosneft	1	1	0.74	1	0.81
Surgutneftegaz	1	0.99	0.79	0.82	0.79
Transneft	1	1	1	1	1
Tatneft	0.99	1	0.93	1	0.94
Novatek	1	0.99	0.97	1	0.94
Average	0.97	1	0.89	0.97	0.88

Thus, in accordance with the three models built by the DEA, PJSC "Transneft" and PJSC "Gazprom" are recognized as the most efficient companies. However, it should be noted that all companies were characterized by high performance indicators in different periods. The lowest efficiency among the sample companies belongs to PJSC Surgutneftegaz. Such conclusions could not be made on the basis of indicators of return on assets and return on equity, which confirms the hypothesis adopted in this study. The DEA model, based on relative indicators (input parameters) and an output parameter in the form of revenue, allowed us to determine the general trend in the industry related to external economic impact.

The ability of companies to adapt to external conditions is essential for the possibilities of survival and development in the market. That is why constant monitoring of the external situation around the company is necessary, as well as a calculation in advance of possible changes, including both optimistic and pessimistic development strategies. For successful management of companies, analysis of the external environment, monitoring of its changes, are inseparable elements of competent management. It is the factors of the external environment that are the most unpredictable, therefore, difficult to predict, but taking into account the various options for their development, the company can reduce losses or gain benefits. The possibility of developing other sectors of the economy will de-pend on how the largest oil and gas companies react to external shocks (Mahmood et al., 2021).

In times of crisis in the Russian economy, the efficiency of oil and gas companies is changing. The difficult economic situation following the results of certain periods can be illustrated by such indicators as: GDP, the key rate of the Central Bank, the inflation rate, the consumer price index. In the research aimed at developing a methodology for evaluating the effectiveness of companies taking into account the market situation, inflation and the consumer price index are also singled out among the indicators of the market situation. The price level in general and other mandatory characteristics of the current economic situation are important, as they affect the solvency of the population, the labor market in the country, resource attraction and development, therefore it is important to take into account when forming directions for improving the efficiency of companies. Economic factors and factors of the banking system are assessed as environmental factors affecting the economic efficiency of companies.

Groups of external indicators were considered, their number is not exhaustive, but sufficient to characterize the most important factors of influence. All the stated hypotheses were tested by constructing correlation models.

In the article, estimates for companies using the DEA method were obtained as performance indicators, as well as profitability indicators were predicted. Based on these da-ta, it was decided to check the influence of external indicators on the values of the DEA analysis of the efficiency of oil and gas companies and the profitability of their assets. Since some companies were characterized by absolute efficiency according to the DEA model

(for each year under study, the efficiency is equal to 1), it is impractical for them to obtain values for correlations.

In the course of the regression analysis, the following internal indicators were considered as influencing revenue and net profit: oil and gas production volumes, dividend payments, dividend size, share yield, profitability indicators: equity, return on assets and return on sales, as well as current liquidity and autonomy coefficients reflecting the solvency of companies.

During the regression analysis, several checks were carried out, the final regression dependence on the revenue indicator under study is presented in the following form:

$$\text{Log } (x3) \sim \log (x1) + x6 + x10, \quad (6)$$

Where log (x3) – the natural logarithm of companies' revenue
Log (x1) – natural logarithm of oil production volume
x6 – dividend on company shares
x10 – profitability of sales of companies.

The logarithm of volume indicators is necessary due to the significant difference in their magnitude with other indicators and their natural expression.

The results of the regression analysis of the model presented in formula 1 are shown in Table 8.

The coefficient of determination of the model is 0.61, which is a reliable indicator for determining the relationship between the dependent variable and the explanatory factors. The factors of the model are significant, since the indicators of their significance (probability) are <0.1. With an increase in the volume of oil production by companies by 1%, there is an increase in the revenue of companies by 0.776%. If the dividend per share of companies increases by 1%, revenue will be higher by 0.004%. An increase in the return on sales by 1% will cause the revenue of companies to grow by 0.022%.

Further, to consider the modifications of the results, the regression dependence of net profit on the characteristics of the company was also considered. The equation of the regression under study has the following form:

$$\text{Log } (x4) \sim \log (x1) + x6 + x10, \quad (7)$$

Where log (x4) – the natural logarithm of the net profit volume;
Log (x1) – natural logarithm of oil production volume;
x6 – dividend on company shares;
x10 – profitability of sales of companies.

The results of the regression model calculations are shown in Table 9.

The coefficient of determination of the model is 0.55, which is a sufficient indicator for determining the relationship between the dependent variable and the explanatory factors. The factors of the model are significant, since the indicators of their significance (probability) are <0.1.

Based on Table 9, it can be seen that an increase in the volume of oil production by companies by 1% accompanies an increase in net profit by 0.657%. If the dividend per share of companies increases by 1%, then the net profit of companies will increase by 0.004%. With an increase in return on equity of 1%, net profit growth of 0.016% is observed.

Thus, the hypotheses accepted for consideration in the article were analyzed through the aspect of efficiency in general terms, revenue and net profit (the company's financial result for the year) were the indicators of efficiency.

Hypothesis 1. Natural indicators reflecting the production volumes of oil and gas companies have a direct impact on the efficiency of companies.

The hypothesis has been partially proved. There is no direct dependence of efficiency on the volume of gas production, but the most significant among other factors is the dependence on the volume of oil production (Figure 1).

Hypothesis 2. Increasing the attractiveness of oil and gas companies' shares on the stock market depends on increasing the efficiency of their activities.

The hypothesis was confirmed in terms of the impact of the dividend on company shares on the revenue and net profit of companies. The dependence of the efficiency of the studied oil

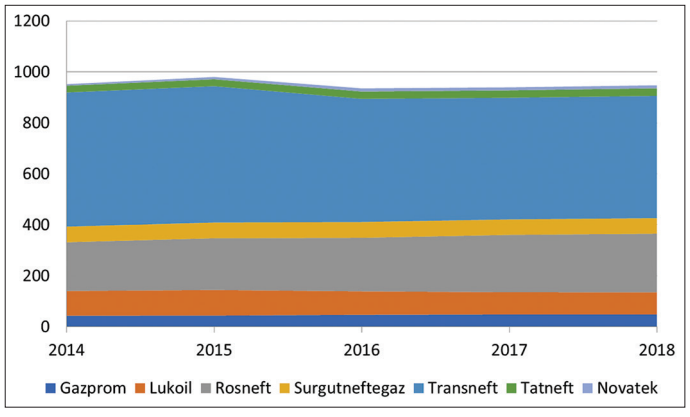
Table 8: Results of regression analysis calculations with a dependent variable-revenue volume

Variable	Coefficient	t-statistics	Significance
log(×1)	0.776	3.99	0.0005
×6	0.004	3.3	0.0029
×10	0.022	3.68	0.0011

Table 9: The results of regression analysis calculations with a dependent variable-net profit

Variable	Coefficient	t-statistics	Significance
log (x1)	0.657	3.42	0.0003
x6	0.004	2.57	0.0006
x10	0.016	2.62	0.0102

Figure 1: Oil production volume



and gas companies on dividend payments and the profitability of shares was not observed in the considered periods.

Hypothesis 3. Relative financial ratios with growth stimulate an increase in the efficiency of the company.

The dependence of revenue and net profit in this group of indicators is also presented as the influence of only one indicator-the profitability of own capital. Other profitability coefficients and solvency indicators did not affect the efficiency of companies.

Thus, the influence of the internal characteristics of the company's activities does not have a strong impact on its effectiveness. However, there are factors, the change of which will be relevant in order to slightly increase the efficiency of companies. In addition, this study cannot reflect all the indicators within the company, since there is closed information that should be used by managers in a similar regression analysis, then the probability of finding factors that strongly affect the final results of the company's activities may be much higher.

The article considers groups of external indicators, their number is not exhaustive, but sufficient to characterize the most important factors of influence. All 3 stated hypotheses were tested by constructing correlation models.

In this paper, estimates for companies using the DEA method were obtained as performance indicators, as well as rent indicators were predicted. Based on these data, it was decided to check the impact of external indicators on the values of the DEA analysis of the efficiency of oil and gas companies and the profitability of their assets. Since some companies were characterized by absolute efficiency according to the DEA model (for each year under study, the efficiency is equal to 1), it is impractical for them to obtain values for correlations.

The researchers note that the ability of companies to adapt to external conditions is essential for the possibilities of survival and development in the market. That is why it is necessary to constantly monitor the external situation around the company, as well as to calculate possible changes in advance, including both optimistic and pessimistic development strategies. For successful management of companies, analysis of the external environment, monitoring of its changes, are essential elements of competent management. It is the factors of the external environment that are the most unpredictable, therefore, difficult to predict, but taking into account the various options for their development, the company can reduce losses or gain benefits. The possibility of developing other sectors of the economy will depend on how the largest oil and gas companies react to external shocks.

To verify the presence of the influence of external factors on the efficiency of oil and gas companies in 2015-2018, the following hypotheses were considered:

Hypothesis 4. In times of crisis in the Russian economy, the efficiency of oil and gas companies is changing.

Hypothesis 5. The growth of the dollar against the ruble affects the efficiency of oil and gas companies in Russia.

Hypothesis 6. The increase in oil and gas prices leads to a change in the efficiency of Russian oil and gas companies.

The study of external factors on the effectiveness of companies was conducted individually for each company, taking into account 5 years from 2014 to 2018. The designations of the indicators used later in the tables with the results are presented in Table 10.

Correlations were checked in stages for each company. The results for PJSC Gazprom are shown in Table 11.

Correlations with efficiency by the DEA method could not be built, since the company is absolutely effective in each year considered. The profitability of Gazprom's assets is most influenced by GDP. That is, the newly created value in the country will potentially affect the efficiency of the company, the consumer price index will also have an impact. With less force, but there is a relationship between the exchange rate of the national currency against the dollar and inflation.

Since the values used in the analysis vary significantly in magnitude, the correlation was calculated for the same values, but logarithmic. The results for PJSC Gazprom are shown in Table 12.

The results of Table 12 allow us to highlight the previously noted indicators, but the strength of the relationship between the efficiency of Gazprom and the exchange rate has become higher than with GDP. In this case, the most relevant is the confirmation of the existence of a relationship, which, it is worth noting, has become weaker with logarithmic indicators.

The same calculation Tables 13 are presented below for other companies under study, the next of which is PJSC Lukoil.

The efficiency of PJSC Lukoil DEA did not take all the maximum values, so the results of its correlation with external factors were obtained. The effectiveness of the DEA of PJSC Lukoil is strongly influenced by inflation and the consumer price index. In addition, the correlation with GDP is significant. And also, with less force, the exchange rate correlates with the efficiency of the company. The results of the correlation of the return on assets with the parameters reflecting the external environment look different: the equally strong impact is observed from the side of oil prices and

Table 10: Designations of indicators-factors of the external environment of companies and performance indicators

Group of indicators	Indicators	Designation
Indicators of the state of the country's economy	GDP, rub.	X1
	The Central Bank's key rate, %	X2
	Inflation rate	X3
	Producer Price Index	X4
Oil and gas prices	Brent oil price, USD	X5
	Gas price, USD	X6
Exchange rate	The exchange rate is RUB/USD.	X7
Performance indicators	DEA Effectiveness	Y1
	ROI efficiency	Y2

gas prices. For verification, a correlation was carried out based on logarithmic indicators (Table 14).

The correlation of external indicators with the company's performance showed a similar picture. There is an increase in the relationship between the effectiveness of the DEA with inflation, the consumer price index and the exchange rate, as well as a decrease in the correlation between return on assets and oil and gas prices.

The next step was to assess the correlation of the efficiency of PJSC Rosneft with environmental factors (Table 15).

The efficiency of PJSC Rosneft according to the DEA method has the highest score, so no correlations have been built. Efficiency, expressed return on assets, strongly correlates with oil and gas prices. The same was confirmed by the correlation analysis of logarithmic indicators (Table 16).

Table 16 shows that when analyzing the correlations of logarithmic indicators, compared with the correlation of indicators in ordinary values, the strength of the connection weakens, and to a greater extent this is expressed in the relationship between the efficiency of PJSC Rosneft and gas prices.

Table 11: Correlation dependence of environmental indicators and efficiency of PJSC "Gazprom"

Indicators	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1	−0.51	0.85	0.98	−0.17	−0.33	0.51		0.65
X2	−0.51	1	−0.11	−0.35	−0.64	−0.61	0.38		−0.20
X3	0.85	−0.11	1	0.94	−0.65	−0.71	0.83		0.44
X4	0.98	−0.35	0.94	1	−0.36	−0.50	0.66		0.62
X5	−0.17	−0.64	−0.65	−0.36	1	0.95	−0.90		−0.04
X6	−0.33	−0.61	−0.71	−0.50	0.95	1	−0.95		−0.31
X7	0.51	0.38	0.83	0.66	−0.90	−0.95	1		0.46
Y1									
Y2	0.65	−0.20	0.44	0.62	−0.04	−0.31	0.46		1

Table 12: Correlation dependence of logarithmic indicators of the external environment and the efficiency of PJSC Gaz-prom

Indicators	X11	X22	X33	X44	X55	X66	X77	Y11	Y22
X11	1	−0.51	0.85	0.97	−0.12	−0.30	0.55		0.35
X22	−0.51	1	−0.07	−0.32	−0.69	−0.65	0.37		−0.04
X33	0.85	−0.07	1	0.95	−0.61	−0.69	0.87		0.21
X44	0.97	−0.32	0.95	1	−0.34	−0.50	0.72		0.33
X55	−0.12	−0.69	−0.61	−0.34	1	0.92	−0.87		−0.03
X66	−0.30	−0.65	−0.69	−0.50	0.92	1	−0.94		−0.31
X77	0.55	0.37	0.87	0.72	−0.87	−0.94	1		0.38
Y11									
Y22	0.35	−0.04	0.21	0.33	−0.03	−0.31	0.38		1

Table 13: Correlation dependence of environmental indicators and efficiency of PJSC Lukoil

Indicators	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1	−0.51	0.85	0.98	−0.17	−0.33	0.51	0.89	−0.68
X2	−0.51	1	−0.11	−0.35	−0.64	−0.61	0.38	−0.29	−0.07
X3	0.85	−0.11	1	0.94	−0.65	−0.71	0.83	0.94	−0.96
X4	0.98	−0.35	0.94	1	−0.36	−0.50	0.66	0.94	−0.80
X5	−0.17	−0.64	−0.65	−0.36	1	0.95	−0.90	−0.45	0.80
X6	−0.33	−0.61	−0.71	−0.50	0.95	1	−0.95	−0.51	0.80
X7	0.51	0.38	0.83	0.66	−0.90	−0.95	1	0.62	−0.91
Y1	0.89	−0.29	0.94	0.94	−0.45	−0.51	0.62	1	−0.83
Y2	−0.68	−0.07	−0.96	−0.80	0.80	0.80	−0.91	−0.83	1

Table 14: Correlation dependence of logarithmic indicators of the external environment and the efficiency of PJSC Lukoil

Indicators	X11	X22	X33	X44	X55	X66	X77	Y11	Y22
X11	1	−0.51	0.85	0.97	−0.12	−0.30	0.55	0.88	−0.70
X22	−0.51	1	−0.07	−0.32	−0.69	−0.65	0.37	−0.17	−0.01
X33	0.85	−0.07	1	0.95	−0.61	−0.69	0.87	0.97	−0.95
X44	0.97	−0.32	0.95	1	−0.34	−0.50	0.72	0.95	−0.81
X55	−0.12	−0.69	−0.61	−0.34	1	0.92	−0.87	−0.49	0.73
X66	−0.30	−0.65	−0.69	−0.50	0.92	1	−0.94	−0.57	0.70
X77	0.55	0.37	0.87	0.72	−0.87	−0.94	1	0.75	−0.88
Y11	0.88	−0.17	0.97	0.95	−0.49	−0.57	0.75	1	−0.87
Y22	−0.70	−0.01	−0.95	−0.81	0.73	0.70	−0.88	−0.87	1

The correlation of environmental indicators and the efficiency of PJSC Surgutneftegaz is reflected in Table 17.

For PJSC Surgutneftegaz, it was expedient to conduct a correlation analysis on two effective parameters. The strongest relationship is observed between oil and gas prices and return on assets. The efficiency obtained during the DEA analysis is influenced by the inflation rate, the consumer price index with less force and the gross domestic product with even less force. It should be noted that there is a correlation between the company's efficiency and the exchange rate, but weak (Table 18).

Due to the analysis of the prologarithmic indicators, the same connections were revealed as for simple indicators. Table 18 shows an increased correlation of external factors with the effectiveness of the DEA, especially with the exchange rate. However, the correlation of indicators and return on assets has taken noticeably lower values.

PJSC "Transneft" was characterized as the most efficient company according to the DEA criterion during the years under study, therefore, the correlation is further calculated for the return on assets as an effective indicator of efficiency (Table 19).

Table 15: Correlation dependence of environmental indicators and efficiency of PJSC "Rosneft"

Indicators	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1	−0.51	0.85	0.98	−0.17	−0.33	0.51		−0.31
X2	−0.51	1	−0.11	−0.35	−0.64	−0.61	0.38		−0.47
X3	0.85	−0.11	1	0.94	−0.65	−0.71	0.83		−0.76
X4	0.98	−0.35	0.94	1	−0.36	−0.50	0.66		−0.49
X5	−0.17	−0.64	−0.65	−0.36	1	0.95	−0.90		0.97
X6	−0.33	−0.61	−0.71	−0.50	0.95	1	−0.95		0.90
X7	0.51	0.38	0.83	0.66	−0.90	−0.95	1		−0.89
Y1									
Y2	−0.31	−0.47	−0.76	−0.49	0.97	0.90	−0.89		1

Table 16: Correlation dependence of logarithmic indicators of the external environment and the efficiency of PJSC Ros-neft

Indicators	X11	X22	X33	X44	X55	X66	X77	Y11	Y22
X11	1	−0.51	0.85	0.97	−0.12	−0.30	0.55		−0.18
X22	−0.51	1	−0.07	−0.32	−0.69	−0.65	0.37		−0.46
X33	0.85	−0.07	1	0.95	−0.61	−0.69	0.87		−0.66
X44	0.97	−0.32	0.95	1	−0.34	−0.50	0.72		−0.38
X55	−0.12	−0.69	−0.61	−0.34	1	0.92	−0.87		0.93
X66	−0.30	−0.65	−0.69	−0.50	0.92	1	−0.94		0.75
X77	0.55	0.37	0.87	0.72	−0.87	−0.94	1		−0.77
Y11									
Y22	−0.18	−0.46	−0.66	−0.38	0.93	0.75	−0.77		1

Table 17: Correlation dependence of environmental indicators and efficiency of PJSC "Surgutneftegaz"

Indicators	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1.00	−0.51	0.85	0.98	−0.17	−0.33	0.51	0.43	−0.25
X2	−0.51	1.00	−0.11	−0.35	−0.64	−0.61	0.38	−0.10	−0.24
X3	0.85	−0.11	1.00	0.94	−0.65	−0.71	0.83	0.63	−0.68
X4	0.98	−0.35	0.94	1.00	−0.36	−0.50	0.66	0.51	−0.40
X5	−0.17	−0.64	−0.65	−0.36	1.00	0.95	−0.90	−0.43	0.84
X6	−0.33	−0.61	−0.71	−0.50	0.95	1.00	−0.95	−0.32	0.68
X7	0.51	0.38	0.83	0.66	−0.90	−0.95	1.00	0.31	−0.75
Y1	0.43	−0.10	0.63	0.51	−0.43	−0.32	0.31	1.00	−0.57
Y2	−0.25	−0.24	−0.68	−0.40	0.84	0.68	−0.75	−0.57	1.00

Table 18: Correlation dependence of logarithmic indicators of the external environment and the efficiency of PJSC Sur-gutneftegaz

Indicators	X11	X22	X33	X44	X55	X66	X77	Y11	Y22
X11	1.00	−0.50	0.91	0.98	−0.26	−0.39	0.69	0.55	−0.37
X22	−0.50	1.00	−0.14	−0.32	−0.66	−0.60	0.28	0.00	−0.05
X33	0.91	−0.14	1.00	0.97	−0.64	−0.68	0.89	0.78	−0.64
X44	0.98	−0.32	0.97	1.00	−0.45	−0.56	0.82	0.65	−0.47
X55	−0.26	−0.66	−0.64	−0.45	1.00	0.93	−0.84	−0.68	0.63
X66	−0.39	−0.60	−0.68	−0.56	0.93	1.00	−0.93	−0.49	0.38
X77	0.69	0.28	0.89	0.82	−0.84	−0.93	1.00	0.61	−0.46
Y11	0.55	0.00	0.78	0.65	−0.68	−0.49	0.61	1.00	−0.98
Y22	−0.37	−0.05	−0.64	−0.47	0.63	0.38	−0.46	−0.98	1.00

The efficiency of PJSC "Transneft" is influenced by the level of inflation in the country. There is a positive, but very weak correlation with GDP indicators, the consumer price index and the exchange rate. As a comparison and adequacy of the assessment, a correlation table with logarithmic indicators is presented below (Table 20).

The correlation of the return on assets of Transneft PJSC with environmental factors in logarithmic form showed the same result with the previous table in terms of the relationship with the inflation rate. The correlation with other indicators has also not changed much. Thus, the influence of external factors on the efficiency of Transneft, with the exception of the amount of inflation in the country, is practically absent. That is, the company can be called stable in relation to external shocks, which may already indicate competent management on the part of managers and the correct allocation of resources.

Further, a correlation analysis of the relationship between environmental factors and the effectiveness of PJSC Tatneft was carried out (Table 21).

The results of the correlation analysis in Table 21 show that the effectiveness of DHEA is influenced only by the key rate of the Central Bank of Russia. The return on assets is significantly affected by factors such as GDP, consumer price index and inflation, and the exchange rate and oil price have a minor impact.

Correlation analysis of logarithmic indicators shows similar results (Table 22).

The correlation of the Central Bank rate and the effectiveness of the DEA is observed unchanged. The strength of the relationship between GDP, consumer price index, inflation and return on assets has become slightly weaker.

The latest analysis of correlation relationships was carried out for the company PJSC Novatek (Table 23).

PJSC Novatek is not an absolutely effective company according to the DEA criterion, therefore there is a correlation between the effectiveness of the DEA and external factors, but this relationship is characteristic only of the Central Bank's key rate. There is a significant dependence of the profitability of the company's assets on the level of inflation in the country and the exchange rate. The consumer price index and GDP have a smaller but also significant impact on the return on assets.

Table 19: Correlation dependence of environmental indicators and efficiency of the company of PJSC "Transneft"

Indicators	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1	−0.51	−0.11	−0.35	−0.64	−0.62	0.38		0.00
X2	−0.51	1	0.85	0.98	−0.17	−0.33	0.51		0.12
X3	−0.11	0.85	1	0.94	−0.65	−0.71	0.83		0.42
X4	−0.35	0.98	0.94	1	−0.36	−0.50	0.66		0.21
X5	−0.64	−0.17	−0.65	−0.36	1	0.95	−0.90		−0.45
X6	−0.62	−0.33	−0.71	−0.50	0.95	1	−0.95		−0.22
X7	0.38	0.51	0.83	0.66	−0.90	−0.95	1		0.21
Y1									
Y2	0.00	0.12	0.42	0.21	−0.45	−0.22	0.21		1

Table 20: Correlation dependence of logarithmic indicators of the external environment and the efficiency of the company PJSC "Transneft"

Indicators	X11	X22	X33	X44	X55	X66	X77	Y11	Y22
X11	1	−0.51	0.85	0.97	−0.12	−0.30	0.55		0.08
X22	−0.51	1	−0.07	−0.32	−0.69	−0.65	0.37		0.14
X33	0.85	−0.07	1	0.95	−0.61	−0.69	0.87		0.42
X44	0.97	−0.32	0.95	1	−0.34	−0.50	0.72		0.19
X55	−0.12	−0.69	−0.61	−0.34	1	0.92	−0.87		−0.54
X66	−0.30	−0.65	−0.69	−0.50	0.92	1	−0.94		−0.25
X77	0.55	0.37	0.87	0.72	−0.87	−0.94	1		0.29
Y11									
Y22	0.08	0.14	0.42	0.19	−0.54	−0.25	0.29		1

Table 21: Correlation dependence of environmental indicators and efficiency of PJSC "Tatneft"

Indicators	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1	−0.51	0.85	0.98	−0.17	−0.33	0.51	−0.70	0.82
X2	−0.51	1	−0.11	−0.35	−0.64	−0.61	0.38	0.83	−0.61
X3	0.85	−0.11	1	0.94	−0.65	−0.71	0.83	−0.29	0.48
X4	0.98	−0.35	0.94	1	−0.36	−0.50	0.66	−0.57	0.73
X5	−0.17	−0.64	−0.65	−0.36	1	0.95	−0.90	−0.45	0.20
X6	−0.33	−0.61	−0.71	−0.50	0.95	1	−0.95	−0.28	−0.04
X7	0.51	0.38	0.83	0.66	−0.90	−0.95	1	0.03	0.25
Y1	−0.70	0.83	−0.29	−0.57	−0.45	−0.28	0.03	1	−0.94
Y2	0.82	−0.61	0.48	0.73	0.20	−0.04	0.25	−0.94	1

The results of correlation of logarithmic indicators of the external environment and efficiency of PJSC Novatek show the following picture (Table 24).

The strength of the relationship between the effectiveness of the DEA and the Central Bank's key rate in Table 23 remained unchanged compared to the results in Table 24. The strength of the impact of indicators on the return on assets of the inflation rate, exchange rate, consumer price index and GDP has become more pronounced.

Thus, the results of the correlation between the performance indicators of oil and gas companies in Russia, reflected by two approaches: DEA and ROA, with environmental factors were considered. To test the hypotheses that were put not as individual characteristics of the company, but generalized, a table of the influence of external factors on efficiency was compiled (Table 25).

R-the presence of a correlation with the return on assets, D-the presence of a correlation with the effectiveness of DEA

Table 22: Correlation dependence of logarithmic indicators of the external environment and efficiency of PJSC Tatneft

Indicators	X11	X22	X33	X44	X55	X66	X77	Y11	Y22
X11	1	−0.51	0.85	0.97	−0.12	−0.30	0.55	−0.71	0.78
X22	−0.51	1	−0.07	−0.32	−0.69	−0.65	0.37	0.83	−0.65
X33	0.85	−0.07	1	0.95	−0.61	−0.69	0.87	−0.30	0.44
X44	0.97	−0.32	0.95	1	−0.34	−0.50	0.72	−0.56	0.67
X55	−0.12	−0.69	−0.61	−0.34	1	0.92	−0.87	−0.47	0.26
X66	−0.30	−0.65	−0.69	−0.50	0.92	1	−0.94	−0.27	0.01
X77	0.55	0.37	0.87	0.72	−0.87	−0.94	1	0.00	0.24
Y11	−0.71	0.83	−0.30	−0.56	−0.47	−0.27	0.00	1	−0.96
Y22	0.78	−0.65	0.44	0.67	0.26	0.01	0.24	−0.96	1

Table 23: Correlation dependence of environmental indicators and efficiency of PJSC "Novatek"

Indicators	X1	X2	X3	X4	X5	X6	X7	Y1	Y2
X1	1	−0.51	0.85	0.98	−0.17	−0.33	0.51	−0.47	0.67
X2	−0.51	1	−0.11	−0.35	−0.64	−0.62	0.38	0.87	−0.02
X3	0.85	−0.11	1	0.94	−0.65	−0.71	0.83	−0.25	0.90
X4	0.98	−0.35	0.94	1	−0.36	−0.50	0.66	−0.36	0.77
X5	−0.17	−0.64	−0.65	−0.36	1	0.95	−0.90	−0.34	−0.72
X6	−0.33	−0.62	−0.71	−0.50	0.95	1	−0.95	−0.40	−0.72
X7	0.51	0.38	0.83	0.66	−0.90	−0.95	1	0.10	0.90
Y1	−0.47	0.87	−0.25	−0.36	−0.34	−0.40	0.10	1	−0.35
Y2	0.67	−0.02	0.90	0.77	−0.72	−0.72	0.90	−0.35	1

Table 24: Correlation dependence of logarithmic indicators of the external environment and the efficiency of PJSC No-vatek

Indicators	X11	X22	X33	X44	X55	X66	X77	Y11	Y22
X11	1	−0.51	0.85	0.97	−0.12	−0.30	0.55	−0.54	0.70
X22	−0.51	1	−0.07	−0.32	−0.69	−0.65	0.37	0.87	0.06
X33	0.85	−0.07	1	0.95	−0.61	−0.69	0.87	−0.27	0.94
X44	0.97	−0.32	0.95	1	−0.34	−0.50	0.72	−0.41	0.82
X55	−0.12	−0.69	−0.61	−0.34	1	0.92	−0.87	−0.36	−0.74
X66	−0.30	−0.65	−0.69	−0.50	0.92	1	−0.94	−0.40	−0.76
X77	0.55	0.37	0.87	0.72	−0.87	−0.94	1	0.07	0.93
Y11	−0.54	0.87	−0.27	−0.41	−0.36	−0.40	0.07	1	−0.28
Y22	0.70	0.06	0.94	0.82	−0.74	−0.76	0.93	−0.28	1

Table 25: Cumulative table of the influence of environmental factors on the effectiveness of DEA and return on assets of the companies studied

Company	X1		X2		X3		X4		X5		X6		X7	
	R	D	R	D	R	D	R	D	R	D	R	D	R	D
Gazprom	+				+		+						+	
Lukoil		+				+		+	+		+			+
Rosneft									+		+			
Surgutneftegaz		+				+		+	+		+			+
Transneft					+									
Tatneft	+			+	+		+							
Novatek	+			+	+		+						+	

Table 25 shows that the same dependence of the efficiency of the largest Russian oil and gas companies on all environmental factors is not observed, but some similar trends are noticeable. The level of inflation in the country has the greatest impact on the efficiency of companies, that is, the success of the company's activities in a given period will depend on changes in the price level in the country. The key rate of the Central Bank most rarely affects the efficiency of companies, it should be noted that this is observed for companies with the lowest efficiency ratings.

Thus, the following hypotheses were partially confirmed during the study:

Hypothesis 4. In times of crisis in the Russian economy, the efficiency of oil and gas companies is changing.

This hypothesis is confirmed for most companies due to such indicators as the inflation rate, GDP and consumer price index, to a lesser extent by the Central Bank's key rate.

Hypothesis 5. The growth of the dollar against the ruble affects the efficiency of oil and gas companies in Russia.

This hypothesis is confirmed for most companies.

Hypothesis 6. The increase in oil and gas prices leads to a change in the efficiency of Russian oil and gas companies.

This hypothesis has been confirmed within a smaller part of the oil and gas companies studied, which means that the efficiency of companies may suffer from changes in oil and gas prices, which should be taken into account in their strategic development plans.

5. DISCUSSION

Reserves for improving the efficiency of oil and gas companies can be divided into 2 blocks in accordance with the previous studies described above. The first block concerns the internal reserves of the company's efficiency. The CFO can propose several strategies to improve the efficiency of the company by setting certain benchmarks and using material, labor, organizational and process resources to achieve them. In the course of our research, we suggest 3 strategies for improving the efficiency of oil and gas companies: real, optimistic and pessimistic. An example of the implementation of such a strategy is presented in the work. When implementing a real strategy, an in-crease in oil production by 5% results in an increase in the company's revenue by 3.88% and an increase in the company's net profit by 3.29%.

As for the second block-external factors, they have different effects for oil and gas companies, in practice it can be recommended to respond to changes in external indicators selectively. The most resistant to external influences is the company of PJSC "Transneft", the most dependent on external factors are the companies of PJSC "Tatneft" and PJSC "Novatek."

The management of companies in the oil and gas sector should pay attention to the indicator of the exchange rate, for most companies, changes in the ruble exchange rate immediately affect its effectiveness, especially for the companies of PJSC Gazprom, PJSC Lukoil, PJSC Surgutneftegaz and PJSC Novatek. That is, the hypothesis retains validity for most of the companies studied. As for the increase in oil and gas prices, it is a significant factor for PJSC Lukoil, PJSC Rosneft and PJSC Surgutneftegaz, which means that the efficiency of companies may suffer from changes in oil and gas prices, which should be taken into account in their strategic development plans.

Thus, the influence of environmental factors on the efficiency of Russian companies exists, but manifests itself more individualized, not reflecting the general trends in the industry. This may be due to the tools already introduced in companies to regulate the main areas that ensure the effective operation of the company, as well as the peculiarities of the production and sale of these companies.

The developed recommendations for improving the efficiency of the company's activities can be recommended for practical application.

6. CONCLUSION

The article substantiates the factors influencing the types of efficiency of companies, including direct indicators of its activities, including natural indicators, reporting indicators, financial ratios, market indicators and indicators of the external economic situation, both in the country where the objects under study operate, and on the world stage.

Variables at the input and output of the DEA model (analysis of the functioning environment) in domestic and foreign studies and a conceptual scheme for setting the problem of factor financial analysis based on the synthesis of deterministic and stochastic methods of financial analytics are considered. The main stages of the methodology for evaluating the effectiveness of companies have been developed.

The main parameters of the DEA model with capitalization of companies, revenue at the company's output and oil production volumes have been developed.

Models of the influence of external and internal factors based on correction and regression analysis are constructed. It was revealed that during crisis periods in the Russian economy, the efficiency of oil and gas companies changes, the growth of the dollar against the ruble affects the efficiency of oil and gas companies in Russia, the increase in oil and gas prices leads to a change in the efficiency of Russian oil and gas companies.

The prospects for further research by the authors will consist in the development of an algorithm for conducting factor analysis of an economic entity based on the use of a DUPONT software product. In conducting a factor analysis of the efficiency of Russian oil and gas companies based on the DUPONT model. The model toolkit proposed for development will create a digital platform for effective management of enterprises based on the forecast of their performance indicators.

The oil and gas sector of the economy in Russia brought superprofits in 2021. First of all, these are high indicators of the price rally in the oil and gas markets. Secondly, a 54% increase in the value of exports of crude oil, petroleum products, natural gas and LNG. Thirdly, revenues from large natural gas export volumes and simultaneous price increases have increased.

REFERENCES

Ajemyan, A.A., Muratova, K.K., Frolova, V.B. (2016), Identification of dynamic dependencies of changes in the market value of oil companies. Modern Scientific Research and Innovation, 11(67), 352-360.

Aleinikova, A.I., Mileta, V.I. (2019), The role of economic efficiency in the economic activity of the company. Economics and Management of Innovative technologies, 11(98), 4-20.

Alimkhanova, A.N., Mizel, A.A. (2019), Evaluating the effectiveness of enterprises based on the DEA method. Dokladi Tomskogo Gosudarstvennogo Universiteta Sistem Upravleniya Radioelektroniki, 22(2), 104-108.

Alkhateeb, T.T.Y., Mahmood, H. (2020), Oil price and energy depletion nexus in GCC countries: Asymmetry Analyses. Energies, 13(12), 3058.

Al-Mana, AA, Nawaz, W., Kamal, A., Koc, M. (2020), Financial and operational efficiencies of National and International oil companies: An empirical investigation. Resource Policy, 68, 101701.

Altoe, A.V., da Costa, N Jr., Lopes, A.L.M., Veloso, T.R.M., Saurin, V. (2017), Technical efficiency and financial performance in the Brazilian distribution service operators. Socio Economic Planning Sciences, 59, 79-92.

Bagirov, M., Mateus, C. (2019), Oil prices, stock markets and firm performance: Evidence from Europe. International Review of Economics and Finance, 61, 270-288.

Borodin, A., Mityushina, I. (2020), Evaluating the effectiveness of companies using the DEA method. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu, 6, 193-197.

Borodin, A., Zaitsev, V., Mamedov, Z.F., Panaedova, G., Kulikov, A. (2022), Mechanisms for tax regulation of CO2-equivalent emissions. Energies, 15(9), 7111.

Bushueva, N.V., Sklyar, B.S., Syromyatnikov, A.A. (2018), Practical aspects of the formation of the company's financial strategy based on market performance indicators. Natural Humanitarian Studies, 19(1), 42-52.

Butorina, O.V., Shishkina, I.V. (2017), The company's investment attractiveness: essence, comparison of valuation methods. Bulletin of the Perm National Research Polytechnic University. Social and Economic Sciences, 2017(2), 206-221.

Byk, F.L., Myshkina, L.S. (2018), Improving technical efficiency is the basis for innovation. Business Education Right, 2(43), 93-98.

Calof, J. (2018), Improving the efficiency of innovative activities of companies. Foresight and STI Governance, 12(3), 30-33.

Cardinal, L.B., Opler, T.C. (1995), Corporate diversification and innovative efficiency an empirical study. Journal of Accounting and Economics, 19(2-3), 365-381.

Chao, S.L., Yu, M.M., Hsieh, W.F. (2018), Evaluating the efficiency of major container shipping companies: A framework of dynamic network DEA with shared inputs. Transportation Research Part A Policy and Practice, 117, 44-57.

Chernov, S., Kolkova, N. (2019), Determination of the economic efficiency index of electric grid companies based on DEA analysis. Biznes Obrazovanie Pravo, 1(46), 285-292.

Coto-Millán, P., de la Fuente, M., Fernández, X.L. (2018), Determinants of the European electricity companies efficiency: 2005-2014. Energy Strategy Reviews, 21, 149-156.

Elhuni, R.M., Ahmad, M.M. (2017), Key performance indicators for sustainable production evaluation in oil and gas sector. Procedia Manufacturing, 11, 718-724.

Fedorova, E., Lapshina, N., Borodin, A., Lazarev, M. (2021), Impact of information in press releases on the financial performance of Russian companies. Ekonomicheskaya Politika, 16(3), 138-157.

Filimonova, I.V., Komarova, A.V., Chebotareva A. (2019), Factor analysis of economic efficiency of the oil and gas Industry in Russia. E3S Web of conferenses, Topical Problems of Green Architecture, Civil and Environmental Engineering, TPACEE, 164, 09028.

Kaya, B., Abubakar, A.M., Behravesh, E., Yildiz, H., Mert, I.S. (2020), Antecedents of innovative performance: Findings from PLS-SEM and fuzzy sets (fsQCA). Journal of Business Research, 114, 278-289.

Konstantinova, A.G. (2018), Evaluation of the economic efficiency of the use of innovative technologies by International companies. Economics Theory and Practice, 2(50), 103-108.

Kuramshina, A.O., Dyrdonova, A.N. (2018), Improving the environmental policy of the enterprise: An indicator of environmental efficiency. Innovative Science, 9, 5-7.

Lan, S., Yang, C., Tseng, M.L. (2019), Corporate sustainability on causal financial efficiency model in a hierarchical structure under uncertainties. Journal of Cleaner Production, 237(10), 117769.

Lin, Y.H., Hong, C.F. (2022), Efficiency and effectiveness of airline companies in Taiwan and Mainland China. Asia Pacific Management Review, 25(1), 13-22.

Lysenkova, A.I., Makludova, A.M. (2018), The influence of external factors on the corporation's activities (on the example of PALUKOIL). Problems of Economics and Legal Practice, 6, 97-99.

Mahmood, H., Alkhateeb, T.T.Y., Furqan, M. (2020), Oil sector and CO2 emissions in Saudi Arabia: Asymmetry analysis. Palgrave Communications, 6, 88.

Mahmood, H., Asadov, A., Tanveer, M., Furqan, M., Yu, Z. (2022), Impact of oil price, economic growth and urbanization on CO2 emissions in GCC countries: Asymmetry analysis. Sustainability, 14, 4562.

Mahmood, H., Maalel, N., Hassan, M.S. (2021), Probing the energy-environmental Kuznets curve hypothesis in oil and natural gas consumption models considering urbanization and financial development in Middle East countries. Energies, 14(11), 3178.

Mamedov, Z.F., Qurbanov, S.H., Streltsova, E., Borodin, A., Yakovenko, I., Aliev, A. (2022), Assessment of The Potential for Sustainable Development of Electric Power Enterprises: Approaches, Models, Technologies. SOCAR Proceedings, 2022(2), 15-27.

Merzlikina, G.S. (2019), Environmental economic efficiency of industrial enterprises: Evaluation and management. Bulletin of the Astrakhan state technical university. Series Economics, 3, 7-20.

Moiseeva, I.I., Tormyshev, D.S. (2018), Methodological aspects of assessing the effectiveness of the enterprise. Socio Economic Phenomena and Processes, 13(104), 198-206.

Nasreen, S., Tiwari, A.K., Eizaguirrec, J.C., Wohar, M.E. (2020), Dynamic connectedness between oil prices and stock returns of clean energy and technology companies. Journal of Cleaner Production, 260, 121015.

Nifontov, A.I., Chernikova, O.P., Kushnerov, Y.P. (2015), The development of awarding bonus-es system of mining preparatory sections employees. Mines week-2015. Reports of the XXI international scientific symposium, 4(2), 239-245.

Polunina, N.L. (2017), Factors of the external and internal environment that influence the social and economic Efficiency of entrepreneurial activity. Bulletin of the Tambov university. Series Humanities, 3(119), 23-27.

Postnikov, V.P., Temirova, K.A. (2019), Study of the relation between investment performance of an oil company and market conditions.

Bulletin of Perm national research polytechnic university. Socio Economic Sciences, 1, 260-278.

Rybin, I.V., Anisimova, N.A., Smotrova, T.I. (2019), Evaluation of the economic efficiency of the introduction of innovative industrial technology. Innovation Technology and Business, 1(5), 49-53.

Shevtsov, V.V., Demchenko, M.M. (2017), The practice of assessing the investment attractiveness of an enterprise. Scientific Almanac, 1-1(27), 222-225.

Smirnova, E.D., Matrosova, E.V. (2018), Increasing the economic efficiency of the company through the introduction of an automated information system. Synergy of Sciences, 30, 731-736.

Stepanova, A.N., Shikhantsova, O.S. (2015), Insider ownership and strategic performance of companies in the BRIC countries: An analysis of 2003-2013. Russian Journal of Management, 13(1), 43-64.

Streltsova, E., Borodin, A., Yakovenko, I. (2022), Fuzzy-logic model for feasibility study of project implementation: Project's investment risk. Iranian Journal of Fuzzy Systems, 19(2), 1-15.

Trifonov, A.Y., Mikhalchuk, A.A., Ryzhkova, M., Spitsyn, V., Bulykina, A.A. (2018), Technical efficiency of metallurgical enterprises in Russian and foreign ownership in 2012-2016. Bulletin of Tomsk State University. Economics, 44, 283-304.

Troyanova, E.N. (2015), Methods of estimation operation efficiency with regard to the market situation. Business Education Right, 2(31), 148-153.

Trunova, E.V., Gubarenko, A.A. (2013), The method of assessing the level in the analysis of the financial efficiency of an insurance company. Economic Analysis: Theory and Practice, 41(344), 21-28.

Wang, G., Li, K.X., Xiao, Y. (2019), Measuring marine environmental efficiency of a cruise shipping company considering corporate social responsibility. Marine Policy, 2019, 140-147.

Wang, Q., Sun, Y., Yuan, X., Cao, D., Zuo, J., Gao, Z. (2017), Addressing the efficiency of the core ecological industrial chain: A DEA approach. Journal of Cleaner Production, 156, 235-243.

Xu, P., Luo, F., Zhang, Z., Xu, H. (2020), Research on innovation efficiency of listed companies in development Zone based on the three-stage DEA-tobit model: A case study of Hubei province. Discrete Dynamics in Nature and Society, 2020, 1-12.

Yang, L., Yang, Y. (2019), Evaluation of eco-efficiency in China from 1978 to 2016: Based on a modified ecological footprint model. Science of the Total Environment, 662, 581-590.

Yudkina, L.V., Berlin, Y, I. (2009), Correlation analysis of interrelations of indicators of capitalization dynamics and efficiency of public Russian companies. Finance and Credit, 9(345), 16-21.