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BORSA İSTANBUL'DA ENERJİ ŞİRKETLERİNİN NAKİT AKIM ORANLARINA DAYALI FİNANSAL PERFORMANS ANALİZİ[1]

FINANCIAL BENCHMARKING OF ENERGY COMPANIES IN THE BORSA ISTANBUL BASED ON CASH FLOW RATIOS

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Öz

Bu çalışmanın amacı, Borsa İstanbul'da işlem gören on altı enerji şirketinin finansal performansını nakit yeterliliği ve nakit verimliliği açısından değerlendirerek, COVID-19 dönemini kapsayan 2020 ve 2021 yıllarında şirketlerin finansal performanslarının çok kriterli karar verme yöntemleri aracılığıyla kıyaslanmasıdır. Bu çalışmada şirketlere ait nakit oranlarının objektif ağırlıklarını belirlemek için MEREC yöntemi kullanılmıştır. Enerji şirketlerinin sıralaması ise çok kriterli karar verme yöntemlerinden Gri İlişkisel Analiz (GRA) yaklaşımı kullanılarak tahmin edilmiştir. Finansal performans karşılaştırmasının yapılabilmesi için yedi tane nakit temelli finansal oran performans kriteri göz önünde bulundurulmuştur. Sonuçlar, enerji şirketlerinin çoğunun 2020'de finansal performanslarının düşük olduğu ve 2021'de finansal performanslarını iyileştirdiğini göstermiştir.

Anahtar Kelimeler: Finansal Performans Kıyaslama, Performans Değerlendirme, Finansal Oran, Çok Kriterli Karar Verme, Gri İlişkisel Analiz

JEL Sınıflaması: C44, C61, G17

Abstract

The purpose of this paper is to evaluate the financial performance of the sixteen energy companies listed in Borsa Istanbul in terms of cash sufficiency and cash efficiency and benchmark them in 2020 and 2021; during the COVID-19 period by using multi-criteria decision making methods. This paper utilizes the Method Based on the Removal Effects of Criteria (MEREC) technique to determine the objective weights of cash ratios. Energy companies' ranking is estimated using the Grey Relational Analysis (GRA) approach. In the case of the financial performance evaluation problem, 7 performance attributes and 16 alternative layouts were considered. The results show that most of the energy companies have weak financial performance in 2020 and then improve their financial performance in 2021.

Keywords: Financial Benchmarking, Performance Evaluation, Financial Ratios, Multi-Criteria Decision Making, Grey Relational Analysis

JEL Classification: C44, C61, G17

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1. Introduction

Energy is a significant factor for sustainable development goals such as expanding access to electricity, sustainable industrialization, and economic growth. Industrialization, digitalization, rapid population growth, and urbanization increase the demand for energy all over the world. The companies in the energy sector are vital for the energy supply and sustainable development of the countries. Evaluating the financial performance of energy companies is significant for the future sustainable development policies of countries.

The financial ratio analysis has always been considered fundamental in financial statements and performance analyses. Financial ratios can be calculated based on the financial statements of companies. The cash flow statement, one of the financial statements, demonstrates how a company balances its receivables and payables, pays for its growth and manages its flow of funds. While cash flow statements may present considerable information about the real situation of the company, the literature has focused on income statements and balance sheets (Hertenstein and McKinnon, 1997; s.69).

The financial performance of any company can be measured by financial ratios including traditional ratios such as liquidity, activity, debt, and profitability ratios, and cash flow ratios such as cash sufficiency and cash efficiency ratios. Traditional ratios are based on the income statement and balance sheet which are on the accrual basis of accounting while cash flow ratios are calculated on a cash basis.

Traditional ratios may be manipulated by the way of noncash expenditures like depreciation. This constraint of traditional ratios is attempted to be overcome by cash flow ratios. There are few opportunities to alter cash flow data since they are not susceptible to accounting policy interpretation. Therefore, compared to traditional ratios, cash flow ratios are likely to be more reliable and a better indicator of the performance of the company (Porwal and Jain, 2013; s.56).

Financial statement users such as investors, managers, and creditors are required to evaluate financial performance and benchmark other companies in the sector. Financial performance benchmarking gives the advantage of selecting the company which has the higher financial performance to invest, taking managerial decisions to improve the performance of the company, and analyzing the company's debt payments ability.

This paper aims to analyze the financial performance of energy companies that are listed on Borsa İstanbul (BIST) using cash flow ratios and benchmark them. The Method Based on the Removal Effects of Criteria (MEREC) method is used in weighting benchmarking criteria and Grey Relational Analysis (GRA) for ranking the companies. The rest of this study is as follows. In Section 2, the literature on multi-criteria decision-making methods used for financial benchmarks is reviewed. In Section 3, data and the methods of MEREC and Grey Relational Analysis are given briefly. Empirical results are evaluated in Section 4. The last section is the conclusion that summarizes the findings of the study.

2. Literature Review

Multi-criteria decision analysis has been used increasingly in many fields such as financial performance analysis and benchmarking, and optimal selection. The method allows for preferences and performance about different management alternatives to be assessed in a clear, formal way that is both mathematically rigorous and transparent to stakeholders. Multi-criteria decision analysis methods are a powerful set of tools that combine information about a decision maker's preferences and the performance of different alternatives to reach a defensible decision (Linkov and Moberg, 2012; ss.4-8).

There are several studies focused on the analysis of financial performance and benchmarking of companies operating in several sectors using different multi-criteria decision analysis methods. The financial performance of energy companies in Borsa Istanbul has been analyzed with the support of multi-criteria decision analysis by several studies (Sakarya et al., 2015; Eyüboğlu & Çelik, 2016; Metin et al., 2017; Bağcı & Yüksel Yiğiter, 2019; Kayahan Karakul & Özaydın, 2019; Güler, 2019; Avcı, 2019; Orçun, 2019; Çiftçi & Yıldırım, 2020; Karcıoğlu et al., 2020; Kuvat & Güler, 2020; Mercan & Çetin, 2020; Çiftçi et al., 2021; Keleş et al., 2021). Topal (2021) analyzed the financial performance of ten companies that operate in the electricity generation sector and the first 40 in terms of installed capacity in Turkey and are included in the Forbes 500 list by using multi-criteria decision methods. İskenderoğlu et al. (2015) and Beller Dikmen (2021) analyzed the financial performance of the energy sector in Turkey through financial ratio analysis.

Sueyoshi (2005) used financial ratio analysis to analyze the financial performance and classify the US energy firms by the status of default or non-default. Goto and Sueyoshi (2009) also examined the financial performance of the American energy industry by discriminant analysis. Capece et al. (2013) used financial ratio analysis to measure and evaluate the economic and financial performance of 90 Italian energy companies, between the years 2008 and

2010 in which electricity and natural gas were liberalized. Yadav et al. (2016) evaluated the financial performance of oil and gas companies in India using the TOPSIS method. Paun (2017) analysed also the financial performance of the companies operating in Romania by conventional ratio analysis Moon and Min (2020) used data envelopment analysis to analyze the relationship between energy efficiency and financial performance in Korea. Moon and Min (2009) used financial ratios such as return on equity, return on assets, return on investments, return on invested capital, return on sales, sales growth, and Tobin's Q to measure financial performance. Neves et al. (2021) evaluated the financial performance of electric utilities in Portugal using conventional ratio analysis and data envelopment analysis. Zhou and Sun (2022) compared the financial performance of fossil-fired and renewable energy generation companies by using financial ratios to measure the performance of companies.

The literature focused on the analysis of financial performance and benchmarking of energy companies is given in Table 1. Conventional financial ratios have been used in the literature to measure financial performance except for the study of Çiftçi et al. (2021).

Table 1. A summary of literature based on financial performance measurement of energy companies

Year	Source	Method	Country	The Years Analysed
2015	Sakarya et al.	TOPSIS	Turkey	2010-2014
2015	İskenderoğlu et al.	Ratio analysis	Turkey	2009-2012
2016	Eyüboğlu & Çelik	Fuzzy AHP-Fuzzy TOPSIS	Turkey	2008-2013
2017	Metin et al.	TOPSIS and MOORA	Turkey	2010-2015
2019	Kayahan Karakul & Özaydın	TOPSIS and VIKOR	Turkey	2017
2019	Bağcı & Yüksel Yiğiter	SD-Waspas	Turkey	2008-2017
2019	Güler	Fuzzy TOPSIS	Turkey	2014-2017
2019	Avcı	ARAS and MOORA	Turkey	2016
2019	Orçun	Entropi-WASPAS	Turkey	2016-2017
2020	Mercan & Çetin	COPRAS-VIKOR	Turkey	2014-2018
2020	Kuvat & Güler	Fuzzy TOPSIS	Turkey	2014-2017
2020	Karcıoğlu et al.	Entropy- Intuitionistic Fuzzy Logic	Turkey	2013-2017
2020	Çiftçi & Yıldırım	Grey Relational Analysis	Turkey	2011-2019
2021	Çiftçi et al.	CRITIC-CoCoSo	Turkey	2012-2019
2021	Keleş et al.	ROC-SMART	Turkey	2020
2021	Topal	Entropy-CoCoSo	Turkey	2019
2021	Beller Dikmen	Ratio analysis	Turkey	2015-2018
2005	Sueyoshi	Ratio analysis	USA	
2009	Goto & Sueyoshi	Discriminant analysis	USA	2003
2013	Capece et al.	Ratio analysis	Italy	2008-2010
2016	Yadav et al.	Entropy-TOPSIS	India	2011-2015
2017	Paun	Ratio analysis	Romania	2012-2015
2020	Moon & Min	Data envelopment analysis	Korea	2011-2016
2021	Neves et al.	Data envelopment analysis	Portugal	2010-2014
2022	Zhou & Sun	Entropy-Catastrophe model	China	2013-2020

Several studies analyze the relationship the between financial performance of energy companies and other indicators of companies such as stock returns (Sakarya and Yildirim, 2016), financial leverage (Akhtar et al., 2012; Chemosit and Atheru, 2021); corporate social responsibility (Kludacz-Alessandri and Cyganska, 2021; Shukla and Geetika, 2021), and environmental investment and expenditure (Sueyoshi and Goto, 2009) by using financial ratios.

3. Data and Methodology

In this section, the data set and the process of MEREC and GRA methods are explained.

3.1. Data

The financial performance of listed energy companies in Borsa İstanbul (Turkey) for the years 2020 and 2021 is analyzed using cash flow ratios. Three energy companies listed on BIST are excluded from the data set due to data deficiency. Table 2 demonstrates the companies as decision alternatives have been analyzed in this study.

Table 2. Decision Alternatives

Alternative Nu	The Company
A1	Ak Enerji Elektrik Üretim A.Ş.
A2	Aksa Enerji Üretim A.Ş.
A3	Aksu Enerji ve Ticaret A.Ş.
A4	Doğu Aras Enerji Yatırımları A.Ş.
A5	Aydem Yenilenebilir Enerji A.Ş.
A6	Ayen Enerji A.Ş.
A7	Biotrend Çevre ve Enerji Yatırımları A.Ş.
A8	Çan2 Termik A.Ş.
A9	Enerjisa Enerji A.Ş.
A10	Esenboğa Elektrik Üretim A.Ş.
A11	Galata Wind Enerji A.Ş.
A12	Margün Enerji Üretim Sanayi ve Ticaret A.Ş.
A13	Naturel Yenilenebilir Enerji Ticaret A.Ş.
A14	Odaş Elektrik Üretim Sanayi Ticaret A.Ş.
A15	Pamel Yenilenebilir Elektrik Üretim A.Ş.
A16	Zorlu Enerji Elektrik Üretim A.Ş.

The companies will be benchmarked by their seven cash flow ratios as decision criteria. The ratios are calculated using the financial data of companies that were obtained from the income statement, balance sheet, and statement of cash flows of companies published on the website www.kap.org.tr.Table 3 summarizes the measures of cash flow ratios used as decision criteria.

Table 3. Decision Criteria (Cash Flow Ratios)

Ratio	Code	Indicator	Formation
Cash Sufficiency	C1	Long-term debt payments	Long-term debt payments / CFO
	C2	Cash debt coverage	CFO / Total debts
	C3	Cash flow adequacy	CFO / (Asset purchase + Long-term debts + Cash dividend)
	C4	Reinvestment	Asset purchase/CFO
Cash Efficiency	C5	Operating cash margin	CFO/Sales
	C6	Cash flow return on assets	CFO/Total Assets
	C7	Operations index	CFO/Earnings Before Tax

*CFO; cash flow from operations.

The cash sufficiency ratios describe the relationship between several costs and liabilities incurred by a business and the cash generated from core business operations. The ability of a company to have sufficient cash to pay its debts, dividends to shareholders, and also reinvest in its activities is measured by the cash sufficiency ratios (Sunmola, 2021; s.16). Long-term debt payment, cash flow adequacy ratio, cash debt coverage ratio, and reinvestment ratio are several cash sufficiency ratios. The long-term debt payment ratio indicates the sufficiency of cash flow to settle long-term debt payments. The cash debt coverage ratio measures a company's ability to repay its total debts by comparing the cash flow from operations. The cash flow adequacy ratio evaluates the ability to generate sufficient cash to meet primary obligations such as long-term debt, asset purchase, and distributed

dividends. The reinvestment ratio measures the company's ability to pay for its non-current assets out of cash from operations.

Operating cash margin, cash flow returns on assets, and operation index ratios measure the cash efficiency of companies. These efficiency ratios evaluate how effectively a company manages its assets and liabilities (Sunmola, 2021; s.18). The operating cash margin indicates the percentage of each dollar sale from operating activities that is realized as cash. The cash flow return on assets ratio evaluates the cash flow from assets utilized. The operations index compares cash flow from operating activities with income from continued activities.

3.2. Criteria Weight Determination with MEREC Method

Determination of criteria weights is vital for a multi-criteria decision-making process. The weighting methods are divided into subjective and objective methods in the literature. The subjective weighting methods are based on direct judgments and opinions of decision-makers. Meanwhile, the initial data defined in the multi-criteria decision-making problem-solving matrices support objective criteria weights (Keshavarz-Ghorabaee et al., 2021; s.17).

Keshavarz-Ghorabaee et al. (2021) proposed the MEREC method as an objective weight determination method. This method consists of the following steps.

Step 1: Construct the decision matrix as seen in Equation (1).

$$D = [dij]_{mxn} \quad (1)$$

The dij value is the value of the alternative i in the j criterion. If the dij value is negative, it should be converted to positive using appropriate methods. In this study, the Z-score standardization method, which was proposed by Zhang et al. (2014), is used. Z-score standardization is calculated by using Equation 8 and Equation 9.

Step 2: Perform the normalization process.

Decision matrix normalization can be done in two different ways. Equation 2 is used for benefit criterias, that are, for values that should be maximum. Equation 3 is used for cost criterias, that are, for the values that must be minimum.

$$d_{ij}^{*} = \frac{mind_{ij}}{d_{ij}} \quad (2)$$

$$d_{ij}^{*} = \frac{d_{ij}}{max_{dij}} \quad (3)$$

Step 3: Calculate the overall performance (Si) of the alternatives using Equation 4.

In this step, an equal criterion weighted logarithmic measure is used to calculate overall performance.

$$S_i = \ln\left(1+\left(\frac{1}{m}\sum_j |\ln(d_{ij}^{*})|\right)\right) \quad (4)$$

Step 4: Calculate 'S'_{ij}' values using Equation 5.

In this step, it is calculated by removing each criterion to get the 'S'_{ij}' values. It is formed by removing each criterion separately. In this way, the changes in the performance value of the alternatives are calculated.

$$S'_{ij} = \ln\left(1+\left(\frac{1}{m}\sum_{k,k\neq j} |\ln(d_{ik}^{*})|\right)\right) \quad (5)$$

Step 5: Compute the summation of the absolute deviations using Equation 6.

In this step, the removal effect of the criterias is calculated.

$$E_j = \sum_i |S'_{ij} - S_i| \quad (6)$$

Step 6: Calculate the weights of criteria (wj) using Equation 7.

$$w_j = \frac{E_j}{\sum_k E_k} \quad (7)$$

In the Z-score standardization method, the elements of the decision matrix are transformed using Equation 8 first. Then negative values in the decision matrix are converted to positive ones using Equation 9.

$$x_{ij} = \frac{X_{ij} - \overline{X_{ij}}}{S_j} \quad (8)$$

x_{ij} is the standardized data of the ith index in the jth region

X_{ij} is the original data

$\bar{X}_j$ is the mean value of the jth criteria

S_j is the standard deviation of the jth criteria

$$x'_{ij} = x_{ij} + A \quad A > |\min x_{ij}| \quad (9)$$

x'_{ij} is the standard value after transformation. $x'_{ij} > 0$.

Based on the above procedure, we can get the weights of financial performance criteria, as shown in Table 6.

3.3. Grey Relational Analysis Method

Grey relational analysis is one of the methods of MCDM techniques used for decision making. The GRA method was proposed by Deng in 1982. GRA is an objective and quantitative approach to analyzing the relationship among various sequences based on the similarity of the geometric patterns of sequence curves. GRA is an effective method for grey systems and has wider usage in many fields, such as financial investment, optimal selection, and energy sustainability (Yi et al., 2021; s.2). GRA is a quantitative analysis and shows the similarity and dissimilarity between the reference and alternative series. The alternative series which has the closest similarity to the reference series is the best alternative for the problem (Hamzaçebi and Pekkaya, 2011; s.9186). The GRA function deals with alternative ranking, performance measurement, relationship analysis, optimal selection, and factor effect evaluation (Arce et al., 2015; s.927).

The grey relational analysis method consists of 6 steps. The steps of the algorithm are explained below (Zhai et al., 2009; s.7076).

Step 1: Create the decision matrix as seen in Equation (10).

A decision matrix of mxn consists of m alternatives and n criteria.

$$X_i = \begin{bmatrix} x_1(1), x_1(2) \dots x_1(n) \\ \vdots \quad \ddots \quad \vdots \\ x_m(1), x_m(2) \dots x_m(n) \end{bmatrix} \quad (10)$$

Step 2: Create the reference series.

Reference series ;

$x_0 = (x_0(1), x_0(2), \dots, x_0(j), \dots, x_0(n))$

$x_0(j)$ is the maximum value of the j. criterion within the normalized values.

Step 3: Perform the normalization process.

Decision matrix normalization can be done in three different ways.

Equation 11 is used to convert the benefit (desired to be maximum), Equation 12 cost (desired to be minimum), and Equation 13 to convert the average type criterion values to standard values.

$$x_i^*(j) = \frac{x_i(j) - min_j x_i(j)}{max_j x_i(j) - min_j x_i(j)} \quad (11)$$

$$x_i^*(j) = \frac{max_j x_i(j) - x_i(j)}{max_j x_i(j) - min_j x_i(j)} \quad (12)$$

$$x_i^*(j) = \frac{|x_i(j) - x_{ob}(j)|}{max_j x_i(j) - x_{ob}(j)} \quad (13)$$

$x_{ob}(j)$ is the target value of the j.criterion in Equation 14.

$$max_j x_i(j) \geq x_{ob}(j) \geq min_j x_i(j) \quad (14)$$

After these calculations, the final state of the decision matrix is as in Equation 15.

$$X_i^* = \begin{bmatrix} x_1^*(1), x_1^*(2) \dots x_1^*(n) \\ \vdots \quad \ddots \quad \vdots \\ x_m^*(1), x_m^*(2) \dots x_m^*(n) \end{bmatrix} \quad (15)$$

Step 4: The absolute value table was created according to Equation 16.

The absolute value ($\triangle_{0i}(j)$) between x_0^* and x_i^* was calculated using Equation 16.

$$\triangle_{0i}(j) = |x_0^*(j) - x_i^*(j)| \quad (16)$$

$$\triangle = \begin{bmatrix} \triangle_{01}(1) \triangle_{01}(2) \dots \triangle_{01}(n) \\ \vdots \quad \ddots \quad \vdots \\ \triangle_{0m}(1) \triangle_{0m}(2) \dots \triangle_{0m}(n) \end{bmatrix}$$

Step 5: The grey relational coefficient matrix is calculated using Equation 17.

$$\gamma_{0i}(j) = \frac{\triangle_{min} + \zeta \triangle_{max}}{\triangle_{0i}(j) + \zeta \triangle_{max}} \quad (17)$$

It is the ζ distinguish coefficient in Equation 17. It must take a value in the range [0,1]. In the literature, it is generally recommended to take 0.5.

The Maximum value in Equation 17 is calculated using Equation 18 and the minimum value is calculated using Equation 19.

$$\triangle_{max} = max_i\ max_j\ \triangle_{0i}(j) \quad (18)$$

$$\triangle_{min} = min_i\ min_j\ \triangle_{0i}(j) \quad (19)$$

Step 6: Calculate the grey relational degree.

Γoi, indicates the grey relational degree of the i.element. If the criteria weights are of equal importance, Equation 20, if different criteria weights are used, Equation 21 is used to calculate the grey degree of relationship.

$$\Gamma_{0i} = \frac{1}{n} \sum_{j=1}^{n} \gamma_{0i}(j) \quad (20)$$

$$\Gamma_{0i} = \sum_{j=1}^{n}[W_i(j)x\,\gamma_{0i}(j)\,] \quad (21)$$

4. Empirical Results

Seven cash flow ratios of two periods for sixteen companies are shown in Table 4.

Table 4. The decision matrix of the energy companies concerning cash flow ratios (2020-2021)

	2020								2021						
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**		**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
A1	15,753	0,054	0,059	0,060	0,170	0,055	-0,320		8,657	0,088	0,100	0,163	0,258	0,077	-0,351
A2	0,742	0,251	0,669	0,208	0,170	0,129	1,735		1,657	0,150	0,231	1,820	0,109	0,073	0,629
A3	2,057	0,297	0,366	0,342	1,191	0,237	-2,293		2,974	0,182	0,279	0,268	0,746	0,154	-0,696
A4	0,217	0,500	4,113	0,007	0,201	0,250	1,234		4,973	0,024	0,179	0,089	0,006	0,012	0,076
A5	3,903	0,084	0,090	0,070	0,800	0,086	-1,501		6,354	0,223	0,243	0,245	1,179	0,065	-102,044
A6	4,367	0,168	0,202	0,437	0,726	0,124	-5,073		4,796	0,139	0,202	0,002	0,332	0,094	3,667
A7	6,954	0,086	0,078	5,420	0,216	0,065	0,892		2,386	0,256	0,263	1,352	0,763	0,179	16,020
A8	6,428	0,103	0,141	0,604	0,273	0,073	-1,345		0,610	0,934	0,588	1,024	2,299	0,494	-10,042
A9	1,920	0,221	0,406	0,080	0,178	0,157	2,740		0,957	0,230	0,596	0,149	0,166	0,161	1,609
A10	4,111	0,063	0,074	0,086	0,523	0,061	1,021		-1,110	-0,866	-1,550	-0,128	-1,552	-0,148	-0,836
A11	1,077	0,393	0,334	1,562	0,812	0,168	1,370		1,249	0,415	0,563	0,268	0,591	0,181	1,627
A12	4,020	0,121	0,170	0,086	0,864	0,070	1,115		0,947	0,648	0,904	0,111	1,985	0,172	0,995
A13	-7,838	-0,071	-0,087	-0,382	-0,303	-0,032	-0,467		-2,156	-0,274	-0,377	-0,374	-0,728	-0,075	-0,441
A14	22,463	0,025	0,040	2,393	0,068	0,019	-0,146		0,659	0,822	0,529	1,150	1,877	0,389	-16,709
A15	3,645	0,126	0,161	0,018	0,988	0,070	-16,741		9,074	0,087	0,085	2,657	0,358	0,015	0,798
A16	5,325	0,101	0,171	0,132	0,225	0,090	13,364		9,163	0,068	0,100	0,170	0,172	0,056	-10,259

The decision matrix includes negative values because of that decision matrix has been transformed as Zhang et al. (2014) proposed and shown in Table 5.

Table 5. The transformed decision matrix of the energy companies concerning cash flow ratios (2020-2021)

	2020								2021						
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**		**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
A1	4,488	2,118	2,455	2,390	2,161	2,209	2,826		5,143	3,363	3,468	3,135	3,338	3,356	3,884
A2	2,242	3,483	3,066	2,493	2,160	3,208	3,179		3,191	3,513	3,708	5,163	3,186	3,331	3,921
A3	2,439	3,801	2,763	2,587	4,668	4,671	2,488		3,558	3,590	3,797	3,263	3,837	3,843	3,871
A4	2,163	5,200	6,522	2,353	2,236	4,837	3,093		4,116	3,210	3,613	3,044	3,081	2,943	3,900
A5	2,715	2,325	2,486	2,396	3,709	2,626	2,623		4,501	3,688	3,729	3,236	4,279	3,278	0,010
A6	2,784	2,908	2,598	2,653	3,527	3,142	2,011		4,067	3,486	3,655	2,937	3,414	3,462	4,037
A7	3,172	2,340	2,474	6,135	2,274	2,341	3,034		3,394	3,767	3,767	4,591	3,854	4,003	4,508
A8	3,093	2,454	2,537	2,770	2,413	2,452	2,650		2,899	5,388	4,361	4,189	5,424	6,011	3,515
A9	2,418	3,272	2,802	2,404	2,180	3,584	3,351		2,996	3,704	4,377	3,118	3,244	3,893	3,959
A10	2,746	2,177	2,470	2,408	3,029	2,288	3,056		2,420	1,080	0,449	2,778	1,488	1,919	3,865
A11	2,292	4,459	2,730	3,439	3,738	3,734	3,116		3,077	4,147	4,316	3,263	3,679	4,016	3,959
A12	2,732	2,577	2,567	2,408	3,865	2,404	3,072		2,993	4,705	4,939	3,071	5,103	3,963	3,935
A13	0,958	1,250	2,309	2,081	1,000	1,028	2,801		2,128	2,499	2,596	2,477	2,330	2,387	3,880
A14	5,493	1,919	2,435	4,020	1,910	1,725	2,856		2,913	5,120	4,254	4,343	4,993	5,346	3,261
A15	2,676	2,613	2,557	2,360	4,169	2,405	0,010		5,259	3,362	3,442	6,188	3,441	2,963	3,928
A16	2,928	2,444	2,567	2,440	2,297	2,684	5,173		5,284	3,317	3,468	3,143	3,250	3,225	3,506

By Eq. (2) and Eq. (3) financial ratios in Table 5 are normalized. After normalizing, the performance of the alternatives is calculated by using Eq. (4). Then the performance of alternatives by removing each criterion is calculated by using Eq. (5). After this calculation, the removal effect of each criterion on the overall performance of the alternatives is calculated based on the deviation-based formula of Equation (6).

By using Equation (7) the weights of financial ratios for the performance evaluation of energy companies in both years are presented in Table 6. As presented in Table 6, the operation index ratio obtained the largest weight among the other financial ratios.

Table 6. Criteria weights

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
2020	0,099	0,072	0,015	0,025	0,095	0,090	0,603
2021	0,041	0,096	0,171	0,028	0,070	0,048	0,546

All of the criteria measuring financial performance are larger-the-better attributes in this study. Using Eq. (11) the results of grey relational generating of alternative nu. 1 is equal to (4,488-0,958) / (5,493-0,958) = 0,779. The entire results of grey relational generating are shown in Table 7.

Table 7: Results of grey relational generating

2020									**2021**						
Alternative nu	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**		**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
X_0	1,000	1,000	1,000	1,000	1,000	1,000	1,000		1,000	1,000	1,000	1,000	1,000	1,000	1,000
A_1	0,779	0,220	0,035	0,076	0,316	0,310	0,545		0,955	0,530	0,672	0,177	0,470	0,351	0,861
A_2	0,283	0,565	0,180	0,102	0,316	0,572	0,614		0,337	0,565	0,726	0,724	0,431	0,345	0,870
A_3	0,327	0,646	0,108	0,125	1,000	0,956	0,480		0,453	0,583	0,746	0,212	0,597	0,470	0,858
A4	0,266	1,000	1,000	0,067	0,337	1,000	0,597		0,630	0,494	0,705	0,153	0,405	0,250	0,865
A5	0,387	0,272	0,042	0,078	0,738	0,419	0,506		0,752	0,605	0,731	0,204	0,709	0,332	0,000
A6	0,403	0,420	0,069	0,141	0,689	0,555	0,388		0,614	0,559	0,714	0,124	0,489	0,377	0,895
A7	0,488	0,276	0,039	1,000	0,347	0,345	0,586		0,401	0,624	0,739	0,570	0,601	0,509	1,000
A8	0,471	0,305	0,054	0,170	0,385	0,374	0,511		0,244	1,000	0,871	0,461	1,000	1,000	0,779
A9	0,322	0,512	0,117	0,080	0,322	0,671	0,647		0,275	0,609	0,875	0,173	0,446	0,482	0,878
A10	0,394	0,235	0,038	0,081	0,553	0,331	0,590		0,092	0,000	0,000	0,081	0,000	0,000	0,857
A11	0,294	0,812	0,100	0,335	0,746	0,710	0,602		0,301	0,712	0,861	0,212	0,557	0,513	0,878
A12	0,391	0,336	0,061	0,081	0,781	0,361	0,593		0,274	0,842	1,000	0,160	0,919	0,499	0,873
A13	0,000	0,000	0,000	0,000	0,000	0,000	0,541		0,000	0,329	0,478	0,000	0,214	0,114	0,861
A14	1,000	0,169	0,030	0,478	0,248	0,183	0,551		0,249	0,938	0,847	0,503	0,891	0,837	0,723
A15	0,379	0,345	0,059	0,069	0,864	0,362	0,000		0,992	0,530	0,666	1,000	0,496	0,255	0,871
A16	0,434	0,302	0,061	0,089	0,354	0,435	1,000		1,000	0,519	0,672	0,179	0,448	0,319	0,777

In Table 7, X0 is the reference sequence. For example, Δ_11=|1-0,779|=0,221, Δ_max=1, Δ_min=0 , if f = 0.5, then c(x01, x11) = (0 + 0.5 . 1)/(0.221 + 0.5 · 1) = 0.693. The entire results for the grey relational coefficient are shown in Table 8.

Table 8: Results of grey relational coefficient

	2020								**2021**						
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**		**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**
A1	0,693	0,391	0,341	0,351	0,422	0,420	0,524		0,918	0,515	0,604	0,378	0,485	0,435	0,783
A2	0,411	0,535	0,379	0,358	0,422	0,539	0,564		0,430	0,535	0,646	0,644	0,468	0,433	0,793
A3	0,426	0,585	0,359	0,364	1,000	0,920	0,490		0,478	0,545	0,663	0,388	0,554	0,486	0,779
A4	0,405	1,000	1,000	0,349	0,430	1,000	0,554		0,575	0,497	0,629	0,371	0,457	0,400	0,787
A5	0,449	0,407	0,343	0,352	0,657	0,463	0,503		0,668	0,559	0,650	0,386	0,632	0,428	0,333
A6	0,456	0,463	0,349	0,368	0,616	0,529	0,449		0,564	0,531	0,636	0,363	0,495	0,445	0,827
A7	0,494	0,408	0,342	1,000	0,434	0,433	0,547		0,455	0,571	0,657	0,537	0,556	0,505	1,000
A8	0,486	0,418	0,346	0,376	0,449	0,444	0,506		0,398	1,000	0,795	0,481	1,000	1,000	0,694
A9	0,424	0,506	0,362	0,352	0,424	0,603	0,586		0,408	0,561	0,800	0,377	0,474	0,491	0,804
A10	0,452	0,395	0,342	0,352	0,528	0,428	0,549		0,355	0,333	0,333	0,352	0,333	0,333	0,778
A11	0,415	0,727	0,357	0,429	0,663	0,633	0,557		0,417	0,634	0,783	0,388	0,530	0,506	0,804
A12	0,451	0,430	0,348	0,352	0,695	0,439	0,551		0,408	0,759	1,000	0,373	0,860	0,500	0,797
A13	0,333	0,333	0,333	0,333	0,333	0,333	0,521		0,333	0,427	0,489	0,333	0,389	0,361	0,782
A14	1,000	0,376	0,340	0,489	0,399	0,380	0,527		0,400	0,889	0,766	0,501	0,820	0,755	0,643
A15	0,446	0,433	0,347	0,349	0,786	0,439	0,333		0,985	0,515	0,600	1,000	0,498	0,402	0,795
A16	0,469	0,417	0,348	0,354	0,436	0,469	1,000		1,000	0,510	0,604	0,379	0,475	0,423	0,692

In this paper, the importance of all performance attributes was defined by the MEREC method as seen in Table 6. By using Eq. (21), the grey relational grades and rankings of two periods can be calculated and are shown in Table 9.

As shown in Table 9, PAMEL has the lowest score of 0,4050 and ZOREN has the highest score of 0,7775 in 2020. The rankings of nine companies are among the scores of 0,50 and 0,59. The rankings of five companies are less than 0,5, which indicates the poor financial performance of companies in 2020. BIOEN with a score of 0,8097

and AYDEM with a score of 0,4449 got the highest and lowest ranks respectively in 2021. While one company ranked less than 0,5, one company ranked between 0,5 and 0,59. Fourteen companies have higher grey relational grades which indicate better cash management performance in 2021. The results in Table 9 may indicate the negative COVID-19 effect on the financial performance of companies in 2020.

Table 9. Grey relational grades and rankings (2020-2021)

		2020		2021	
		Grey relational grade	**Ranking**	**Grey relational grade**	**Ranking**
AKENR	A1	0,5049	11	0,6833	11
AKSEN	A2	0,5231	8	0,6838	9
AKSUE	A3	0,5730	3	0,6835	10
ARASE	A4	0,6015	2	0,6701	12
AYDEM	A5	0,4956	12	0,4499	16
AYEN	A6	0,4706	14	0,7004	7
BIOEN	A7	0,5187	9	0,8097	1
CANTE	A8	0,4808	13	0,7586	3
ENJSA	A9	0,5412	5	0,7134	5
ESEN	A10	0,5075	10	0,5773	15
GWIND	A11	0,5656	4	0,7229	4
MAGEN	A12	0,5281	7	0,7903	2
NATEN	A13	0,4465	15	0,6189	14
ODAS	A14	0,5338	6	0,6917	8
PAMEL	A15	0,4050	16	0,7085	6
ZOREN	A16	0,7775	1	0,6352	13

It is observed that the financial performance of ZOREN has decreased markedly. A sharp decrease of operations index of ZOREN in 2021 might cause its decreasing financial performance ranking or grey relational grade.On the contrary, the financial performance of BIOEN has significantly increased over two years due to a noticeable increase of its operation index.

The financial performance of company ARASE and AKSUE, which ranked second and third in 2020, decreased significantly in 2021.This significant decrease of in ARASE's financial performance might be related to the decrease in its operation index. The operation index of AKSUE is negative for both years. Decreasing in its financial performance can be caused by a significant decrease in its operating cash margin. The increase in the operation index of AYEN, PAMEL which had the weakest financial performance in 2020, is accompanied by their higher financial performance in 2021.

The number of initially publicly offered energy companies increased in 2020. Therefore, Table 9 is useful for analyzing financial performance of newer listed energy companies in BIST. The companies which are initially publicly offered in 2020 are ARASE, AYDEM, BIOEN, CANTE, GWIND, MAGEN, and PAMEL. The financial performance of these companies have increased between the years 2020 and 2021 except for ARASE and AYDEM.

Keles et al. (2021) have found the financial performance of ZOREN has the lowest performance in 2020, while ZOREN has the best performance in 2020. The difference between rankings results from using conventional or cash financial ratios.

5. Conclusion

The countries need energy to industrialize, digitalize, and develop. The role of energy in the sustainable development of countries is indisputable. Therefore; the performance of energy companies should be evaluated to analyze the success of countries to reach sustainable development goals. This paper aims to rank the level of financial performance of sixteen energy companies in Borsa Istanbul during the COVID-19 period. The cash sufficiency and cash efficiency ratios are used to measure the financial performance of companies; because the cash ratios are better than conventional financial ratios in analyzing financial performance.

Multi-criteria decision making methods have been used increasingly in financial performance analysis and benchmarking of companies. The grey relational analysis is used to measure the grades of financial performance of companies and benchmark them. The steps of grey relational analysis; normalization of a decision matrix, the calculation of reference sequence and the grey coefficient, and obtaining the final grey relational grades by multiplying the relative weight by relational coefficients. The MEREC method is used to determine the weight of cash ratios/criteria.

As a result of the study, PAMEL performed the poorest financial performance with a score of 0,4050 while ZOREN got the highest rank with a score of 0,7775 which shows its higher financial performance in 2020. BIOEN with a score of 0,8097 and AYDEM with a score of 0,4449 got the highest and lowest ranks respectively in 2021. It has been seen that the operation index is important in the decrease and increase of companies' financial performance.

According to grey relational grades in Table 9, while most of the companies have weak financial performance in 2020, the companies improve their financial performance in 2021. The weaker financial performance in 2020 may result from the negative COVID-19 effect on companies. Most of the initially publicly offered energy companies also increased their financial performance between the years 2020 and 2021 except for ARASE and AYDEM.

References

AKHTAR, S., JAVED, B., MARYAM, A. and SADIA, H. (2012). Relationship Between Financial Leverage And Financial Performance: Evidence From Fuel & Energy Sector of Pakistan. *European Journal of Business and Management, 4*(11), 7-17.

ARCE, M. E., SAAVEDRA, Á., MÍGUEZ, J. L. and GRANADA, E. (2015). The use of grey-based methods in multi-criteria decision analysis for the evaluation of sustainable energy systems: A review. *Renewable and Sustainable Energy Reviews, 47*, 924-932.

AVCI, M. C. (2019). Çok Kriterli Karar Verme Yöntemleriyle Enerji Sektöründe Faaliyet Gösteren Firmalarda Performans Analizi. Yüksek Lisans Tezi, İstanbul: Marmara Üniversitesi Sosyal Bilimler Enstitüsü.

BAĞCI, H. and YÜKSEL YİĞİTER, Ş. (2019). BİST'te Yer Alan Enerji Şirketlerinin Finansal Performansının SD ve WASPAS Yöntemleriyle Ölçülmesi. *Bingöl Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 9* (18), 877-898.

BELLER DİKMEN, B. (2021). Elektrik Enerjisi Sektörünün Finansal Performanslarının Oran Analizi Yöntemi ile İncelenmesi. *İşletme Araştırmaları Dergisi, 13* (1), 912-926.

CAPECE, G., PILLO, F. D. and LEVIALDI, N. (2013). The Performance Assessment of Energy Companies. *APCBEE Procedia, 5*, 265 – 270. doi: 10.1016/j.apcbee.2013.05.046.

CHEMOSIT, J. and ATHERU, G. (2021). Financial Leverage and Performance of the Energy and Petroleum Sector Companies Listed in the Nairobi Securities Exchange. *International Journal of Current Aspects in Finance, Banking, and Accounting, 3*(2), 113-128.

ÇİFTÇİ, H. N., KUZU YILDIRIM, S. and YILDIRIM, B. F. (2021). Nakit Akış Oranlarına Dayalı Finansal Performansların Kombine Uzlaşık Çözüm Yöntemi ile Analizi: BİST'te İşlem Gören Enerji Firmaları Üzerine Bir Uygulama. *Muhasebe ve Finansman Dergisi*, (92), 207-224.

ÇİFTÇİ, H. V. and YILDIRIM, B. F. (2020). BİST Enerji Sektöründe Faaliyet Gösteren İşletmelerin Finansal Performanslarının İncelenmesi: Gri Sayılara Dayalı Zaman Kesiti Örneği. *Muhasebe Bilim Dünyası Dergisi, 22*(3), 384-404.

DENG, J. L. (1982). Grey System Fundamental Method. Huazhong University of Science and Technology, Wuhan, China.

EYÜBOĞLU, K. and ÇELİK, P. (2016). Financial Performance Evaluation of Energy Companies with Fuzzy AHP And Fuzzy TOPSİS Methods. *Business and Economics Research Journal, 7*(3), 21-37.

GOTO, M. and SUEYOSHI, T. (2009). "Financial Ratio Analysis: An Application to US Energy Industry", (Eds: Lee, Jeong-Dong and Heshmati, Almas) Productivity, Efficiency and Economic Growth in the Asia – Pacific Region Contributions to Economics (59-79). Physica: Verlag Heidelberg.

GÜLER, G. (2019). Çok Kriterli Karar Verme ile Finansal Performans Analizi Üzerine Bir Uygulama. Yüksek Lisans Tezi, Balıkesir: Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü.

HAMZAÇEBİ, C. and PEKKAYA, M. (2011). Determining of Stock Investments with Grey Relational Analysis. *Expert Systems with Applications, 38*, 9186-9195.

HERTENSTEIN, J. H., and MCKINNON, S. M. (1997). Solving The Puzzle of the Cash Flow Statement. *Business Horizons*, January-February 1997.

İSKENDEROĞLU, Ö., KARADENİZ, E. and AYYILDIZ, N. (2015). Enerji Sektörünün Finansal Analizi: Türkiye ve Avrupa Enerji Sektörü Karşılaştırması. *İşletme ve İktisat Çalışmaları Dergisi, 3*(3), 86 – 97.

KARCIOĞLU, R., YALÇIN, S. and GÜLTEKİN, Ö.F. (2020). Sezgisel Bulanık Mantık ve Entropi Tabanlı Çok Kriterli Karar Verme Yöntemiyle Finansal Performans Analizi: BİST'te İşlem Gören Enerji Şirketleri Üzerine Bir Uygulama. *Manas Sosyal Araştırmalar Dergisi, 9*(1), 360 – 373.

KAYAHAN KARAKUL, A. and ÖZAYDIN, G. (2019). TOPSIS ve VIKOR Yöntemleri ile Finansal Performans Değerlendirmesi: XELKT Üzerinde Bir Uygulama. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 60*, 68-86.

KELEŞ, M. K., ARMAĞAN, İ. Ü. and ÖZDAĞOĞLU, A. (2021). Elektrik Enerjisi Üreten Şirketlerin Covid-19 Salgın Ortamındaki Finansal Performanslarının ROC ve SMART Bütünleşik Yaklaşımı İle Analizi. *BŞEÜ Sosyal Bilimler Dergisi, 6*(2), 227-235.

KESHAVARZ-GHORABAEE, M., AMIRI, M., ZAVADSKAS, E.K., TURSKIS, Z. and ANTUCHEVICIENE, J. (2019). Determination of Objective Weights Using A New Method Based on the Removal Effects of Criteria (MEREC). *Symmetry, 13*, 525. https://doi.org/10.3390/ sym13040525.

KLUDACZ-ALESSANDRI, M. and CYGANSKA, M. (2021). Corporate Social Responsibility and Financial Performance Among Energy Sector Companies. *Energies, 14*. https://doi.org/10.3390/en14196068.

KUVAT, Ö. and GÜLER, G. (2020). Energy Sector Analysis with Fuzzy TOPSIS. *International Scientific and Vocational Journal, 4*(1), 37-48.

LINKOV, I. and MOBERG, E. (2012). *Multi-Criteria Decision Analysis: Environmental Applications and Case Studies*. CRC Press.

MERCAN, Y. and ÇETİN, O. (2020). COPRAS ve VIKOR Yöntemleri ile BIST Elektrik Endeksindeki Firmalarının Finansal Performans Analizi. *Uluslararası Afro-Avrasya Araştırmaları Dergisi, 5*(9), 123-139.

METİN, S., YAMAN, S. and KORKMAZ, T. (2017). Finansal Performansın TOPSIS ve MOORA Yöntemleri ile Belirlenmesi: BİST Enerji Firmaları Üzerine Karşılaştırmalı bir Uygulama. *KSÜ Sosyal Bilimler Dergisi, 14* (2), 371-394.

MOON, H. and MIN, D. (2020). A DEA Approach for Evaluating the Relationship Between Energy Efficiency and Financial Performance for Energy-Intensive Firms in Korea. *Journal of Cleaner Production, 255*. https://doi.org/10.1016/j.jclepro.2020.120283.

NEVES, M. E., HENRIQUES, C. and VILAS, J. (2021). Financial Performance Assessment of Electricity Companies: Evidence From Portugal. *Operational Research, 21*, 2809–2857.https://doi.org/10.1007/s12351-019-00504-1.

ORÇUN, Ç. (2019). Enerji Sektöründe WASPAS Yöntemiyle Performans Analizi. *BAİBÜ Sosyal Bilimler Enstitüsü Dergisi, 19* (2), 439-453.

PAUN, D. (2017). Sustainability and Financial Performance of Companies in the Energy Sector in Romania. *Sustainability, 9*, 1722. doi:10.3390/su9101722.

PORWAL, H. K. and JAIN, S. (2013). Cash Flow Ratios to Predict Investments Soundness. *Asia-Pacific Finance and Accounting Review, 1* (4), 55–76.

SAKARYA, Ş. and YILDIRIM, H. H. (2016). Determining The Relation Between Financial Performance and Stock Returns of Energy Companies on Borsa İstanbul with Panel Data Analysis. *Journal of Economics, Finance, and Accounting, 3* (1), 71 – 88.

SAKARYA, Ş., YILDIRIM, H. H. and AKKUŞ, H. T. (2015). Bist'de İşlem Gören Enerji Şirketlerinin Finansal Performanslarının TOPSIS Çok Kriterli Karar Verme Yöntemi İle Belirlenmesi. 19. Finans Sempozyumu, Çorum: 21 - 24 EKİM 2015.

SHUKLA, A. and GEETIKA, N. A. (2021). Impact of Corporate Social Responsibility on Financial Performance of Energy Firms in India. *International Journal of Business Governance and Ethics, 1*(1).

SUEYOSHI, T. (2005) Financial Ratio Analysis of the Electric Power Industry, *Asia-Pacific Journal of Operational Research, 22*(3): 349-376.

SUEYOSHI, T. and GOTO, M. (2009). Can Environmental Investment and Expenditure Enhance Financial Performance of US Electric Utility Firms Under the Clean Air Act Amendment Of 1990? *Energy Policy, 37*, 4819-4826.

SUNMOLA, P. T. (2021). The Use of Cash Flow Ratios for Risk Evaluation in An Organisation. Bachelor's thesis, Tallinn: Tallinn University of Technology School of Business and Governance.

TOPAL, A. (2021). Çok Kriterli Karar Verme Analizi İle Elektrik Üretim Şirketlerinin Finansal Performans Analizi: Entropi Tabanlı Cocoso Yöntemi. *Business and Management Studies: An International Journal, 9* (2), 532-546. https://doi.org/10.15295/bmij.v9i2.1794.

YADAV, S. K., KAPOOR, R. and DHAIGUDE, A. (2016). Financial Performance Ranking of Oil and Gas Companies in India Using TOPSIS Method. *International Journal of Applied Business and Economic Research, 14* (6), 4463-4473.

YI, P., DONG, Q., LI, W. and WANG, L. (2021). Measurement of City Sustainability Based on the Grey Relational Analysis: The Case of 15 Sub-Provincial Cities in China. *Sustainable Cities and Society, 73*, https://doi.org/10.1016/j.scs.2021.103143.

ZHAI, L. Y., KHOO, L. P. and ZHONG, Z. W. (2009). Design Concept Evaluation in Product Development Using Rough Sets and Grey Relation Analysis. *Expert Systems with Applications, 36*(3), 7072-7079. http://dx.doi.org/10.1016/j.eswa.2008.08.068

ZHANG, X., WANG, C., LI, E. and XU, C. (2014). Assessment Model of Ecoenvironmental Vulnerability Based on Improved Entropy Weight Method. *The Scientific World Journal*, http://dx.doi.org/10.1155/2014/797814.

ZHOU, H. and SUN, J. (2022). Do New Energy Power Generation Companies Have Better Financial Performance? An Analysis For China's Power Generation Industry. E*nergy Sources, Part B: Economics, Planning, and Policy*, https://doi.org/10.1080/15567249.2021.2023707.