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# A Fuzzy Multi-Criteria Decision-Making Approach to Financial Performance Analysis of Energy Firms Listed on BIST

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### ABSTRACT

Financial performance analysis plays a crucial role in evaluating a company's financial health, profitability, and long-term sustainability. This study examines the financial performance of ten energy companies listed on the Borsa Istanbul Index through the application of Multi-Criteria Decision-Making (MCDM) techniques and time-series trend analysis. The criteria weights, derived from previous empirical studies, were computed using the MEREC (Method based on the Removal Effects of Criteria) approach, while the ranking of alternatives was conducted using the Fuzzy Einstein TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method. The distinct contribution of this study lies in its integrated use of MCDM and trend-analysis methodologies to provide a comprehensive, longitudinal, and data-driven evaluation of financial performance assessment within the energy sector.

## 1. Introduction

The rapid pace of industrialization, accompanied by technological advancement, has led to a substantial escalation in consumption costs and an annual increase in global energy demand of approximately 4–5% [1]. At the same time, intensified international competition for fossil fuel resources has fostered a highly competitive global energy landscape. Turkiye, a country heavily dependent on imported energy [2], is among the nations most affected by these dynamics. The country's energy demand—particularly for oil and natural gas—are primarily met through external suppliers, underscoring its structural reliance on foreign energy sources.

Companies operating in Turkiye's energy sector possess significant potential to reduce this dependency. However, achieving this objective requires these firms to maintain robust financial structures and demonstrate strong financial performance. Financial performance reflects the extent to which a company effectively manages its resources and sustains profitability over time. This

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performance is typically assessed through the systematic analysis of financial data derived from past operations. By examining historical financial indicators and ratios—such as those calculated from balance sheets and income statements, companies can identify patterns, measure operational efficiency, and make informed strategic decisions for the future [3]. Comparative financial analysis further enables firms to evaluate their standing against industry benchmarks, detect early signs of financial distress, and enhance competitiveness [4].

A review of the extant literature reveals that numerous studies have examined the financial performance of energy companies using diverse analytical frameworks. However, the present study distinguishes itself from prior research in several important respects. First, it specifically focuses on energy companies listed on the Borsa Istanbul (BIST) Index, thereby providing a targeted assessment of the Turkish energy market. Second, it employs the MEREC (Method based on the Removal Effects of Criteria) approach—a relatively recent and innovative Multi-Criteria Decision-Making (MCDM) technique—to determine the weights of evaluation criteria derived from previous studies. Third, the study applies the Fuzzy Einstein TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method to rank alternatives based on their performance. Finally, a time-series trend analysis is conducted using Python programming and relevant libraries to identify and interpret performance patterns over time, offering a dynamic perspective beyond static evaluation.

The structure of the study is as follows: Section 2 presents a review of the relevant literature. Section 3 outlines the research methodology and analytical framework. Section 4 details the implementation of the proposed model, followed by Section 5, which reports the empirical findings and results of the trend analysis. Section 6 concludes the paper by summarizing key findings, discussing their implications, and proposing directions for future research.

## 2. Literature Review

The financial performance analysis of companies is quite popular in the literature, and there is a growing number of studies aiming to explore new directions in this field.

The primary purpose of these studies is to evaluate and select companies' performance in any sector, and these studies utilize various MCDM methods due to their advantages in complex decision-making processes. The relevant social and environmental impacts of the alternatives considered are subject to certain uncertainties [5]. The aim is to obtain the optimum option with the highest level of satisfaction for all relevant features [6]. A summary of some studies conducted in recent years using different MCDM methods is shown in Table 1.

**Table 1**  
 Various similar studies

Year	References	Sector	Method	Year	References	Sector	Method
2025	[7]	Insurance	LOPCOW-RANCOM-RAWEC	2024	[15]	Brokerage	VIKOR-TOPSIS
2025	[8]	Banking	NMV-TOPSIS	2024	[16]	Cement	LODECI-CRADIS
2025	[3]	Energy	COPRAS	2024	[17]	Technology	COCOSO-COPRAS
2025	[9]	Banking	LOPCOW-RAFSI	2023	[18]	Sport	CRITIC-MULTIMOORA-TOPSIS
2025	[10]	Brokerage	ENTROPY-TOPSIS	2023	[19]	Insurance	CRITIC-COCOSO
2025	[11]	Banking	LOPCOW-RAM	2022	[20]	Technology	ARAS-COPRAS
2025	[12]	Insurance	LOPCOW-PIV	2022	[21]	Transportation	TOPSIS-MABAC
2024	[13]	Banking	CRITIC-COPRAS	2021	[22]	Manufacturing	MABAC-MAIRCA
2024	[14]	Banking	TOPSIS	2021	[23]	Transportation	IDOCRIW-MARCOS

In addition to the studies in Table 1, there are a few papers in the literature that use the MEREC method to determine the criteria weights.

This study [24] aimed to evaluate the financial performance of energy companies included in the BIST100 index in 2022. Seven criteria were determined for the analysis, and companies included in the BIST100 index were included as decision alternatives. The MEREC method was used as the criterion weighting method in the study, while the MABAC method was used to rank the alternatives. As a result of the analysis, the companies with the best financial performance for 2022 were identified as ENJSA, AKSEN, and ZOREN, respectively.

In another study [25], the financial performance of 39 different companies in the Chemical, Petroleum, Rubber, and Plastic Products sectors, included in the BIST index, was measured using MCDM methods for the 2021 fiscal year. The Simultaneous Evaluation of Criteria and Alternative (SECA) method was used to weight the criteria and rank the alternatives. The sensitivity analysis used the Method Based on the Removal Effects of Criteria (MEREC)-based Simple Additive Weighting (SAW), Weighted Aggregated Sum Product Assessment (WASPAS) and Range of Value (ROV) methods. To ensure a rational ranking, the Copeland method was used in the final stage. The findings revealed that the top three companies in the ranking were ANGEN, ALKIM, and ACSEL.

In another study [26], the aim was to measure the financial performance of companies included in the BIST Balikesir Index (XSBAL) between the fourth quarter of 2021 and the third quarter of 2023 using MCDM methods. Six criteria were used to analyze the companies' financial performance. The weights of the six criteria were calculated using the MEREC method. After the weighting process, it was determined that the Company Value/Net Sales criterion was the most important criterion in all periods except the first quarter of 2022. The CoCoSo method was used in the ranking of the alternatives, and according to the findings obtained as a result of the analysis, the companies with the best financial performance were YAPRK and GWIND, respectively, while the companies with the lowest financial performance were BANVT and BAGFS.

The complex and non-linear nature of the factors affecting business economics necessitates the use of advanced analytical and decision-support methods in addressing such problems [27]. As can be deduced from the extant literature, there are very few studies that analyse the financial performance of companies—particularly those operating in the energy sector—using the MEREC method. The MEREC method, developed in recent years, is a novel MCDM approach that provides more precise and accurate results [28], therefore, the financial performance analysis of energy companies conducted via MEREC method will make a significant contribution to the literature.

### **3. Methodology**

In this study, MEREC, a MCDM method, was utilized to assign weights to the criteria, and subsequently, the Fuzzy Einstein TOPSIS method was employed to arrange alternatives into a hierarchy. The scope of the study is presented in Figure 1.



Fig. 1. Overview of the proposed framework

### 3.1 MEREC

In 2021, a novel methodology for determining weights in MCDM problems was introduced in [30], termed the MEREC (METHod based on the Removal Effects of Criteria) approach [29]. This approach utilizes the leverage effects of criteria to enhance the efficacy of MCDM decision-making processes. This is an objective weighting method. Logarithmic measures are utilized in the calculation of the performance of alternatives. The impact of the aforementioned criteria on performance is calculated.

The steps of the MEREC method are shown below [30-32].

*Step 1:* The decision matrix is formulated as shown in Equation 1. In this equation,  $m$  denotes the number of alternatives and  $n$  denotes the number of criteria. The elements of the matrix are denoted by  $d_{ij}$ .

$$D = [d_{ij}]_{m \times n} \quad (1)$$

*Step 2:* The benefit criteria of the decision matrix are then normalized using equation 2, and the cost criteria are normalized using Equation 3.

$$d_{ij}^* = \frac{(d_{ij} - \min d_{ij})}{(\max d_{ij} - \min d_{ij})} \quad (2)$$

$$d_{ij}^* = \frac{(\max d_{ij} - d_{ij})}{(\max d_{ij} - \min d_{ij})} \quad (3)$$

*Step 3:* The total performance value ( $S_i$ ) of each alternative is calculated. Equation 4 demonstrates this [30].

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

*Step 4:* The performance of the alternatives is calculated by removing each criterion. The performance of the alternatives can be determined by systematically eliminating each criterion one by one. The quantity  $S'_{ij}$  is calculated in Equation 5 [30].

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

*Step 5:* The sum of absolute deviations ( $E_j$ ) is then calculated. In this step, the effect of removing the criterion on itself is measured.

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

*Step 6:* The weight of the criteria ( $w_j$ ) is calculated as follows [31].

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

### 3.2 Fuzzy Einstein TOPSIS

The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method was developed by [33] as a multi-criteria decision-making technique. The TOPSIS approach is a technique used to solve risk ranking problems that require selecting alternatives according to different criteria. This is based on the principle that the most preferred alternative is not only the one closest to the positive ideal solution, but also the one farthest from the negative ideal solution [34-37].

The development of fuzzy methods has been instrumental in addressing the inherent uncertainties present in real-life scenarios, thereby facilitating the development of more realistic solution approaches. The fuzzy TOPSIS method utilizes triangular fuzzy numbers [38]. The TOPSIS method is a distance-based approach that determines the optimal solution based on the proximity of alternatives to the Fuzzy Positive Ideal Solution (FPIS). In this regard, the optimal alternative is delineated as the alternative that is proximate to the FPIS, whilst concurrently being distant from the Fuzzy Negative Ideal Solution (FNIS). The method also calculates the Closeness Coefficient (CC) value, which contributes to the assessment of risk severity [34].

The utilization of Einstein summation operators to achieve superior outcomes in uncertain circumstances has garnered significant traction within the extant literature. The Fuzzy Einstein TOPSIS approach was presented in [39]. It is evident that the provision of structure by Einstein t-norms and t-conorms has resulted in enhanced efficacy in decision-making models.

The method steps are listed below.

*Step 1:* In the first stage, the alternatives are evaluated using a fuzzy scale for each criterion.

*Step 2:* They are integrated using the fuzzy Einstein weighted average (FEWAA) operator given in Equation (8) to be converted into an aggregate decision matrix [39].

$$\tilde{x}_{ij} = (\tilde{l}_{ij}, \tilde{m}_{ij}, \tilde{u}_{ij}) = \left( \begin{array}{c} \sum_{k=1}^e (l_{ij}^{(k)}) \frac{\prod_{k=1}^e (1+f(l_{ij}^{(k)}))^{1/e} - \prod_{k=1}^e (1-f(l_{ij}^{(k)}))^{1/e}}{\prod_{k=1}^e (1+f(l_{ij}^{(k)}))^{1/e} + \prod_{k=1}^e (1-f(l_{ij}^{(k)}))^{1/e}} \\ \sum_{k=1}^e (m_{ij}^{(k)}) \frac{\prod_{k=1}^e (1+f(m_{ij}^{(k)}))^{1/e} - \prod_{k=1}^e (1-f(m_{ij}^{(k)}))^{1/e}}{\prod_{k=1}^e (1+f(m_{ij}^{(k)}))^{1/e} + \prod_{k=1}^e (1-f(m_{ij}^{(k)}))^{1/e}} \\ \sum_{k=1}^e (u_{ij}^{(k)}) \frac{\prod_{k=1}^e (1+f(u_{ij}^{(k)}))^{1/e} - \prod_{k=1}^e (1-f(u_{ij}^{(k)}))^{1/e}}{\prod_{k=1}^e (1+f(u_{ij}^{(k)}))^{1/e} + \prod_{k=1}^e (1-f(u_{ij}^{(k)}))^{1/e}} \end{array} \right) \quad (8)$$

$$f(t_{ij}^{(k)}) = \frac{t_{ij}^{(k)}}{\sum_{p=1}^e (t_{ij}^{(p)})} \quad (9)$$

$e$  represents expert opinions.

$$y_{ij} = \left( \frac{\bar{l}_{ij} + 4\tilde{m}_{ij} + \tilde{u}_{ij}}{6} \right) \quad (10)$$

**Step 3:** The weighted normalized decision matrix is created. The decision matrices are normalized as in Equation 2 and Equation 3.

And the weighted normalized matrix  $V = [v_{ij}]_{m \times n}$  can be obtained using the weights of criteria as follows:

$$v_{ij} = z_{ij} \times w_j \quad (11)$$

**Step 4:** Positive and negative ideal solutions are calculated.

$$D^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad (12)$$

$$D^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad (13)$$

$$v_j^+ = \begin{cases} \min_{1 \leq i \leq m} (v_{ij}) ; & \text{if } j \text{ is a Cost type criterion} \\ \max_{1 \leq i \leq m} (v_{ij}) ; & \text{if } j \text{ is a Benefit type criterion} \end{cases} \quad (14)$$

$$v_j^- = \begin{cases} \max_{1 \leq i \leq m} (v_{ij}) ; & \text{if } j \text{ is a Cost type criterion} \\ \min_{1 \leq i \leq m} (v_{ij}) ; & \text{if } j \text{ is a Benefit type criterion} \end{cases} \quad (15)$$

**Step 5:** The closeness coefficients of each alternative are calculated and ranked.

$$CC_i = \frac{D^-}{D^- + D^+} \quad (16)$$

#### 4. Case Study

This study examined the following companies in the BIST Index: AHGAZ, AKENR, AKSEN, CANTE, ENJSA, ESEN, ZOREN, MAGEN, ZEDUR, and CONSE. Their performance was evaluated under six different criteria: ROA, ROE, ROS, SIZE, LEV, and LEV2. Explanations of these criteria are provided in Table 2.

**Table 2**  
 Explanations of criteria

Criteria	Explanation
ROA (Net Profit / Total Assets)	It shows how efficiently the company uses its total assets.
ROE (Net Profit / Equity)	It shows how much profit the company has made from the capital of its partners.
ROS (Net Profit / Net Sales)	It shows how much of the revenue from sales is converted into profit.
SIZE	It is usually calculated by taking the logarithm (ln) of the firm's total assets.
LEV (Total Debt / Total Assets)	It shows how much of the company's assets are financed by debt.
LEV2	It is added to the model to analyze the quadratic effect (non-linear effect) of the leverage ratio.

In the first stage of the study, criteria weighting was performed using the MEREC method. Companies were ranked using the resulting criteria weights employing the Fuzzy Einstein TOPSIS method. In the final stage, TOPSIS results were checked using trend analysis. Table 3 shows the normalized matrix.

**Table 3**  
 Normalized matrix

Alternatives/Criteria	ROA	ROE	ROS	SIZE	LEV	LEV2
AHGAZ	0.480273	0.489784	0.11089	0.962464	0.579962	0.359136
AKENR	0	0	0	0.543138	0	0
AKSEN	1	0.778612	0.124563	1	0.733944	0.492364
CANTE	0.889052	0.726403	0.081746	0.801659	1	1
ENJSA	0.866503	1	0.059156	0.030247	0.279113	0.10461
ESEN	0.317002	0.324675	0.249161	0.7696	0.913656	0.754752
ZOREN	0.331097	0.476129	0.108429	0	0.080334	0.051229
MAGEN	0.313054	0.320357	0.37105	0.766218	0.924569	0.77476
ZEDUR	0.702016	0.50504	1	0.431581	0.970753	0.869278
CONSE	0.420394	0.54096	0.12398	0.549867	0.303918	0.127591

Total performance values of the alternatives were calculated and are given in Table 4.

**Table 4**  
 Total performance values

$S_1$	0.718183
$S_2$	0.115183
$S_3$	0.512949
$S_4$	0.490107
$S_5$	1.098804
$S_6$	0.620252
$S_7$	1.068983
$S_8$	0.575605
$S_9$	0.343163
$S_{10}$	0.909597

$S_1$ : AHGAZ,  $S_2$ : AKENR,  $S_3$ : AKSEN,  $S_4$ : CANTE,  $S_5$ : ENJSA,  $S_6$ : ESEN,  $S_7$ : ZOREN,  $S_8$ : MAGEN,  $S_9$ : ZEDUR,  $S_{10}$ : CONSE.

Changes in the performance value of the alternatives are calculated in Table 5.

The weight of each criterion is given in Table 6.

Fuzzy Einstein TOPSIS was used using these criterion weights. The creation of a fuzzy normalized matrix is outlined in Table 7 and Table 8. Subsequently, FPIS and FNIS were calculated in Table 9.

**Table 5**  
 Performance changes

Alternatives/Criteria	ROA	ROE	ROS	SIZE	LEV	LEV2
AHGAZ	0.643968754	0.646026442	0.476767988	0.714444222	0.663586583	0.612962552
AKENR	0.115182617	0.115182617	0.115182617	0	0.115182617	0.115182617
AKSEN	0.512948542	0.48252505	0.226035609	0.512948542	0.47520511	0.424287702
CANTE	0.475595259	0.450159059	0.123689399	0.462649879	0.490107437	0.490107437
ENJSA	1.089207041	1.098803797	0.889971323	0.833302039	1.009907438	0.935729057
ESEN	0.488351495	0.491282436	0.458352186	0.591679079	0.610491818	0.589520509
ZOREN	0.990041765	1.016679676	0.903441905	1.06898283	0.878839825	0.840758928
MAGEN	0.435626298	0.438605214	0.457376358	0.545197545	0.566745311	0.546482123
ZEDUR	0.291653134	0.241199468	0.343162931	0.216190074	0.338941845	0.323082991
CONSE	0.837251655	0.858848105	0.725515281	0.860230873	0.808760134	0.728290517

**Table 6**  
 Weights of criteria

Criteria	Weight	Score
ROA	W1	0,116735552
ROE	W2	0,124989503
ROS	W3	0,353126686
SIZE	W4	0,131852421
LEV	W5	0,100856726
LEV2	W6	0,172439113

**Table 7**  
 Normalized fuzzy matrix

Alternatives/Criteria	ROA (l)	ROA (m)	ROA (u)	ROE (l)	ROE (m)	ROE (u)	ROS (l)	ROS (m)	ROS (u)
AHGAZ	0.432	0.480	0.528	0.441	0.490	0.539	0.100	0.111	0.122
AKENR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AKSEN	0.900	1.000	1.100	0.701	0.779	0.856	0.112	0.125	0.137
CANTE	0.800	0.889	0.978	0.654	0.726	0.799	0.074	0.082	0.090
ENJSA	0.780	0.867	0.953	0.900	1.000	1.100	0.053	0.059	0.065
ESEN	0.285	0.317	0.349	0.292	0.325	0.357	0.224	0.249	0.274
ZOREN	0.298	0.331	0.364	0.429	0.476	0.524	0.098	0.108	0.119
MAGEN	0.282	0.313	0.344	0.288	0.320	0.352	0.334	0.371	0.408
ZEDUR	0.632	0.702	0.772	0.455	0.505	0.556	0.900	1.000	1.100
CONSE	0.378	0.420	0.462	0.487	0.541	0.595	0.112	0.124	0.136

**Table 8**  
 Normalized fuzzy matrix (continued)

Alternatives/Criteria	SIZE (l)	SIZE (m)	SIZE (u)	LEV (l)	LEV (m)	LEV (u)	LEV2 (l)	LEV2 (m)	LEV2 (u)
AHGAZ	0.866	0.962	1.059	0.522	0.580	0.638	0.323	0.359	0.395
AKENR	0.489	0.543	0.597	0.000	0.000	0.000	0.000	0.000	0.000
AKSEN	0.900	1.000	1.100	0.661	0.734	0.807	0.443	0.492	0.542
CANTE	0.721	0.802	0.882	0.900	1.000	1.100	0.900	1.000	1.100
ENJSA	0.027	0.030	0.033	0.251	0.279	0.307	0.094	0.105	0.115
ESEN	0.693	0.770	0.847	0.822	0.914	1.005	0.679	0.755	0.830
ZOREN	0.000	0.000	0.000	0.072	0.080	0.088	0.046	0.051	0.056
MAGEN	0.690	0.766	0.843	0.832	0.925	1.017	0.697	0.775	0.852
ZEDUR	0.388	0.432	0.475	0.874	0.971	1.068	0.782	0.869	0.956
CONSE	0.495	0.550	0.605	0.274	0.304	0.334	0.115	0.128	0.140

**Table 9**  
 Fuzzy Positive Ideal Solution and Fuzzy Negative Ideal Solution

Criteria	FPIS (l)	FPIS (m)	FPIS (u)	FNIS (l)	FNIS (m)	FNIS (u)	Type
ROA	0.096535	0.116736	0.14085	0	0	0	Benefit
ROE	0.103439	0.12499	0.150672	0	0	0	Benefit
ROS	0.298505	0.353127	0.415304	0	0	0	Benefit
SIZE	0.109188	0.131852	0.158826	0	0	0	Benefit
LEV	0	0	0	0.083283	0.100857	0.121903	Cost
LEV2	0	0	0	0.143333	0.172439	0.206797	Cost

The scores of the alternatives were calculated as outlined in Equation 16. The top five companies were ZEDUR, AKSEN, ENJSA, AHGAZ, and CONSE. The ranking of the 10 companies is given in Table 10.

**Table 10**  
 Fuzzy Positive Ideal Solution and Fuzzy Negative Ideal Solution

Alternatives	D+	D-	Score	Rank
AHGAZ	0.592885973	0.427683823	0.419063767	4
AKENR	0.689252397	0.331075037	0.324479208	7
AKSEN	0.49667947	0.523826665	0.513300849	2
CANTE	0.740362606	0.280101132	0.27448416	9
ENJSA	0.533486957	0.486896249	0.477169994	3
ESEN	0.743783167	0.276828461	0.271237808	10
ZOREN	0.66052388	0.359896329	0.352694238	6
MAGEN	0.717396486	0.303234396	0.29710486	8
ZEDUR	0.46877463	0.551763368	0.540659308	1
CONSE	0.610926248	0.409635281	0.401382248	5

## 5. Results and Trend Analysis

The data set was created according to ROA, ROE, ROS, SIZE, LEV and LEV2 criteria of 10 different companies in BIST Index in 2022, 2023 and 2024. The data set is given in Table 11 and Table 12.

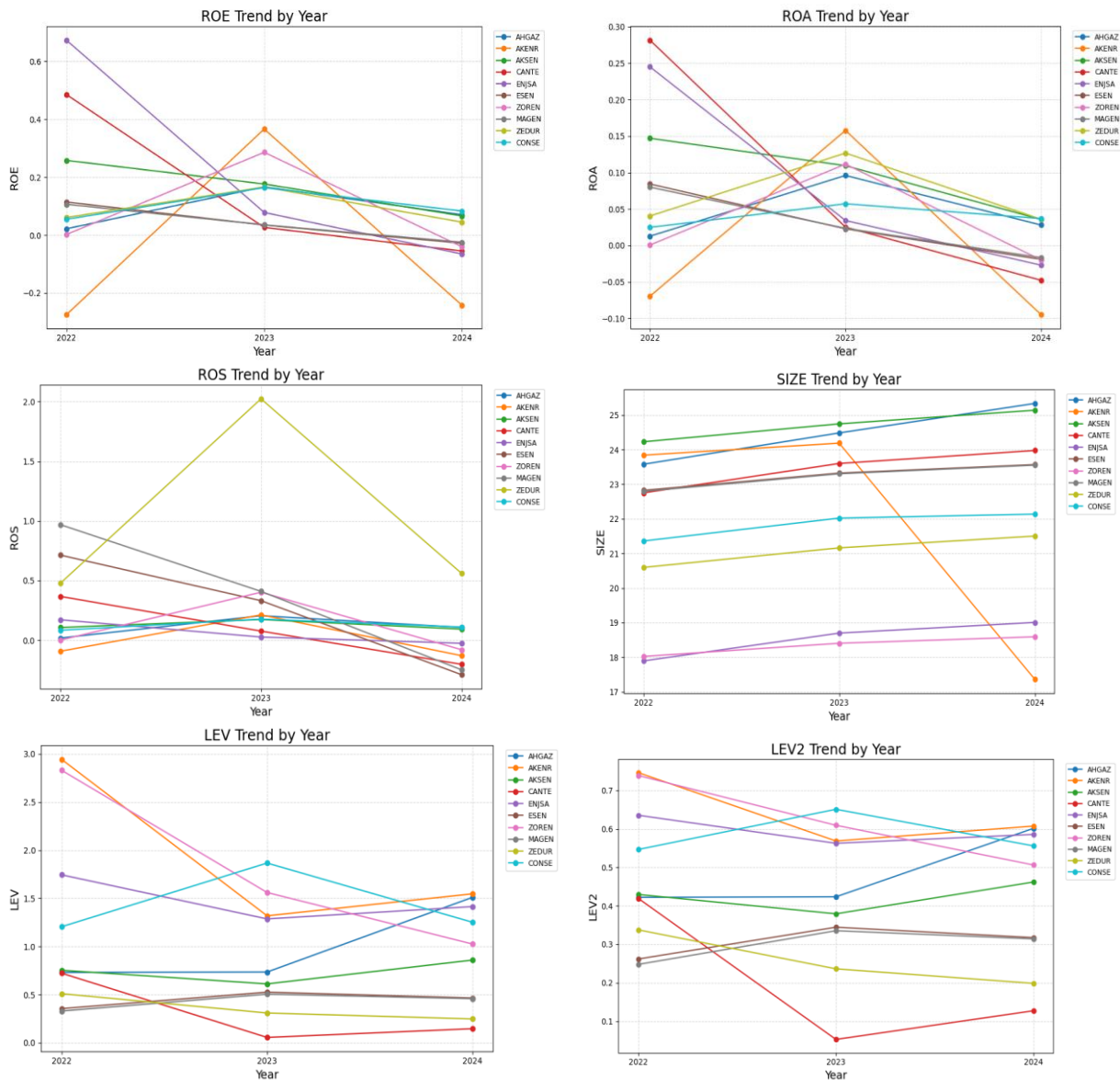
**Table 11**  
 Trend analysis

Alternatives	ROA			ROE			ROS		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
AHGAZ	0.013	0.096	0.028	0.022	0.167	0.070	0.018	0.206	0.108
AKENR	-0.070	0.158	-0.095	-0.274	0.366	-0.242	-0.092	0.213	-0.129
AKSEN	0.147	0.109	0.036	0.258	0.176	0.066	0.107	0.174	0.093
CANTE	0.281	0.025	-0.048	0.485	0.027	-0.055	0.368	0.077	-0.202
ENJSA	0.245	0.034	-0.027	0.672	0.078	-0.065	0.172	0.027	-0.025
ESEN	0.084	0.023	-0.019	0.114	0.035	-0.028	0.714	0.332	-0.289
ZOREN	0.001	0.112	-0.020	0.002	0.286	-0.040	0.001	0.403	-0.080
MAGEN	0.080	0.024	-0.017	0.106	0.035	-0.024	0.969	0.410	-0.248
ZEDUR	0.040	0.127	0.036	0.061	0.166	0.045	0.478	2.024	0.560
CONSE	0.025	0.057	0.037	0.055	0.164	0.083	0.084	0.177	0.111

**Table 12**  
 Trend analysis (continued)

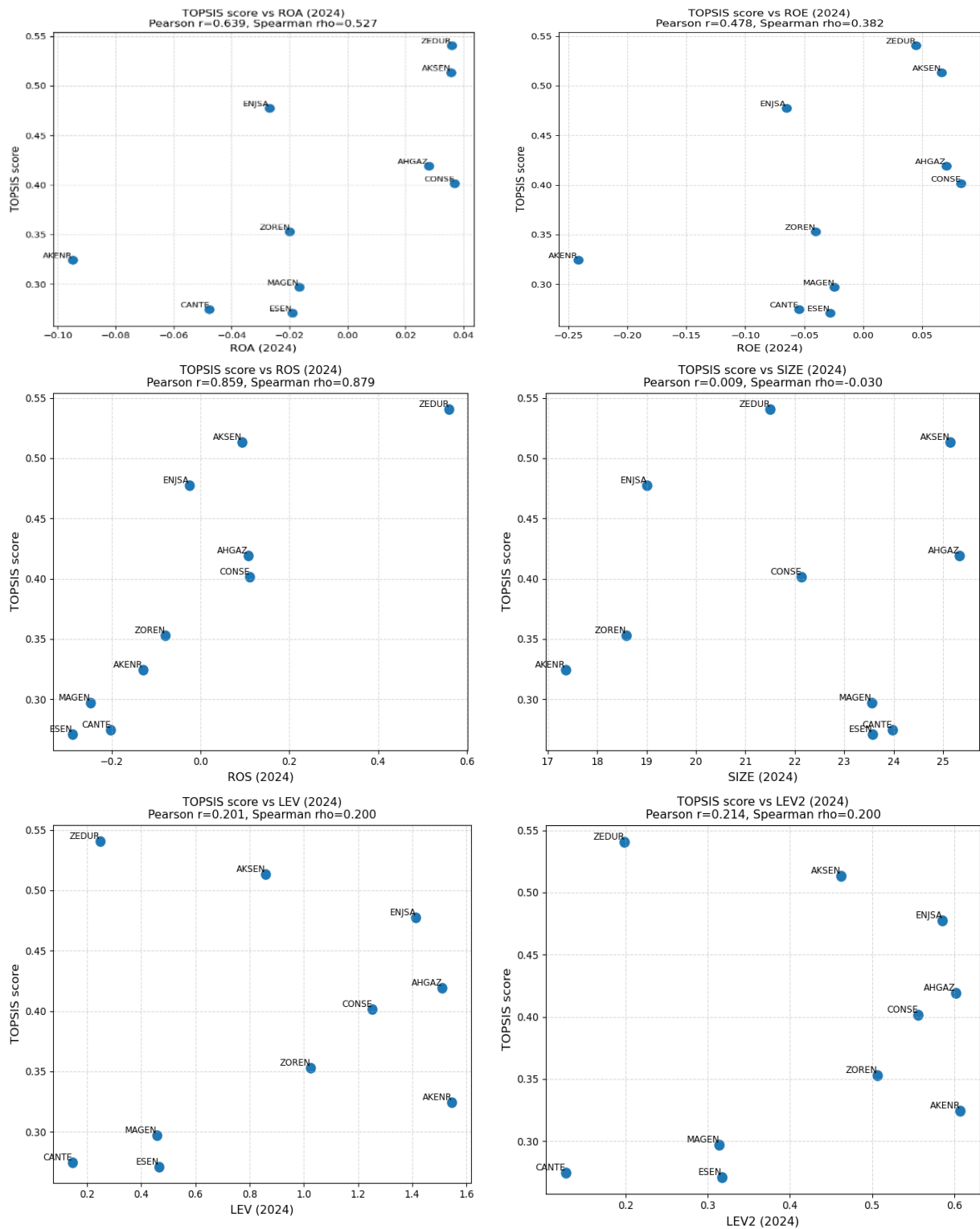
Alternatives	SIZE			LEV			LEV2		
	2022	2023	2024	2022	2023	2024	2022	2023	2024
AHGAZ	23.578	24.483	25.334	0.730	0.735	1.510	0.422	0.423	0.602
AKENR	23.840	24.187	17.364	2.942	1.318	1.547	0.746	0.569	0.607
AKSEN	24.227	24.745	25.139	0.753	0.611	0.859	0.430	0.379	0.462
CANTE	22.750	23.600	23.975	0.722	0.056	0.146	0.419	0.053	0.127
ENJSA	17.896	18.699	19.007	1.744	1.286	1.414	0.636	0.563	0.586
ESEN	22.823	23.323	23.568	0.355	0.525	0.465	0.262	0.344	0.317
ZOREN	18.027	18.406	18.593	2.829	1.561	1.025	0.739	0.609	0.506
MAGEN	22.794	23.303	23.552	0.329	0.504	0.458	0.248	0.335	0.314
ZEDUR	20.597	21.162	21.503	0.510	0.309	0.248	0.338	0.236	0.198
CONSE	21.361	22.022	22.137	1.205	1.866	1.252	0.547	0.651	0.556

The distribution of the data set by years is illustrated in Figure 2.



**Fig. 2.** Trend analysis

A comparison of the criteria with the TOPSIS result is given in Figure 3.



**Fig. 3.** Comparison of criteria according to TOPSIS

ZEDUR demonstrated the highest TOPSIS score (0.5407). Furthermore, the company has demonstrated a favorable return on assets (ROA) and return on equity (ROE), along with a notably elevated return on sales (ROS) of 0.5599% in the year 2024. This signifies that the TOPSIS score accurately reflects the company's financial strength. ESEN and CANTE are companies with low TOPSIS

scores (approximately 0.27), and both ROA, ROE, and ROS are negative, indicating underperformance. AKSEN (0.5133) has been demonstrated to exhibit a positive profitability ratio, concomitant with a high TOPSIS score, which is consistent. The performance scores obtained by employing the TOPSIS method demonstrate a positive correlation with profitability indicators, particularly in the 2024 period. This finding indicates that the model offers a meaningful reflection of company performance across a range of criteria.

A robust positive correlation exists between ROA, ROE, and ROS on the one hand, and TOPSIS on the other. The correlation between SIZE, LEV and LEV2 is negligible.

## **6. Discussion and Conclusion**

Energy is a fundamental driver of economic and financial activity as well as social development. In Türkiye, energy demand has risen steadily in recent years, aligned with increased industrialization and urban expansion. Since Türkiye is a net energy importer, analyzing the financial performance of major energy companies is of crucial importance to meet this growing energy demand.

In this context, this paper evaluated the financial performance of ten different energy companies that are listed in the BIST Index, spanning the years 2022 and 2024 using MEREC, Fuzzy Einstein TOPSIS as well as trend analysis methods. MEREC is a relatively new method created in recent years and has several advantages compared to other MCDM methods. First of all, MEREC method objectively determines criteria weights by examining the effect of each criterion on the decision-making process. Therefore, it can be argued that MEREC method eliminates biases arising from subjective evaluations, as well as establishing a data-driven hierarchy of importance of criteria [27]. In addition, the weights acquired from the MEREC method produce more consistent and robust results for decision-making processes. Due to these advantages, MEREC method is chosen in this study to weigh criteria. According to the results, the criterion with the highest weight is ROS, whereas the criterion with the lowest weight is LEV. The criteria are ranked in descending order of weight as follows: ROS > LEV2 > SIZE > ROE > ROA > LEV.

Before discussing the results of the Fuzzy Einstein TOPSIS Method, it is important to discuss the order of financial ratios. During the period considered in this paper (2022 and 2024), Türkiye experienced high inflation as well as energy price volatility. Thus, the high importance of ROS suggests that the market prioritized core operational efficiency over broader balance sheet metrics like ROA or ROE. On the other hand, relatively lower importance of common ratios such as ROE and ROA suggests that accounting-based profitability measures may be less informative in capital-intensive sectors like energy, especially at times of high inflation.

After weighing the criteria via MEREC method, this paper applies the Fuzzy Einstein TOPSIS method, which can be regarded as an iteration of classical and fuzzy TOPSIS methods. Through Einstein operations, this method generates more precise and consistent rankings when operating with uncertain and fuzzy data. As a result, Fuzzy Einstein TOPSIS method emerges as an efficient, data-driven tool for handling uncertainty in MCDM processes. Following the determination of criteria weights, the Fuzzy Einstein TOPSIS method was applied to rank ten energy companies included in this paper. The results showed that ZEDUR is the top-performing alternative, while ESEN is the lowest-ranked alternative. The ranking of the alternatives from best to worst is as follows: ZEDUR > AKSEN > ENJSA > AHGAZ > CONSE > ZOREN > AKENR > MAGEN > CANTE > ESEN.

The superior performance of ZEDUR can simply be explained by its strong performance in operational efficiency. This can clearly be seen in the data. An examination of the three-year (2022-2024) data taken from the Public Disclosure Platform for the ten selected companies (30 observations in total) reveals that ZEDUR appeared in the top six for Return on Sales on all three occasions (years). This consistent performance reveals that ZEDUR maintained a high and sustainable level of

profitability among the evaluated energy firms. However, it is crucial to analyze the reasons behind this high efficiency. Energy sector is mainly characterized by its high volatility, and this mostly comes from its sensitivity to changes in commodity prices, frequent geopolitical shocks, the capital-intensive nature of energy production, and the structural adjustments associated with the transition to low-carbon energy systems. It should be noted that in addition to investments in energy sector (especially in electricity and renewable energy), ZEDUR has also diversified its operations by investing in construction. Diversifying its investments in energy sectors such as electricity and renewables as well as investing in construction made ZEDUR less fragile against domestic and international shocks and allowed ZEDUR to maintain efficiency. Similarly, the second-best alternative firm, AKSEN, also diversified its portfolio in energy sector, by investing abroad. AKSEN has investments in Africa, Asia and Northern Cyprus in addition to its operations in Turkey. Therefore, AKSEN's overseas investments and its ability to generate revenues in foreign currencies improve the firm's resilience to potential economic and financial shocks. On the other hand, among the worst two performers, ESEN only invests in renewable energy sector, and CANTE's core business is electricity generation, and it is carried out within an integrated structure linked to mining activities. This suggests that diversifying portfolio, either by investing in different alternatives or investing in international markets reduces uncertainty and allows firms to have a stronger economic and financial structure. Therefore, it can be argued that diversifying investments is the core reason in explaining firm performance.

Although this study has its novelties, such as using relatively new and robust approaches in analyzing the financial performance of energy companies in BIST Index, it has also some limitations. The first limitation is clearly the time span, which only covers 3 years. However, due to the data limitations and the effects of COVID-19 pandemic that occurred between 2020 and 2022 on data reliability, we chose to limit the period to only 3 years. In addition, alternatives were ranked using the Fuzzy Einstein TOPSIS method in this paper, however, alternative criteria selection could be made using different methods such as WASPAS, EDAS or ARAS, and therefore inclusion of a comparative analysis section would further contribute to the literature.

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### Conflicts of Interest

The authors declare no conflicts of interest.

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