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Financial Performance Analysis of Airlines Operating in Europe: CRITIC Based MAUT and MARCOS Methods

Avrupa'da Faaliyet Gösteren Havayolu İşletmelerinin Finansal Performans Analizi: CRITIC Temelli MAUT ve MARCOS Yöntemleri

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ABSTRACT

This paper aims to measure the financial performance of 6 airline operators operating in Europe between the periods of 2019-2021. For performance measurement, 8 financial criteria were used: current ratio, cash ratio, financial leverage ratio, equity multiplier, asset turnover rate, equity turnover rate, return on equity and return on assets ratio. For the analysis of these criteria, the importance levels of the criteria related to the CRITIC method, one of the MCDM methods, were determined. At the same time, with the MAUT and MARCOS methods, the financial performance ranking of the airline enterprises was obtained according to the relevant years. According to the findings of the CRITIC method; It was determined that asset turnover rate in 2019 and financial leverage ratio criteria in 2020 and 2019 were the most important criteria. As a result of the MAUT method, it was concluded that the airline with the best financial performance in 2019, 2020 and 2021 was Air France. According to the findings of the MARCOS method, the airline with the highest financial performance in 2019 was Pegasus Airlines and in 2020 and 2021 it was determined as EasyJet.

Anahtar Kelimeler:
Havayolu İşletmesi,
Finansal Performans
ÇKKV,
CRITIC,
MARCOS
Jel Kodları:
C02, C30, C44

ÖZET

Bu çalışmada Avrupa'da faaliyet gösteren 6 havayolu işletmesinin 2019-2021 dönemleri arasında finansal performans ölçümü yapılması amaçlanmıştır.Performans ölçümü için cari oran, nakit oran, finansal kaldıraç oranı, özsermaye çarpanı, aktif devir hızı, özsermaye devir hızı, özsermaye karlılığı ve aktif karlılık oranı olmak üzere 8 finansal kriter kullanılmıştır. Bu kriterlerin analizi için ÇKKV yöntemlerinden CRITIC yöntemi ile ilgili kriterlerin önem düzeyleri belirlenmiştir. Aynı zamanda MAUT ve MARCOS yöntemleri ile de havayolu işletmelerinin finansal performans sıralaması ilgili yıllara göre elde edilmiştir. CRITIC yöntemi bulgularına göre; 2019 yılında aktif devir hızı, 2020 ve 2019 yıllarında ise finansal kaldıraç oranı kriterlerinin en çok önem arz eden kriterler olduğu belirlenmiştir. MAUT yöntemi sonucunda, 2019,2020 ve 2021 yıllarında en iyi finansal performansa sahip havayolu işletmesinin Air France olduğu sonucuna ulaşılmıştır. MARCOS yöntemi bulgularına göre ise 2019 yılında en yüksek finansal performansa sahip havayolu işletmesi Pegasus Havayolları, 2020 ve 2021 yıllarında EasyJet olarak tespit edilmiştir.

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1. INTRODUCTION

The airline sector is one of the key service sectors that supports the growth of the global economy. Following deregulation, radical changes have occurred in the airline industry with liberalization and globalization. New business models emerged, liberal markets were created, airlines' existing networks were expanded, and flights to new destinations were launched. In this way, the airline industry has become more competitive and airline businesses have been under pressure to respond instantly to the moves of their competitors to survive. It is important for airlines to use their existing capacities and resources more effectively and efficiently to survive in the current situation and gain a competitive advantage (Bakir et al., 2020). Therefore, airlines are looking for ways to improve their operational and financial efficiency in order to maintain their growth and financial sustainability in the long term (Huang et al., 2021).

The aviation sector has faced a serious demand thanks to the important steps taken after the liberalization movements. As a result of the increasing demand, issues such as how to provide appropriate service, adequacy of performance level and competitiveness, etc. have also been raised (Belton & Stewart, 2002). Operators and investors perform various performance measurements in order to observe the extent to which the company can meet the increasing demand and to what extent the demand met increases or decreases the company's resources.

In general, a preliminary idea can be obtained by looking at company balance sheets, operating income, flight traffic, occupancy rates and passenger numbers. However, it has recently been determined that the airline sector is not only related to financial ratios, operational factors interact with both financial ratios and service quality (Francis et al., 2005). For example; If the airline shows a growth trend, the high occupancy rates for that airline are an indication that the airline has high competitiveness in the sector (Schefczyk, 1993).

Although the aviation sector is a rapidly growing and developing sector, it is the most preferred type of transportation by passengers in direct proportion to the development of technology. In line with the increasing demand, airline operators want to measure financial performance for competition among airlines, strategic plans and track the financial status of companies. Financial values can provide convenience to the decision-maker when companies need to make decisions in risky environments that are possible to live in along with giving investors an idea about them (Koçyiğit, 2009).

Many performance measurement methods have been developed to date. The common feature of each of these methods is to eliminate the deficiencies of the methods applied before them and to ensure that the performance is measured in a more accurate and objective way (Sümerli Sarıgül & Coşkun, 2021). Many businesses prefer financial-based performance measurement models (Sümerli Sarıgül & Özkan, 2020). There are many analysis methods in financial performance evaluation. However, since it can evaluate more than one alternative and criterion simultaneously, MCDM methods were used within the scope of this study. The importance of the financial criteria was determined with the CRITIC method, which is one of the MCDM techniques, and the airline enterprises were ranked in terms of financial performance with MAUT and MARCOS methods.

The next part of the study is a literature search. In the third part, the methods used in the study are introduced and the steps related to the method are included. In the fourth section, the findings of the methods and then the results are included. It is thought that the study will contribute to the literature because it analyzes the airline enterprises operating in Europe and having an important share in the aviation sector with up-to-date methods.

2. LITERATURE REVIEW

Financial valuation has been carried out in almost every sector using the multi-criteria decision-making method. When financial performance studies are examined by using CRITIC, MAUT and MARCOS methods; Öztel and Yavuz (2019) evaluated the financial performance analysis of the textile sector with the CRITIC-based MAUT method. In their article, Yürük & Orhan (2020) investigated the financial ratios of the manufacturing industry sub-sector by using CRITIC and the Entropy-based MAUT method. In his article, Pala (2021) investigated the financial performance of the enterprises in the BIST insurance index with CRITIC and MULTIMOOSRAL techniques. In their study, Gençtürk et al. (2021) analyzed the financial performance of participation banks during the pandemic period with the help of CRITIC and MARCOS methods. In their article, Dwivedi et al. (2021) examined the performance of steel enterprises with MARCOS and CRITIC methods. In their study, Köse et al. (2021) investigated the financial performance of 6 participating banks operating in Turkey using MAUT method. In his article Pala (2021) examined the financial performance of the enterprises traded in the BIST transportation index with IDOCRIW and MARCOS methods. In their research, Koca & Bingöl (2022) analyzed the financial performance of non-life insurance companies using CRITIC and MARCOS methods. Ayaz & Ömürbek (2023)

analyzed the impact of the Covid-19 pandemic on the financial performance of logistics companies using CRITIC and PROMETHEE methods.

When the studies evaluating the airline and airport financial performances in the aviation sector are examined, it is possible to come across many studies using MCDM methods. Feng & Wang (2000) surveyed Taiwan's top 5 airlines with a total of 6 main criteria and 22 sub-criteria using financial ratios and efficiency-related ratios.

In the study using TOPSIS and Gray Relationship Analysis, Far Eastern Airlines has the highest performance level. In their study, Chang & Yeh (2001) examined 5 airline companies engaged in domestic transportation in Taiwan with cost, efficiency, service quality, price main criteria and 11 sub-criteria. The analysis was carried out with SAW, WP and TOPSIS methods and Eastern Airline was the best-performing company.

Wang (2008) discussed the financial performance of 3 domestic airlines operating in Taiwan. While determining the importance of financial performance criteria with the Grey Relational analysis method, it determined the ranking of the three airlines with the fuzzy TOPSIS method. As a result of the findings obtained, it was concluded that the A2-coded airline had the best financial performance.

In his article Aydoğan (2011) evaluated 4 companies operating in the Turkish aviation sector according to the criteria of effectiveness, efficiency, risk, quality and professional satisfaction. In this study, AHP and Fuzzy TOPSIS methods were used. According to the findings, it was determined that the No. 4 company showed the best performance as a result of the determined criteria.

In their research, Ömürbek & Kınay (2013) examined the financial performance of two airline companies operating on the Borsa İstanbul and Frankfurt Stock Exchange based on 2012. In this study, where the TOPSIS method was preferred, liquidity, financial structure, profitability and activity rates were used as financial criteria. They found that the financial performance of the airline listed on Borsa Istanbul was higher.

Similarly, Akgün & Temur (2016) examined the financial performance of Turkish Airlines and Pegasus Airlines, which are traded on Borsa Istanbul. The researchers compared the financial data for the years 2010-2015 using the TOPSIS method. According to their findings, they determined that Pegasus Airlines exhibited a more effective financial performance in 2010-2011 and that Turkish Airlines had the highest financial performance in 2012. However, according to another finding, they found that Pegasus Airlines exhibited a more efficient financial performance than Turkish Airlines in 2013-2015 with the entry of Pegasus Airlines into the stock market in 2013.

In his article Köse (2021), with a similar result, analyzed the financial performance of Turkish Airlines and Pegasus Airlines between 2014 and 2019 with the TOPSIS method and determined that Pegasus Airlines was more successful financially. In their research, Kurt & Kablan (2022) discussed the measurement of the financial performance of airline companies traded on Borsa Istanbul and operating in Turkey during the COVID-19 period. As a result of the analyzes made with TOPSIS and MABAC methods, they concluded that the financial performance of the relevant airline companies was adversely affected due to the COVID-19 outbreak.

In their study, Wanke et al. (2015) aimed to examine the financial performance of airline companies operating in Asian countries by considering the periods 2006-2012. In their research using the TOPSIS method, they used the criteria of operating cost, depreciation, salary, total assets, fixed assets, revenues and EBITDA. In the findings obtained, they found that cost structure, type of ownership, market position and distance program offered had significant effects on the efficiency levels of airline operations.

Dinçer et al. (2017) focused on the financial performance of airlines in Africa, North America, Asia Pacific, Europe, Latin America and the Middle East. They used the criteria of growth in profit, liquidity ratio, number of customers, sales performance, number of flights, number of fleets, and profit per employee. In their studies carried out using DEMATEL, AHP and VIKOR methods, they concluded that airlines operating in Europe have higher efficiency in terms of financial performance.

In their research, Avcı & Çınaroğlu (2018) analyzed the financial performance of 5 airline enterprises, including airlines operating in Europe, using AHP and TOPSIS methods. The current ratio, cash ratio, financial leverage ratio, equity multiplier, asset turnover rate, equity turnover rate, return on equity and return on assets criteria were used. As a result of the study, they concluded that Ryanair has the best financial performance in terms of financial performance. Durmaz et al. (2020), which supports this study, examined the financial performance and service quality of the main low-cost airline carriers operating in Europe. As a result of the study using CRITIC, TOPSIS and EDAS methods from MCDM methods, they determined that Ryanair was the airline with the most successful financial performance.

In another study, Barros & Wanke (2015) aimed to measure efficiency by analyzing 29 airlines operating in Africa with TOPSIS and VZA methods. They preferred the criteria of the number of employees, operating cost, passenger revenue, fleet percentage, total destination and passenger revenue/km. In the findings, they revealed that the criteria included in the analysis were the most important variables affecting the efficiency levels in the African airline industry.

Pineda et al. (2018) focused on identifying critical factors for improving airline performance. According to the findings of their research, which prefers DANP and VIKOR methods, they have determined that the highest priority criterion of airline companies is the stock price. The most successful airline in terms of financial performance is Delta Airlines.

Bae et al. (2021) analyzed the factors affecting the financial performance of airline enterprises with FAHP and TOPSIS methods. As a result of the study, they determined that the most important criterion affecting financial performance was gross profit margin and that the airline operating with the most successful financial performance was the airline specified with the A8 code.

Garg & Agrawal (2023) conducted a case study of Indian airlines. They used fuzzy theory and the AHP method in their studies in which they evaluated the key performance indicators including the financial performance of airline enterprises. As a result of the findings obtained, they concluded that indicators related to safety and security are more important and that financial criteria and business-related parameters are in last place.

In their studies, Kaya et al. (2023) carried out airline performance evaluations with the DEA method and performed efficiency measurements. In this context, they examined 35 airlines and found that the airlines with the highest efficiency performance were Aeromexico and Icelandair. According to another finding; they identified the number of wide-body aircraft and the increase in asset return as criteria that adversely affect productivity.

When the studies in the literature are examined, it is thought that the study will contribute to the literature because the study uses CRITIC, MAUT and MARCOS methods, which are current and popular in MCDM methods, and analyzes low-cost and traditional airline enterprises operating in Europe together.

3. METHODOLOGY

In the study, 6 airline operators operating in Europe were selected and subjected to financial performance measurement on the basis of 8 financial criteria. The relevant criteria were determined as a result of the literature review. MCDM methods were used to determine financial performance. The analysis was carried out with the CRITIC method in order to determine the importance levels of 8 financial criteria. By integrating the results obtained from the CRITIC method with the MAUT and MARCOS methods, the financial performance ranking of 6 airline companies was obtained.

The airlines identified as alternatives are in Table 1 and the criteria for measuring financial performance are set out in Table 2.

Table 1. Airline Used in the Study

Airlines	IATA Code
Turkish Airlines	**TK**
Pegasus Airlines	**PC**
Lufthansa	**LH**
Air France	**AF**
Ryanair	**FR**
EasyJet	**EC**

Table 2. Financial Criteria Used in the Study

Codes	Direction of Criterion	Criteria	Formulas	Studies Using Criteria
FR1	Benefit	Current ratio	Current assets / Short term debt	Gallizo & Salvador, 2003; Perçin & Aldalou, 2018; Abdel-Basset et al. 2020
FR2	Benefit	Cash ratio	Cash / Short term debt	Perçin & Aldalou, 2018; Kızıl & Aslan, 2019; Yaşar & Över, 2022
FR3	Cost	Financial leverage ratio	Total debt / Total assets	Moghimi & Anvari, 2014; Gümüş & Bolel, 2017; Dayı & Esmer, 2017
FR4	Cost	Equity Multiplier	Equity / Total debt	Turan Kurtaran, 2016; Karkacıer & Yazgan, 2017; Yılmaz et al. 2017

FR5	Benefit	Asset turnover rate	Sales / Total assets	Dalak et al. 2018; Macit & Göçer, 2020; Arsu, 2021
FR6	Benefit	Equity turnover rate	Sales / equity	Akkaya, 2004; Ding & Liang, 2005; Avcı & Çınaroğlu, 2018
FR7	Benefit	Return on equity ratio	Net profit / equity	Doğan 2015; Özbek & Ghouchi, 2021; Ömürbek & Kınay, 2013; Cocis et al. 2021
FR8	Benefit	Return on assets ratio	Net profit / Total assets	Öncü et al., 2013; Doğan & Mecek 2015; Dong et al., 2018; Kablan & Altuk, 2021

The financial data of the airlines examined within the scope of the study between 2019-2021 were accessed from the annual reports and annual reports on the websites of the airline operators. Due to the fact that the data of the relevant airlines for 2022 have not yet been published, the study is restricted to 2021. Since the CRITIC, MAUT and MARCOS methods used in the study consist of many stages and separate analyzes should be performed for each year, the analyzes of 2021, which is the current year in the study, are presented in detail through tables. The details of the analyzes that took place in 2019 and 2020 were shared in the Appendix section at the end of the study.

3.1. CRITIC Method

CRITIC (CRiteria importance through inter-criteria correlation) method is a method introduced to the literature by Diakoulaki et al. for the objective determination of criterion weights (Ulutaş & Karaköy, 2019: 225). In this method, the importance levels of the criteria in the decision process are determined by taking into account the standard deviation of the criteria and the correlation relationships between the criteria (Işık, 2019: 547).

The stages of this approach are as follows (Yaşar and Çınaroğlu, 2021:962):

Step 1: A decision matrix containing m decision alternatives and n evaluation criteria is created.

$$X = \left[x_{ij}\right]_{n*m} = \begin{bmatrix} X_{11} & X_{12} & \dots X_{1m} \\ X_{21} & X_{22} & \dots X_{2m} \\ \vdots & \vdots & \vdots \ \vdots \\ X_{n1} & X_{n2} \cdots & X_{nm} \end{bmatrix} \quad (1)$$

Step 2: In order to eliminate the abnormalities, the decision matrix is normalized based on the types of criteria that are benefit-qualified or cost-qualified criteria.

The normalization of the criteria of the benefits quality is as follows:

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \quad (2)$$

The normalization of cost-qualified criteria is as follows:

$$r_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \quad (3)$$

In the equations $\overline{x_j^{min}}$ represents the minimum value of the j.criterion, x_j^{max} indicates the maximum value of the j.criterion.

Step 3: Using the elements in the normalized decision matrix, the correlation coefficient values between the criteria pairs are calculated as shown below.

$$P_{jk} = \frac{\sum_{i=1}^{m}(r_{ij} - \overline{r_j})(r_{ik} - \overline{r_k})}{\sqrt{\sum_{i=1}^{m}(r_{ij} - r_j)^2 \sum_{i=1}^{m}(r_{ik} - r_k)^2}} \quad (4)$$

Step 4: The amount of information value (C_j) is calculated as shown in the equation below.

$$C_j = \sigma_j \sum_{k=1}^{n}\left(1 - P_{jk}\right) \quad (5)$$

$|\sigma_j|$ refers to the standard deviation value of criterion j. and is calculated as follows:

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}(r_{ij} - \overline{r_j})^2}{m}} \quad (6)$$

Step 5: In the last step, the weight values of each criterion are determined with the help of the following equation.

$$w_j = \frac{C_j}{\sum_{k=1}^{2} c_k} \quad (7)$$

3.2. MAUT Method

This method also referred to as utility theory, Multi-Attribute Utility Theory (MAUT), which was proposed by Fishburn (1967), Fishburn & Keeney (1974) and developed by Løken (2007), determines useful options based on concrete and abstract criteria (Løken & Botterud, 2007: 1586-1587).

Step 1: The criteria (an) that are relevant to the Decision Problem and the criteria/qualifications (x_m) that will be supportive in selecting the criteria should be determined.

Step 2: The assignment of the values (w_i) of the weights for which the priorities are determined and the correct evaluation of the criteria is carried out. The sum of all wi values must be equal to 1.

$$\sum_1^m w_i = 1 \quad (8)$$

Step 3: The value criteria of the criteria are assigned. Assignments are quantitative values for quantitative criteria. For qualitative criteria, bilateral comparisons are made by taking into account. In line with these, value assignments are made in the system of 5, 100 etc.

Step 4: The assigned values are put into the decision matrix and the normalization application continues. In the normalization application, first of all, the best and worst values are determined for all qualities the best value is assigned to 1 value and the worst value is 0 and the calculation of other values is started. The formula is as follows:

$$ui\ (xi) = \frac{X - X\dot{I}^-}{X\dot{I}^+ - X\dot{I}^-} \quad (9)$$

The terms used in this formula are as follows:

$X\dot{I}^+$: Best Value for Qualification

$X\dot{I}^-$: Best Value for Qualification

X : Current Utility Value in Calculated Line

Step 5: After the normalization application, the application of determining the benefit values is started. Utility Function application:

$$U(X) = \sum_1^m ui\ (xi) * wi \quad (10)$$

$U(X)$: Alternative Utility Value

$ui\ (xi)$: Normalized Utility Values for Every Criterion and Every Alternative

wi: Weight Values.

3.3. MARCOS Method

MARCOS (Measurement Alternatives and Ranking According to Compromise Solution) Stevic et al. (2019) is a multi-criteria decision-making method introduced to the literature. This method involves measuring alternatives and ranking them according to a compromise solution. The compromise solution is based on the determination of utility functions according to the distance between ideal and non-ideal (anti-ideal) solutions and their combinations (Gençtürk et al., 2021).

The steps of the method are carried out in the following stages (Sümerli Sarıgül et al., 2023);

Step 1: Creating the Decision Matrix:

The decision matrix is obtained by determining the evaluation criteria and alternatives.

Step 2: Creating the Extended Startup Matrix:

As seen in Equation (11), the ideal (AI) and non-ideal (AAI) solutions are added to the initial decision matrix to obtain an extended initial matrix.

$$C_1\ C_2 \qquad \cdots \qquad C_n$$

$$X^G = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \\ AI \\ AAI \end{matrix} \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m1} & \cdots & x_{mn} \\ x_{ai1} & x_{ai2} & \cdots & x_{ain} \\ x_{aa1} & x_{aa2} & \cdots & x_{aan} \end{bmatrix} \quad (11)$$

AI and AAI values; Equality (12) and Equality (13) are used to calculate the criteria according to the benefit-cost direction.

$$AI = \overset{max}{i}\ X_{ij} \ \rightarrow\ j \in F \quad and \quad \overset{min}{i}\ X_{ij} \ \rightarrow\ j \in M \quad (12)$$

$$AAI = \overset{min}{i}\ X_{ij} \ \rightarrow\ j \in F \quad and \quad \overset{max}{i}\ X_{ij} \rightarrow j \in M \quad (13)$$

Here F represents the benefit-side criteria, and M represents the cost-side criteria.

Step 3: Normalize the Extended Startup Matrix:

For the normalization process, Equality (14) is used for benefit-based criteria and Equality (15) is used for cost-oriented criteria.

$$n_{ij} = \frac{x_{ij}}{x_{ai}} \quad j \in F \quad (14)$$

$$n_{ij} = \frac{x_{ai}}{x_{ij}} \quad j \in M \quad (15)$$

Step 4: Creating the Weighted Matrix:

Equation (16) is used to create the weighted matrix (V). The weighted matrix is obtained by multiplying the elements of the normalized matrix by the criterion weights (w_j).

$$v_{ij} = n_{ij}.w_j \quad (16)$$

Step 5: Calculation of the degree of utility of the alternatives:

With the help of equality (17) and (18), the degree of utility is calculated according to ideal and non-ideal solutions, respectively. The S_i value in the equations refers to the sum of the weighted matrix elements and is calculated using Equation (19).

$$K_i^+ = \frac{S_i}{S_{ai}} \quad (17)$$

$$K_i^- = \frac{S_i}{S_{aai}} \quad (18)$$

$$S_i = \sum_{i=1}^{n} v_{ij} \quad (19)$$

Step 6: Calculation of Utility Functions of Alternatives:

The utility function refers to the consensus solution of the observed alternative according to the ideal and anti-ideal solution. The utility function of the alternatives is calculated by Equality (20).

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}} \quad (20)$$

In the equation, $f(K_i^+)$ refers to the utility function according to the ideal solution and $f(K_i^-)$ refers to the utility function according to the non-ideal solution. It is calculated using Equality (21) and (22) respectively.

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \quad (21)$$

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \quad (22)$$

Step 7: Ranking the Alternatives:

Sort is done according to the utility functions calculated by equality (20). The alternative with the highest value is determined as the most preferred alternative.

4. RESULTS

In this part of the study, 2019, 2020 and 2021 financial data of 6 airline operators included in the analysis were analyzed using CRITIC, MAUT and MARCOS methods. While determining the importance of financial criteria with the CRITIC method, financial performance ranking was obtained with MAUT and MARCOS methods.

The decision matrix, which is used in all of the methods, is arranged according to Equation (1). The decision matrix for the years 2021-2019 is included in Table 3.

Table 3. Decision Matrix

2021	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,729	0,395	0,742	0,347	0,403	1,563	0,140	0,036
PC	1,073	0,671	0,861	0,161	0,190	1,365	-0,191	-0,027
LH	1,303	0,229	0,785	0,274	0,483	2,248	-0,309	-0,066
AF	0,915	0,568	1,124	0,111	0,053	0,426	0,863	0,107
FR	0,980	0,751	0,623	0,605	0,133	0,352	0,218	0,082
EC	1,556	1,321	0,730	0,370	0,149	0,552	0,325	0,088
2020	**FR1**	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
TK	0,647	0,281	0,789	0,267	0,264	1,251	-0,155	-0,033
PC	0,824	0,554	0,815	0,227	0,165	0,892	-0,365	-0,068
LH	0,743	0,098	0,764	0,309	0,421	1,782	-0,102	-0,024
AF	0,840	0,545	1,177	0,150	0,047	0,268	1,330	0,235
FR	0,816	0,466	0,667	0,500	0,576	1,729	0,132	0,044
EC	0,670	0,597	0,771	0,297	0,363	1,585	0,568	0,130
2019	**FR1**	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
TK	0,800	0,348	0,722	0,384	0,535	1,927	0,115	0,032
PC	1,278	0,879	0,746	0,340	0,524	2,064	0,250	0,063
LH	0,410	0,108	0,722	0,385	0,559	2,009	0,073	0,020
AF	0,675	0,294	0,925	0,081	0,088	1,182	0,127	0,010
FR	0,929	0,409	0,606	0,649	0,581	1,476	0,164	0,065
EC	0,794	0,482	0,634	0,576	0,782	2,139	0,117	0,043

4.1. Findings on the CRITIC Method

The decision matrix, the first step of the CRITIC method, is shown in Table 3. The normalization process is applied to remove the abnormality between the measurement units and to ensure that the values can be valued between 0 and 1. In the normalization process, Equality (2) was used for benefit-qualified criteria and Equality (3) was used for cost-qualified criteria. The normalization process is shown in Table 4. As an example, the year 2021 is included and the steps for the other years are included in the appendices of the study.

Table 4. Normalization Process

2021	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,000	0,153	0,762	0,522	0,680	0,310	0,383	0,590
PC	0,415	0,405	0,525	0,897	0,143	0,259	0,101	0,230
LH	0,695	0,000	0,677	0,670	0,883	0,485	0,000	0,000
AF	0,225	0,310	0,000	1,000	1,000	1,000	1,000	1,000
FR	0,304	0,478	1,000	0,000	0,000	0,000	0,450	0,856
EC	1,000	1,000	0,787	0,475	0,041	0,051	0,541	0,889

According to Equation (4), the correlation coefficient between the criteria was calculated and given in Table 5.

Table 5. Correlation Matrix

2021	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
FR1	1,000	0,571	0,211	-0,046	-0,337	-0,316	-0,227	-0,138
FR2	0,571	1,000	0,215	-0,269	-0,725	-0,493	0,323	0,574
FR3	0,211	0,215	1,000	-0,870	-0,642	-0,921	-0,536	-0,149
FR4	-0,046	-0,269	-0,870	1,000	0,578	0,760	0,122	-0,253
FR5	-0,337	-0,725	-0,642	0,578	1,000	0,875	0,206	-0,179
FR6	-0,316	-0,493	-0,921	0,760	0,875	1,000	0,470	0,051

FR7	-0,227	0,323	-0,536	0,122	0,206	0,470	1,000	0,904
FR8	-0,138	0,574	-0,149	-0,253	-0,179	0,051	0,904	1,000

Equity (5) was used for the purpose of calculating the value of the amount of information. The amount of information obtained is shown in Table 6.

Table 6. $1 - P_{jk}$ Matrix

2021	**FR1**	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
FR1	0,000	0,429	0,789	1,046	1,337	1,316	1,227	1,138
FR2	0,429	0,000	0,785	1,269	1,725	1,493	0,677	0,426
FR3	0,789	0,785	0,000	1,870	1,642	1,921	1,536	1,149
FR4	1,046	1,269	1,870	0,000	0,422	0,240	0,878	1,253
FR5	1,337	1,725	1,642	0,422	0,000	0,125	0,794	1,179
FR6	1,316	1,493	1,921	0,240	0,125	0,000	0,530	0,949
FR7	1,227	0,677	1,536	0,878	0,794	0,530	0,000	0,096
FR8	1,138	0,426	1,149	1,253	1,179	0,949	0,096	0,000

The finding of weights related to the criteria is provided by Equality (7). The criterion weights for 2019, 2020 and 2021 are shown in Table 7.

Table 7. Calculation of Importance Levels of Criteria

2021	**FR1**	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
σ_j	0,357	0,345	0,343	0,356	0,449	0,364	0,355	0,401
C_j	2,600	2,347	3,326	2,486	3,240	2,393	2,039	2,485
w_j	0,124	0,112	0,159	0,119	0,155	0,114	0,097	0,119
2020	**FR1**	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
σ_j	0,431	0,391	0,347	0,335	0,359	0,338	0,368	0,382
C_j	2,552	2,288	3,707	2,437	1,984	1,559	1,590	1,643
w_j	0,144	0,129	0,209	0,137	0,112	0,088	0,090	0,093
2019	**FR1**	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
σ_j	0,331	0,335	0,352	0,351	0,419	0,391	0,344	0,409
C_j	1,588	1,606	2,935	2,726	3,188	2,945	1,637	2,412
w_j	0,083	0,084	0,154	0,143	0,167	0,155	0,086	0,127

When Table 7 is examined, the most important criterion for 2021 is FR3 with a value of 0.159, FR3 with a value of 0.209 for 2020, and FR5 with a value of 0.167 for 2019 is determined as the most important criterion. The ranking of the relevant criteria is given in Figure 1.

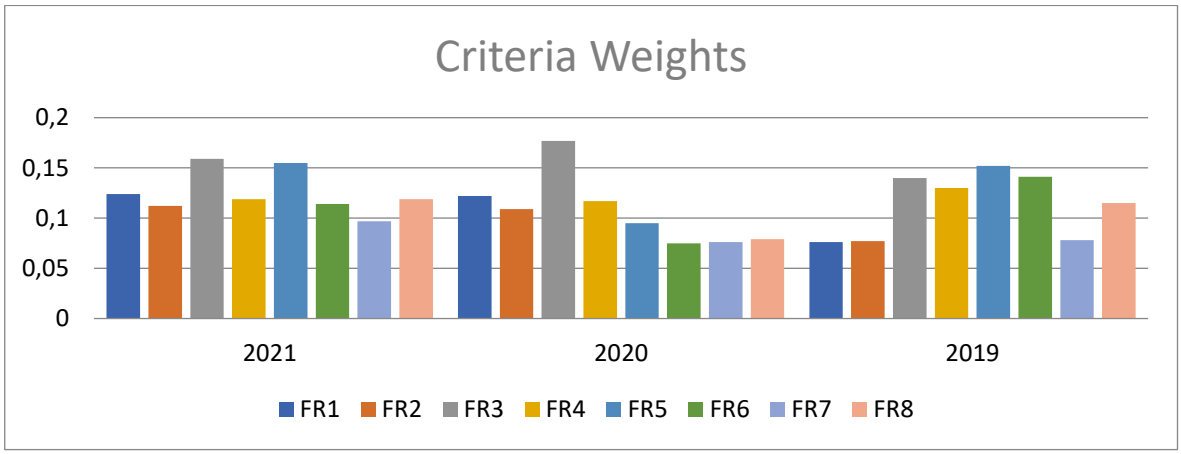

Figure 1. Criterion Weights by Year

The criterion weights obtained here will be used in both the MAUT method and the CODAS method.

4.2. Findings of the MAUT Method

The decision matrix, the initial stage of the MAUT method, is shown in Table 3. The sum of the criterion weights determined by the CRITIC method must be equal to 1. Equality (8) was used to check that the weights were equal to 1.

For the normalization of values, the best values are given 1 and the worst values are zero. For the normalization of the other values, Equation (9) is used and the normalized decision matrix is given in Table 8.

Table 8. Normalization Process

2021	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,000	0,153	0,238	0,478	0,680	0,310	0,383	0,590
PC	0,415	0,405	0,475	0,103	0,143	0,259	0,101	0,230
LH	0,695	0,000	0,323	0,330	0,883	0,485	0,000	0,000
AF	0,225	0,310	1,000	0,000	1,000	1,000	1,000	1,000
FR	0,304	0,478	0,000	1,000	0,000	0,000	0,450	0,856
EC	1,000	1,000	0,213	0,525	0,041	0,051	0,541	0,889

Utility values are determined with the help of normalized values. The utility value is calculated by Equation (10) and given in Table 9.

Table 9. Utility Matrix

2021	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,000	0,017	0,038	0,057	0,105	0,035	0,037	0,070
PC	0,052	0,045	0,076	0,012	0,022	0,030	0,010	0,027
LH	0,086	0,000	0,051	0,039	0,137	0,055	0,000	0,000
AF	0,028	0,035	0,159	0,000	0,155	0,114	0,097	0,119
FR	0,038	0,054	0,000	0,119	0,000	0,000	0,044	0,102
EC	0,124	0,112	0,034	0,062	0,006	0,006	0,052	0,106

Through the obtained utility values, the ranking of the alternatives with Equality (10) is obtained and is included in Table 10.

Table 10. Determining the Ranking

Airline	2021	2020	2019
	w_j	w_j	w_j
TK	0,360	0,209	0,280
PC	0,273	0,340	0,520
LH	0,369	0,314	0,182
AF	0,707	0,822	0,549
FR	0,356	0,571	0,423
EC	0,503	0,443	0,444

When Table 10 is examined, Air France has been the best-performing airline for the 3 years considered. The ranking of the financial performance of other airlines in the relevant years is given in Figure 2.

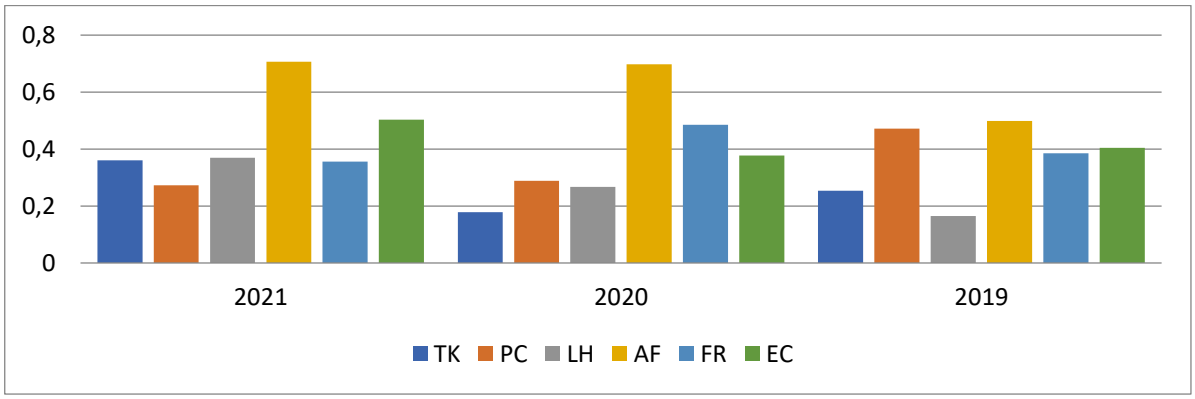

Figure 2. Financial Performance Ranking by Year with MAUT Method

4.3. Findings of the MARCOS Method

The decision matrix, which is the first step of the MARCOS method, is included in Table 3 as in other methods. Equations 12 and 13 were used respectively to create the expanded decision matrix and to calculate the AI and AII values.

Table 11. Expanded Decision Matrix

	FR1	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
TK	0,729	0,395	0,742	0,347	0,403	1,563	0,140	0,036
PC	1,073	0,671	0,861	0,161	0,190	1,365	-0,191	-0,027
LH	1,303	0,229	0,785	0,274	0,483	2,248	-0,309	-0,066
AF	0,915	0,568	1,124	0,111	0,530	4,261	0,863	0,107
FR	0,980	0,751	0,623	0,605	0,133	0,352	0,218	0,082
EC	1,556	1,321	0,730	0,370	0,149	0,552	0,325	0,088
AI	1,556	1,321	0,623	0,111	0,530	4,261	0,863	0,107
AII	0,729	0,229	1,124	0,605	0,133	0,352	-0,309	-0,066

After the expanded decision matrix is brought to the Equality 11 format, the normalization process is carried out. In the normalization process, Equality 14 is used for benefit-side criteria and Equality 15 is used for cost-side criteria. The normalized decision matrix is shown in Table 12.

Table 12. Normalized Decision Matrix

	BENEFIT	*BENEFIT*	*COST*	*COST*	*BENEFIT*	*BENEFIT*	*BENEFIT*	*BENEFIT*
	FR1	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
TK	0,469	0,299	0,839	0,319	0,760	0,367	0,162	0,337
PC	0,689	0,508	0,724	0,686	0,358	0,320	-0,221	-0,247
LH	0,838	0,173	0,794	0,404	0,912	0,528	-0,358	-0,619
AF	0,588	0,430	0,554	1,000	1,000	1,000	1,000	1,000
FR	0,630	0,569	1,000	0,183	0,250	0,083	0,253	0,767
EC	1,000	1,000	0,853	0,299	0,281	0,130	0,377	0,820
AI	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
AII	0,469	0,173	0,554	0,183	0,250	0,083	-0,358	-0,619
w_j	0,124	0,112	0,159	0,119	0,155	0,114	0,097	0,119

The normalized decision matrix is multiplied by the criterion weights obtained through the CRITIC method to create a weighted decision matrix. Equation 16 is used for this process. The weighted matrix is located in Table 13.

Table 13. Weighted Matrix

	FR1	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
TK	0,058	0,034	0,133	0,038	0,118	0,042	0,016	0,040
PC	0,086	0,057	0,115	0,082	0,055	0,037	-0,022	-0,029
LH	0,104	0,019	0,126	0,048	0,141	0,060	-0,035	-0,074
AF	0,073	0,048	0,088	0,119	0,155	0,114	0,097	0,119
FR	0,078	0,064	0,159	0,022	0,039	0,009	0,025	0,091
EC	0,124	0,112	0,136	0,036	0,044	0,015	0,037	0,097
AI	0,124	0,112	0,159	0,119	0,155	0,114	0,097	0,119
AII	0,058	0,019	0,088	0,022	0,039	0,009	-0,035	-0,074

Equations 17, 18, 19, 21 and 22 were used, respectively, for the calculation of utility degrees and utility functions for the alternatives. With these obtained values, the value of the utility functions of the alternatives was determined thanks to Equation 20 and thus the ranking was obtained.

Table 14. Calculation of Utility Values

	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K)$
TK	0,527	4,630	0,528	0,102	0,898	13,404
PC	0,418	3,673	0,419	0,102	0,898	12,447
LH	0,458	4,024	0,459	0,102	0,898	12,798
AF	0,583	5,118	0,583	0,102	0,898	13,892
FR	0,499	4,381	0,499	0,102	0,898	13,155
EC	0,617	5,419	0,618	0,102	0,898	14,193

When Table 14 is examined, it is determined that EasyJet ranks first with a value of 14,193 for 2021. The benefit values calculated for the years considered within the scope of the study are included in Table 15.

Table 15. Degrees of Benefit by Year

	2021	**2020**	**2019**
Airline	$f(K)$	$f(K)$	$f(K)$
TK	13,404	5,763	5,259
PC	12,447	5,887	5,908
LH	12,798	5,900	5,015
AF	13,892	6,551	4,873
FR	13,155	6,520	5,538
EC	14,193	6,589	5,623

When Table 15 is examined, EasyJet ranks first with a value of 6,589 for 2020. In 2019, Pegasus Airlines was selected with the highest financial performance of 5,908. The ranking of financial performance by year is shown in Figure 3.

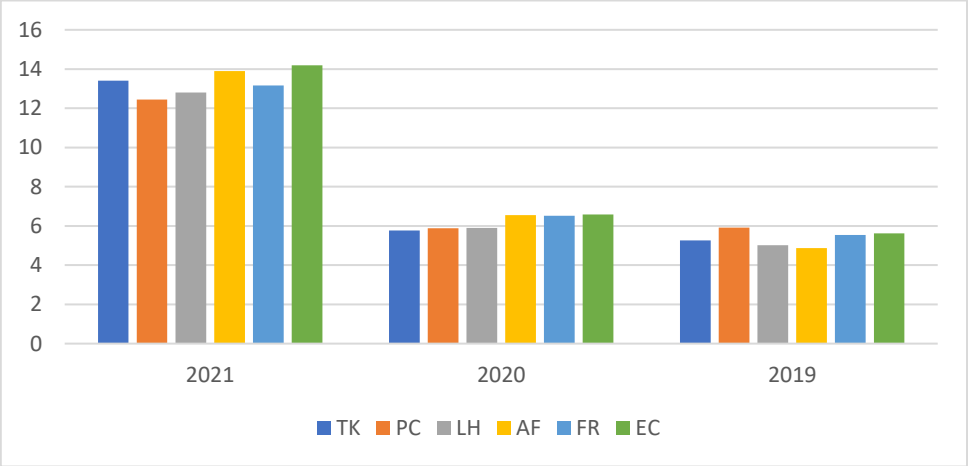

Figure 3. Financial Performance Ranking by Year with MARCOS Method

5. CONCLUSION

The transportation sector plays an important role in the development of an economy by connecting different sectors of the economy (Yaşar, 2022). In the aviation sector, which is an important branch of the transportation sector, it has prepared the ground for the increasingly competitive environment in the globalizing world with the acceleration of activities (Sümerli Sarıgül & Coşkun, 2022). In an increasingly competitive environment, financial performance measurement has also become a focal point for airline operators. Thanks to the financial performance indicators, company executives and stakeholders can be informed about the company's financial position and have an idea about the direction of the steps towards the future.

Within the scope of the study, it is aimed to measure the financial performance of 6 airline companies operating in Europe between 2019-2021. While determining the importance levels of the financial criteria with the CRITIC

method, which is one of the MCDM methods, the financial performance ranking of the relevant airlines was obtained by integrating the results of the CRITIC method into the MAUT and MARCOS methods. The financial criteria included in the analysis are; current ratio, cash ratio, financial leverage ratio, equity multiplier, asset turnover rate, equity turnover rate, return on equity and return on assets ratio.

When the findings obtained from the CRITIC method are examined; The most important criterion affecting financial performance for 2021 was the financial leverage ratio. The criteria following the relevant ranking continue in the form of asset turnover rate, current rate, and equity multiplier. The criterion with the least significant value for 2021 was determined as the return on equity ratio. When the year 2020 is examined, it is determined that the most important criterion is the financial leverage ratio. The criteria following the relevant ranking are the current rate, and equity multiplier. It was determined that the least important criterion in 2020 was the equity turnover rate. While the most important value for 2021 and 2020 was determined as the financial leverage ratio, it was determined that the most important criterion in 2019 was the asset turnover rate. It was determined that the least important criterion was the current ratio.

The benchmark weights obtained thanks to the CRITIC method were integrated into the MAUT and MARCOS methods and the success ranking of the financial performances of 6 airline companies was obtained. According to the findings obtained from the MAUT method; The airline with the highest financial performance success in the periods considered was determined as Air France. In the MARCOS method, EasyJet was the airline with the highest level of financial performance for 2021. It was identified as the EasyJet with the best performance in 2020 and Pegasus Airlines in 2019.

If the criteria, alternative, method or data set included in the analysis change, it will be inevitable to obtain different results. In future studies, the importance of different criteria can be re-evaluated by using objective or subjective weighting methods. With the inclusion of different MCDM techniques in the study, more comments about the performance of airline companies and ranking studies involving the comparison of companies can be discussed. In addition, studies in this field can be supported by making evaluations with different methods.

The period in which the study is discussed is a period in which the global COVID-19 pandemic is experienced and economic crises are seen. One of the sectors most financially affected by the pandemic has been the aviation sector. With the analyzes to be made in future studies, the results of this study can be compared and the past effects of the pandemic can be examined in detail.

This study provides some policy recommendations for improving the financial performance of airline operators. In order to increase the activities of the aviation sector and increase passenger demand, policymakers should give importance to tourism activities. With the support of tourism activities, there will be an increase in the demands of tourists coming and going to the countries. Meeting these demands will be possible by air transportation. In line with the increasing demand for airline transportation, it is thought that although there are improvements in the financial performance of airline enterprises, it will also contribute to the country's economy.

AUTHORS' DECLARATION

This paper complies with Research and Publication Ethics, has no conflict of interest to declare, and has received no financial support.

AUTHORS' CONTRIBUTIONS

Conceptualization, writing-original draft, editing – SSS and EY, data collection, methodology, formal analysis – MÜ, Final Approval and Accountability – SSS, EY and MÜ.

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APPENDIX

Appendix 1. Findings on the CRITIC Method (2020)

Appendix 1.1. Normalization Process

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,000	0,366	0,760	0,666	0,240	0,201	0,124	0,115
PC	0,915	0,914	0,710	0,779	0,000	0,000	0,000	0,000
LH	0,496	0,000	0,810	0,545	0,623	0,498	0,155	0,143
AF	1,000	0,896	0,000	1,000	0,752	1,000	1,000	1,000
FR	0,873	0,737	1,000	0,000	1,000	0,468	0,293	0,368
EC	0,117	1,000	0,796	0,580	0,481	0,388	0,550	0,652

Appendix 1.2. Correlation Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
FR1	1,000	0,326	-0,391	0,038	0,304	0,347	0,245	0,215
FR2	0,326	1,000	-0,293	0,159	-0,055	0,055	0,450	0,504
FR3	-0,391	-0,293	1,000	-0,797	-0,054	-0,687	-0,769	-0,690
FR4	0,038	0,159	-0,797	1,000	-0,519	0,195	0,363	0,277
FR5	0,304	-0,055	-0,054	-0,519	1,000	0,737	0,516	0,547
FR6	0,347	0,055	-0,687	0,195	0,737	1,000	0,883	0,852
FR7	0,245	0,450	-0,769	0,363	0,516	0,883	1,000	0,992
FR8	0,215	0,504	-0,690	0,277	0,547	0,852	0,992	1,000

Appendix 1.3. $1 - P_{jk}$ Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
FR1	0,000	0,674	1,391	0,962	0,696	0,653	0,755	0,785
FR2	0,674	0,000	1,293	0,841	1,055	0,945	0,550	0,496
FR3	1,391	1,293	0,000	1,797	1,054	1,687	1,769	1,690
FR4	0,962	0,841	1,797	0,000	1,519	0,805	0,637	0,723
FR5	0,696	1,055	1,054	1,519	0,000	0,263	0,484	0,453
FR6	0,653	0,945	1,687	0,805	0,263	0,000	0,117	0,148
FR7	0,755	0,550	1,769	0,637	0,484	0,117	0,000	0,008
FR8	0,785	0,496	1,690	0,723	0,453	0,148	0,008	0,000

Appendix 1.4. Calculation of Importance Levels of Criteria

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
σ_j	0,431	0,391	0,347	0,335	0,359	0,338	0,368	0,382
C_j	2,552	2,288	3,707	2,437	1,984	1,559	1,590	1,643
w_j	0,144	0,129	0,209	0,137	0,112	0,088	0,090	0,093

Appendix 2. Findings on the CRITIC Method (2019)

Appendix 2.1. Normalization Process

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,449	0,312	0,636	0,466	0,032	0,044	0,234	0,406
PC	1,000	1,000	0,561	0,544	0,000	0,057	1,000	0,979
LH	0,000	0,000	0,638	0,464	0,097	0,051	0,000	0,198
AF	0,306	0,241	0,000	1,000	1,000	1,000	0,306	0,000
FR	0,598	0,391	1,000	0,000	0,159	0,000	0,513	1,000
EC	0,443	0,485	0,914	0,128	0,716	0,064	0,247	0,609

Appendix 2.2. Correlation Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
FR1	1,000	0,959	0,177	-0,167	-0,291	-0,242	0,956	0,802
FR2	0,959	1,000	0,129	-0,104	-0,214	-0,228	0,931	0,730
FR3	0,177	0,129	1,000	-0,989	-0,484	-0,884	0,019	0,690
FR4	-0,167	-0,104	-0,989	1,000	0,384	0,810	-0,011	-0,687
FR5	-0,291	-0,214	-0,484	0,384	1,000	0,788	-0,273	-0,513
FR6	-0,242	-0,228	-0,884	0,810	0,788	1,000	-0,115	-0,656
FR7	0,956	0,931	0,019	-0,011	-0,273	-0,115	1,000	0,732
FR8	0,802	0,730	0,690	-0,687	-0,513	-0,656	0,732	1,000

Appendix 2.3. $1 - P_{jk}$ Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
FR1	0,000	0,041	0,823	1,167	1,291	1,242	0,044	0,198
FR2	0,041	0,000	0,871	1,104	1,214	1,228	0,069	0,270
FR3	0,823	0,871	0,000	1,989	1,484	1,884	0,981	0,310
FR4	1,167	1,104	1,989	0,000	0,616	0,190	1,011	1,687
FR5	1,291	1,214	1,484	0,616	0,000	0,212	1,273	1,513
FR6	1,242	1,228	1,884	0,190	0,212	0,000	1,115	1,656
FR7	0,044	0,069	0,981	1,011	1,273	1,115	0,000	0,268
FR8	0,198	0,270	0,310	1,687	1,513	1,656	0,268	0,000

Appendix 2.4. Calculation of Importance Levels of Criteria

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
σ_j	0,331	0,335	0,352	0,351	0,419	0,391	0,344	0,409
C_j	1,588	1,606	2,935	2,726	3,188	2,945	1,637	2,412
w_j	0,083	0,084	0,154	0,143	0,167	0,155	0,086	0,127

Appendix 3. Findings on the MAUT Method (2020)

Appendix 3.1. Normalization Process

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,000	0,366	0,240	0,334	0,240	0,201	0,124	0,115
PC	0,915	0,914	0,290	0,221	0,000	0,000	0,000	0,000
LH	0,496	0,000	0,190	0,455	0,623	0,498	0,155	0,143
AF	1,000	0,896	1,000	0,000	0,752	1,000	1,000	1,000
FR	0,873	0,737	0,000	1,000	1,000	0,468	0,293	0,368
EC	0,117	1,000	0,204	0,420	0,481	0,388	0,550	0,652

Appendix 3.2. Utility Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,000	0,047	0,050	0,046	0,027	0,018	0,011	0,011
PC	0,131	0,118	0,061	0,030	0,000	0,000	0,000	0,000
LH	0,071	0,000	0,040	0,062	0,070	0,044	0,014	0,013
AF	0,144	0,115	0,209	0,000	0,084	0,088	0,090	0,093
FR	0,125	0,095	0,000	0,137	0,112	0,041	0,026	0,034
EC	0,017	0,129	0,043	0,058	0,054	0,034	0,049	0,060

Appendix 3.3. Determining the Ranking

	Total
TK	0,209
PC	0,340
LH	0,314
AF	0,822
FR	0,571
EC	0,443

Appendix 4. Findings on the MAUT Method (2019)

Appendix 4.1. Normalization Process

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,449	0,312	0,364	0,534	0,032	0,044	0,234	0,406
PC	1,000	1,000	0,439	0,456	0,000	0,057	1,000	0,979
LH	0,000	0,000	0,362	0,536	0,097	0,051	0,000	0,198
AF	0,306	0,241	1,000	0,000	1,000	1,000	0,306	0,000
FR	0,598	0,391	0,000	1,000	0,159	0,000	0,513	1,000
EC	0,443	0,485	0,086	0,872	0,716	0,064	0,247	0,609

Appendix 4.2. Utility Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,037	0,026	0,056	0,077	0,005	0,007	0,020	0,051
PC	0,083	0,084	0,068	0,065	0,000	0,009	0,086	0,124
LH	0,000	0,000	0,056	0,077	0,016	0,008	0,000	0,025
AF	0,025	0,020	0,154	0,000	0,167	0,155	0,026	0,000
FR	0,050	0,033	0,000	0,143	0,027	0,000	0,044	0,127
EC	0,037	0,041	0,013	0,125	0,120	0,010	0,021	0,077

Appendix 4.3. Determining the Ranking

	Total
TK	0,280
PC	0,520
LH	0,182
AF	0,549
FR	0,423
EC	0,444

Appendix 5. Findings on the MARCOS Method (2020)

Appendix 5.1. Expanded Decision Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,647	0,281	0,789	0,267	0,264	1,251	-0,155	-0,033
PC	0,824	0,554	0,815	0,227	0,165	0,892	-0,365	-0,068
LH	0,743	0,098	0,764	0,309	0,421	1,782	-0,102	-0,024
AF	0,840	0,545	1,177	0,150	0,047	0,268	1,330	0,235
FR	0,816	0,466	0,667	0,500	0,576	1,729	0,132	0,044
EC	0,670	0,597	0,771	0,297	0,363	1,585	0,568	0,130
AI	0,840	0,597	0,667	0,150	0,576	1,782	1,330	0,235
AII	0,647	0,098	1,177	0,500	0,047	0,268	-0,365	-0,068

Appendix 5.2. Normalized Decision Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,771	0,470	0,845	0,563	0,458	0,702	-0,117	-0,139
PC	0,980	0,928	0,818	0,661	0,287	0,500	-0,274	-0,287
LH	0,884	0,165	0,873	0,486	0,731	1,000	-0,077	-0,103
AF	1,000	0,914	0,567	1,000	0,082	0,150	1,000	1,000
FR	0,971	0,780	1,000	0,301	1,000	0,970	0,099	0,187
EC	0,797	1,000	0,865	0,506	0,630	0,889	0,427	0,553
AI	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
AII	0,771	0,165	0,567	0,301	0,082	0,150	-0,274	-0,287
w_j	0,144	0,129	0,209	0,137	0,112	0,088	0,090	0,093

Appendix 5.3. Weighted Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,111	0,061	0,176	0,077	0,051	0,062	-0,010	-0,013
PC	0,141	0,120	0,171	0,091	0,032	0,044	-0,025	-0,027
LH	0,127	0,021	0,182	0,067	0,082	0,088	-0,007	-0,009
AF	0,144	0,118	0,118	0,137	0,009	0,013	0,090	0,093
FR	0,140	0,101	0,209	0,041	0,112	0,085	0,009	0,017
EC	0,115	0,129	0,181	0,069	0,070	0,078	0,038	0,051
AI	0,144	0,129	0,209	0,137	0,112	0,088	0,090	0,093
AII	0,111	0,021	0,118	0,041	0,009	0,013	-0,025	-0,027

Appendix 5.4. Calculation of Utility Values

	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K)$
TK	0,514	1,957	0,514	0,208	0,792	5,763
PC	0,547	2,081	0,547	0,208	0,792	5,887
LH	0,550	2,094	0,550	0,208	0,792	5,900
AF	0,721	2,745	0,721	0,208	0,792	6,551
FR	0,713	2,714	0,713	0,208	0,792	6,520
EC	0,731	2,783	0,731	0,208	0,792	6,589

Appendix 6. Findings on the MARCOS Method (2019)

Appendix 6.1. Expanded Decision Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,800	0,348	0,722	0,384	0,535	1,927	0,115	0,032
PC	1,278	0,879	0,746	0,340	0,524	2,064	0,250	0,063
LH	0,410	0,108	0,722	0,385	0,559	2,009	0,073	0,020
AF	0,675	0,294	0,925	0,081	0,088	1,182	0,127	0,010
FR	0,929	0,409	0,606	0,649	0,581	1,476	0,164	0,065
EC	0,794	0,482	0,634	0,576	0,782	2,139	0,117	0,043
AI	1,278	0,879	0,606	0,081	0,782	2,139	0,250	0,065
AII	0,410	0,108	0,925	0,649	0,088	1,182	0,073	0,010

Appendix 6.2. Normalized Decision Matrix

	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8
TK	0,626	0,396	0,840	0,210	0,684	0,901	0,460	0,494
PC	1,000	1,000	0,813	0,238	0,669	0,965	1,000	0,982
LH	0,321	0,123	0,840	0,210	0,714	0,939	0,294	0,317
AF	0,528	0,334	0,656	1,000	0,113	0,553	0,510	0,148
FR	0,727	0,465	1,000	0,125	0,743	0,690	0,656	1,000
EC	0,622	0,548	0,956	0,140	1,000	1,000	0,468	0,663
AI	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
AII	0,321	0,123	0,656	0,125	0,113	0,553	0,294	0,148
w_j	0,083	0,084	0,154	0,143	0,167	0,155	0,086	0,127

Appendix 6.3. Weighted Matrix

	FR1	**FR2**	**FR3**	**FR4**	**FR5**	**FR6**	**FR7**	**FR8**
TK	0,052	0,033	0,129	0,030	0,115	0,139	0,040	0,063
PC	0,083	0,084	0,125	0,034	0,112	0,149	0,086	0,124
LH	0,027	0,010	0,130	0,030	0,120	0,145	0,025	0,040
AF	0,044	0,028	0,101	0,143	0,019	0,086	0,044	0,019
FR	0,061	0,039	0,154	0,018	0,124	0,107	0,056	0,127
EC	0,052	0,046	0,147	0,020	0,167	0,155	0,040	0,084
AI	0,083	0,084	0,154	0,143	0,167	0,155	0,086	0,127
AII	0,027	0,010	0,101	0,018	0,019	0,086	0,025	0,019

Appendix 6.4. Calculation of Utility Values

	S_i	K_i^-	K_i^+	$f(K_i^-)$	$f(K_i^+)$	$f(K)$
TK	0,601	1,975	0,601	0,233	0,767	5,259
PC	0,799	2,624	0,799	0,233	0,767	5,908
LH	0,527	1,731	0,527	0,233	0,767	5,015
AF	0,484	1,588	0,484	0,233	0,767	4,873
FR	0,686	2,254	0,686	0,233	0,767	5,538
EC	0,712	2,338	0,712	0,233	0,767	5,623

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An Empirical Analysis of the Impact of Environmental Taxes, Renewable Energy Consumption, and Economic Growth on Environmental Quality: Evidence from Twelve Selected Countries

Çevre Vergileri, Yenilenebilir Enerji Tüketimi ve Ekonomik Büyümenin Çevre Kalitesi Üzerindeki Etkisinin Ampirik Bir Analizi: Seçilmiş Oniki Ülkeden Kanıtlar

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ABSTRACT

Environmental pollution (EP) and global warming (GW), which emerged with industrialization, have become an increasing global problem in recent years. Greenhouse gases (GHGs) resulting from EP forced countries to introduce carbon tax (CT). This study aims to examine the effect of environmental taxes (ETs), renewable energy consumption (REC), and economic growth (EG) on environmental quality (EQ) in 12 countries with the highest carbon emissions (CEs) over the period 1998-2019. The long-term AMG estimation results showed that ETs and REC reduced EP while EG deteriorates EQ in the countries included in the analysis. Nonetheless, Dumitrescu and Hurlin's (D-H) causality test results indicated that a bilateral causality existed between REC and EG and CEs, whereas a unilateral causality existed from ETs to CEs. Therefore, it is important to implement more effective policies to increase ETs and REC in terms of a sustainable environment in the relevant countries.

Anahtar Kelimeler:

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AMG Tahmincisi

Jel Kodları:

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ÖZET

Sanayileşme ile birlikte ortaya çıkan çevre kirliliği ve küresel ısınma son yıllarda giderek artan küresel bir sorun haline gelmiştir. Çevre kirliliği sonucu ortaya çıkan sera gazları, ülkeleri piyasa temelli bir mali araç olan karbon vergisini uygulamaya geçirmeye zorlamıştır. Bu çalışmanın amacı, 1998-2019 döneminde en fazla karbon emisyonuna neden olan 12 ülkede çevre vergileri, yenilenebilir enerji tüketimi ve ekonomik büyümenin çevre kalitesi üzerindeki etkisinin araştırılmasıdır. Uzun dönem AMG tahmin sonuçları analize dahil edilen ülkelerde çevre vergilerinin ve yenilebilir enerji tüketiminin çevre kirliliğini azalttığını, ekonomik büyümenin ise çevre kalitesini bozduğunu göstermiştir. Diğer yandan Dumitrescu ve Hurlin nedensellik test sonuçlarına göre yenilenebilir tüketimi ve ekonomik büyüme ile karbon emisyonu arasında çift yönlü nedensellik ilişkisi olduğu, çevre vergilerinden karbon emisyonuna doğru tek yönlü nedensellik ilişkisi olduğu bulgusuna ulaşılmıştır. Dolayısıyla ilgili ülkelerde sürdürülebilir çevre açısından çevre vergilerinin ve yenilenebilir enerji tüketiminin artırılmasına yönelik daha etkin politika uygulamaları önem arz etmektedir.

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1. INTRODUCTION

In the international literature, ETs are referred to as environmental taxes, pollution taxes, green taxes, ecological taxes, and CTs. Under the name of Green Tax Reform, the tendency towards ETs has increased for specific purposes for both environmental policies and fiscal, economic, and social policies. A new ET aims to reduce environmental destruction, prevent the loss of biodiversity, reduce GHG emissions, internalize externalities by directing production and consumer preferences in an environmentally sensitive manner, and prevent air and water pollution (Tasdemir & Turgay, 2021; Ozbek, 2023).

In recent years, the increase in the amount of GHGs as a result of increasingly unconscious production and consumption activities has caused EP. The emergence of these negative consequences has necessitated a joint decision at the global level. The Rio Convention in 1992 and the Kyoto Protocol in 1997 were signed to solve problems such as increasing EP and GW, which have become common problems in the world. Signed in 1997, the Kyoto Protocol entered into force on February 16, 2005, with the participation of Russia in 2004. The success of the international decisions taken in the Kyoto Protocol and the Rio Convention is related to the majority of the countries that have ratified these conventions. Because GW and similar environmental problems do not occur within the borders of a single country. Environmental degradation (ED), which affects the whole world, has brought along the measures to be taken by countries. One of these measures used by some countries is CT (Organ & Ciftci, 2013).

A CT is a market-based fiscal instrument. Producers are taxed for the amount of CO2 gas they emit. Therefore, firms, which happen to be taxpayers, provide the state budget with additional revenue and assume social responsibility by incurring social costs (Organ & Ciftci, 2013). CT is based on the "polluter pays" principle. According to this principle, the parties that cause EP should also bear the cost of this pollution. Parties that pollute the environment are obliged to pay for the externalities that cause EP. Therefore, the parties will tend to use the lowest-cost resources that can reduce the level of pollution by paying as much tax as they pollute the environment. Thus, by increasing the prices of fossil-based energy resources (FBER) in countries where CTs are applied, both producers and consumers will avoid the consumption of resources with high carbon intensity and prefer to use less carbon-intensive resources such as hydroelectric, solar, geothermal, wave, and wind energy (Costello, 2019).

This study investigates the effectiveness of ETs in reducing CEs for the 12 countries that generate the highest CEs in the 1998-2019 period by using next-generation panel data analysis. The main motivation for this study is the fact that the effect of ET on EQ has not yet been determined in the country group that generates the highest CEs. It is thought that the study can contribute to the literature in three aspects. i) The impact of ET on EQ is evaluated in terms of countries that cause EP the most. ii) The impact of ET on EQ is analyzed with second-generation panel data techniques. iii) Detection of this effect may guide policymakers in the implementation of effective environmental policies in the relevant countries.

The study first reviews the literature on the subject. Then, the model and data constructed in the study are discussed. Lastly, the study model's theoretical framework and the results of the analysis are revealed, and conclusions and policy implications are presented.

2. LITERATURE REVIEW

There are many studies in the literature that do not focus on ET and investigate the determinants of CEs. When the literature on EQ is examined, it is seen that the Environmental Kuznet Curve (EKC) hypothesis has been tested in some of the studies published in this field (Baek, 2015; Seker & Cetin, 2015; Cetin et al., 2018; Cetin et al., 2020). In some studies, many variables such as fossil-based energy consumption, renewable energy consumption, financial development, income inequality, agricultural added value, direct investment, trade openness, tourism, political stability, corruption control, rule of law, and natural resource revenues are used as determinants of CEs (Lee & Brahmasrene, 2013; Purcel, 2019; Muhammad & Long, 2021; Altay Topcu, 2022; Cetin et al., 2022; Ozturk et al., 2022).

Studies investigating the association between ET and variables used as EQ indicators (CO2 emissions and ecological footprint (EFP)) have reached various results. In most of the studies, it has been found that ETs increase EQ, thus ETs are an effective policy tool in improving EQ (Nordhaus, 2006; Abrell & Rausch, 2017; Lin & Li, 2011; Liang et al., 2007; Hajek et al., 2019; Liu et al., 2017; Alper, 2017; Allan et al., 2014). In some studies in the literature, it has been found that ETs do not affect EQ (Hatunluoğlu & Tekeli, 2007; Bayar & Şaşmaz, 2016). Some of the studies analyzing this relationship in the literature are presented below.

Pizer (2002) evaluated price and quantity control policies for ETs in mitigating the adverse effects of global climate change and stated that price control policies favoring ETs are more effective than quantity control policies in global climate change policy. The findings showed that the expected welfare gain from the optimal price policy exceeded the expected gain from the optimal quantity policy with fivefold. Morley (2012) investigated the impact of ET on pollution levels and energy consumption (EC) in EU countries and the Norwegian economy for the period 1995-2006. The study concludes that an increase in ETs leads to a decrease in CO2 emissions, but there is no relationship between ETs and EC. Miller & Vela (2013) analyzed the association between ETs, CO2 emissions, REC, and non-REC in 50 developing and developed countries between 1995-2010. The analysis results indicated that an increase in ETs decreased CO2 emissions and fossil-based EC, and encouraged REC.

Bayar & Sasmaz (2016) investigated the relationship between CT and CO2 emissions in Sweden, Denmark, Norway, Finland, and the Netherlands between 1996-2011 conducting panel causality analysis. It is concluded that no causality existed between CT and CO2 emissions. Tekin & Sasmaz (2016) investigated the effect of environmental, energy, and transportation taxes on EP in 25 EU countries between 1995-2012. They found that ETs and transportation taxes had no impact on EP, whereas energy taxes reduced EP. He et al. (2019) examined the association between ETs and EQ in 31 Chinese provinces and 35 OECD countries in the period 2004-2016. They found that ETs reduced CO2 emissions in the short- and long-run in the countries included in the analysis. Aydin (2020) investigated the causality between ETs and EP in OECD countries between 1995-2016 using the Fourier-Granger causality method. The analysis results indicated that there was a unilateral causality from ETs to EFP in Denmark, Sweden, and Germany, and from EFP to ET in Spain and France

Damirova & Yayla (2021) analyzed the impact of ETs on EQ in the UK, Switzerland, Hungary, Slovakia, Italy, Portugal, Malta, Denmark, the Netherlands, and Turkey for the period 1995-2016. Their panel-wide findings showed that ETs did not affect EQ. They also found that ETs increased EP in Denmark and Portugal, whereas they improved EQ in Italy, Switzerland, Hungary, and Turkey. Meireles et al. (2021) examined the relationship between transportation taxes and CO2 emissions in EU countries for the period 2008-2018 and found that a rise in transportation taxes mitigated CO2 emissions. Sümerli Sarıgül & Altay Topcu (2021), in their study for the period 1994-2015 in Turkey, found that ET and REC reduced CO2 emissions in the long-run, whereas EG had a deteriorating impact on EQ.

Wolde-Rufael et al. (2021) found that ET and REC were effective in improving EQ in 18 Latin American and Caribbean (LAC) countries for the period 1994-2018. Wolde-Rufael & Mulat-Weldemeskel (2022) concluded that ETs and REC improved EQ in 18 Latin American and Caribbean countries between 1994-2018. Similarly, Rafique et al. (2022) found that ETs reduced the EFP in 29 OECD countries in the period 1994-2016. Kesbic & Simsek (2022) determined the causality between ET, REC, GDP, and urbanization rate and EFP by performing the D-H (2012) causality test for 9 EU countries and Turkey for the period 1997-2015. They found that there is bilateral causality between ET and REC and EFP, and unilateral causality from GDP and urbanization to EFP.

Ozkaya (2022) found that EG increased CO2 emissions, but no significant association existed between ET revenues and CO2 emissions for 27 EU countries for the period 2000-2017. Causality analysis results indicated that bilateral causality existed between ETs and CO2 emissions, while unilateral causality existed from CO2 emissions to EG. Ozbek (2023) investigated the relationship between ETs, patents on environmental technologies, EC, EG, and CO2 emissions for the period 1994-2021 in Turkey and found that ETs and patents on environmental technologies reduced EP. On the other hand, EC and EG had a deteriorating effect on EQ. Saqib et al. (2023) investigated the effectiveness of ET on EQ in G-10 countries, using the data for the period 1995-2020. As a result of the analysis, it was emphasized that ET is important for sustainable and low-carbon growth in the G-10 countries. O'Ryan et al. (2023) using the Computable General Equilibrium (CGE) model for the Chilean economy, found that carbon taxes are an important tool to reduce CEs and encourage the energy transition to low-carbon sources.

When the literature is evaluated in general, ET can be used as an effective policy tool in improving EQ. Therefore, it is clear that governments should include carbon taxes more effectively in their environmental policies.

3. MODEL AND DATASET

In the study, the impact of ETs on CEs in 12 countries with the highest CO2 emissions (China, USA, Japan, Germany, Brazil, South Africa, Mexico, Turkey, Australia, Italy, Poland, UK)1 over the period 1998-2019 is analyzed. The study is based on the panel data of 12 countries among the 20 countries with the highest CO2 emissions according to the availability of ETs. For this purpose, the effectiveness of ETs on EQ in the relevant countries will be determined. Upon evaluating the literature, it is seen that the said effect is mostly evaluated in terms of EU and OECD countries.

The most important motivating factor for this study is the fact that the related issue has not been evaluated in the literature in terms of the countries that cause the most EP in the world. Thus, the effectiveness of ETs, which have a crucial place in climate change policies, will be evaluated in terms of the relevant countries.

The logarithmic form of the model is given in Equation 1.

$$\ln CO2_{i,t} = \beta_0 + \beta_1 \ln ET_{i,t} + \beta_2 \ln REC_{i,t} + \beta_3 \ln GDP_{i,t} + \varepsilon_{i,t} \quad (1)$$

In the model established to measure the effectiveness of ETs on EQ, REC, and GDP variables are included as control variables.

Table 1 indicates the descriptions of the variables in the model.

Table 1. Descriptions of Variables Used in the Analysis

Variables 1998-2019	Description	Source
lnCO2	CO2 emissions (metric tons per capita)	WB
lnET	Environmental tax (Total, % of GDP)	OECD
lnREC	Renewable energy consumption (% of total final EC	WB
lnGDP	GDP (constant 2015 US$)	WB

4. ECONOMETRIC METHODOLOGY AND ANALYSIS RESULTS

First, descriptive statistics of the panel data for 12 countries are presented. Then, since the time dimension of the panel data set (T=22) is larger than the unit dimension (N=12) (T>N), the cross-section dependence (CSD) of the model is determined by the LM test developed by Breusch and Pagan (1980). In the next phase, the homogeneity of the model was tested with the Δ tests developed by Blomquist and Westerlund (2013). Since CSD and slope heterogeneity (SH) are detected in the model, Peseran's (2007) CIPS test is performed. Before estimating the long-run model, the cointegration relationships among the variables are tested with Westerlund's (2007) cointegration test, which is suitable for second-generation panel data analysis. Afterwards, the AMG estimator developed by Bond & Eberhardt (2013) and Eberhardt & Bond (2009) is used to estimate the long-run model. Lastly, the causalities among the variables are determined by D-H (2012) causality test.

3.1. Descriptive Statistics of Variables and Correlation Results

Descriptive statistics and correlation results of the panel data of the 12 countries that cause the highest CEs with 264 observations over the period 1998-2019 are presented in Table 2.

Table 2. Descriptive Statistics and Correlation Results of Variables

	lnCO2	lnET	lnREC	lnGDP
Mean	1.935	0.010	2.281	28.182
Median	2.043	-0.010	2.317	28.230
Max.	3.018	2.708	3.890	30.623
Min.	0.530	-1.791	-0.162	26.059
Std. dev.	0.616	0.375	0.754	1.143

[1] World Population Review, https://worldpopulationreview.com/country-rankings/co2-emissions-by-country, Date of Access: 04.05.2023.

Skewness	-0.364	2.191	-0.353	0.220
Kurtosis	2.713	26.161	4.578	2.494
Obs.	264	264	264	264
lnCO2	1.000			
lnET	-0.027	1.000		
lnREC	-0.655	-0.007	1.000	
lnGDP	0.324	-0.010	-0.201	1.000

The variable with the highest mean, median, max., and min. values are lnGDP. The variable with the lowest values is lnET. The variable with the highest std. dev. value is lnREC, while the variable with the lowest value is lnET. In addition, descriptive statistics show that the variable with the highest skewness value is lnET and the variable with the lowest skewness value is lnCO2. Lastly, the variable with the highest kurtosis value is lnET and the variable with the lowest kurtosis value is lnGDP. In line with the theoretical expectation, there is a negative correlation between lnET, lnREC, and lnCO2. However, a positive correlation exists between lnCO2 and lnGDP.

3.2. CSD and Homogeneity Analysis

The LM test statistic used to test for CSD is as shown in Equation 2:

$$LM = T\sum_{\text{İ}=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}{}^{2} \tag{2}$$

Equation 2 $\hat{\rho}ij2$ shows the correlation coefficient of the residuals. Acceptance of the null hypothesis (H_0) in this test indicates that no CSD exists between the series (Breusch & Pagan, 1980; Tatoglu, 2018; Altay Topcu & Dogan, 2022; Kevser et al., 2022; Shahbaz et al., 2023).

According to the test results presented in the table below, H_0 is rejected at the 1% significance level and the alternative hypothesis (H_1) stating that CSD exists between the series is accepted.

Table 3. CSD Test Results

Test	Statistic	P-value
LM	130	0.000
LM adj*	10.93	0.000
LM CD*	5.906	0.000

The HAC version of the homogeneity test is shown in Equation 3:

$$\Delta_{HAC} = \sqrt{N}\left(\frac{N^{-1}S_{HAC} - k}{\sqrt{2k}}\right) \tag{3}$$

When H_0 is rejected and H_1 is accepted in the homogeneity test, the slope coefficients are found to be heterogeneous. Accordingly, the 2nd generation tests should be preferred (Blomquist & Westerlund, 2013; Altay Topcu, 2022). The test results are According to the Δ test results shown in the table below, H_0 expressing the existence of SH is rejected at the 1% significance level. This result shows that the panel data are heterogeneous.

Table 4. SH Test Results

		P-value
$\tilde{\Delta}$	7.487	0.000
$\tilde{\Delta}$adj	8.810	0.000

3.3. Panel Unit Root and Cointegration Analysis

The CIPS panel unit root test is preferred due to the CSD test result. The CIPS test yields strong results when T>N. The CIPS test is calculated by averaging the Pesaran (2007) CADF test. This test is formulated as in Equations 4 and 5 (Pesaran, 2007; Keskin & Şimşek, 2020):

$$CIPS(N,T) = t - bar = \frac{1}{N}\sum_{i=1}^{N} t_i\,(N,T) \tag{4}$$

$$CIPS = N^{-1}\sum_{i=1}^{N} CADF_i \quad (5)$$

CIPS panel unit root test results are given in Table 5. CIPS panel unit root test results for the constant and constant & trend models reveal that all series become stationary in the first difference.

Table 5. CIPS Unit Root Test Results

Variables	CIPS test statistic for constant		CIPS test statistic for constant & trend	
	I(0)	I(1)	I(0)	I(1)
lnCO2	-1.129	-5.773***	-2.283	-5.880***
lnET	-1.660	-5.371***	-2.129	-5.757***
lnREC	-0.662	-4.353***	-1.769	-4.698***
lnGDP	-1.747	-4.979***	-1.701	-5.206***

Note: *** and ** indicate significance at %1 and %5 levels, respectively.

The cointegration test developed by Westerlund (2007), which takes into account CSD, is used to determine the existence of a cointegration relationship. This test is formulated as in Equation 6 (Zafar et al., 2019; Altay Topcu, 2022):

$$\Delta Y_{it} = \delta_i d_t + \alpha_i Y_{i,t-1} + \gamma_i X_{i,t-1} + \sum_{j=1}^{pi} \alpha_{ij} \Delta Y_{i,t-1} + \sum_{j=-qi}^{pi} \gamma_{ij} \Delta X_{i,t-1} + \varepsilon_{it} \quad (6)$$

Panel cointegration test results are given in Table 6. According to the Gt and Pt test results, H_1 indicating the existence of cointegration is accepted. Therefore, it is determined that a long-run relationship exists between lnET, lnREC and lnGDP, and CO2.

Table 6. Westerlund (2007) ECM Test Results

Statistic	Value	Z-value	P-value
G_t	-2.593	-1.322	0.093*
G_a	-8.825	1.055	0.854
P_t	-9.171	-2.382	0.009***
P_a	-8.682	-0.646	0.259

Note: * and *** denote 10% and 1% significance levels, respectively.

3.4. Long-Term Estimation Results

The AMG estimator is used to estimate the long-run elasticity coefficients. The most important feature of this estimation method is that all cross-sectional coefficients are heterogeneous and robust to CSD. The mathematical representation of the AMG estimator is shown in Equation 7 (Topcu & Ozdemir, 2019; Usman et al., 2021; Tekbas, 2022):

$$\widehat{\beta_{AMG}} = N^{-1}\Sigma_{i=1}^{N}\widehat{\beta_t} \quad (7)$$

In Equation 7, $\widehat{\beta_{AMG}}$ denotes the average of the cross-section estimators.

Table 7 reflects the parameter estimates obtained from the AMG estimator.

Table 7. Panel-Wide AMG Estimation Results

Dependent Variable: lnCO2		
	Coefficient	**P-Value**
Constant	-13.795***	0.000
lnET	-0.133**	0.021
lnREC	-0.213***	0.000
lnGDP	0.591***	0.000
Wald χ2	62.24***	
Prob > χ2	0.000	
RMSE	0.024	
Number of Observations	264	
Number of Countries	12	

Note: ***, and ** denote 1% and 5% significance levels, respectively.

As a result of the estimations, a 1% rise in lnET lowers lnCO2 by 0.133% and a 1% rise in lnREC lowers lnCO2 by 0.213%. In other words, ETs and REC improve EQ. Another result obtained from the study is that a 1% increase in lnGDP increases lnCO2 by 0.591%. Therefore, an increase in EG deteriorates EQ.

In the study, the finding that ET improves EQ is consistent with the finding of O'Ryan et al. (2023) for the Chilean. On the other hand, it does not show parallelism with the finding of Tekin and Sasmaz (2016) that ET does not affect environmental pollution (EP) in EU countries.

Another result obtained from the study is related to the positive effect of REC on CEs in the countries included in the analysis. These findings are consistent with the findings of Kesbic and Simsek (2020), Wolde-Rufael et al. (2021), Wolde-Rufael & Mulat-Weldemeskel (2022), and Altay Topcu (2022). On the other hand, the finding in the study that economic growth causes EP is consistent with the findings in studies of Ertugrul et al. (2016) and Sumerli Sarıgul & Altay Topcu (2021).

Panel-specific AMG estimation results are presented in Table 8.

Table 8. Country-Specific AMG Estimation Results

Countries	lnET	lnREC	lnGDP	Constant
China	0.003	-0.604***	0.329**	-6.412
	(0.834)	(0.000)	(0.044)	(0.217)
The USA	0.902***	-0.271***	0.851***	-22.245***
	(0.001)	(0.000)	(0.001)	(0.004)
Japan	-0.351	-0.243	0.773**	-19.698**
	(0.259)	(0.110)	(0.011)	(0.024)
Germany	0.017	-0.079***	0.587*	-14.392*
	(0.830)	(0.002)	(0.057)	(0.103)
Brazil	-0.050***	-1.094***	0.718***	-15.313***
	(0.000)	(0.000)	(0.000)	(0.000)
South Africa	-0.268***	-0.132	0.515***	-11.007***
	(0.001)	(0.187)	(0.000)	(0.002)
Mexico	-0.001	-0.278***	0.337***	-7.212***
	(0.685)	(0.000)	(0.000)	(0.007)
Turkey	-0.107***	-0.362***	0.339***	-6.765***
	(0.005)	(0.000)	(0.000)	(0.001)
Australia	-0.021	-0.229***	-0.058	5.005***
	(0.317)	(0.000)	(0.315)	(0.002)
Italy	-0.118	-0.165***	1.422***	-37.683***
	(0.238)	0.000	(0.000)	(0.000)
Poland	-0.247	-0.301***	0.456***	-9.181***
	(0.002)	(0.000)	(0.000)	(0.000)
The UK	-0.307**	-0.101***	0.135	-1.322
	(0.101)	(0.000)	(0.608)	(0.864)

Note: ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

According to Table 8, ETs have an improving effect on EQ in Turkey, South Africa, Brazil, the UK, and Poland. In the top-four countries (China, USA, Japan, and Germany), which generate the highest CEs, it is noteworthy that this tax is not implemented effectively. In this framework, it can be interpreted that these countries should reconsider their environmental policies. The effect of REC on EQ is observed in all countries except Japan and South Africa in the panel. On the other hand, the impact of EG on EP is positive in all countries except for Australia and the UK.

3.5. Causality Test Results

The D-H (2012) test is developed for heterogeneous panels and gives consistent results when both T>N and N>T. Acceptance of H_1 implies that causality exists between the variables. The mathematical expression of this test is given below (Dumitrescu & Hurlin, 2012; Kesbiç & Şimşek, 2020; Altay Topcu, 2022):

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \beta_{ik}\, y_{i,t-k} + \sum_{k=1}^{K} \gamma_{i,k}\, X_{i,t-k} + \varepsilon_{it} \quad (8)$$

Causality test results are presented in Table 9.

Table 9. D-H Causality Test Results

Causality	W-bar	Z-bar	P-value
lnET→lnCO2	4.7461	4.7563	0.000***
lnCO2→lnET	2.880	1.5256	0.127
lnREC→lnCO2	4.356	4.081	0.000***
lnCO2→lnREC	5.555	6.157	0.000***
lnGDP→lnCO2	5.1270	5.4161	0.000***
lnCO2→lnGDP	4.4057	4.1668	0.000***

Note: *** indicates a 1% significance level.

The directions of the causality are summarized in Figure 1.

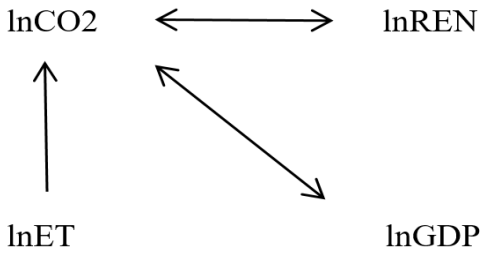

Figure 1. Directions of Causality

Note: → and ↔ indicate the existence of unilateral and bilateral causalities, respectively.

As seen in Figure 1, a bilateral causality exists between lnCO2 and lnREC, and lnGDP, whereas a unilateral causality exists from lnET to lnCO2.

5. CONCLUSION AND POLICY IMPLICATIONS

Today, global problems such as increasing EP and climate change have made environmental regulations important. The importance of EQ has increased to ensure sustainable development in the world. One of the public regulations related to improving EQ is ETs. ETs have been applied in many countries since the 1990s. This tax aims to increase social welfare by reducing negative externalities in production and consumption activities.

In this study, the relationship between ETs, REC, and EG and CO2 emissions in a sample of 12 countries that caused the highest CEs in the 1998-2019 period is investigated with second-generation panel data techniques. AMG estimation concluded that ETs and REC reduce CO2 emissions, but EG increases CO2 emissions. D-H causality test results indicated a bilateral causality between REC and EG and CO2 emissions, while there was a unilateral causality from ETs to CO2 emissions.

The finding that ETs improve EQ is consistent with the studies of Morley (2012), Miller & Vela (2013), He et al. (2019), and Özbek (2023). However, this finding is not consistent with the finding of Damirova &Yayla (2021) and Ozkaya (2022) that ETs do not affect EQ. On the other hand, the finding that REC reduces EP is consistent with the studies of Meireles et al. (2021); Wolde-Rufael, Sumerli Sarıgul & Altay Topcu (2021); Mulat-Weldemeskel (2022). In addition, the finding that EG has a deteriorating effect on EQ is in line with the studies of Ozkaya (2022) and Ozbek (2023).

The pressure of EG on the environment can be perceived as the rise in production and consumption activities of individuals with increasing welfare levels and the fact that these activities are largely carried out with FBER. According to the panel-specific results, the fact that ETs have no or insufficient effect on CO2 emissions in most of the countries that cause the most EP indicates that CT implementation is not used as an efficient policy instrument to enhance EQ in the relevant countries. Therefore, the effectiveness of ETs on EQ depends on increasing the CT burden based on the polluter pays principle and encouraging REC.

The results of the analysis obtained in this study have some policy recommendations. Renewable energy costs can be reduced by increasing R&D investments in 12 selected countries that cause the most carbon emissions. Thus, policies to promote clean energy technologies should be developed and implemented in these countries. In addition, effective environmental tax policies should be established and implemented to improve EQ in the countries included in the analysis. In this context, regulations that encourage investment in sustainable and low-

carbon areas such as carbon taxes, additional fees, and/or taxes on carbon emissions where upper and lower limits are determined should be implemented.

In subsequent studies, this effect can be investigated by using independent variables such as globalization, financial development, and technological innovation. In addition, the Environmental Kuznets Curve Hypothesis can be tested by evaluating different country groups.

AUTHORS' DECLARATION

This paper complies with Research and Publication Ethics, has no conflict of interest to declare, and has received no financial support.

AUTHORS' CONTRIBUTIONS

All sections are written by the author.

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Does Being Listed in BIST Sustainability Participation Index Affect Share Prices?

BİST Sürdürülebilirlik Katılım Endeksi'nde Listelenmek Hisse Fiyatlarını Etkiler mi?

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ABSTRACT

According to the Efficient Market Hypothesis, stock prices are affected by all market information simultaneously. Hence, it does not appear conceivable for the investor to obtain returns above the market average, according to this hypothesis. On the other hand, the market anomalies shown by empirical studies highlight the impossibility of an efficient market and the potential for divergent responses to news and announcements from the market and investors. Whereas the idea that stock prices reflect both recently made public announcements and historical information is described as an efficient market in semi-strong form, it is tested to see how the market responds to particular events that might have an impact on it and lead to predictable price movements. The main purpose of the research is to ascertain whether being included in the Borsa Istanbul Sustainability Participation Index has an effect on stock returns. Through using the Event Study approach, the analysis focused on the stock closing data of 23 companies whose uninterrupted data were acquired from 29 companies in the BIST Sustainability Participation Index, which began trading on November 12, 2021. The major findings demonstrate that the market is not efficient in a semi-strong form based on statistically significant findings in Average Abnormal Returns as well as Cumulative Average Abnormal Returns. It might be countered, though, that the fact that these outcomes are discontinuous suggests that the investor may face obstacles to achieving returns above the market average.

Anahtar Kelimeler:

BİST Sürdürülebilirlik

Katılım Endeksi,

Yarı Güçlü Formda Etkinlik,

Olay Çalışması

Jel Kodları:

G10 G14

ÖZET

Etkin Piyasa Hipotezi piyasadaki tüm bilgilerin hisse senedi fiyatlarına eşanlı olarak yansıdığını ileri sürmektedir. Dolayısıyla, bu hipoteze göre yatırımcının piyasa ortalaması üzerinde getiri elde etmesi mümkün görünmemektedir. Öte yandan, yapılan ampirik çalışmalarda ortaya çıkarılan piyasa anomalileri, etkin bir piyasanın mümkün olamayacağını, piyasanın ve yatırımcının haber ve duyurulara karşı farklı reaksiyonlar gösterebileceği gerçekliğinin altı çizilmiştir. Hisse senedi fiyatlarının tarihsel bilgilerin yanı sıra kamuya açıklanan duyuruları da yansıttığı görüşü yarı-güçlü formda etkin piyasa olarak nitelendirilirken, piyasayı etkileyebilecek ve tahmin edilebilir fiyat hareketlerine neden olabilecek spesifik olaylara karşı tepkiler test edilmektedir. Bu doğrultuda, çalışmanın amacı Borsa İstanbul Sürdürülebilirlik Katılım Endeksi'ne dâhil olmanın hisse senedi getirilerine etkisinin var olup olmadığını bulabilmektir. Bu kapsamda, 12 Kasım 2021 tarihi itibariyle işlem göremeye başlayan BİST Sürdürülebilirlik Katılım Endeksi'nde yer alan 29 firmadan kesintisiz verilerine ulaşılan 23 firmanın hisse senedi kapanış verileriyle Olay Çalışması yöntemi kullanılarak analiz gerçekleştirilmiştir. Elde edilen ana bulgulara göre, hem Ortalama Anormal Getiriler hem de Kümülatif Ortalama Anormal Getirilerde tespit edilen istatistiksel olarak anlamlı bulgular piyasanın yarı güçlü formda etkin olmadığına işaret etmektedir. Ancak, bu sonuçların süreklilik arz etmiyor olması, yatırımcının piyasa ortalamasının üzerinde getiri elde etmede kısıtlarla karşılayabileceği öngörüsüne de işaret ettiği iddia edilebilir.

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1. INTRODUCTION

The efficient market is acknowledged as an opinion that the news spreads very quickly when the information is released and that it is immediately reflected in the prices of shares. It signifies that the securities markets are very efficient at reflecting information about the stock market (Malkiel, 2003: 59). Market efficiency is divided into three types according to Fama's (1970) Efficient Market Hypothesis. The first of them, known as weak-form efficiency, asserts that the stock price of today reflects all previous stock prices' history. This is the reason why it's impossible to forecast and outperform the market via technical analysis. Efficiency, in semi-strong form, indicates that all publicly available information is evaluated using the stock's most recent share price. This suggests that neither technical analysis nor fundamental analysis can be employed in order to achieve better gains. The strongest variation of market efficiency is strong form efficiency. It claims that a stock price accounts for all market information, both public and private. Even insider information, according to some, cannot benefit investors (Vulic, 2009). Therefore, the Efficient Market Hypothesis proposes that it is impossible for an investor to beat the market on average. Although the primary premise of the aforementioned hypothesis is that people are rational, certain scholars hold the opinion that people are neither rational nor just reasonable or irrational beings. It is asserted that investors may be able to generate abnormal returns as a consequence. Behavioral Finance Theory is based on scenarios in which an investor might choose to maximize value rather than reap benefits (Tversky & Kahneman, 1989; Kahneman, 2018; Housel, 2022). However, when examined from a different angle, it is well known that market anomalies play a significant role in the decision-making process for investors, in addition to value judgments or prejudices. It is crucial to consider if market participants who invest from an Islamic perspective and, consequently, with interest sensitivity, have the ability to outperform the market as this topic is evaluated in terms of investor behavior.

Corporate Sustainability is defined as the process of integrating economic, social, and environmental factors into organizational activities and decision-making processes in order to maximize long-term value to companies. It also includes overseeing any hazards that could arise from the aforementioned issues (Rahman, 2011). Four factors may be considered to make up the sustainability issues that need to be acknowledged and examined. The first of them is social impact, which is characterized as an assessment of how society as a whole affects the company in terms of stakeholder effect and social contract. The company's actions' effects on the geophysical environment are referred to as the environmental impact, which comes in second. The connection between the business and its internal stakeholders, particularly the workers, is defined as well as the corporate culture, which encompasses all facets of this relationship, and the financial resources are described in terms of providing a suitable rate of return for the degree of risk assumed (Aras & Crowther, 2009: 282). Companies trading on the Borsa Istanbul are deemed to have encountered the sustainability criteria and are qualified to participate in the BIST Sustainability Index if they have a general sustainability rating of 50 or higher, each main heading score of 40 or higher, and at least 8 category grades of 26 or higher. For investors who desire to engage in both the Participation and Sustainability Indices at the same time, the BIST Sustainability Participation Index was established on November 12, 2021.

The main motivation of this study is to examine the effect of being included in the sustainability participation index on firm performance, both within the framework of competition conditions and within the scope of the index created from an Islamic point of view, on the investor behavior of firms. In this perspective, the primary objective of the research is, under the assumption that all other factors remain constant, to analyze the impact of being a part of the BIST Sustainability Participation Index on stock prices by employing the Event Study approach. By evaluating the outcomes in view of the spectrum of hypotheses, it is possible to determine the efficiency of the market. In this vein, a literature study review was carried out, the data set and methodology were described, and the conclusions drawn from the analysis were assessed within the framework of all this theoretical underpinning.

2. LITERATURE REVIEW

In keeping with the objective of the research, the evidence from empirical investigations in the literature that produced both comparable and dissimilar outcomes are presented below.

Oberndorfer et al. (2013) used the Fama and French 3-Factor Model and t-GARCH (1,1) models to examine the impact of to be listed German firms in the Dow Jones STOXX Sustainability (DJSI STOXX) and Dow Jones Sustainability World (DJSI World) Indices. The results demonstrate the unfavorable effect of being a part of DJSIWorld. Regrettably, it was just not attainable to identify any significant cumulative average abnormal returns for their participation in DJSI. In a comparable sense, Özmen et al. (2022) evaluated by using the TOPSIS

(Technique for Order Preference by Similarity to Ideal Solutions) method in the research aiming to measure the financial performance of 15 companies included in the BIST Sustainability Index for the first time. The investigation revealed that, despite the positive impact on company performance of being included in the Index, these impacts were not statistically significant. On the other side, Uzunoğlu (2022) used event study method to examine how the Covid-19 pandemic affected the BIST Sustainability Index. While not statistically significant, the research's results suggested that there were negative abnormal returns on the event day. However, it was discovered that the cumulative abnormal returns were negative after the first death was reported.

In their analysis spanning the years 2001–2006, Consolandi et al. (2008) identified firms with the highest CSR (Corporate Social Responsibility) ratings among those included in the Dow Jones Stoxx 600 Index. Through using the Event Study approach, it was determined how each of these firms' share prices reacted to being included or excluded in the Dow Jones Sustainability Stoxx Index (DJSSI). As a consequence, the benefits of inclusion in the index and the negatives of exclusion from the index were established. In contrast, Wai Kong Cheung (2011) evaluates the US equities added to or removed from the Dow Jones Sustainability Global Index between the years of 2002 and 2008 in order to investigate their impact on the share prices of firms included and excluded from the index. There was no conclusive proof that the announcement alone had a major influence on stock return, according to the examination of the impacts assessed on the basis of liquidity, risk, and return on equity. But nevertheless, it was found that the return of stocks included in (excluded from) the index had a substantial but transient boost (down) on the day of the shift.

Eyüboğlu & Bulut (2015) evaluated how stock performance was impacted by announcements made by firms quoted on the BIST 30. According to the statistical findings before and after the event, the market is not efficient in a semi-strong form. Parallel to this, Kavcar and Gümrah (2017) examined the impact on stock returns of Borsa Istanbul-based firms entering the BIST Corporate Governance Index. The event study methodology was employed in the experiment to gauge the market's efficiency. The results of this analysis included abnormal returns and the observation that the market was not efficient in a semi-strong form. In their study, Temiz and Acar (2018) used an event study to assess how firms trading in the BIST Sustainability Index reacted to the news that they had been included in the index. Accordingly, 44 firms listed in the Index were grouped according to earnings per share (EBK), indebtedness and Tobins' q values in the event windows created, and the findings were interpreted. The outcomes illustrate that, in terms of average abnormal returns, there is no noticeable difference between the series belonging to the companies categorized in accordance with the specified criteria. In a related manner, Parlakkaya et al. (2019) used the event study methodology to determine the impact of this shift on the stock returns of the firms included in the BIST Sustainability Index. When all years are considered independently and combined in the research conducted between the years 2014 and 2016, it is evident that statistically meaningful findings could not be reached.

Barroso Del Toro et al. (2022), aimed to measure the reactions of the shareholders of the leading US energy companies to the sustainability announcements. 4101 events were found using the Global Database of Events, which considered 207,386 news headlines from 2017 to 2019. As a result, it has been demonstrated that shareholder reaction to sustainability-related announcements is meaningful and substantial. In contrast, Çimen (2019) used the event study approach to look into the effect of company inclusion in the BIST sustainability index on stock returns. The impact of being included in the index was examined in the context of the seven-day event window. The study's conclusions show that the announcement of inclusion in the Sustainability Index has a positive impact on the performance of the company. It may be concluded from the results that the market is not efficient in semi-strong form. Also, in the research on the link between market-specific business performance metrics of firms quoted in Borsa Istanbul for the years 2014 to 2017, Yilmaz et al. (2020) examine the efficacy of corporate sustainability (CS-measured by participation in the sustainability index). The results demonstrate that being a part of the index lessens a company's total risk and improves its resilience relative to other firms that are not, safeguarding it against stock drops in the case of a major catastrophe.

When the studies in the literature are taken as a whole, it is clear that, within certain bounds, the influence of being included in sustainability-based indexes on the market value of the shares differs in both domestic and foreign securities markets. While Consolandi (2008), Wai Kong Cheung (2011), Eyüboğlu & Bulut (2015), Kavcar & Gümrah (2017) and Çimen (2019) found findings that the market was not efficient in a semi-strong form, statistically significant findings could not be reached in the studies of Oberndorfer et al. (2013), Parlakkaya (2019), Özmen et al. (2022); Uzunoğlu Ünlü (2022).

3. DATASET AND METHODOLOGY

In light of the specific objectives of the research, 23 out of 29 firms that fulfill the Participation Index and Sustainability Index requirements and whose uninterrupted information is available are included in the analysis. The date of the event, 12 November 2021, was taken into consideration when these firms began to be listed in the Borsa Istanbul Sustainability Participation Index. The range of -20, and -270 before the day of the Event was considered as the estimation period in the Event study's content that is employed in the research. Also, during the timespans of 20 days prior to and 20 days following the event date, separate assessments of Average Abnormal Returns (AAR) and Cumulative Average Abnormal Returns (CAAR) are determined.

In semi-strong form, the idea that all information that is publicly available is reflected simultaneously on asset values is accepted in efficient markets. In other words, this theory is more comprehensive than weak-form efficient markets and includes news, comments, sales, profit for the time, capital increase, dividend distribution, mergers, transfers, and other corporate operations in addition to publicly published firm information. The event study approach is frequently employed in the literature to assess market efficiency within the context of the aforementioned premise. By taking the date of the firm's activities' public disclosure as day 0, this technique analyzes any potential differences in the stock returns of the company in the days before and after the event. Also, the post-event forecast window is frequently used to examine a firm's performance after announcements like a significant acquisition or initial public offering (IPO). The post-event prediction window enables determining the event's longer-term effects (Benninga, 2008: 333). The event study's approach consists of supposing that all other parameters remain constant while examining the information set on the inside of the analysis.

- The daily returns of the Index and associated firms are first estimated by calculating their natural logarithms in order to approximate the normal distribution as follows:

$$R_t = l_n(\frac{P_t}{P_{t-1}}) \times 100 \quad (1)$$

In this formula, R_t represents the logarithmic return of the stock in period t, P_t refers to the price of the stock in period t and P_{t-1} demonstrates the price of the stock on day t-1.

- The market model is used to determine the Expected Return on stocks in the following stage (Brenner, 1979):

$$E_{it} = \alpha_i + \beta_i \times R_{mt} + \varepsilon_t \quad (2)$$

R_{mt} indicates the market rate of return, while α_i and β_i are the regression coefficients for the stock's expected rate of return.

- In the next step, during the announcement process, the Abnormal Return is computed.

$$AR_{it} = R_{it} - E_{(r)it} \quad (3)$$

The average abnormal return rate, or AR, of the stock "i" is determined by subtracting the expected return from the actual return.

- In the last step, different event windows are used to determine the Cumulative Average Abnormal Returns employing the formula below:

$$CAAR_t = \sum_{t=0}^{x} ARi,_t \quad (4)$$

$CAAR_t$ is the stock's cumulative abnormal return within the event window period.

The analyses conducted lead to the conclusion that market efficiency is indicated by average abnormal returns and cumulative average abnormal returns that are near zero. On the other hand, the argument that the market is not efficient in a semi-strong form is supported by the fact that this value is not near zero, or, in other words, by a value other than zero (positive or negative) (Tekbaş, 2022: 271). The research's hypotheses were established as follows within the context of this theory:

H_0: Share returns are unaffected by being listed in the Borsa Istanbul Sustainability Participation Index.

H_1: Share returns are affected by being listed in the Borsa Istanbul Sustainability Participation Index.

In case of being included in the Borsa Istanbul Sustainability Participation Index, if statistically significant results are achieved, the H_0 hypothesis will be rejected based on the conclusions drawn from the analyses done within

these hypotheses. In light of the available data and the model, it is possible to conclude that the market is not efficient in a semi-strong form.

4. FINDINGS and ANALYSIS

From the perspective of the purpose of the study, 12 November 2021, when the companies included in the analysis started to be listed in the BIST Sustainability Participation Index, was considered the event day. The Event Study technique is used to uncover potential interactions. The Average Abnormal Returns that occurred on the day of the event and the Cumulative Average Abnormal Returns in different review windows are evaluated in this section of the research.

Table 1. AAR Outcomes for Firms Listed in the BIST Sustainability Participation All Index

Days	AAR	Std. Dev.	P-Value	Negative AARs (%)
-20	0.007227	0.016958	0.32588	0.39
-19	-0.001088	0.013422	0.06387*	0.57
-18	-0.000979	0.013214	0.05837*	0.48
-17	-0.005283	0.017225	0.23804	0.65
-16	-0.001077	0.015920	0.05333*	0.52
-15	-0.003987	0.011558	0.26660	0.65
-14	-0.004337	0.013996	0.24043	0.74
-13	0.001400	0.012978	0.08495*	0.39
-12	-0.002760	0.018611	0.11653	0.43
-11	-0.003009	0.014012	0.16805	0.61
-10	-0.008512	0.018410	0.35162	0.70
-9	-0.006948	0.020817	0.25828	0.61
-8	-0.013171	0.025727	0.38622	0.87
-7	-0.002746	0.021474	0.10059	0.57
-6	-0.001578	0.021316	0.058332*	0.57
-5	-0.003865	0.016625	0.18170	0.65
-4	-0.003149	0.016855	0.14651	0.52
-3	0.000215	0.023198	0.00732***	0.61
-2	0.006806	0.024003	0.22059	0.43
-1	0.001987	0.015336	0.10189	0.57
0	***-0.016324***	***0.026905***	***0.44975***	***0.74***
1	-0.002547	0.024184	0.082915*	0.65
2	-0.003259	0.012316	0.20622	0.57
3	-0.006631	0.016873	0.30186	0.74
4	0.008101	0.030449	0.20732	0.30
5	0.007969	0.014905	0.40174	0.30
6	0.010032	0.034156	0.22826	0.48
7	-0.001106	0.033928	0.0257**	0.57
8	-0.009339	0.020406	0.34832	0.74
9	0.000451	0.033015	0.01076**	0.48
10	0.001803	0.029012	0.04899**	0.65
11	0.006500	0.028276	0.17968	0.52
12	-0.001803	0.023515	0.06041*	0.57
13	-0.004001	0.020807	0.15073	0.65
14	-0.001557	0.022321	0.05496*	0.70
15	-0.006031	0.025537	0.18451	0.57
16	-0.003170	0.024844	0.10038	0.65
17	-0.007802	0.022599	0.26679	0.65
18	0.003797	0.025691	0.11616	0.57
19	0.003805	0.026359	0.11345	0.52
20	-0.004000	0.032919	0.0956*	0.70

Statistical significance is indicated by *, ** and *** at the 10%, 5%, and 1% levels, respectively.

Table 1 presents the AAR values for the stocks included in the Borsa Istanbul Sustainability Participation Index. While the day of the event, 12 November 2021, was labeled as day 0, it is worth noting that the AAR values that appeared on this day were negative. Admittedly, this outcome is not statistically significant. Six significant outcomes in total were obtained in the 20 days before the event day when the other findings listed in Table 1 are taken into consideration. According to the observations, the 3rd day before the event day is positive at the 1% significance level, the 6th day is negative at the 10% significance level, the thirteenth day is positive at the 10% level, and the sixteenth, eighteenth, and nineteenth days seemed to be positive at the 10% significance level. On the other hand, 10% significance level and negative outcomes were obtained on the 1st, 12th, 14th, and 20th days following the event day; on the 9th and 10th days, positive AAR values were detected at the 5% significance level. Also, an extra negative abnormal return is figured out on the 7th day at 5% significance level. It may be argued that the BIST Sustainability Participation Index is not efficient in semi-strong form when the significant AAR findings from the analyses are assessed within the framework of the Efficient Markets Hypothesis. But, the lack of continuity in the relevant data leads to the conclusion that, for the purposes of a particular trend, it is impossible to outperform the market.

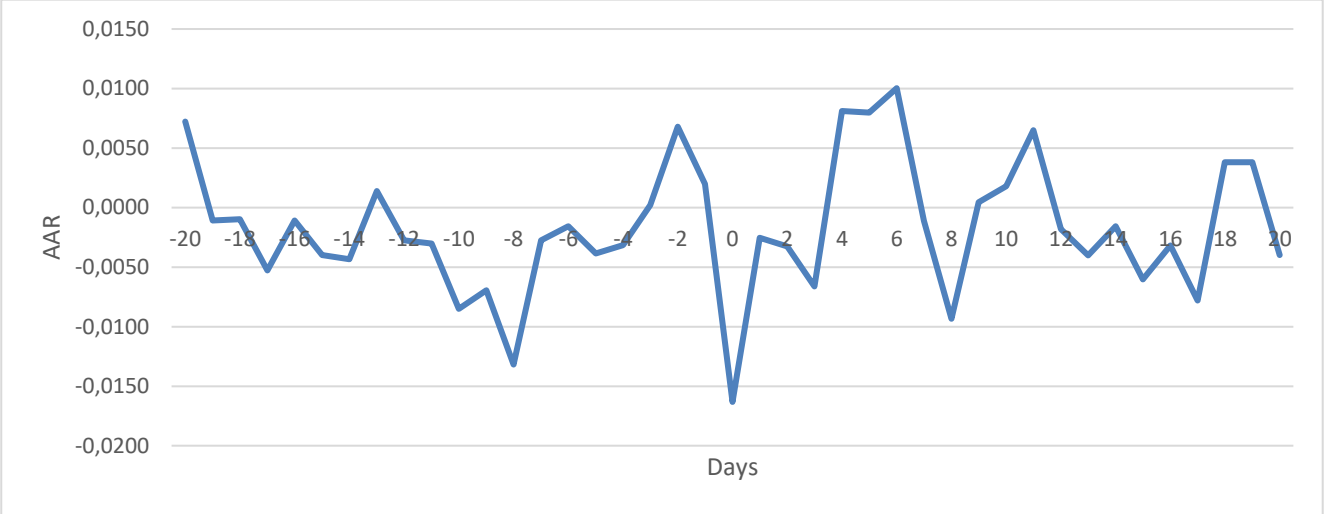

Chart 1. Graphical Representation of AAR Outcomes for Firms Listed in the BIST Sustainability Index

The average abnormal return outcomes for the firms quoted in the BIST Sustainability Participation Index throughout the predefined timeframe are represented graphically in Chart 1. This indicator is developed to monitor potential fluctuations in the pre- and post-event periods. The graphic obviously demonstrates that neither the day included in the Index nor the days around it exhibit any discernible trend. It might be argued that there is no obvious path to be taken in this manner or proposed for market participants.

Table 2. CAAR Outcomes for Firms Listed in the BIST Sustainability Participation All Index

	CAAR	Std. Dev.	P-Value	Negative CAARs (%)
[-20,20]	-0.069965	0.153128	0.34778	0,61
[-15,15]	-0.061395	0.124219	0.37397	0,83
[-10,10]	-0.041811	0.098146	0.32576	0,78
[-5,5]	-0.010697	0.067650	0.12419	0,57
[-1,1]	-0.016884	0.031330	0.40463	0,65
[-20,0]	-0.044854	0.098050	0.34817	0,65
[-15,0]	-0.059978	0.088548	0.49475	0,70
[-10,0]	-0.047285	0.084881	0.41689	0,74
[-5,0]	-0.014330	0.056937	0.19638	0,70
[0,2]	-0.022129	0.027646	0.56798	0,78
[0,5]	-0.012690	0.056086	0.17691	0,48
[0,10]	-0.010850	0.107745	0.07929*	0,39
[0,15]	-0.017741	0.120954	0.11527	0,48
[0,20]	-0.025111	0.135591	0.14523	0,57

Statistical significance is indicated by *, ** and *** at the 10%, 5%, and 1% levels, respectively.

Table 2 illustrates the CAAR outcomes at various review intervals as of November 12, 2021, the first day when companies began being listed on the BIST Sustainability Participation Index. Once the table is examined, it can be seen that the event window [0,10] had a negative statistically significant CAAR value at the 10% level of significance. It is interesting to observe that all of the other windows in the table have a negative cumulative average abnormal return. Given that no obvious pattern has been identified in the context of any of the aforementioned analyses, it is less unlikely that investors would outperform the market by using the information provided. Another viable defense for this unfortunate situation is the market's propensity to purchase expectations and sell real circumstances.

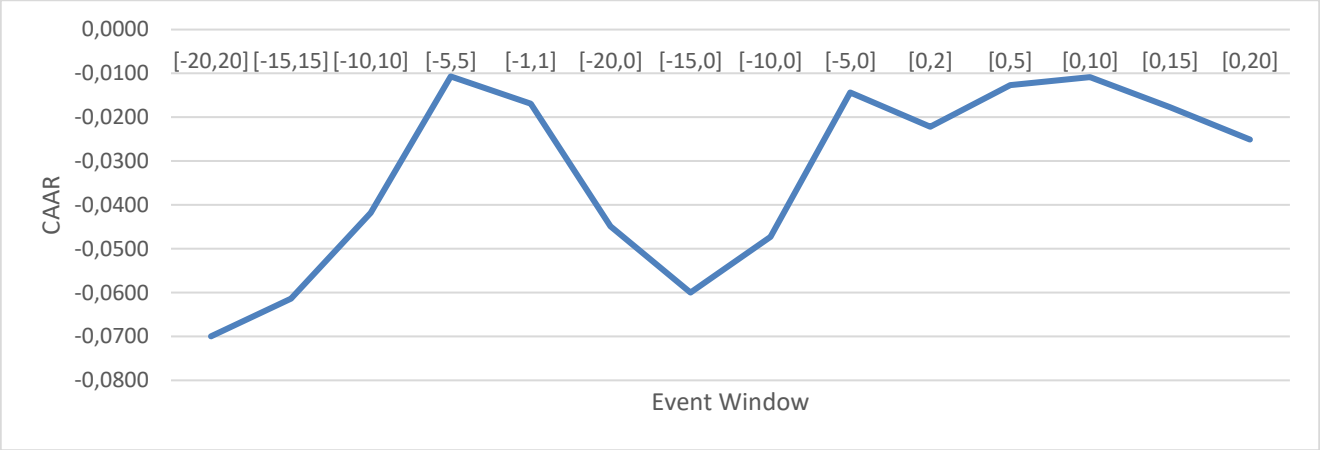

Chart 2. Graphical Representation of CAAR Outcomes for Firms Listed in the BIST Sustainability Index

The Cumulative Average Abnormal Return results in various periods before and after the firms were included in the BIST Sustainability Participation Index are shown graphically in Chart 2. it is easy to observe how the results in Table 2 are distributed and how strongly negative they are.

5. CONCLUSION

Semi-strong form efficiency tests among efficient market models are conducted to determine if current security prices accurately and simultaneously represent all information that is currently accessible to the public. Nonetheless, each particular test may be related to an evaluation of worth in relation to cases that offer a collection of data regarding security prices (such as stock splits, the announcement of financial reports by firms, and new securities issuances). Hence, each test offers evidence to support the model, with the expectation that gathering this data will ensure the model's validity. Researchers employ Event Studies to experimentally examine the effectiveness of the market in a semi-strong form. The abnormal returns around the time of the first announcement are often the focus of studies of these events.

The objective of this research is to ascertain whether the inclusion of firms listed in the BIST Sustainability Participation Index, which is made up of companies that fulfill both the BIST Participation Index and BIST Sustainability Index criteria and whose transactions started to be calculated as of November 12, 2021, has an impact on stock prices. In this regard, a data set containing the closing prices of 23 firms on a daily basis was produced using uninterrupted data obtained from 29 companies participating in the BIST Sustainability Participation Index and analyzed by employing the Event Study. The statistically significant results indicated that the market was not efficient in the semi-strong form and that the launch of the list in the Borsa Istanbul Sustainability Participation Index had an impact on the stock returns of the companies. Although the H_0 hypothesis was rejected in this manner, it was concluded that using this information set would make it challenging for us to outperform the market since the facts gleaned from the results lack continuity. Therefore, it can be concluded that investors cannot outperform the market in light of the findings when the findings are examined from the perspective of market participants who make investment decisions from an Islamic perspective in regard of being included in the BIST Participation Sustainability Index.

At this point, it can be said that the findings of this research and those of Oberndorfer et al. (2013) and Parlakkaya et al. (2019) are in conflict. Nonetheless, similarities may be shown in the research of Çimen (2019), Kavcar and Gumrah (2017), Eyübolu & Bulut (2015), and Consoladi et al. (2008). Furthermore, since the creation of the BIST Sustainability Participation Index, the BIST Participation 50, the BIST Participation 30 and the BIST Participation

Dividend Indices accompanied similar processes, it can be extrapolated that future research on market efficiency in this configuration and valuations of firm performance will add to the scientific literature.

AUTHORS' DECLARATION:

There is no need to obtain ethical permission for the current study as per the legislation. The "*Declaration Form Regarding No Ethics Permission Required*" was sent to the journal by the authors on this subject**.**

AUTHORS' CONTRIBUTIONS:

Conceptualization, writing-original draft, editing- FK and DT, data collection, methodology, formal analysis- FK, DT, Final Approval and Accountability -FK and DT.

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The Reaction of the Greek Stock Market to IFRS 16

Yunanistan Menkul Kıymetler Borsası'nın UFRS 16'ya Tepkisi

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ABSTRACT

In this paper, we examine if the implementation of the IFRS 16 about leases had an impact on the stocks traded on Athens Exchange. We use a sample of 79 listed companies to examine whether the prices and the risk of their stocks were affected by the new accounting standard. In doing so, we conduct an event study to estimate abnormal return and volatility of stocks around the publication dates of the sample's financial statements for year 2019. Similar estimates are prepared for year 2018, which is used as the control year. Afterwards, we compute three representative financial ratios concerning the companies' profitability, leverage and liquidity. Finally, we check the validity of three assumptions about the impact of IFRS 16 on stock performance and volatility; 1) higher profitability results in higher stock returns and lower volatility, 2) higher leverage ratios, leads to lower stock returns and increased risk, and 3) decreased liquidity results in lower stock returns and increased risk. The empirical findings do not verify these assumptions.

Anahtar Kelimeler:
Muhasebe Standartları,
UFRS 16,
Operasyonel Kiralama,
Finansal Kiralama,
Hisse Senedi Getirisi
Jel Kodları:
G41, M41

ÖZET

Bu çalışmada, kiralamalarla ilgili UFRS 16 uygulamasının Atina Menkul Kıymetler Borsası'nda işlem gören hisse senetleri üzerinde bir etkisi olup olmadığını incelenmiştir. Hisse senetlerinin fiyatlarının ve riskinin yeni muhasebe standardından etkilenip etkilenmediğini incelemek için borsaya kote 79 şirketten oluşan bir örneklem kullanılmıştır. Bunu yaparken, örneklemin 2019 yılı mali tablolarının yayınlanma tarihleri civarında hisse senetlerinin anormal getirisini ve oynaklığını tahmin etmek için bir olay çalışması yürütülmüştür. Kontrol yılı olarak kullanılan 2018 yılı için de benzer tahminler hazırlanmıştır. Daha sonra, şirketlerin karlılığı, kaldıracı ve likiditesi ile ilgili üç temsili finansal oran hesaplanmıştır. Son olarak, UFRS 16'nın hisse senedi performansı ve volatilite üzerindeki etkisine ilişkin üç varsayımın geçerliliğini kontrol edilmiştir; 1) daha yüksek karlılık, daha yüksek hisse senedi getirileri ve daha düşük volatilite ile sonuçlanır, 2) daha yüksek kaldıraç oranları, daha düşük hisse senedi getirileri ve artan riskle sonuçlanır ve 3) azalan likidite, daha düşük hisse senedi getirileri ve artan riskle sonuçlanır. Ampirik bulgular bu varsayımları doğrulamamaktadır.

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1. INTRODUCTION

In the framework of the International Financial Reporting Standards (IFRS) issued by the International Accounting Standards Board (IASB), there had been severe criticism over the years by academics, analysts and other practitioners that the International Accounting Standard (IAS) 17 - "Leases" allowed companies to keep significant future leasing payments off-books, based on whether a lease contract would be classified as an operating or a financial lease agreement. That discrimination between operating and financial leases frequently meant that a certain asset and the corresponding liability for its financing would or would not be written on the balance sheet depending on the type of the leasing agreement used. The main consequence of that accounting treatment was that the financial statements of two companies choosing different types of agreements for the lease of a certain asset were not comparable to each other.

To answer these voices and concerns, the IASB launched a new relevant accounting standard, that is the IFRS 16 – "Leases", which was effective for the annual periods beginning on or after the 1st of January 2019. This standard provides a new model for the accounting treatment of the operating leases on behalf of the lessee. More specifically, IFRS 16, more or less, ceased, the discrimination between financial and operating leases for the lessee, but not for the lessor, who still treats operating leases as they used to in accordance with IAS 17.

Under IFRS 16, all operating leases, excluding agreements with a duration of less than 12 months and of immaterial value (about 5,000 euros), must be recognized on the balance sheet of the lessee as rights-of-use assets, while a corresponding liability must be written too. Essentially, the IFRS 16 demands that all liabilities for leases be accounted for in books, and not just being disclosed in the notes to financial statements, as it was the case under IAS 17. In its turn, the capitalization of leases means that a relevant amortization cost concerning the rights-of-use assets must be recognized in the profit and loss statement along with a financial cost relating to the operating leasing liability. However, the rental payments, which were treated as expenses under IAS 17, are no longer included in the profit and loss statement as they are perceived as decreases in the operating leasing liability.

Along with the significant impact on the financial statements of the lessee, the IFRS 16 causes material changes in several financial ratios used for the evaluation of a company's financial performance, which is computed with the use of accounting data. For instance, the Earnings Before and Taxes (EBIT) and the Earnings Before, Taxes, Depreciation and Amortization (EBITDA) are expected to improve after replacing rental expenses, which affect the ratios, with amortization and financial cost, which do not affect these ratios. On the contrary, the interest coverage ratio is expected to weaken due to the increased interest expenses resulting from the new framework. At the balance sheet level, ratios relating to liquidity and leverage are affected by the new standard.

Along with the obvious implications of IFRS 16 for the financial statements of the lessee, one might wonder whether the new standard could bear influence on the pricing of the lessee's shares that are traded on a stock exchange. This paper seeks to answer this question by using data from a sample of 79 Greek companies listed on the Athens Exchange. The research focus is paid on the return and risk of these stocks.

In particular, we conduct an event study to estimate abnormal return and volatility of stocks around 21, 5 and 1 days before and after the publication dates of the Greek companies' financial statements for year 2019. We obtain similar estimates for year 2018, which is used as the control year in our study. In the next step, we calculate three financial ratios concerning the profitability, leverage and liquidity of the firms in the sample, which are the EBITDA to Turnover Ratio, the Leverage Ratio and the Current Ratio, respectively, and briefly discuss the impact of IFRS 16 on these ratios. Finally, by seeking to answer our key research question about the impact of IFRS 16 on the pricing of the Greek stocks, we assess the validity of three assumptions. The first assumption says that the higher the profitability is, after the implementation of the new standard, the higher the stock returns and the lower their volatility will be. The second assumption says that the increased leverage ratios resulted from the recognition of the operating lease liabilities, will lead to lower stock returns and higher risk estimates. The recognition of the operating lease obligations will contribute to lower liquidity ratios and, thus, our third hypothesis assumes that the lower the liquidity is, the lower the stock returns and the higher their risk will be. These assumptions are examined with relevant multifactor cross-sectional regression analysis.

At first, our empirical findings verify the expected significant impact of IFRS 16 on the accounting figures of the Greek firms. For the majority of the companies in the sample, operating profitability improves but the opposite is the case for leverage. When it comes to liquidity, the impact of the new standard seems not to be that significant.

With respect to returns, our results reveal an existing pattern, according to which the returns are positive one day

before the publication of financial statements but they become negative on the first day after the publication. However, this pattern applies both to 2018 and 2019 and, thus, it cannot be attributed to the application of IFRS 16.

As far as risk is concerned, the results show that the volatility of stocks on the day before the publication of financial statements is much lower than that on the day after the publication. One interesting additional finding is that over "longer" periods, that is over 21 days before and 21 days after the publication of financial statements, the average risk estimates are quite close to each other. Based on these results, we may conclude that the impact of IFRS 16 on the risk of the Greek stocks cannot be material.

In regard to the three key research assumptions examined, the results provide some weak evidence about a positive relationship between performance and leverage before the publication of financial statements. This relationship becomes negative after the publication of financial statements. However, this weak evidence concerns both years 2018 and 2019, and, thus, it cannot verify some sort of an impact exerted by the implementation of IFRS 16 on stock performance. Finally, some weak evidence on a constantly positive relationship between stock risk and financial leverage is obtained.

We deem our study as a significant contribution to the relevant literature. To the best of our knowledge, this is the first study to examine the impact of IFRS 16 on the pricing of stocks of the Greek-listed companies. Given that the stock exchange in Athens is considered to be an advanced emerging market, we believe that our findings may be reflected in other national capital markets with similar characteristics. If so, we could obtain a broader view of the impact that is possibly made by IFRS 16 on the pricing of stocks. Furthermore, there are just a few recent studies that focus on the implications IFRS 16 may have for shares traded on stock exchanges. Thus, our study seeks to fulfill this gap in the literature.

The rest of the paper is structured as follows: Next section discusses the main findings of the literature on the subject so far. Section three describes the research approach and the sample of our study. Section 4 provides the findings of our empirical analysis. Finally, section 5 summarizes the conclusions of the study.

2. LITERATURE REVIEW

The correlation between accounting data and stock returns has been acknowledged early in the literature. Ball and Brown (1968) say that net income is a figure of particular interest to investors, who form their investment choices, among other factors, on the basis of accounting data. As a result, the accounting information can be reflected in security prices. Beaver (1968) reports that both financial ratios, which are calculated with accounting numbers, and stock prices can be useful in assessing the probability of a company's future failure. In particular, the dramatic price decline in the final year before the failure of a company acts as if investors base their assessments on financial ratios and impound the ratio information into the prices of common stocks.

Fama & French (1992) employ accounting-based variables, i.e., the leverage, book-to-market equity, and earnings-to-price ratios, to capture the cross-sectional variation in average stock returns. More recently, Cai & Zhang (2011) document a negative and significant effect of a change in the leverage ratio of a firm on its stock prices. They add that the higher the leverage ratio of a company, the more negative the effect on its stock prices. Other representative studies examining the correlation between financial ratios and security prices are those of Johnson & Soenen (2003), Dimitrov & Jain (2008), Dimitropoulos & Asteriou (2009), Sivaprasad & Muradoglu (2009), Şărămăt et al. (2013), Katchova & Enlow (2013), Ligocká & Stavárek (2019), and Aliu et al. (2021).

On the influence of capitalizing leases on stock prices, there are several studies that have tried to evaluate the magnitude of this impact. Ro (1978) examines whether the decision of the Securities and Exchange Commission (SEC) at the time requiring the disclosure of information regarding noncapitalized financing leases had any influence on stock pricing. If capitalized lease data convey any new information relevant to investors, one could anticipate a market reaction to the disclosure of this data reflected in the prices of stocks. The empirical findings confirm these assumptions.

Bowman (1980) investigates the relationship between leases and the market risk of lessees. In doing so, he uses a multiple regression model with market risk (beta) as the dependent variable of the model and an accounting beta, debt-to-equity ratio and leases-to-equity ratio as the independent variables. The lease variable is significantly associated with market risk when tests free of the multicollinearity problem are applied.

Imhoff et al. (1991) examine the correlation between the long-term operating lease commitments and measures used for determining the risk and performance of a firm. They find that many firms do not capitalize operating leases. This policy results in lower reported assets and liabilities and higher operating profits. In addition, the leverage status of these firms is actually higher than that shown in their reported debt-to-equity ratios. The authors create a method to assess the effect of capitalizing leases on a company's risk and performance. This method indicates that the relevance and comparability of firm-specific measures of risk and performance increases with the capitalization of operating leases. In the same context, Imhoff et al. (1993) find that in the airline and grocery industries, the debt-to-equity ratios, which are adjusted for operating leases, are more highly correlated with equity risk than the ratios which are not adjusted for operating leases.

Ely (1995) tests whether equity risk is associated with the debt to equity and the return on assets ratios, which are adjusted for operating leases. To adjust for operating leases, the author uses the relevant information found in the disclosures to financial statements. A significant relation between equity risk and the debt-to-equity adjustment for operating leases is accentuated. The results suggest that investors evaluate the operating lease liability when assessing equity risk.

Arata (2010) investigates whether there has been any market reaction in Japan associated with the movement of the finance lease disclosures from footnotes to the body of financial statements. The findings show that, on average, the market did not react to this change in the accounting treatment of finance leases. The authors conclude that the results can also be relevant to the capitalization of operating leases.

Sengupta & Wang (2011) examine whether the public debt market evaluates information concerning operating leases remaining off-balance sheet. They find that the rating agencies do price off-balance sheet debt relating to operating leases. They also find that the coefficient on the off-balance sheet debt measure of operating leases is similar to that of capital leases that are written on the balance sheet.

Giner & Pardo (2018) assess whether capitalized operating leases are priced by market users. They employ a sample of Spanish-listed firms for which they collect data on operating leases disclosed in the notes to financial statements. This data is used to constructively capitalize the assets and liabilities resulting from operating leases. The findings indicate that investors in countries with less developed stock markets and low enforcement quality do not behave differently to those in countries with more developed markets and stricter enforcement policies. Investors value in the same manner the recognized debts and the operating lease liabilities resulting from information disclosed in the notes. Based on these results, the authors conclude that the capitalization of leases will not have a major impact on stocks.

Finally, Kedmi (2021) investigates how IFRS 16 can affect the risk pricing of Israelian firms, using corporate bonds traded on the Tel Aviv Stock Exchange. The empirical results reveal that on the first disclosure date regarding the expected impact of the new standard (2018: Q2) the yield spreads of the firms that were affected by the standard increased, compared to those of the firms that were not affected by the standard. These findings indicate that, because of the information provided by IFRS 16, the stock market adjusts the prices of traded debt instruments in a way that reflects more accurate pricing of the firm's risk of default.

3. RESEARCH METHODOLOGY

In this section, we describe our research approach towards the investigation of IFRS 16's impact on the performance and risk of the Greek listed companies.

3.1. Performance and Risk Evaluation

In this section we use an event study methodology to assess the performance and risk of the Greek-listed companies around the publication dates of their financial statements for years 2018 and 2019.[1]

In our analysis, we compute four alternative types of performance, that is, daily returns, cumulative daily returns, abnormal daily returns and cumulative abnormal daily returns. The estimation window considered ranges from 21 trading days before the publication date of financial statements to 21 trading days after the publication. The

[1] Event studies have been extensively used to evaluate the response of investors to changes in the financial statements triggered by changes in the applicable accounting framework or other similar events [refer to Woolridge and Snow (1990), MacKinlays (1997), and Holthausen and Watts (2001)].

day of publication is added to this window and, thus, a total estimation window of 43 days is taken into consideration. Daily return is computed using the following formula (1):

$$Ret_{i,t} = \frac{P_t - P_{t-1}}{P_{t-1}} \quad (1)$$

where, $R_{i,t}$ refers to the percentage return of the *ith* company on day *t* and $P_{i,t}$ refers to the close price of this company on day *t*. In our event study, we compute daily returns for seven different days, namely for the 21st and the 5th day before the publication of financial statements, the day before the publication date, the publication date, the first day after the publication, and the 5th and the 21st day after the publication of financial statements. The cumulative daily return is calculated as the sum of the daily returns obtained via formula (1) over these estimation windows.

In order to estimate abnormal returns, we follow the approach of Karolyi and Martell (2010). We first estimate the time series market model expressed in equation (2), via which the return of each company in the sample is regressed on the General Index of Athens Exchange:

$$R_{i,t} = \alpha_{i,t} + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (2)$$

where R_i is defined as above, R_m represents the return of the stock market index, and ε_i is the residual return of a firm not explained by the model. We run the market model to obtain the alpha and beta estimates of each company that we use to compute abnormal returns with the following model (3):

$$AR_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{m,t} \quad (3)$$

where, $AR_{i,t}$ is the abnormal daily return of the *ith* company on day *t*, computed as the difference between the actual return of the company and the expected return based on the market model.[2] $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the estimated market model parameters. Model (3) is run over an estimation window ranging from 224 days to 22 days prior to the publication of each company's financial statements in 2018 and 2019. The cumulative abnormal daily return is calculated by summing the abnormal daily returns computed with equation (3) over the seven estimation windows described above.

When it comes to risk, we examine whether the Greek stocks become more or less volatile after the publication of financial statements of the Greek companies for years 2018 and 2019 trying to identify whether such a change in the risk profile of the companies can be attributed to the implementation of IFRS 16. The measure used to evaluate risk is the standard deviation of daily returns over the estimation windows considered in our analysis. This is a measure of a company's so-called "total risk". Similar standard deviations are calculated for abnormal daily returns.

3.2. Financial Ratios

We use the accounting information found in the published financial statements of the Greek companies for 2019, and the comparative figures for 2018, to compute three key financial ratios concerning the profitability, leverage and liquidity of these firms, respectively. The profitability ratio considered is shown in the following formula (4):

[2] Model (2) is applied for each individual company under the assumptions about the existence of a linear relationship between the dependent and independent variables, homoscedasticity, that is the variables of the model must have equal or similar variances, no autocorrelation, that is no identifiable relationship exists between the values of the error term in the applied model. When needed, the results have been corrected for autocorrelation, by adding the necessary number of lags in the right side of the model, and for heteroskedasticity with the relevant corrective process of White.

$$\frac{\text{EBITDA}}{\text{Turnover}} = \frac{\text{Profit for the year + Income TAX + Interest Expense – Interest Revenue + Depreciation + Amortization}}{\text{Turnover}} \quad (4)$$

The leverage ratio examined is expressed via the following formula (5):

$$\text{Leverage Ratio} = \frac{\text{Net Debt}}{\text{Total Capital Employed}} = \frac{\text{Total Debt + Total Leasing Liability - Cash}}{\text{Total Debt + Total Leasing Liability – Cash + Equity}} \quad (5)$$

Finally, the liquidity ratio assessed is expressed in formula (6):

$$\text{Current Ratio} = \frac{\text{Current Assets}}{\text{Current Liabilities}} \quad (6)$$

The ratios are calculated for both 2019 and 2018 trying to determine the impact of IFRS 16 on the accounting figures of the Greek companies. Moreover, we calculate the adjusted versions of the ratios for 2019. In particular, adjusted EBITDA in the first ratio is calculated by subtracting the amortization and interest expenses relating to the rights-of-use resulted from the operating leases from the non-adjusted EBITDA. The adjusted Leverage Ratio (Net Debt/Total Capital Employed) for 2019 is calculated after subtracting the operating leasing liability as of 31/12/2019 from the numerator and denominator of the ratio. Finally, the adjusted Current Ratio for 2019 is calculated after subtracting the current liability for operating leasing as of 31/12/2019 from total current liabilities.

3.3. Regression Analysis of Performance

In our analysis, we examine three hypotheses about the relationship between the stock performance of a company and its accounting profitability, leverage and liquidity.

The first hypothesis assumes that there is a direct and linear relationship between the profitability of a company and its performance in the stock market. Therefore, the higher the EBITDA to Turnover ratio is, the higher the stock returns will be. If this hypothesis is true, the profitability of the Greek companies in 2019 will be higher than that in 2018 due to the replacement of rental expenses, which affect EBITDA, with amortization and interest costs, which do not affect this ratio, and, thus, stock returns in 2019 will be higher than those in 2018.

The second hypothesis says that an increase in the leverage ratio of a company triggers a decline in its stock prices. As a result of the implementation of IFRS 16, an increase in the leverage ratios for year 2019 is expected, compared to those in 2018, due to the recognition of the operating lease liabilities on the balance sheet. According to the second hypothesis tested, the negative impact of the increased leverage on stock returns for year 2019 will be more significant than that for year 2018.

The recognition of the operating lease obligations in 2019 will also result in lower liquidity ratios relative to 2018. Consequently, our third hypothesis assumes that the lower the liquidity is, the lower the stock returns will be in 2019 compared to 2018 as a result of applying the new accounting model for leases prescribed by IFRS 16.

We combine these three assumptions to evaluate the relationship between the performance of Greek firms and their financial ratios separately for 2018 and 2019 by using the following cross-sectional regression model (7):

$$\text{Per} = \lambda_0 + \lambda_t\text{Profit} + \lambda_2\text{Lev} + \lambda_3\text{Liq} + u \quad (7)$$

where Per stands for the performance of the sample's stocks in 2018 or 2019, Profit stands for the EBITDA to the Turnover ratio in 2018 or 2019, Lev is the Leverage Ratio in 2018 or 2019, and Liq is the Liquidity Ratio in 2018 or 2019 of the firms examined. If our assumptions hold true, the coefficient λ_t will be positive and significant

for both 2018 and 2019 but more significant for 2019, the coefficient λ_2 will be negative for both years but more negative for 2019, and the coefficient λ_3 will be positive and significant for 2018 and 2019 but less significant for 2019.

In order to isolate the impact of IFRS 16 on performance we run model (7) for 2019 twice by using both unadjusted and adjusted versions of the financial ratios. If the implementation of IFR6 16 is the driving force of stock performance over the estimation window considered in our event study, the coefficients of the model (7) with the adjusted financial ratios as the explanatory variables for 2019 will be more significant than those for 2018 or the unadjusted version of the model for 2019.

3.4. Regression Analysis of Risk

We evaluate three hypotheses about the relationship between the risk of a security listed on the Athens Exchange and the financial ratios of the corresponding company relating to accounting profitability, leverage and liquidity.

The first hypothesis says that there must be a negative correlation between the profitability of a company and the volatility in its stock prices. Based on this assumption, the higher the EBITDA to Turnover ratio is, the lower the stock risk will be. Therefore, if the profitability ratios of the Greek companies in 2019 are, as expected, higher than those in 2018, stock risk in 2019 will be lower than that in 2018.

The second hypothesis assumes that an increase in the leverage ratio of a firm results in increased volatility in its stock prices. Given that an increase in the leverage ratios for year 2019 is expected, compared to those in 2018, as a result of the first-time application of IFRS 16, the positive relationship between stock risk and leverage will be more significant in 2019 than that in 2018.

The third hypothesis concerns the relationship between a company's stock risk and its accounting liquidity. A lower liquidity level casts doubt to investors about the ability of the company to meet its obligations. This doubt is reflected in increased volatility in stock prices. As a consequence, the expected weaker liquidity ratios in 2019, resulted from the recognition of operating lease liabilities, will contribute to higher risk levels for this year relative to 2018.

The three assumptions are combined to assess the relationship between the risk of Greek firms and their financial ratios separately for 2018 and 2019 via the following cross-sectional regression model (8):

$$Vol = \lambda_0 + \lambda_1 Profit + \lambda_2 Lev + \lambda_3 Liq + u \quad (8)$$

where Vol is the risk of the sample's stocks in 2018 or 2019. All other variables are defined as above. If our assumptions hold true, the coefficient λ_1 will be negative and significant for both 2018 and 2019 but more significant for 2019, the coefficient λ_2 will be positive for both years but more positive for 2019, and the coefficient λ_3 will be negative and significant for 2018 and 2019 but more significant for 2019.

To isolate the impact of IFRS 16 on volatility, we apply the model (8) for 2019 twice by having unadjusted and adjusted versions of the financial ratios as the independent variables of the model. If IFR6 16 is the driving force of securities risk over the estimation window considered, the coefficients of the model (8) with the adjusted financial ratios as the explanatory variables for 2019 will be more significant than those for 2018 or the unadjusted version of the model for 2019.

3.5. Sample

The sample of our study includes 79 non-financial companies listed on Athens Exchange. The banking and insurance sectors of the Greek stock exchange, as well as investment and other companies from the financial sector, have been excluded from the sample. The main condition to be met in order for a company to be included in our sample was that the company has been affected by the application of IFRS 16 at the beginning of 2019. This means that the company must have had operating leases as of 1/1/2019 not recognized in its financial statements under the accounting model of IAS 17 but recognized, for the first time, in accordance with the requirements of IFRS 16. In addition, a company should have remained listed at the time of our study to be

included in the sample.[3] No criteria concerning the market capitalization or the turnover of the companies were set in the selection process.

Going further, we excluded a small number of companies which proceeded with an early adoption of IFRS 16 before the 1st of January 2019. Moreover, during the selection process, we found some companies, which, by using the provisions of IFRS 16, reclassified assets relating to financial leases, previously recognized under IAS 17, as rights-of-use. Those companies were included in our sample on the degree that they had other operating leases which were recognized, for the first time, as rights-of-use on 1/1/2019. In doing so, we separated the "genuine" rights from those relating to the reclassification of financial leases.

Table 1 presents the sample of the study. For each company, the table exhibits its name along with market capitalization (market cap) as of 31/12/2021 and accounting data as of 31/12/2019 and 31/12/2018, concerning assets (unadjusted and adjusted), equity, turnover, EBITDA (unadjusted and adjusted), profit before taxes (PBT), and profit after taxes (PAT). We note that all the unadjusted data have been found in the published financial statements for year 2019. In addition, the figures concern the stand-alone financial statements of the Parent Company and not the consolidated figures.

As shown in the table, the biggest company listed on Athens Exchange is the Hellenic Telecommunications Organization (OTE), with a market cap of 7.6 billion (bil.) euros. Moreover, the market cap of just nine companies exceeds one bil. euros. On average, the market cap of the Greek listed firms examined amounts to 462 million (mil.) euros. However, as indicated by the median term, the market cap for the majority of the firms in the sample approximates 67 mil. euros.

Average total assets as of 31/12/2019 amount to 632 mil. euros. The respective amount for 2018 is 597 mil. euros. In order to assess the impact of IFRS 16 on total assets, we compute the adjusted amount of assets as of 31/12/2019 by subtracting the current value of rights from operating leases as at 31/12/2019 from the assets found in the published financial statements for that year. Without rights, the average total assets figure as of 31/12/2019 drops to 617 mil. euros.[4] Based on these results, we conclude that the impact of IFRS 16 on average total assets is translated into a total increase of 2.5%. If we take the median term of the total into consideration, we see that there has been an increase in total assets for the majority of firms of 5 mil. euros in comparison to the previous year. However, the median term of the adjusted assets shows a minor increase of 0.3 mil. euros. These figures indicate that, overall, the increase in total assets as of 31/12/2019 can be actually attributed to the impact of IFRS 16.

Average equity in 2019 slightly increased relative to 2018 by 1.7%. This increase should not be attributed to IFRS 16. In fact, upon the recognition of assets and liabilities on the 1st of January 2019, there was an average difference of 0.6 mil. euros between the capitalized rights and operating lease liabilities which was recognized directly to equity.[5] If we exclude the impact of this accounting treatment, the increase in equity of the average Greek firm as of 31/12/2019 is 1.4%. Thus, it can be said that the impact of IFRS 16 on equity is only 0.3%.

The average turnover of the sample's companies in 2019 is slightly lower than that in 2018, being equal to 458 and 469 mil. euros, respectively. Obviously, this decrease in an average turnover of 2.4% is not related to IFRS 16. Moreover, on median terms, the sales of the majority of the Greek-listed firms in 2019 do not exceed 38 mil. euros, while the respective figure for 2018 was 40 mil. euros.

The average EBITDA and adjusted EBITDA in 2019 amount to 19 and 15 mil. euros, respectively.[6] The difference of 4 mil. euros (24.5%) between these figures represents the impact of IFRS 16 on this key accounting ratio.[7] In comparison to the previous year, the average unadjusted (adjusted) EBITDA in 2019 is much lower than that in 2018 (19 or 15 vs 38 million euros). The decrease in average EBITDA in 2019 relative to 2018 would be much

[3] Two companies, which had been affected by IFRS 16 in 2019, voluntarily exited Athens Exchange in 2021 and, thus, they have been excluded from our sample.

[4] We have performed t-testing on the difference between unadjusted and adjusted assets as of 31/12/2019. The t-statistic obtained is 2.52 indicating that the difference between the two figures is significant at 5%.

[5] This accounting treatment has been followed by 16 companies in the sample.

[6] We note that, in several cases, our calculation of EBITDA differs from the EBITDA reported in the published financial statements. The differences are due to the policy followed by the respective firms not to take into consideration in the calculation of EBITDA "extraordinary" and one-off items. In our analysis, we have calculated EBITDA for all companies in the sample in the same way without allowing for extraordinary and other similar transactions.

[7] The t-test applied on the difference between unadjusted and adjusted EBITDA in 2019 indicated that this difference is significant at 5% (t-statistic=2.00).

stronger if had IFRS not been implemented in that year. however, when we look at the median terms of this figure, the EBITDA in 2019 of most of the companies in the sample, either the unadjusted or the adjusted one, is higher than that in 2018. This means that the decrease in EBITDA as of 31/12/2019 compared to the previous year can be attributed to the influence of outliers.[8]

Finally, the average EBT and EAT figures in 2019 are much lower than those in 2018. However, the average terms do not tell the exact truth. In median terms, the profitability of the majority of the firms in the sample, either before or after taxes, in 2019 is better than that in 2018. Overall, any decrease in profits before or after taxes cannot be a result of IFRS 16's implementation given that the replaced rental expenses, which do not affect the operating profitability of a company, have been recognized as depreciation and interest expenses, thus, affecting EBT or EAT.[9]

4. EMPIRICAL RESULTS

The results of our empirical analysis are reported in this section. We first discuss the return and abnormal returns of the Greek companies around the publication dates of their financial statements in 2018 and 2019 along with the corresponding risk estimates. We then focus on the impact of IFRS 16 on financial ratios. Afterwards, the results of the performance regression analysis on financial ratios are broken down. Finally, the regression results on the relationship between risk and financial ratios are analyzed.

4.1. Performance and Risk Evaluation

The four alternative performance estimates of Greek firms, that is daily returns, cumulative daily returns, abnormal daily returns and cumulative abnormal daily returns are presented in Table 2. The table presents returns over the seven estimation windows considered in our event study, namely over 21 days before the publication of financial statements of each company in the sample, 5 days before the publication date, the day before the publication, the day of the publication, the day after the publication, 5 days after the publication and 21 days day after the publication of financial statements. Finally, returns are presented for 2018 and 2019.

When it comes to daily returns in 2018, the average terms before the publication of financial statements are positive. Returns are negative on the publication day and the day after the publication and they revert to a positive territory on the 5th and the 21st day after the publication of financial statements. Abnormal daily returns in 2018 behave in the same way. In sum, returns in 2018 are positive five and twenty-one days before and after the publication of financial statements. In 2019, the average daily and abnormal daily returns display rather unsystematic behavior. However, the average daily returns one day before and one day after the publication behave similarly to those in 2018. In particular, returns are positive before the publication date and become negative after the publication.

Overall, this somehow persistent pattern in daily returns cannot be attributed to any impact by IFRS 16 given that it is observed in both years under study. This pattern could be interpreted as if investors are quite optimistic about the financial performance of the Greek companies before the publication of their financial statements. However, it seems that the information conveyed by the firms via their financial statements proves this optimism of investors wrong. In any case, this inference could be just a guess, and, thus, this validity and persistence should be tested with accounting and stock data of more than two years.

The cumulative daily returns mimic the average daily returns, both in 2018 and 2019 and, thus, no further inferences can be drawn from their analysis. Abnormal returns exhibit a pattern similar to that of daily returns. In both years, they are positive on the day before the publication of financial statements and become negative on the first day after the publication. This is also the case for cumulative abnormal returns. No other patterns are traced that can be attributed to any impact relating to the application of IFRS 16.

On the question of risk, the results in Table 3 reveal that the volatility in daily and abnormal daily returns on the day before the publication of financial statements is much lower than that on the 1st day after the publication. In particular, an average increase in the risk of about 40 basis points (bps) is observed on the first day after the

[8] The most significant outlier is DEH- Hellenic Public Power Corporation, whose unadjusted (adjusted) EBITDA as of 31/12/2019 amounts to -1.78 (-1.80) bil. euros, whereas the respective amount as of 31/12/2018 was -213.92 mil. euros.

[9] As we could not find relevant information in the financial statements of all companies, we assume here that there is an one-to-one relationship between the rental expenses and the replacing depreciation and interest expenses or, alternatively, the difference between them is not significant.

publication of financial statements. This finding concerns both 2018 and 2019 and, thus, it cannot relate to any impact by IFRS 16.

If we combine this observation about risk with the behavior of returns over the day before and after the publication, we may infer that, due to the possible bad news conveyed by the published financial statements, investors tend to redeem some of their shares in the Greek companies. If this assumption is true, this nervousness of investors causes prices to decline with noise and, thus, returns decline and risk moves upwards.

One interesting additional finding is that over "longer" periods, that is over 21 days before and 21 days after the publication of financial statements, the average risk calculations are close to each other. In the case of daily returns, there is an average difference between the two risk estimates of 8 bps, both in 2018 and 2019. In the case of abnormal returns, this difference in volatilities is much lower (2 bps in 2018 and 3 bps in 2019). Based on these results, we may conclude that risk returns to a "normality" after the first days from the publication of financial statements. In addition, once again, we can verify that the application of IFRS 16 in 2019 did not affect the risk of Greek stocks in any way.

4.2. Financial Ratios

Table 4 presents the financial ratios of profitability, leverage and liquidity of the Greek companies in 2018 and 2019. For 2019, both unadjusted and adjusted versions of the ratios are presented. In addition, the ratios are reported in five classes, as well as for the entire sample. Classes 1 to 4 include 16 companies each. Class 5 includes 15 companies. Moreover, for each financial ratio, class 1 includes the 16 companies with the highest figures. Class 2 concerns the 16 companies with the second-best ratios, and so on.

On average, the ratio of EBITDA to Turnover for the entire sample in 2019 has deteriorated significantly in 2019 relative to 2018 (2019: -34 mil. euros and 2018: 5 mil. euros). This is also the case for the adjusted ratio, which is even worse than the unadjusted version of the ratio for 2019 (it amounts to -37 mil. euros). Given that the average turnover of the Greek companies has only slightly decreased in 2019 in comparison to 2018 (as shown in Table 1), this substantial decrease in the average EBITDA to Turnover ratio can be attributed to the significant decrease in the average EBITDA in 2019.

Besides the analysis of average ratios, we should point out that, with the exception of the bottom and the second bottom class, the median and the top two classes presents average EBITDA to Turnover ratios in 2019 which actually exceed the corresponding ratios in 2018. Furthermore, the median term of the ratio for the entire sample is higher in 2019 than in 2018 by 110 bps. These numbers show that, for many companies in the sample, the profitability ratio considered has improved in 2019 in comparison to 2018.

On the other hand, the median term of the adjusted version of the ratio in 2019 is lower than the ratio in 2018 by 71 bps. This element indicates that, overall, the improvement in 2019's unadjusted EBITDA to Turnover ratio can be attributed to the impact of IFRS 16. This finding is in line with the expectations of an improvement in the ratios of operating profitability after the implementation of the accounting model for operating leases prescribed by IFRS 16.

As far as the leverage of the Greek firms is concerned, the average leverage ratio in 2019 is substantially lower than that in 2018 (-0.6% vs 44.5%). Nevertheless, in median terms, the leverage ratio in 2019 is higher than that in 2018 by 1.3% (32.9% vs 31.6%). Furthermore, the median adjusted leverage ratio in 2019, which does include the liabilities for operating leases, is lower than the leverage ratio in 2018 by 477 bps. In addition, the median unadjusted leverage ratio in 2019 exceeds the adjusted one by 608 bps. The latter figure represents the effect of IFRS 16 on the leverage status of the Greek companies examined in our study. The increase in the leverage is also verified by the analysis of the average and median terms of the ratio in 2018 and 2019 of the first four classes considered.

When it comes to liquidity, the figures in Table 4 show that there has been a slight increase in the current ratios in 2019 compared to 2018. The average (median) current ratio of the sample in 2019 is 3.68, while the corresponding ratio in 2018 is 3.55. The adjusted current ratio in 2019 is a bit higher than the unadjusted ratio in the same year by 24 bps. If we focus on the individual classes considered, we obtain a similar behavior of current ratios for the first two classes. In the median class, the average current ratio and the average adjusted current ratio in 2019 are lower than the ratio in 2018 but, actually, there is no difference in median terms. This is also the case for the average ratios of the bottom class, while there are no significant differences in the average ratios of the

fourth class. Overall, we could conclude that the liquidity of the Greek companies has not changed significantly in 2019 in comparison to 2018, while the impact of IFRS 16 on liquidity just amounts to 0.24%.

4.3. Regression Analysis of Performance

The results of the cross-sectional regression model (7) on the relationship between the stock performance of the Greek firms and their financial ratios of profitability, leverage and liquidity are presented in Table 5. The model has been performed separately for 2018 and 2019 and over the seven estimation windows considered in our analysis, that is on the 21st day before the publication date of each company's financial statements, the 5th day before the publication, the day before the publication, the day of the publication, the day after the publication, the 5th day after the publication and the 21st day after the publication of financial statements. Finally, the model is run using each time as the dependent variable one of the four alternative stock performance measures considered, namely daily returns, cumulative daily returns, abnormal daily returns and cumulative abnormal returns. In each case, the independent variables of the model are the unadjusted and adjusted financial ratios computed with year-end accounting figures.

The results in Table 5 are not strong in statistical terms. Most estimates are statistically insignificant, irrespective of the performance measure used and no matter if the adjusted or unadjusted versions of the ratios are taken into account. This general comment applies to both years and, consequently, we cannot detect any significant relationship between stock returns and financial ratios that has been triggered by the implementation of IFRS 16 in 2019.

Besides this general inference, we can trace in Table 5 some weak evidence of a positive relationship between stock performance and leverage before the publication of financial statements. In particular, the models provide six cases of positive and statistically significant coefficients for leverage on the 5th or the 21st day before the publication of financial statements. Furthermore, in ten cases, the models give negative and significant estimates for leverage on the 5th or the 21st day after the release of financial statements. This negative relationship between stock returns and financial leverage, which seems to exist after the publication of financial statements, is in line with the findings of the literature on the subject, which have already accentuated that the returns of stocks are negatively affected by the leverage of the firms [e.g., Dimitrov and Jain (2008)].

One could interpret this weak evidence about a negative correlation between stock returns and leverage as if it was an outcome of IFRS 16 adoption in 2019 given that, as we showed in a previous section, the leverage ratios increased in 2019 relative to 2018. However, the significantly negative coefficients are observed both in 2018 and 2019. Consequently, we cannot attribute this relationship to IFRS 16. In addition, both the significant leverage coefficients and the R^2 of the models approximate zero. Therefore, we should be very careful when interpreting the results in Table 5.

4.4. Regression Analysis of Risk

The results of the regression model (8) on the correlation between stock risk and the financial ratios of profitability, leverage and liquidity are presented in Table 6. The model has been performed separately for 2018 and 2019 and over the several estimation windows considered in our analysis. The model is applied with either the volatility in daily returns or the volatility in abnormal daily returns as the dependent variable, while, in each case, the independent variables of the model are the unadjusted and adjusted financial ratios computed with year-end accounting data found in the published financial statements.

As it was the case for performance, the majority of the models' coefficients are not statistically significant, both in 2018 and 2019. Consequently, a strong relationship between the stock risk and the financial ratios of the Greek firms examined cannot be established. Therefore, we cannot claim that IFRS 16 has affected the risk of the stock traded on the Athens Exchange in any way.

Besides the general absence of strong results in statistical terms, there are six significantly positive coefficients for leverage and two which are significantly negative, either before or after the publication dates of financial statements. These results can be viewed as indicative, in some cases, of a positive relationship between stock risk and financial leverage, as we expected. Two points should be made here. The first one is that this positive relationship cannot relate to IFRS 16 as it is observed mainly in 2018, while the two significantly negative estimates for the leverage ratios are found in 2019. The second point is that the magnitude of the significant coefficients as well as R^2 are quite close to zero, thus, lacking any material economic significance.

5. CONCLUSION

The implementation of IFRS 16 – "Leases" for the first time in 2019 was expected to result in significant changes in relevant accounting figures, such as rights-of-use assets and liabilities for operating leases, since the new standard requires all leases, either financial or operating, be recognized on the balance sheet of the lessee. In addition, key profit and loss items, such as rental expenses and amortization and financial costs, were expected to be affected too. As a consequence of these changes, key financial ratios computed with such accounting data were reasonably certain to be influenced too by the new standard.

Along with the impact of IFRS 16 on accounting data, one could ask whether the new standard can affect the prices of stocks traded on stock exchanges. In other words, the question here is how the stock market can react to the implementation of the new standard and the changes it brings in the financial statements of lessees. This paper tries to identify this reaction, if any, with data from a sample of 79 companies listed in the Athens Exchange in Greece.

In our research, we use an event study methodology to estimate abnormal return and risk of the Greek stocks around 21, 5 and 1 days before and after the publication of their financial statements in 2019. We do so for 2018 too, which is the control year of our study. Along with returns and risks, we compute three financial ratios concerning the profitability, leverage and liquidity of the companies examined for year 2018 and 2018. These ratios are the EBITDA to Turnover Ratio, the Leverage Ratio and the Current Ratio. After all these calculations, we discuss the impact of IFRS 16 on these basic financial ratios and then we examine the relationship between stock return or risk with these financial ratios in years 2018 and 2019 with relevant multi-factor cross-sectional regression analysis.

The empirical results confirm that the impact of IFRS 16 on key accounting figures of the Greek firms in 2019 was significant. More specifically, for most of the firms in the sample, the ratio of operating profitability improves. The opposite is the case for the leverage of Greek firms. In regard to liquidity, the results indicate that the influence of the new accounting model for leases is not that significant.

When it comes to stock performance, our findings indicate that there is no material impact by IFRS 16. This inference applies unanimously to the several types of stock returns considered in our investigation. This finding contradicts the results of Ro (1978) who found that the capitalization of leases conveys relevant information to investors that is reflected in stock prices, as well as the results of Kedmi (2021), who also found a significant impact on risk. However, our results resemble those of Arata (2010) who show that the Japanese stock market did not react to changes in the accounting treatment of finance leases, a behavior that could be relevant to the capitalization of operating leases. Our results are also on the same page with the study of Giner and Pardo (2018).

Going further, our analysis revealed an interesting pattern, according to which average returns are positive on the day before the publication of financial statements but they become negative on the very first day after the publication. This trend concerns both 2018 and 2019 and, consequently, it cannot be attributed to IFRS 16.

On the question of stock risk, the results show that volatility is much lower on the day before the publication of financial statements relative to the first day after the publication. However, over longer periods, i.e. over 21 days before and 21 days after the publication of financial statements, the average risk measures approximate each other, both in 2018 and 2019. According to these results, we infer that the influence of IFRS 16 on stock volatility is not significant. This inference is not in line with the findings of Bowman (1980) who showed that the lease variable is significantly associated with market risk.

Finally, with respect to the relationship between stock performance or risk with the basic ratios of profitability, leverage and liquidity considered in our analysis, the results indicate that, actually, there are no strong such relationships. Nevertheless, the regression analysis showed that leverage can relate somehow to stock return and risk. More specifically, the few statistically significant results indicate that there may be a positive correlation between stock performance and leverage before the publication of financial statements, but this relationship becomes negative after the publication. Anyway, this weak evidence concerns both 2018 and 2019. Therefore, we

cannot claim that this sort of relationship is due to any impact of the application of IFRS 16 in 2019.

In the last step, our analysis provided some weak evidence of a positive relationship between stock risk and financial leverage, either before or after the publication of financial statements. This weak positive relationship concerns 2018. In 2019, the correlation between stock risk and leverage is significantly negative in limited cases. Once again, we cannot infer that IFRS affected the risk of Greek stocks in any material way.

Our results about the lack of a strong relationship between stock return and risk with the revised financial ratios after the capitalization of off-balance sheet leases contradict those of Imhoff *et al*. (1991 & 1993) and Ely (1995) who report significant relationships in this respect.

Overall, the conclusion drawn via our investigation is that, as expected, IFRS 16 affected the accounting figures of the Greek firms, especially, leverage and operating profitability. However, it seems that the stock market did not react to the accounting changes induced by the new standard. The performance and risk of the stocks traded on the Athens Exchange were not affected by IFRS 16 whatsoever.

Before concluding this paper, we should note that our research can be expanded in several ways. First, the financial statements of 2020, 2021 and 2022 could be examined for possible more long-run effects of IFRS 16 on stock return and risk. Comparative analysis between the Greek and other regional stock markets with similar characteristics could be performed too. Such an analysis would answer whether our results are country-specific or can have more international implications. Finally, other significant accounting changes, such as the implementation of IFRS 9 – Financial Instruments, should be examined.

AUTHORS' DECLARATION

This paper complies with Research and Publication Ethics, has no conflict of interest to declare, and has received no financial support.

AUTHORS' CONTRIBUTIONS

All sections are written by the author.

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APPENDIX

Table 1. The Sample of the Study

No	Company	Market Cap[1]	Assets 2019	Adj. Assets 2019[2]	Assets 2018	Equity 2019	Equity 2018	Turnover 2019	Turnover 2018	EBITDA 2019	Adj. EBITDA 2019	EBITDA 2018	PBT 2019	PBT 2018	PAT 2019	PAT 2018
1	AUTOHELLAS	437.62	680.36	672.26	620.57	226.04	192.52	224.73	221.12	108.75	104.91	101.98	36.41	35.92	29.36	27.47
2	ALPHA ASTIKA AKINI	121.10	136.32	135.65	133.05	132.11	129.75	13.56	12.21	3.86	3.74	3.62	3.59	3.55	2.39	2.54
3	LAMDA DEVELOPMENT	1,268.97	1,016.11	1,015.27	373.41	824.56	192.44	1.43	3.59	-11.26	-11.93	-7.63	-20.68	-17.40	-20.77	-18.43
4	REDS	133.82	49.47	49.40	49.34	40.22	41.44	0.05	0.95	-1.17	-1.20	-1.45	-1.58	-1.93	-1.58	-1.92
5	TRASTOR	137.92	202.12	201.71	117.47	117.32	82.65	8.91	5.81	12.65	12.50	4.48	9.59	3.49	9.03	2.74
6	AEGEAN AIRLINES	453.54	1,141.77	801.81	620.13	230.21	209.08	1,049.45	959.58	209.56	76.74	85.57	67.67	73.78	49.01	50.84
7	ALUMIL	70.01	197.09	196.07	204.41	0.52	3.07	152.79	153.28	8.19	7.85	10.33	-2.30	0.65	-2.92	1.62
8	PIPEWORKS L. TZIRAKI	9.24	23.77	23.75	26.30	3.62	6.17	14.53	15.11	-0.23	-0.25	0.30	-1.31	-0.91	-1.86	-0.85
9	KORDELOY BROSS	10.36	50.39	50.34	52.05	15.86	16.83	37.55	40.54	1.09	1.05	2.04	-0.65	-0.16	-0.95	-0.24
10	ELASTRON	44.92	123.39	123.11	121.93	64.12	66.48	110.14	107.24	2.91	2.76	3.21	-1.75	-2.75	-2.32	-2.62
11	SIDMA	36.40	112.75	112.57	116.46	-8.79	-7.48	84.96	85.18	3.39	3.23	3.48	-1.02	-2.83	-1.29	-2.67
12	ELVAL HALKOR	703.95	1,514.49	1,512.29	1,458.53	727.43	705.91	1,429.92	1,486.97	100.29	99.49	114.65	46.42	53.95	32.92	47.34
13	FRIGOGLASS	66.82	90.74	89.75	93.99	26.57	22.55	39.97	42.07	7.39	6.86	4.85	3.96	-0.49	3.77	-1.27
14	MATHIOS REFRACTOR	4.81	19.04	18.02	19.91	5.64	5.78	16.76	13.93	1.31	1.13	0.61	-0.06	-0.94	-0.06	-0.96
15	IKTINOS HELLAS	84.60	101.36	100.85	96.43	43.88	43.88	40.59	53.17	11.29	11.13	21.58	6.04	18.51	4.37	12.05
16	MYTILINAIOS	2,146.23	2,439.65	2,405.34	2,343.35	1,069.25	1,049.03	1,569.31	1,226.12	203.18	196.26	217.03	104.93	151.11	97.48	134.91
17	ATTIKA PUBLICATION	6.61	32.41	32.34	33.07	15.22	15.21	13.90	16.46	1.06	0.75	0.68	0.21	0.22	0.06	0.08
18	XAIDEMENOS	5.46	30.77	30.61	31.76	17.83	18.34	17.52	19.68	1.13	1.03	1.91	-0.70	-0.58	-0.50	-0.36
19	FOURLIS	211.23	91.59	90.17	90.88	88.10	89.03	4.42	4.29	-1.22	-1.57	-1.40	4.53	3.53	3.20	3.45
20	MODA BAGNO	11.38	42.48	40.69	40.80	17.70	18.17	12.66	12.44	1.21	0.64	1.02	-0.18	0.05	-0.43	0.46
21	YALCO	1.32	13.61	13.59	17.16	-36.60	-31.79	7.58	11.09	-2.00	-2.03	-1.02	-4.79	-2.96	-4.79	-2.96
22	PLAISIO	87.64	197.58	164.81	154.21	94.87	94.62	309.62	302.74	13.24	7.47	9.41	2.97	6.04	1.91	3.80
23	SATO	2.61	15.16	11.99	16.37	-32.43	-24.95	13.40	10.63	-5.73	-6.44	0.61	-7.82	-0.85	-7.46	-0.47
24	KARELIAS	778.32	590.99	590.27	548.81	499.48	460.20	736.67	694.75	88.25	88.00	102.51	85.59	98.99	65.66	76.30
25	DEH	3,518.22	12,767.6	12,726.5	13,482.4	2,685.82	3,825.03	4,736.32	4,593.52	-1,783.4	-1,802.6	-213.92	-2,323.7	-802.48	-1,963.1	-874.69
26	TERNA ENERGEIAKH	1,547.82	708.52	707.37	653.96	308.03	290.23	84.05	98.30	14.73	13.71	20.73	21.46	21.83	20.29	21.04
27	MOTOR OIL	1,545.42	2,385.64	2,367.64	2,181.37	1,014.46	958.00	6,936.47	7,237.59	359.61	354.81	411.08	268.67	317.00	205.52	228.10
28	REVOIL	27.94	109.07	94.97	103.63	15.67	12.18	700.29	719.63	10.49	8.69	7.60	2.84	1.41	3.00	1.47
29	ELIN	39.55	208.57	198.25	200.86	51.59	50.45	1,926.89	2,186.49	15.37	12.77	12.42	3.47	3.94	2.70	2.67
30	HELLENIC PETROLEUM	1,934.67	6,473.45	6,441.36	6,376.40	2,238.84	2,146.68	8,023.56	8,967.70	416.10	408.34	618.73	350.09	669.58	316.36	523.39
31	EPSILON NET	278.72	24.47	23.66	21.13	12.55	11.59	13.65	12.41	2.63	2.37	1.96	1.02	0.71	1.05	0.71
32	LOGISMOS	5.02	8.89	8.70	8.97	6.48	6.69	2.56	2.39	0.54	0.48	0.65	-0.17	0.14	-0.21	0.04
33	QUALITY & RELIABILI	11.98	7.76	7.51	8.03	5.12	5.49	2.00	2.32	0.33	0.28	0.46	-0.19	0.01	-0.39	-0.18
34	QUEST HOLDINGS	682.65	82.64	82.07	94.68	80.26	93.15	0.00	0.00	5.45	5.33	0.49	5.26	0.47	-7.58	0.43
35	ENTERSOFT	168.00	15.80	14.18	14.31	10.80	9.87	12.41	11.34	3.44	3.00	2.78	2.32	1.87	1.80	1.47
36	ILYDA	12.34	8.31	8.27	7.92	3.81	3.87	2.79	2.16	1.29	1.27	0.98	-0.05	-0.24	-0.06	-0.19
37	INTRAKAT	113.34	322.55	311.17	341.21	75.22	71.33	272.32	217.58	18.53	16.51	15.61	5.45	6.65	3.54	3.13
38	AVAX	147.79	1,226.07	1,225.65	1,176.69	320.27	249.32	432.11	433.01	29.34	28.86	35.86	-2.55	-2.39	-7.92	-16.56
39	GEK TERNA	999.07	684.57	684.11	716.99	291.99	296.76	5.72	7.43	-7.07	-7.16	-7.61	-17.52	1.41	-12.21	-0.86
40	EKTER	13.61	23.77	23.72	28.52	17.61	19.57	20.11	22.76	-2.50	-2.55	1.77	-2.13	1.43	-1.52	0.60
41	I.KLOUKINAS-I.LAPPAS	26.54	82.33	67.83	72.29	48.61	51.56	24.52	25.27	3.64	1.53	1.89	-1.75	0.46	-1.41	0.24

42	AS KIDS COMPANY	27.83	36.06	35.68	34.24	29.75	27.83	22.15	25.61	3.69	3.58	4.83	3.84	4.16	2.81	7.09
43	MOTODYNAMIKI	57.92	44.77	42.14	39.65	21.79	10.90	60.21	54.70	4.25	3.53	2.59	1.92	1.25	1.29	0.90
44	NAKAS MUSIC	14.84	28.41	27.06	26.53	17.90	17.89	11.51	10.70	1.27	1.10	1.12	0.74	0.74	0.56	0.56
45	JUMBO	1,768.78	1,195.48	1,109.24	1,103.54	786.39	789.07	414.56	391.88	95.32	90.13	82.44	80.49	72.88	61.08	52.57
46	LAMPSA HOTEL	435.83	207.62	207.51	190.15	76.99	73.35	65.08	54.67	19.65	19.58	15.68	11.75	12.47	8.17	9.21
47	THRACE PLASTICS	293.51	88.26	88.08	87.21	70.74	70.45	4.99	4.90	-0.26	-0.41	0.08	2.30	0.68	2.27	0.45
48	CRETE PLASTICS	492.83	211.73	209.72	197.79	189.91	174.53	144.50	139.20	29.16	28.72	25.08	27.94	24.34	23.47	18.54
49	INTERTECH	7.67	18.06	17.92	16.58	8.39	8.32	21.13	19.57	-0.17	-0.25	0.03	-1.28	-0.83	-1.20	-0.94
50	INTERWOOD-XYLEMPO	9.40	49.02	48.72	49.00	13.26	13.03	27.40	27.51	2.14	2.07	2.04	0.22	0.09	0.25	0.17
51	VOGIATZOGLOU SYST	12.65	21.65	20.82	19.55	14.39	14.10	17.53	16.76	1.75	1.36	1.50	1.22	1.46	0.92	1.10
52	ELTON	49.18	77.31	76.53	75.20	48.47	46.85	86.68	85.68	5.75	5.46	6.01	4.31	4.74	3.25	3.28
53	GR. SARANTIS	604.44	302.34	297.74	207.97	196.55	125.96	149.95	135.58	85.19	83.53	9.20	78.48	3.89	78.50	4.21
54	ELVE	19.68	20.54	20.39	20.48	17.40	17.12	6.22	4.88	1.78	1.73	1.50	1.61	0.76	1.07	0.60
55	LANAKAM	5.91	11.78	11.16	11.87	8.09	9.81	1.70	2.02	-0.28	-0.41	-0.71	-0.52	-0.85	-0.51	-0.85
56	ATTICA	226.60	742.10	741.88	582.06	550.58	563.93	0.00	0.00	-1.32	-1.37	-1.26	7.40	1.37	7.40	1.37
57	ANEK	19.78	318.55	317.91	322.73	-5.43	-7.84	157.04	153.45	22.08	21.92	8.01	2.85	-13.07	2.66	-13.22
58	INTRACOM HOLDINGS	137.71	289.72	289.51	322.04	253.60	264.62	2.71	2.52	-9.65	-9.75	-0.53	-10.85	-1.87	-10.80	-1.63
59	OTE	7,577.30	6,371.50	6,101.10	5,836.20	3,154.60	2,888.90	936.10	916.80	708.70	645.30	651.80	706.50	308.20	635.00	196.30
60	SPACE HELLAS	62.63	67.91	66.57	57.22	15.39	14.42	69.60	62.82	5.29	4.75	4.45	1.61	1.53	1.23	0.98
61	OPAP	4,516.56	2,016.47	1,983.84	1,547.87	756.58	717.23	3,722.20	3,644.81	365.03	358.36	288.94	268.32	200.01	205.61	135.19
62	THES. WATER & SEWAG	166.98	218.13	217.06	209.52	182.86	172.81	72.69	73.03	25.90	25.52	25.14	20.62	20.61	14.64	13.66
63	ATH. WATER & SEWAG	820.05	1,563.12	1,559.52	1,533.82	951.38	949.43	323.74	322.40	107.66	106.76	100.76	84.05	80.31	58.11	47.95
64	AVE GROUP	70.01	100.10	97.92	79.05	6.23	15.00	1.68	1.69	-1.37	-1.70	-1.83	-12.12	-13.19	-13.08	-11.07
65	PORT OF THESSALONIK	247.97	224.51	182.39	213.18	161.24	149.89	68.98	58.53	29.75	26.72	28.95	23.03	23.73	16.45	16.40
66	PORT OF PIRAEUS	432.50	472.49	409.51	395.13	233.45	208.95	149.22	132.93	67.47	62.96	56.68	47.61	42.33	35.45	27.88
67	LAVIPHARM	29.37	76.14	75.89	71.62	31.69	26.37	20.17	21.08	4.81	4.72	6.87	2.12	0.61	5.45	-1.03
68	MEDICON HELLAS	22.63	26.69	25.54	26.35	9.91	9.51	11.86	12.25	1.75	1.46	2.56	1.22	3.38	0.59	1.75
69	ATHENS MEDICAL	148.32	373.43	361.00	367.28	75.29	70.66	190.67	176.62	23.66	20.80	21.32	6.93	5.73	4.73	7.81
70	FLEXOPACK	80.28	110.83	110.20	107.38	77.19	70.33	77.26	72.42	13.99	13.71	13.49	9.80	10.15	7.60	7.60
71	VIS	4.97	31.24	31.15	34.09	5.63	8.26	14.37	16.96	-0.98	-1.08	-1.14	-2.81	-2.91	-2.63	-2.57
72	SPIROU GROUP	6.14	34.58	34.20	37.80	5.47	6.15	12.55	11.64	0.86	0.66	-0.67	-1.20	-2.26	-0.65	-0.60
73	ELGEKA	28.82	74.59	74.05	74.54	10.85	9.95	64.52	65.22	3.79	3.51	2.45	1.62	-1.17	0.92	-1.45
74	KARAMOLEGOS	28.94	106.19	104.79	108.26	30.32	31.25	67.91	58.85	9.36	8.67	7.51	1.50	-0.38	0.67	0.40
75	KTHMA K. LAZARIDIS	31.89	42.80	42.69	35.79	26.09	24.17	13.06	11.07	3.75	3.72	2.52	2.54	1.47	1.93	1.82
76	MILLS K. SARANTOPOU	7.07	28.26	26.24	23.17	4.19	4.16	21.76	19.05	1.54	1.19	0.99	0.11	-0.10	0.02	-0.15
77	FLOUR MILLS KEPENOS	20.23	38.44	37.03	40.05	20.21	19.15	33.41	33.29	3.20	2.85	1.90	1.80	0.73	1.37	0.64
78	LOULIS MILLS	41.09	162.85	162.21	160.20	91.81	88.19	100.58	91.89	9.97	9.65	9.39	3.82	3.55	3.92	3.43
79	P.G. NIKAS	65.91	40.32	39.85	34.02	-0.14	2.91	51.72	40.48	0.67	0.50	-2.01	-3.14	-6.32	-3.19	-5.72
Average		**462.05**	**631.61**	**617.47**	**597.07**	**247.07**	**243.14**	**459.79**	**468.51**	**18.87**	**15.16**	**37.56**	**0.23**	**18.08**	**-0.39**	**9.42**
Median		**66.82**	**100.1**	**94.97**	**94.68**	**40.22**	**41.44**	**37.55**	**40.48**	**3.75**	**3.53**	**2.78**	**1.92**	**1.25**	**1.29**	**0.71**
Min		**1.32**	**7.76**	**7.51**	**7.92**	**-36.60**	**-31.79**	**0.00**	**0.00**	**-1,783.4**	**-1,802.6**	**-213.92**	**-2,323.7**	**-802.48**	**-1,963.1**	**-874.69**
Max		**7,577.30**	**12,767.6**	**12,726.5**	**13,482.4**	**3,154.60**	**3,825.03**	**8,023.56**	**8,967.70**	**708.70**	**645.30**	**651.80**	**706.50**	**669.58**	**635.00**	**523.39**

This table presents the names of the sample's companies along with some key accounting figures (assets, equity, turnover, EBITDA, profit before taxes (PBT) and profit after taxes (PAT) as at 31/12/2019 and 31/12/2018. Numbers are presented in million euros. 1. The market capitalization is as of 31/12/2021. 2. The adjusted assets as of 31/12/2019 are calculated by subtracting the current value of rights from operating leasing as at 31/12/2019 from the assets found in the published financial statements for that year. 3.The Adjusted EBITDA for 2019 is calculated by subtracting the deprecation and the interest expense relating to the rights from operating leasing from the non-adjusted EBITDA for that year.

Table 2. Stock Performance

This table presents four alternative calculations of the Greek companies' performance on the 21st day before the publication date of each company's financial statements, the 5th day before the publication, the day before the publication, the day of the publication, the day after the publication, the 5th day after the publication and the 21st day after the publication of financial statements. The performance calculations considered are the daily returns, the cumulative daily returns, the abnormal daily returns and the cumulative abnormal returns. Returns are presented for years 2018 and 2019.

Panel A: Daily Returns							
2018	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	0.27	0.46	0.41	-0.26	-0.38	0.37	0.08
Median	0.16	0.10	0.00	0.00	0.00	0.10	0.05
Min	-2.10	-2.38	-9.80	-13.33	-17.93	-4.00	-1.39
Max	2.63	4.28	9.52	16.51	10.26	7.71	2.20
Companies	79	79	79	79	79	79	79
2019	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	-0.15	-0.08	0.35	0.03	-0.01	0.40	0.30
Median	-0.03	0.00	0.00	0.00	0.00	0.14	0.14
Min	-3.05	-5.62	-15.91	-16.67	-9.87	-5.15	-1.07
Max	2.01	5.18	18.75	21.36	15.00	6.13	3.81
Companies	79	79	79	79	79	79	79
Panel B: Cumulative Returns							
2018	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	5.56	2.28	0.41	-0.26	-0.38	1.87	1.68
Median	3.29	0.49	0.00	0.00	0.00	0.48	1.00
Min	-44.08	-11.89	-9.80	-13.33	-17.93	-20.00	-29.12
Max	55.23	21.40	9.52	16.51	10.26	38.53	46.14
Companies	79	79	79	79	79	79	79
2019	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	-3.15	-0.37	0.35	0.03	-0.01	2.00	6.20
Median	-0.65	0.00	0.00	0.00	0.00	0.70	2.95
Min	-63.98	-28.11	-15.91	-16.67	-9.87	-25.75	-22.51
Max	42.24	25.91	18.75	21.36	15.00	30.63	80.07
Companies	79	79	79	79	79	79	79
Panel C: Abnormal Daily Returns							
2018	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	0.09	0.33	0.31	-0.32	-0.45	0.06	-0.02
Median	-0.03	0.00	0.01	-0.01	0.00	0.00	0.00
Min	-1.91	-2.29	-9.80	-13.42	-17.22	-3.92	-1.40
Max	2.63	4.13	8.97	16.57	10.15	5.53	2.17
Companies	79	79	79	79	79	79	79
2019	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	-0.10	0.05	0.45	0.18	-0.16	0.17	0.17
Median	-0.13	0.02	0.02	0.11	-0.23	-0.04	0.15
Min	-2.57	-3.66	-15.93	-13.61	-9.30	-4.48	-1.51
Max	1.98	4.89	16.34	20.46	9.34	5.74	3.40
Companies	79	79	79	79	79	79	79
Panel D: Abnormal Cumulative Returns							
2018	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	1.83	1.65	0.31	-0.32	-0.45	0.29	-0.48
Median	-0.70	-0.02	0.01	-0.01	0.00	0.00	0.00
Min	-40.03	-11.46	-9.80	-13.42	-17.22	-19.62	-29.49
Max	55.13	20.63	8.97	16.57	10.15	27.63	45.56
Companies	79	79	79	79	79	79	79
2019	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t-0**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	-2.07	0.24	0.45	0.18	-0.16	0.87	3.47
Median	-2.79	0.11	0.02	0.11	-0.23	-0.18	3.13
Min	-53.96	-18.28	-15.93	-13.61	-9.30	-22.39	-31.81
Max	41.50	24.43	16.34	20.46	9.34	28.69	71.39
Companies	79	79	79	79	79	79	79

Table 3. Stock Volatility

This table presents the volatility in the Greek companies' returns and abnormal returns on the 21st day before the publication date of each company's financial statements, the 5th day before the publication, the day before the publication, the day after the publication, the 5th day after the publication and the 21st day after the publication of financial statements. Volatilities are presented for years 2018 and 2019.

Panel A: Volatility in Daily Returns						
2018	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	2.64	2.45	1.92	2.32	1.83	2.72
Median	1.95	1.58	1.07	1.64	1.23	2.10
Min	0.00	0.00	0.00	0.00	0.00	0.00
Max	12.39	21.31	11.67	16.68	8.94	8.79
Companies	79	79	79	79	79	79
2019	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	2.65	2.47	1.91	2.30	1.85	2.73
Median	1.97	1.60	1.02	1.64	1.29	2.12
Min	0.00	0.00	0.00	0.00	0.00	0.00
Max	12.39	21.31	11.67	16.68	8.94	8.79
Companies	79	79	79	79	79	79
Panel B: Volatility in Abnormal Daily Returns						
2018	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	2.63	2.49	1.91	2.30	1.80	2.65
Median	1.92	1.64	1.07	1.65	1.17	2.05
Min	0.00	0.00	0.00	0.00	0.00	0.00
Max	12.36	21.78	11.77	16.67	9.00	8.79
Companies	79	79	79	79	79	79
2019	**Day: t-21**	**Day: t-5**	**Day: t-1**	**Day: t+1**	**Day: t+5**	**Day: t+21**
Average	2.64	2.51	1.90	2.29	1.82	2.67
Median	1.93	1.68	1.05	1.66	1.22	2.08
Min	0.00	0.00	0.00	0.00	0.00	0.00
Max	12.36	21.78	11.77	16.67	9.00	8.79
Companies	79	79	79	79	79	79

Table 4. Financial Ratios

This table presents three representative financial ratios of the Greek companies' profitability, leverage and liquidity, that is, the EBITDA to Turnover Ratio, the Leverage Ratio and the Current Ratio, respectively, for years 2018 and 2019. Adjusted versions of the ratios for year 2019 are presented too. The ratios presented are categorized in 5 five classes from top class 1 with the highest figures to bottom class 5 with the lowest figures.

	EBITDA/ Turnover 2019 (%)	**AdjEBITDA/Turnover 2019 (%)[1]**	**EBITDA/ Turnover 2018 (%)**	**Leverage Ratio 2019 (%)**	**AdjLeverage Ratio 2019 (%)[2]**	**Leverage Ratio 2018 (%)**	**Current Ratio 2019 (times)**	**AdjCurrent Ratio 2019 (times)[3]**	**Current Ratio 2018 (times)**
Class 1									
Average	45.12	43.44	38.37	122.71	123.32	107.36	11.43	12.38	10.85
Median	34.44	34.04	33.49	75.36	74.85	76.13	6.65	7.26	5.92
Min	23.87	23.43	6.79	61.08	60.18	55.86	4.33	4.34	0.95
Max	141.97	140.25	77.07	625.19	626.75	402.94	67.94	70.94	74.79
Companies	16	16	16	16	16	16	16	16	16
Class 2									
Average	17.11	14.69	16.06	51.17	49.81	50.00	3.25	3.36	2.95
Median	17.08	15.05	17.86	50.89	49.82	50.84	3.15	3.31	2.74
Min	12.41	6.25	5.22	39.55	36.13	38.13	2.37	2.43	0.31
Max	22.99	21.74	27.17	60.65	60.17	65.05	4.25	4.30	7.16
Companies	16	16	16	16	16	16	16	16	16
Class 3									
Average	8.59	7.39	6.77	30.16	10.60	15.52	1.79	1.83	1.94
Median	7.83	6.89	7.29	31.25	25.99	28.59	1.85	1.86	1.85
Min	6.80	5.07	-5.74	19.94	-237.68	-207.86	1.28	1.32	1.08
Max	11.98	11.95	14.76	39.05	38.93	65.34	2.37	2.50	3.13
Companies	16	16	16	16	16	16	16	16	16
Class 4									
Average	3.68	3.38	3.75	13.58	4.89	0.66	1.06	1.12	1.05
Median	4.13	3.30	3.92	14.91	10.25	7.72	1.09	1.10	1.08
Min	0.00	0.00	-4.97	3.94	-45.77	-53.16	0.81	0.82	0.41
Max	6.79	6.68	9.70	19.60	17.57	19.07	1.27	1.77	1.60
Companies	16	16	16	16	16	16	16	16	16
Class 5									
Average	-276.45	-287.12	-47.78	-251.93	-98.59	49.40	0.45	0.45	0.61
Median	-32.59	-36.78	-15.06	-28.21	-43.13	-13.24	0.52	0.52	0.66
Min	-2,345.31	-2,397.02	-212.80	-2,853.26	-641.40	-125.70	0.08	0.08	0.13
Max	-1.62	-1.72	7.78	2.06	1.26	1,091.30	0.69	0.69	1.42
Companies	15	15	15	15	15	15	15	15	15
Sample									
Average	-34.34	-37.40	4.75	-0.58	21.00	44.46	3.68	3.92	3.55
Median	8.70	6.89	7.60	32.95	26.87	31.64	1.89	1.89	1.57
Min	-2,345.31	-2,397.02	-212.80	-2,853.26	-641.40	-207.86	0.08	0.08	0.13
Max	141.97	140.25	77.07	625.19	626.75	1,091.30	67.94	70.94	74.79
Companies	79	79	79	79	79	79	79	79	79

1. The adjusted EBITDA for 2019 is calculated by subtracting the deprecation and the interest expense relating to the rights from operating leasing from the non-adjusted EBITDA for that year.
2. The adjusted Leverage Ratio (Net Debt/Total Capital Employed) for 2019 is calculated after subtracting the operating leasing liability as at 31/12/2019 from the numerator and denominator of the ratio.
3. The adjusted Current Ratio and Adjusted Cash Ratio for 2019 are calculated after subtracting the current liability for operating leasing as at 31/12/2019 from total current liabilities.

Table 5. Performance Regression Results

This table presents the results of the cross-sectional regression analysis for years 2018 and 2019 of Greek companies' performance on their profitability, leverage and liquidity on the 21st day before the financial statements' publication date of each company in the sample, the 5th day before the publication, the day before the publication, the day of the publication, the day after the publication, the 5th day after the publication and the 21st day after the publication of financial statements. The performance calculations considered are the daily returns, the cumulative daily returns, the abnormal daily returns and the cumulative abnormal returns. The profitability, leverage and liquidity ratios considered are the EBITDA to Turnover Ratio, the Leverage Ratio and the Current Ratio, respectively. Adjusted versions of the ratios for year 2019 are used too.

Panel A: Daily Returns														
	Day: t-21		**Day: t-5**		**Day: t-1**		**Day: t-0**		**Day: t+1**		**Day: t+5**		**Day: t+21**	
2018	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	0.25*	3.02	0.36**	2.29	0.49	1.28	-0.48	-0.92	-0.36	-0.69	0.56*	3.02	0.05	0.63
Profitability	0.00	-0.12	0.00	-0.86	0.01	0.71	0.00	0.35	0.00	0.20	0.00	0.31	0.00	0.62
Leverage	0.00	1.33	0.00*	2.83	0.00	-0.03	0.00	0.09	0.00	-0.54	0.00*	-2.77	0.00	1.15
Liquidity	0.00	-0.42	0.00	-0.26	-0.04	-1.14	0.02	0.35	-0.01	-0.18	-0.01	-0.62	0.00	-0.13
R^2	0.03		0.12		0.02		0.00		0.00		0.10		0.02	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-0.16	-1.11	-0.12	-0.54	0.24	0.43	0.08	0.12	0.12	0.20	0.37	1.46	0.31*	3.08
Profitability	0.00	-0.60	0.00	-0.37	0.00	0.07	0.00	-0.07	0.00	-0.31	0.00	0.80	0.00	0.28
Leverage	0.00	-0.08	0.00	-0.14	0.00	0.23	0.00	0.20	0.00	-0.02	0.00***	-1.75	0.00	-1.58
Liquidity	0.00	-0.08	0.00	-0.18	-0.01	-0.23	0.00	0.00	-0.02	-0.30	0.02	0.63	0.00	-0.22
R^2	0.01		0.00		0.00		0.00		0.00		0.05		0.03	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-0.18	-1.20	-0.11	-0.49	0.28	0.49	-0.15	-0.22	0.07	0.12	0.43***	1.66	0.33*	3.08
AdjProfitability	0.00	-0.65	0.00	-0.38	0.00	0.07	0.00	-0.18	0.00	-0.31	0.00	0.86	0.00	0.30
AdjLeverage	0.00	0.56	0.00	-0.02	0.00	-0.23	0.01	1.45	0.00	0.24	0.00	-1.22	0.00	-0.70
AdjLiquidity	0.00	-0.01	-0.01	-0.27	-0.02	-0.31	0.02	0.24	-0.01	-0.20	0.01	0.49	0.00	-0.27
R^2	0.01		0.00		0.00		0.03		0.00		0.04		0.01	
Panel B: Cumulative Returns														
	Day: t-21		**Day: t-5**		**Day: t-1**		**Day: t-0**		**Day: t+1**		**Day: t+5**		**Day: t+21**	
2018	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	5.33*	3.02	1.82**	2.29	0.49	1.28	-0.48	-0.92	-0.36	-0.69	2.80*	3.02	1.07	0.63
Profitability	-0.01	-0.12	-0.02	-0.86	0.01	0.71	0.00	0.35	0.00	0.20	0.01	0.31	0.02	0.62
Leverage	0.02	1.33	0.01*	2.83	0.00	-0.03	0.00	0.09	0.00	-0.54	-0.02*	-2.76	0.01	1.15
Liquidity	-0.07	-0.42	-0.02	-0.26	-0.04	-1.14	0.02	0.35	-0.01	-0.18	-0.06	-0.62	-0.02	-0.13
R^2	0.03		0.12		0.02		0.00		0.00		0.097		0.02	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-3.41	-1.11	-0.61	-0.54	0.24	0.43	0.08	0.12	0.12	0.20	1.83	1.46	6.58*	3.08
Profitability	-0.01	-0.60	0.00	-0.37	0.00	0.07	0.00	-0.07	0.00	-0.31	0.00	0.80	0.00	0.28
Leverage	0.00	-0.08	0.00	-0.14	0.00	0.23	0.00	0.20	0.00	-0.02	-0.01***	-1.75	-0.01	-1.58
Liquidity	-0.03	-0.08	-0.02	-0.18	-0.01	-0.23	0.00	0.00	-0.02	-0.30	0.09	0.63	-0.05	-0.22
R^2	0.01		0.00		0.00		0.00		0.00		0.05		0.03	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-3.80	-1.20	-0.57	-0.49	0.28	0.49	-0.15	-0.22	0.07	0.12	2.17***	1.66	6.90*	3.08
AdjProfitability	-0.01	-0.65	0.00	-0.38	0.00	0.07	0.00	-0.18	0.00	-0.31	0.00	0.86	0.00	0.30

AdjLeverage	0.01	0.56	0.00	-0.02	0.00	-0.23	0.01	1.45	0.00	0.24	-0.01	-1.22	-0.01	-0.70
AdjLiquidity	0.00	-0.01	-0.03	-0.27	-0.02	-0.31	0.02	0.24	-0.01	-0.20	0.07	0.49	-0.07	-0.27
R^2	0.01		0.00		0.00		0.03		0.00		0.04		0.01	
Panel C: Abnormal Daily Returns														
	Day: t-21		**Day: t-5**		**Day: t-1**		**Day: t-0**		**Day: t+1**		**Day: t+5**		**Day: t+21**	
2018	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	0.06	0.72	0.23	1.45	0.39	1.03	-0.53	-1.01	-0.44	-0.89	0.22	1.35	-0.07	-0.84
Profitability	0.00	0.19	-0.00	-0.78	0.01	0.79	0.00	0.31	0.00	0.29	0.00	0.71	0.00	0.88
Leverage	0.00***	1.68	0.00*	2.98	0.00	0.01	0.00	0.13	-0.00	-0.50	-0.00*	-3.08	0.00	1.59
Liquidity	-0.00	-0.25	-0.00	-0.26	-0.04	-1.16	0.02	0.28	-0.01	-0.18	-0.01	-0.45	0.00	-0.04
R^2	0.04		0.13		0.03		0.00		0.01		0.12		0.04	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-0.10	-1.04	0.11	0.59	0.38	0.71	0.26	0.43	-0.03	-0.06	0.14	0.66	0.19**	2.14
Profitability	0.00	-0.21	0.00	-0.17	0.00	0.15	0.00	0.12	0.00	-0.24	0.00	0.54	0.00	0.89
Leverage	0.00	-0.63	0.00	-0.20	0.00	0.16	0.00	0.16	0.00	-0.23	0.00**	-2.30	0.00**	-2.51
Liquidity	0.00	-0.19	-0.02	-1.08	-0.01	-0.21	-0.01	-0.08	-0.02	-0.34	0.02	0.66	0.00	-0.28
R^2	0.01		0.02		0.00		0.00		0.00		0.08		0.09	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-0.09	-0.89	0.13	0.68	0.39	0.71	0.10	0.16	-0.04	-0.09	0.21	0.94	0.21**	2.28
AdjProfitability	0.00	-0.20	0.00	-0.16	0.00	0.13	0.00	0.03	0.00	-0.23	0.00	0.61	0.00	0.89
AdjLeverage	0.00	-0.47	0.00	-0.28	0.00	-0.09	0.01	1.14	0.00	0.02	0.00	-1.51	0.00	-1.27
AdjLiquidity	0.00	-0.30	-0.02	-1.20	-0.01	-0.23	0.01	0.09	-0.01	-0.26	0.01	0.46	0.00	-0.42
R^2	0.00		0.02		0.00		0.02		0.00		0.04		0.03	
Panel D: Abnormal Cumulative Returns														
	Day: t-21		**Day: t-5**		**Day: t-1**		**Day: t-0**		**Day: t+1**		**Day: t+5**		**Day: t+21**	
2018	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	1.28	0.72	1.15	1.45	0.39	1.03	-0.53	-1.01	-0.44	-0.89	1.10	1.35	-1.36	-0.84
Profitability	0.00	0.12	-0.01	-0.78	0.01	0.79	0.00	0.31	0.00	0.29	0.01	0.71	0.03	0.88
Leverage	0.02***	1.68	0.02*	2.98	0.00	0.01	0.00	0.13	-0.00	-0.50	-0.02*	-3.08	0.02	1.59
Liquidity	-0.05	-0.25	-0.02	-0.26	-0.04	-1.16	0.02	0.28	-0.01	-0.18	-0.04	-0.45	-0.01	-0.04
R^2	0.04		0.13		0.03		0.00		0.01		0.12		0.04	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-2.11	-1.04	0.53	0.59	0.38	0.71	0.26	0.43	-0.03	-0.06	0.69	0.66	3.89*	2.14
Profitability	0.00	-0.21	0.00	-0.17	0.00	0.15	0.00	0.12	0.00	-0.24	0.00	0.54	0.01	0.89
Leverage	0.00	-0.63	0.00	-0.20	0.00	0.16	0.00	0.16	0.00	-0.23	-0.01**	-2.30	-0.01**	-2.51
Liquidity	-0.04	-0.19	-0.11	-1.08	-0.01	-0.21	-0.01	-0.08	-0.02	-0.34	0.08	0.66	-0.06	-0.28
R^2	0.01		0.02		0.00		0.00		0.00		0.08		0.09	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	-1.86	-0.89	0.63	0.68	0.39	0.71	0.10	0.16	-0.04	-0.09	1.04	0.94	4.42*	2.28
AdjProfitability	0.00	-0.20	0.00	-0.16	0.00	0.13	0.00	0.03	0.00	-0.23	0.00	0.61	0.01	0.89
AdjLeverage	-0.01	-0.47	0.00	-0.28	0.00	-0.09	0.01	1.14	0.00	0.02	-0.01	-1.51	-0.02	-1.27
AdjLiquidity	-0.07	-0.30	-0.12	-1.20	-0.01	-0.23	0.01	0.09	-0.01	-0.26	0.05	0.46	-0.09	-0.42
R^2	0.00		0.02		0.00		0.02		0.00		0.04		0.03	

* Statistically significant at the 1%, ** Statistically significant at the 5%, *** Statistically significant at the 10%.

Table 6. Volatility Regression Results

This table presents the results of the cross-sectional regression analysis for years 2018 and 2019 of Greek companies' volatility on their profitability, leverage and liquidity on the 21st day before the financial statements' publication date of each company in the sample, the 5th day before the publication, the day before the publication, the day of the publication, the day after the publication, the 5th day after the publication and the 21st day after the publication of financial statements. The volatility is calculated for the daily returns and the abnormal daily returns. The profitability, leverage and liquidity ratios considered are the EBITDA to Turnover Ratio, the Leverage Ratio and the Current Ratio, respectively. Adjusted versions of the ratios for year 2019 are used too.

Panel A: Volatility in Daily Returns												
	Day: t-21		**Day: t-5**		**Day: t-1**		**Day: t+1**		**Day: t+5**		**Day: t+21**	
2018	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	2.61*	9.35	2.27*	5.47	1.91*	5.48	2.31*	6.02	1.58*	6.47	2.54*	11.48
Profitability	0.00	-0.18	0.00	-0.02	0.01	0.76	0.01	0.66	0.00	-0.07	0.00	0.35
Leverage	0.00	1.10	0.01**	2.01	0.00	-0.30	0.00	-0.46	0.01*	3.79	0.01*	3.76
Liquidity	0.00	-0.17	-0.01	-0.20	0.00	-0.04	0.02	0.49	0.00	0.13	-0.01	-0.56
R^2	0.02		0.06		0.01		0.02		0.17		0.18	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	4.19*	10.66	4.10*	7.14	2.69*	5.85	3.32*	6.63*	4.10*	10.83	3.67*	14.84
Profitability	0.00	-0.55	0.00	-0.09	0.00	0.55	0.00	0.08	0.00	0.89	0.00	0.92
Leverage	0.00	1.22	0.00	0.89	0.00	0.64	0.00	0.65	0.00	-1.52	0.00	-0.46
Liquidity	-0.02	-0.54	-0.03	-0.52	-0.04	-0.70	0.00	0.05	-0.01	-0.16	-0.03	-1.09
R^2	0.03		0.02		0.02		0.01		0.04		0.03	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	4.16*	10.15	4.08*	6.84	2.81*	5.93*	3.35	6.45*	4.24*	10.83*	3.67*	14.31
AdjProfitability	0.00	-0.55	0.00	-0.08	0.00	0.66	0.00	0.13	0.00	0.97	0.00	0.87
AdjLeverage	0.00	0.43	0.00	0.14	0.00	-1.04	0.00	-0.12	0.00	-1.56	0.00	0.16
AdjLiquidity	-0.02	-0.50	-0.03	-0.49	-0.04	-0.87	0.00	-0.02	-0.02	-0.39	-0.03	-1.04
R^2	0.01		0.00		0.02		0.00		0.04		0.03	
Panel B: Volatility in Abnormal Daily Returns												
	Day: t-21		**Day: t-5**		**Day: t-1**		**Day: t+1**		**Day: t+5**		**Day: t+21**	
2018	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	2.58*	9.20	2.31*	5.51	1.93*	5.56	2.29*	6.01	1.53*	6.57	2.46*	11.12
Profitability	0.00	-0.10	0.00	-0.05	0.00	0.62	0.01	0.67	0.00	-0.14	0.00	0.42
Leverage	0.00	1.12	0.01***	1.95	0.00	-0.38	0.00	-0.42	0.01*	4.19	0.01*	3.87
Liquidity	0.00	-0.14	-0.01	-0.16	0.00	-0.06	0.02	0.47	0.00	0.21	-0.01	-0.49
R^2	0.02		0.05		0.01		0.01		0.20		0.18	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	3.56*	10.55	3.44*	6.77	2.56*	6.52	2.85*	6.29	3.50*	10.28	3.23*	14.20
Profitability	0.00	-0.08	0.00	0.25	0.00	0.32	0.00	-0.11	0.00	0.95	0.00	1.00
Leverage	0.00	1.19	0.00	0.84	0.00	0.73	0.00	0.73	0.00***	-1.76	0.00	-0.58
Liquidity	-0.02	-0.40	-0.01	-0.14	-0.03	-0.69	0.02	0.45	0.00	0.01	-0.02	-0.92

R^2	0.02		0.01		0.02		0.01		0.05		0.03	
2019	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
Intercept	3.50*	9.98	3.39*	6.43	2.62*	6.45	2.78*	5.94	3.64*	10.34	3.21*	13.63
AdjProfitability	0.00	-0.11	0.00	0.24	0.00	0.38	0.00	-0.13	0.00	1.04	0.00	0.94
AdjLeverage	0.00	0.76	0.00	0.37	0.00	-0.63	0.00	0.65	0.00***	-1.77	0.00	0.33
AdjLiquidity	-0.01	-0.29	0.00	-0.06	-0.03	-0.76	0.03	0.52	-0.01	-0.23	-0.02	-0.82
R^2	0.01		0.00		0.01		0.01		0.05		0.02	
* Statistically significant at the 1%, ** Statistically significant at the 5%, *** Statistically significant at the 10%.												

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Investigating the Effects of Natural Disasters on the Stock Market on a Sectoral Basis: The Case of 2023 Kahramanmaraş/Türkiye Earthquake

Doğal Afetlerin Borsaya Etkilerinin Sektörel Bazda İncelenmesi: 2023 Kahramanmaraş/Türkiye Depremi Örneği

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ABSTRACT

This study aims to examine the effects of two earthquakes in Kahramanmaraş/Türkiye on February 06, 2023 on Borsa Istanbul (BIST) stock markets on a sectoral basis. In this context, whether there is a statistically significant difference between sectoral stock returns before and after the earthquake is investigated. The study divides 18 BIST sectoral index returns into two sub-samples, pre-earthquake and post-earthquake and analyzed by the event study method. For this purpose, Paired Samples t-Test, a parametric test, and the Wilcoxon Signed Rank Test, the non-parametric equivalent of this test, are used. According to the research results, no statistically significant difference was found between the pre-and post-earthquake returns of BIST sector indices. The findings show that, in the case of investing in BIST sectoral indices, abnormal returns cannot be obtained depending on the earthquake event. Accordingly, BIST sectoral indices are an efficient market in a semi-strong form.

Anahtar Kelimeler:
Doğal Afetler,
Deprem,
BIST Sektör Endeksleri,
Eşleştirilmiş Örneklem t-Testi,
Wilcoxon İşaretli Sıralar Testi

Jel Kodları:
C12, C16, G11, G14

ÖZET

Bu çalışma, 06 Şubat 2023 tarihinde Kahramanmaraş/Türkiye'de meydana gelen iki depremin Borsa İstanbul (BİST) borsalarına etkilerini sektörel bazda incelemeyi amaçlamaktadır. Bu kapsamda deprem öncesi ve deprem sonrası sektörel hisse senedi getirileri arasında istatistiksel olarak anlamlı bir fark olup olmadığı araştırılmaktadır. Çalışma, 18 BİST sektörel endeks getirisini deprem öncesi ve deprem sonrası olmak üzere iki alt örnekleme ayırarak olay çalışması yöntemiyle analiz etmektedir. Bu amaçla parametrik bir test olan Bağımlı Örneklem t-Test ve bu testin parametrik olmayan karşılığı olan Wilcoxon İşaretli Sıra Sayıları Testi kullanılmaktadır. Araştırma sonuçlarına göre BIST sektör endekslerinin deprem öncesi ve sonrası getirileri arasında istatistiksel olarak anlamlı bir fark bulunmamıştır. Bulgular, BIST sektör endekslerine yatırım yapılması durumunda deprem olayına bağlı olarak anormal getirilerin elde edilemeyeceğini göstermektedir. Buna göre, BIST sektör endeksleri yarı güçlü formda etkin bir piyasadır.

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1. INTRODUCTION

Although disaster is defined as "destruction caused by various natural events", according to the Turkish Language Association (www.tdk.gov.tr), today, it can be said that this definition is relatively narrow. Özler (2019) mentions many factors such as natural, environmental, global, biological, meteorological, chemical, nuclear, social, political and technological in the classification of events leading to disasters.

Among the disasters, earthquake is the one that causes tremendous destruction (Akdur, 2000: 2). One of the giant earthquakes of the recent period is the earthquake that took place in Kahramanmaraş/Türkiye on 06 February 2023, which also affected Syria. Two earthquakes with magnitudes Mw7.7 (focal depth = 8.6km) and Mw7.6 (focal depth = 7km) occurred at 04:17 and 13:24, Türkiye time, with epicentres in Pazarcık and Elbistan districts of Kahramanmaraş. On February 20, 2023, at 20:04 Turkish time, an earthquake with a magnitude of Mw6.4 occurred, the epicentre of which was Hatay-Yayladağı. The earthquakes mentioned above caused great destruction in 11 provinces (Kahramanmaraş, Malatya, Gaziantep, Diyarbakır, Hatay, Şanlıurfa, Kilis, Osmaniye, Adana, Adıyaman, Elazığ). More than 14 million people were directly affected by the earthquakes, more than 50 thousand people lost their lives, more than half a million buildings were damaged, communication and energy infrastructures were damaged, and significant financial losses occurred (T.C. SBB, 2023). Because there were two earthquakes with a magnitude greater than 7 in the same region within 12 hours, the losses caused by the earthquakes to date, and the first assessment reports prepared for the earthquakes, the Kahramanmaraş earthquakes were recorded as the most significant earthquake disaster we experienced in the Turkish Republic period (Şen, 2023: 5). It is estimated that the total burden of the disaster caused by the earthquake on the Turkish economy is approximately 2 trillion TL (103.6 billion dollars). This size will reach approximately 9 per cent of the national income in 2023 (T.C. SBB, 2023).

This study aims to examine the effects of two earthquakes in Kahramanmaraş/Türkiye on February 06, 2023, on Borsa Istanbul (BIST) stock markets on a sectoral basis. Comprehensive studies on the effects of the earthquake on the stock markets are insufficient on a sectoral basis, and detailed studies on a sectoral basis have not yet been found in the case of the February 06, 2023, Kahramanmaraş/Türkiye earthquake. With this study, the effects of the earthquake on the stock markets of different sectors are revealed by determining whether abnormal returns can be obtained during the earthquake period. Studies in which many different sectors are included, as in this study, are not frequently encountered in the literature. In addition, the distribution characteristics of the variables were taken into account in the analyses. Accordingly, Paired Samples t-Test, one of the parametric tests, is used for normally distributed variables, and non-parametric Wilcoxon Signed Rank Test is used for non-normally distributed variables. The results obtained in this respect can be a guide for stock investors in their investment decisions for Turkey, which is an earthquake country, as well as for regulatory authorities to be informed about the measures to be taken regarding stock market transactions in the event of an earthquake, taking into account the said effects.

We planned the rest of the study as follows. In the second section of the study, we included the literature review on the subject, and in the third section, we explained the method of the study. In the fourth section, we presented the dataset and descriptive statistics of the study, and in the fifth section, the empirical findings and discussion. In the sixth section, we have included the results of the study and general evaluations.

2. LITERATURE REVIEW

Due to their essential consequences, natural disasters have economic, financial, social, political, and psychological effects. Many aspects of its effects are examined in the literature. In this context, there are many studies on the economic-financial effects of natural disasters, such as economic growth, exchange rates, stock market effects, Etc. However, since this study examines the economic effects of the earthquake, this section includes studies on natural disasters and especially the effects of earthquakes on the stock market.

Shelor et al. (1990) examined the effect of the October 17, 1989, California earthquake on the stock values of companies in the real estate sector. The findings showed the earthquake's statistically significant negative effect on real estate firms in the San Francisco area; in contrast, real estate firms operating in other parts of California are generally unaffected.

Worthington & Valadkhani (2004) investigated the impact of 42 natural disasters in Australia on the Australian stock market. They discovered that forest fires, hurricanes and earthquakes have a significant effect on market returns; however, severe storms and floods do not have a significant effect.

Worthington & Valadkhani (2005) investigated the impact of natural, industrial and terrorist disasters on the Australian capital market. They determined that the shocks created by natural disasters and other disasters affect the sector's returns.

Lee et al. (2007) examined whether a contagion effect occurred between 26 international stock indices and exchange rates after the Southeast Asian earthquake in 2004. As a result of the research, although there was no contagion effect between any stock markets, a contagion effect was determined for some countries in the foreign exchange markets. Another significant result of the research is that the contagion effects are more pronounced in emerging financial markets than in developed markets.

Worthington (2008) examines the impact of all severe natural events and disasters on Australian stock returns from 01.01.1980-30.06.2003. The results demonstrated that natural events and disasters do not significantly impact individual returns.

Scholtens & Voorhorst (2013) investigated the effects of 101 earthquakes on stock markets in 5 continents and 21 countries. They stated that earthquakes significantly affect the local stock market, and the losses on an annualized basis are in the range of 6-12% of the total market value of the companies traded in the relevant domestic stock exchange. However, they also found that the stock market's response to earthquakes is not different in terms of the severity of earthquakes, the income level of the relevant country or the legal systems; that is, stock market investors tend to respond to earthquakes similarly.

Takao et al. (2013) examine the effects of the Great East Japan Earthquake on the value of Japanese insurance companies, especially non-life insurance companies. They determined that the earthquake affected insurance companies' stock prices negatively in the short term; however, this negative effect was less on the stock prices of non-life insurance companies compared to life insurance companies.

Wang & Kutan (2013) examined the impact of different types of natural disasters on the insurance sector and composite stock market indices for the USA and Japan. They found that while the composite index returns of both countries are unaffected by natural disasters, the insurance sectors are affected. They also discovered that when natural disasters are evaluated regarding risk effects, all returns are affected by natural disasters, except for the Japanese composite market index.

Ruiz & Barrero (2014) investigated the effects of the 2010 Chile earthquake and tsunami on stock prices. As a result of the research, the returns are positive in the retail, real estate and banking sectors; they were found to be negative in the food, steel and forestry sectors.

Ferreira & Karali (2015) examine stock market indices' return and volatility effects in thirty-five financial markets of significant earthquakes in the last two decades. The findings showed that global financial markets resist shocks caused by earthquakes.

Bourdeau-Brien & Kryzanowski (2017) investigated the impact of different types of major natural disasters (storms, floods, extreme temperature, winter weather, hurricanes) on US stock returns and volatility in the period 1990-2014. As a result of the research, a small portion of disasters have a significant impact on returns; It was determined that conditional volatility increased after hurricanes, floods, extreme temperature periods and severe winter weather, but no change in conditional volatility was detected in other storm-like events.

Fakhry et al. (2018) analyzed the short- and long-term effects of the Japanese earthquake and tsunami (Great Tohoku or Sendai earthquake) of 11.03.2011 on the Japanese stock, debt, foreign exchange and gold market. As a result of the research, it was determined that the natural disaster affected the efficiency of the market more in the short term than the long term, and it was stated that the Japanese market could be a partially efficient market.

Tavor & Teitler-Regev (2019) examine the effects of natural disasters, artificial disasters and terrorism on the stock market. According to the findings of the research, natural disasters cause the greatest damage to the economy, and terrorism causes the least damage. In addition, natural disasters show the highest level of severity, while artificial disasters show the lowest impact.

Yıldırım & Alola (2020) investigated the relationship between BIST REIT index and earthquakes in Türkiye between 02.2000-02.2017, the USD exchange rate and global economic policy (GEPU). In the results of working; Statistically significant and negative effects of these variables on BIST REIT were determined in the long term, but the effect of the earthquake on the relevant stock market index was not found in the short term.

Hamurcu (2022) examined the effect of the Izmir earthquake on 30 October 2020 on the stocks of companies in the BIST insurance sector. At the end of the research, it was determined that the earthquake affected the insurance sector stocks negatively.

Pagnottoni et al. (2022) examined the effects of five categories of natural disasters that occurred in 104 countries around the world on global stock market indices. At the end of the study, it has been determined that stock markets give different reactions according to the type of natural disasters and the location of the events. Accordingly, while climatic disasters tend to affect financial markets negatively, other disasters (biological, geophysical, hydrological, meteorological) tend to affect them positively.

Say & Doğan (2023) examined the effect of the February 6, 2023 Kahramanmaraş earthquake on the stock prices traded in Borsa Istanbul using the event analysis method. As a result of the research, it was found that positive cumulative abnormal returns were obtained for BIST 30 companies on the day of the event and all days after the event, and according to this result, they reached the conclusion that the relevant market is not an efficient market in a semi-strong form in terms of the BIST 30 index.

The details of the literature studies described so far are presented in the tables below.

Table 1. Literature Review

Source	Events	Samples/Variables	Data and Frequency	Method
Shelor et al. (1990)	California earthquake of 17.10.1989	19 adet San Francisco Bay Area and 44 other California real estate firms, S&P 500 index for a market proxy	18.10.1989 (-100 to -1; 0 to 20 trading days) (Daily)	T-test SUR model
Worthington & Valadkhani (2004)	42 natural disasters in Australia	Australian All Ordinaries Index (AOI)	31.12.1982-01.01.2002 (Daily)	ARMA regression model
Worthington & Valadkhani (2005)	Natural, industrial and terrorism disasters in Australia	Australian 10 sektörel index	02.01.1995-02.07.2003 (Daily)	ARMA regression model
Lee et al. (2007)	South-East Asia earthquake of 26.12.2004	26 international stock indices and exchange rates	26.12.2003-25.03.2005 (Daily)	Correlation coefficient method
Worthington (2008)	01.01.1980-30.06.2003 period severe natural events and disasters	Australian stock market returns	01.01.1980-30.06.2003 (Daily)	GARCH-M model
Scholtens & Voorhorst (2013)	101 earthquakes in 5 continents and 21 countries	Stock markets of 21 countries	1973–2011 (Daily)	Wilcoxon test
Takao et al. (2013)	Japan earthquake of 11 March 2011	Japanese insurance industry (life and non-life)	11.03.2011- 04.04.2011 (Daily)	Market model regression
Wang & Kutan (2013)	Natural disasters in the USA and Japan	US S&P 500 Insurance Composite and S&P indices; Japan TOPIX Insurance and the Nikkei 225 indices	11.09.1989-08.04.2011 (Daily)	EGARCH(1,1) model
Ruiz & Barrero (2014)	Chile earthquake of 27.02.2010	42 listed companies in the Santiago Stock Exchange	23.01.2009-06.04.2010 (Daily)	GARCH(1,1) model
Ferreira & Karali (2015)	24 distinct earthquakes	35 stock markets, GDP, trade openness, exports and main features of earthquake	03.02.1994–08.08.2013 (Daily)	Regression-based event study methodology GARCH-X(1,1) model
Bourdeau-Brien & Kryzanowski (2017)	1990-2014 period 247 major natural disasters	US stock market	01.1990-06.2015 (Daily)	ARMA-EGARCH model GARCH model
Fakhry et al. (2018)	Japanese earthquake of 11.03.2011	Japanese Nikkei 225 stock index, Japan All Maturities Index, Japanese Yen, gold	31.12.1997- 31.12.2016 (Daily)	Variance bound test using C-GARCH-t model
Tavor & Teitler-Regev (2019)	344 significant events	Pessimism index, fatalities, casualties, location, financial loss	02.09.1983-06.03.2013 (Daily)	Regression model
Yıldırım & Alola (2020)	Earthquakes in Türkiye in the period of 02.2000-02.2017	BIST REIT index, USD Exchange rate, GEPU	02.2000-02.2017 (Monthly)	ARDL model
Hamurcu (2022)	Izmir earthquake of 30 October 2020	Stocks of 6 companies in BIST insurance sector	13.07.2020- 15.02.2021 (Daily)	Paired samples t-test Wilcoxon signed rank test
Pagnottoni et al. (2022)	Natural disasters occurring in 104 countries around the world	27 global stock market index, GDP growth, financial development index	08.02.2001 -31.12.2019 (Daily)	Seemingly Unrelated Regression (SUR) model
Say & Doğan (2023)	Kahramanmaraş earthquake of 06.02.202	BIST 30 companies	16.01.2023-03.03.2023 (Daily)	One sample t-test

When the above studies are evaluated, the effects of earthquakes on both stock market index returns and volatility have been studied. In addition, studies on the stock market indices, especially on the insurance sector, are intense. Comprehensive studies covering many different sectors have not been found in the literature.

3. METHODOLOGY

In the study, the effect of the Kahramanmaraş/Türkiye earthquake of February 06, 2023, on selected BIST sectoral index returns was analyzed by the event study method. The event study method is used to examine any event's effect on returns. Using selected BIST sectoral index data in the examinations, statistical significance, t statistics and calculated probability values were used to determine whether abnormal returns were obtained on a sectoral basis during the earthquake period.

In order to determine the tests to be applied in the analysis, first of all, the typical distribution characteristics of the data should be examined. Accordingly, parametric methods are used for the variables showing normal distribution, and non-parametric methods are used for variables that do not. In this study, since the data belonging to the same variable will be compared by dividing it into sub-periods before and after the earthquake, test methods suitable for "two related variables" are applied in the study. In this context, Paired Samples t-Test, which is a parametric test, and the Wilcoxon Signed Rank Test, which is the non-parametric equivalent of this test, were used.

As it is known, Paired Samples t-Test is applied to measure the mean of a variable observed in two different situations and to understand whether there is a statistically significant difference between these measurements. The hypotheses of the related test are shown below (Güriş & Astar, 2014: 205):

H_0: $\mu_1 = \mu_2$ (There is no significant difference between the means)

H_1: $\mu_1 \neq \mu_2$ (There is a significant difference between the means)

If the p-value obtained in the above test method is less than the previously accepted alpha value (0.05), the H_0 hypothesis is rejected (Baştürk, 2010: 122); the alternative hypothesis is accepted. According to this, it is concluded that there is a significant difference between the means.

On the other hand, Wilcoxon Signed Rank Test is applied to measure the medians of a variable observed in two different situations and to understand whether there is a statistically significant difference between these measurements. This test converts the values into two periods to rank and compare the "values" instead of the "means". Then, it is tested whether there is a difference in the values for these two time periods (Demirgil, 2009: 104). The hypotheses of the related test are shown below:

H_0: $M_1 = M_2$ (There is no significant difference between the medians)

H_1: $M_1 \neq M_2$ (There is a significant difference between the medians)

As a result of the Wilcoxon Signed Rank Test, Z value and Asymp. Sig. (2-tailed) values, which indicate the level of significance, are obtained. Accordingly, in cases where the significance level is less than or equal to 0.05, it is concluded that there is a statistically significant difference between the two corresponding values. Otherwise, if the significance level is more significant than 0.05, it is understood that there is no statistically significant difference between the two corresponding values (Demirgil, 2009: 106).

4. DATASET AND DESCRIPTIVE STATISTICS

In the study, daily data covering the period of 30.11.2022-19.04.2023 belonging to 18 sectors in the BIST share markets were used.[1] In addition, the study is carried out on the basis of two equal sub-periods, pre-earthquake and post-earthquake. For the study, the daily closing price series obtained from the Eikon Datastream database were first converted into daily return series with the help of $Ln(P_t/P_{t-1})$ formula. In order to analyze the effects of the earthquake in the near term and at the same time to have statistically sufficient data for analysis, 48 data in each sub-period were included in the analysis. In the financial markets, quicker reactions can be given to any new event, and accordingly, faster data can be obtained compared to macroeconomic data. Therefore, in this study, data on stocks are analyzed. In addition, Scholtens & Voorhorst (2013) state that stock markets are generally accepted as seismographs of the economy and the business world, although they do not provide very precise information on the assessment of the impact of earthquakes.

[1] The full list of BIST sectoral indices included in the study is in Appendix A with their index codes.

Tables 2 and 3 show descriptive statistics for each of the 18 BIST sectoral indices included in the analysis. In addition, since the normality test results are important in determining the methods to be applied in the study, the normality test results are shown side by side in Table 4, pre-earthquake and post-earthquake.

Table 2. Descriptive Statistics of BIST Sectoral Indices (Pre-Earthquake)

	Index Codes	Mean	Median	Max.	Min.	Std. Dev.	Skew.	Kurto.	Obs.
1	**XBANK**	-0.0011	-0.0033	0.0983	-0.0920	0.0389	0.2662	3.3876	48
2	**XBLSM**	-0.0045	-0.0020	0.0560	-0.0769	0.0255	-0.3629	3.5700	48
3	**XELKT**	-0.0054	-0.0048	0.0420	-0.0820	0.0259	-0.4412	3.3073	48
4	**XGIDA**	-0.0020	0.0022	0.0506	-0.0741	0.0268	-0.4388	3.1606	48
5	**XGMYO**	-0.0004	0.0007	0.0475	-0.0788	0.0279	-0.5786	3.5454	48
6	**XHOLD**	0.0003	0.0028	0.0604	-0.0734	0.0270	-0.5139	3.3597	48
7	**XILTM**	0.0028	0.0030	0.0995	-0.0763	0.0387	0.0909	2.6840	48
8	**XKMYA**	-0.0008	0.0012	0.0697	-0.0619	0.0279	0.1243	2.6384	48
9	**XMADN**	0.0068	0.0005	0.0948	-0.0967	0.0460	-0.0013	2.5262	48
10	**XMANA**	-0.0007	0.0039	0.0724	-0.0747	0.0278	-0.0665	3.3686	48
11	**XMESY**	0.0024	0.0064	0.0591	-0.0618	0.0278	-0.4447	3.0563	48
12	**XSGRT**	-0.0008	-0.0010	0.0723	-0.0874	0.0300	-0.1724	3.8332	48
13	**XSPOR**	0.0011	0.0040	0.0678	-0.0830	0.0291	-0.3535	3.6470	48
14	**XTAST**	-0.0008	0.0032	0.0512	-0.0763	0.0270	-0.3702	3.0439	48
15	**XTEKS**	-0.0014	0.0022	0.0602	-0.0767	0.0303	-0.2842	2.8813	48
16	**XTRZM**	-0.0046	0.0022	0.0512	-0.0827	0.0278	-0.4968	3.0097	48
17	**XULAS**	0.0043	-0.0021	0.0761	-0.0633	0.0333	0.2205	2.5913	48
18	**XYORT**	-0.0013	0.0035	0.0374	-0.0603	0.0246	-0.4632	2.5056	48

Table 3. Descriptive Statistics of BIST Sectoral Indices (Post-Earthquake)

	Index Codes	Mean	Median	Max.	Min.	Std. Dev.	Skew.	Kurto.	Obs.
1	**XBANK**	0.0034	-0.0007	0.0996	-0.0829	0.0324	0.7862	4.8919	48
2	**XBLSM**	-0.0008	0.0010	0.0853	-0.0858	0.0240	-0.2503	8.0066	48
3	**XELKT**	-0.0003	-0.0027	0.0868	-0.0829	0.0270	0.2265	5.1967	48
4	**XGIDA**	0.0016	0.0041	0.0940	-0.0807	0.0250	0.0751	7.6063	48
5	**XGMYO**	-0.0005	-0.0025	0.0842	-0.0820	0.0260	0.3093	5.7676	48
6	**XHOLD**	0.0011	-0.0038	0.0970	-0.0867	0.0269	0.4626	6.7390	48
7	**XILTM**	0.0002	-0.0011	0.0999	-0.0998	0.0338	-0.0623	4.3874	48
8	**XKMYA**	-0.0011	-0.0019	0.0990	-0.0952	0.0296	0.2368	5.9571	48
9	**XMADN**	-0.0008	-0.0006	0.0999	-0.0715	0.0335	0.6353	4.4039	48
10	**XMANA**	0.0001	-0.0016	0.0951	-0.0770	0.0311	0.6036	5.1061	48
11	**XMESY**	0.0023	0.0015	0.0972	-0.0892	0.0245	0.1075	9.7010	48
12	**XSGRT**	-0.0007	-0.0019	0.0427	-0.0696	0.0181	-0.7501	6.7407	48
13	**XSPOR**	0.0004	0.0027	0.0430	-0.0986	0.0247	-1.2909	6.8835	48
14	**XTAST**	0.0054	-0.0047	0.0927	-0.0621	0.0401	0.5879	2.8537	48
15	**XTEKS**	0.0008	0.0006	0.0858	-0.0805	0.0234	0.3538	7.9305	48
16	**XTRZM**	-0.0007	-0.0006	0.0605	-0.0545	0.0209	-0.0277	4.0425	48
17	**XULAS**	-0.0008	-0.0041	0.0991	-0.0926	0.0295	0.4745	5.9756	48
18	**XYORT**	0.0010	0.0035	0.0890	-0.0856	0.0263	-0.1204	6.3243	48

When Table 2 and Table 3 are evaluated together, the most striking feature is that the post-earthquake kurtosis values of the relevant sectors are considerably higher than pre-earthquake. Accordingly, post-earthquake, the sectoral index values became flatter than the normal distribution. Table 4 shows the Jarque-Bera normality test results of BIST sectoral index returns. In the research, the results of the same index are shown side by side, since it will be evaluated together whether there are significant differences between the pre-earthquake and post-earthquake returns in the relevant sectors. According to these results, if the pre- and post-earthquake normality test results of any index show that the series are normally distributed, the parametric test method is preferred for the analysis, and if any normality test result shows that there is no normality distribution, the non-parametric test method is preferred.

Table 4. Normality Test Results of BIST Sectoral Index Returns

	Index Codes	Pre-earthquake Returns		Post-earthquake Returns	
		Jarque-Bera	Probability	Jarque-Bera	Probability
1	XBANK	0.86745	**0.64809**	12.10349	0.00235
2	XBLSM	1.70327	**0.42672**	50.63422	0.00000
3	XELKT	1.74581	**0.41774**	10.06158	0.00653
4	XGIDA	1.59171	**0.45119**	42.48173	0.00000
5	XGMYO	3.27273	**0.19469**	16.08387	0.00032
6	XHOLD	2.37170	**0.30549**	29.67239	0.00000
7	XILTM	0.26589	**0.87551**	3.88094	**0.14364**
8	XKMYA	0.38505	**0.82487**	17.93724	0.00013
9	XMADN	0.44907	**0.79889**	7.17033	0.02773
10	XMANA	0.30702	**0.85769**	11.78662	0.00276
11	XMESY	1.58871	**0.45187**	89.90000	0.00000
12	XSGRT	1.62630	**0.44346**	32.48813	0.00000
13	XSPOR	1.83706	**0.39911**	43.49583	0.00000
14	XTAST	1.10035	**0.57685**	2.80756	**0.24567**
15	XTEKS	0.67437	**0.71378**	49.62082	0.00000
16	XTRZM	1.97493	**0.37252**	2.17964	**0.33628**
17	XULAS	0.72317	**0.69657**	19.50900	0.00006
18	XYORT	2.20522	**0.33200**	22.21743	0.00002

Note: Probability values of normally distributed series are written in bold.

According to the Jarque-Bera normality test results, both pre- and post-earthquake probability values of XILTM, XTAST and XTRZM indices are greater than 0.05, and the probability value for at least one of the other indices is less than 0.05.

5. FINDINGS AND DISCUSSION

As explained above, according to the Jarque-Bera normality test results, since both the pre- and post-earthquake probability values of the XILTM, XTAST and XTRZM indices are greater than 0.05, a parametric method, Paired Samples t-Test, will be applied in the analysis of these three indices. Non-parametric Wilcoxon Signed Rank Test will be applied in the analysis of the other fifteen indices. Table 5 shows the Paired Samples' t-Test results. However, first of all, the hypotheses tested with this test are included.

H_0: $\mu_1 = \mu_2$ (There is no significant difference between the pre-earthquake and post-earthquake returns means)

H_1: $\mu_1 \neq \mu_2$ (There is a significant difference between the pre- and post-earthquake return means.)

Table 5. Paired Samples t-Test Results

Index Codes	Mean	Std. Dev.	S. E. Mean	95% Confidence Interval of the Differ.		t	df	Sig. (2-tailed)
				Lower	Upper			
XILTM	0.0026	0.0557	0.0080	-0.0136	0.0188	0.320	47	0.750
XTAST	-0.0062	0.0494	0.0071	-0.0205	0.0081	-0.870	47	0.389
XTRZM	-0.0039	0.0372	0.0054	-0.0147	0.0069	-0.726	47	0.471

According to the Paired Samples t-Test results in Table 5, since the sig. (2-tailed) value is greater than 0.05 in the 95% confidence interval, the H_0 hypothesis (there is no difference between the means) is accepted and the alternative hypothesis is rejected. Accordingly, no statistically significant difference was found between the pre-earthquake and post-earthquake average returns of the XILTM, XTAST and XTRZM sector indices. Table 6 shows the non-parametric Wilcoxon Signed Rank Test results applied when both series do not exhibit normal distribution pre-earthquake and post- earthquake. However, first of all, the hypotheses tested with this test are included.

H_0: $M_1 = M_2$ (There is no significant difference between the pre- and post-earthquake return medians)

H_1: $M_1 \neq M_2$ (There is a significant difference between the pre- and post-earthquake return medians)

Table 6. Wilcoxon Signed Rank Test Results

	Index Codes	Z	Asymp. Sig. (2-tailed)
1	**XBANK**	-0.349[a]	0.727
2	**XBLSM**	-0.892[a]	0.372
3	**XELKT**	-1.292[a]	0.196
4	**XGIDA**	-0.841[a]	0.400
5	**XGMYO**	-0.174[a]	0.862
6	**XHOLD**	-0.154[b]	0.878
7	**XKMYA**	-0.051[b]	0.959
8	**XMADN**	-0.964[b]	0.335
9	**XMANA**	-0.051[a]	0.959
10	**XMESY**	-0.051[a]	0.959
11	**XSGRT**	-0.103[a]	0.918
12	**XSPOR**	-0.123[b]	0.902
13	**XTEKS**	-0.544[a]	0.587
14	**XULAS**	-0.328[b]	0.743
15	**XYORT**	-0.523[a]	0.601

Note: a; based on negative ranks, b; based on positive ranks.

According to the Wilcoxon Signed Rank Test results in Table 6, since the sig. (2-tailed) values in the 95% confidence interval are greater than 0.05 in all sector indices, the H_0 hypothesis (there is no difference between the medians) is accepted and the alternative hypothesis is rejected. Accordingly, no statistically significant difference was found between the pre-earthquake and post-earthquake medians of all sector indices in Table 6.

The findings show that, in the case of investing in BIST sectoral indices, abnormal returns cannot be obtained depending on the earthquake event. In the Kahramanmaraş/Türkiye earthquake of February 06, 2023 within the scope of this study, although the transactions in BIST continued between 06-07 February 2023 by the BIST management, they were closed for five trading days between 8-14 February 2023. This situation may cause the initial panic effect of the earthquake to disappear. In addition, it can be stated that BIST sectoral indices are an efficient market in a semi-strong form.

The findings of this study are consistent with Shelor et al. (1990) (for real estate sectors in other parts of California), Lee et al. (2007), Worthington (2008), Ferreira and Karali (2015), Yıldırım and Alola (2020) (for short-term results) findings.

6. CONCLUSION AND EVALUATION

Natural disasters have economic, financial, social, political, and psychological effects etc. in many ways. The aim of this study is to examine the effects of two earthquakes in Kahramanmaraş/Türkiye on February 06, 2023 on Borsa Istanbul (BIST) stock markets on a sectoral basis. In this context, it is investigated whether there is a statistically significant difference between sectoral stock returns before and after the earthquake. In the study, the effect of the earthquake in question on the returns of 18 BIST sectoral indexes was analyzed with the event study method, Paired Samples t-Test, which is a parametric test, and Wilcoxon Signed Rank Test, which is the non-parametric equivalent of this test, were used.

According to the findings obtained as a result of the analysis; no statistically significant difference was found between the pre-earthquake and post-earthquake returns of BIST sector indices. The findings show that, in the case of investing in BIST sectoral indices, abnormal returns cannot be obtained depending on the earthquake event. Accordingly, it can be stated that BIST sectoral indices are an efficient market in a semi-strong form. According to the result obtained, the importance of the measures taken by BIST management is also seen here. According to these results, it is possible to re-evaluate the measures that can be taken to protect investors in extraordinary situations such as earthquakes.

The procedures to be applied for earthquakes and similar extraordinary situations should be determined in advance by BIST management. The fact that Turkey is an earthquake zone should be taken into account in all areas and necessary policies should be determined in other areas as well. Investors should consider appropriate

diversification opportunities in their investments accordingly. Investors should be conscious of diversification, especially in investments based on certain regional indices such as city indices.

In this study, researches were carried out on a sectoral basis. However, in future studies, it will be possible to conduct research on city indices, which are among the BIST share indices. In particular, two of the mentioned indices (Adana and Kayseri share indices) are in the earthquake zone. In addition, other indices such as indices, indicator indices, and participation indices belonging to other sectors that are not included in the scope of this study will be discussed in future studies. The effects of different natural events can be compared by including natural events that took place in previous years. Finally, the impact of natural disasters, only the impact on other countries that have a relationship with the country where the natural disaster occurred, can also be examined.

AUTHORS' DECLARATION

This paper complies with Research and Publication Ethics, has no conflict of interest to declare, and has received no financial support.

AUTHORS' CONTRIBUTIONS

Conceptualization, writing-original draft, editing – HTA and VK, data collection, methodology, formal analysis – HTK, Final Approval and Accountability – HTK and VK

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APPENDIX

Appendix 1. BIST Sectors Included in the Analysis

	CODE	BIST SECTORAL INDEX NAME
1	XBANK	BIST BANKS
2	XBLSM	BIST INF. TECHNOLOGY
3	XELKT	BIST ELECTRICITY
4	XGIDA	BIST FOOD BEVERAGE
5	XGMYO	BIST REAL EST. INV. TRUSTS
6	XHOLD	BIST HOLD. AND INVESTMENT
7	XILTM	BIST TELECOMMUNICATION
8	XKMYA	BIST CHEM. PETROL PLASTIC
9	XMADN	BIST MINING
10	XMANA	BIST BASIC METAL
11	XMESY	BIST METAL PRODUCTS MACH.
12	XSGRT	BIST INSURANCE
13	XSPOR	BIST SPORTS
14	XTAST	BIST NONMETAL MIN. PRODUCT
15	XTEKS	BIST TEXTILE LEATHER
16	XTRZM	BIST TOURISM
17	XULAS	BIST TRANSPORTATION
18	XYORT	BIST INVESTMENT TRUSTS