Research Article

Vulnerability of Stock Markets to Earthquakes / The 7.7 and 7.6 Scale Earthquakes in Turkey in 2023: Sectors of Non-Metallic Mineral Products, Basic Metals and Construction & Infrastructure

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Abstract: This study aims to reveal whether stock markets are vulnerable to the effects of earthquakes and how they are affected by earthquakes. The 7.7 and 7.6 magnitude earthquakes in Turkey in February 2023 were explored. The impact of the earthquake on Borsa Istanbul was analyzed with the event study method, specific to non-metallic mineral products, basic metals, and construction & infrastructure sectors. Firstly, the paired-samples T-Test and the Wilcoxon Signed Ranks Test were used to evaluate whether there was a difference that was statistically significant in the cumulative abnormal returns (CARs) of the sector-specific indexes in the 5, 10, 15, 20, 25, 30, 35-, 40-, 45- and 50-hour time periods prior to and following the earthquake first occurred. The first results indicate that for all evaluated time intervals, the first occurred earthquake had positive effects on the CARs of the non-metallic mineral products and base metals sector indices and negative effects on the construction & infrastructure sector indices. Secondly, the effects of both the first and second earthquakes were analyzed with the Seemingly Unrelated Regressions (SUR) Model. According to the SUR Model analysis, the direction of the effects of the first earthquake is consistent with the first findings. In this model, the direction of the effects of the second earthquake is also compatible with the direction of the effects of the first earthquake, but the size and trend of the consequences of these earthquakes change over time. The findings are expected to contribute to the literature by shedding light on how sectors can respond to catastrophes like earthquakes occurrences at the micro level.

Keywords: Earthquake, Stock Market, Non-Metallic Mineral Products, Basic Metals, Construction and Infrastructure
Jel Codes: G1, G11, Q5

Atıf: Hamurcu Ç. (2023). Vulnerability of Stock Markets to Earthquakes / The 7.7 and 7.6 Scale Earthquakes in Turkey in 2023: Sectors of Non-Metallic Mineral Products, Basic Metals and Construction & Infrastructure. *Politik Ekonomik Kuram*, *7*(2), 370-381. https://doi.org/10.30586/pek.1359526

Geliş Tarihi: 13.09.2023
Kabul Tarihi: 09.10.2023

Hisse Senedi Piyasalarının Depremlere Karşı Kırılganlığı / Türkiye'de 2023 Yılında Meydana Gelen 7.7 ve 7.6 Ölçekli Depremler: Taş Toprak, Metal Ana, İnşaat ve Bayındırlık İşleri Sektörleri

Öz: Bu çalışma, borsaların deprem etkilerine karşı kırılgan olup olmadığını ve depremden nasıl etkilendiklerini ortaya çıkarmayı amaçlamaktadır. Bu amaçla Türkiye'de Şubat 2023'te meydana gelen 7,7 ve 7,6 büyüklüğündeki depremler araştırılmıştır. Depremin Borsa İstanbul'a etkisi, taş toprak, metal ana, inşaat ve bayındırlık işleri sektörleri özelinde olay çalışması yöntemiyle analiz edilmiştir. İlk olarak, sektörlere özgü endekslerin ilk depremden önceki ve sonraki 5, 10, 15, 20, 25, 30, 35, 40, 45 ve 50 saatlik zaman periyodlarındaki kümülatif anormal getirileri arasında istatistiksel olarak anlamlı bir fark olup olmadığını değerlendirmek için Eşleştirilmiş Örneklem T Testi ve Wilcoxon İşaretli Sıralar Testi uygulanmıştır. Sonuçlar, ilk meydana gelen depremin ele alınan tüm zaman aralıklarında taş toprak ve metal ana sektörü endekslerini olumlu, inşaat ve bayındırlık işleri endeksini ise olumsuz etkilediğini göstermektedir. İkinci olarak hem birinci hem de ikinci depremlerin etkileri Görünüşte İlişkisiz Regresyonlar (SUR) Modeli ile de analiz edilmiştir. SUR Modeli analizine göre, ilk depremin etkilerinin yönü ilk bulgularımızla tutarlıdır. Bu modele ait sonuçlar, ikinci depremin etkilerinin yönünün birinci deprem ile uyumlu olduğunu gösterirken, etkilerin büyüklüğünün ve

eğiliminin zamanla değişmekte olduğunu ortaya koymaktadır. Bulguların, sektörlerin deprem gibi felaketlere mikro düzeyde nasıl tepki verebileceğine ışık tutarak literatüre katkı sağlaması beklenmektedir.

Anahtar Kelimeler: Deprem, Borsa, Taş Toprak, Metal Ana, İnşaat ve Bayındırlık İşleri
Jel Kodları: G1, G11, Q5

1. Introduction

On February 6, 2023, at 04:17 and 13:24 Turkish time, two earthquakes of magnitude 7.7 and 7.6 MW struck Pazarcık (Kahramanmaraş) and Elbistan (Kahramanmaraş) in Turkey. The first earthquake was 8.6 kilometers deep, and the second was 7 kilometers deep (AFAD, 2023). These earthquakes devastated Adana, Adıyaman, Diyarbakır, Elazığ, Gaziantep, Hatay, Kahramanmaraş, Kilis, Malatya, Osmaniye, and Şanlıurfa.

The fact that the two earthquakes under consideration occurred at very close time intervals and the magnitude of their destructiveness makes it very important to understand the effects of such a disaster. The purpose of this study is to determine whether stock markets are susceptible to earthquake damage and how earthquakes affect them. The magnitude 7.7 and 7.6 earthquakes that struck Turkey in February 2023 were investigated for this purpose.

During the period of the study, the sector indices that showed a high rise in terms of monthly returns were examined and it was observed that the indices of the Non-Metallic Mineral Products and Basic Metals sectors were distinguished from the other indices and brought the highest earnings. In addition, it has been concluded that it is important to consider the Construction and Infrastructure sector, which is thought to be closely related to these sectors and produces with the outputs of these sectors. For these purposes, Non-Metallic Mineral Products, Basic Metals and Construction and Infrastructure sectors were examined.

The iron and steel sub-sector (Basic Metals sectors) provides the majority of the inputs for the building manufacturing sector, while the share of non-metallic mineral products tends to grow with time and the inputs of wood and wood products are significantly declining (Gundes, 2011). The nonmetallic mineral product account for the majority of the world's global material use. In particular, sand, gravel, clay, lime, and gypsum are essential to produce cement and bricks, which are used in residential, commercial, and industrial buildings, as well as on roads, bridges, and railway lines (Miatto, et al., 2017).

Three unique study hypotheses were developed in accordance with the information provided above.

H1: Non-Metallic Mineral Products sector is positively affected by the earthquake.
H2: Basic Metals sector is positively affected by the earthquake.
H3: Construction and Infrastructure sector is negatively affected by the earthquake.

It is intended that this research would add to the literature in terms of the chosen sectors and the examination of the events from a micro viewpoint, which is uncommon in previous studies.

The use of hourly data at the level of micro event windows, which allows short-term effects to be seen instead of daily data, which is also important for the stock market, and the use of a method by analyzing this data scale are the original aspects of the study.

The fundamental components of the study are explained in the first section, significant studies in the literature regarding the subject matter are covered in the second section, and the method used in the study and the variables are explained in the third and fourth sections respectively. The findings are provided in the fifth section, and a thorough

discussion and conclusions are attempted to be presented in the sixth and seventh sections.

2. Literature Review

Shan and Gong (2012) examined the influence of investor sentiment on the return of stocks in the aftermath of the Wenchuan Earthquake in China. They discovered that in the 12 months following the earthquake, the stock returns of enterprises with headquarters closer to the epicenter were much lower than those further away. According to the study, this result cannot be explained by genuine economic losses or changes in systematic risk, but rather by the combination of local bias and investor emotion.

2013's M7.0 Lushan Earthquake was the subject of Tao's (2014) study of its early economic effects. The findings demonstrate that abnormal returns from the entire Chinese stock market, nine traditional sectors, and regional stocks are not significant at the 0.01 level in the succeeding ten days.

Ferreira and Karali (2015) investigated the effect that significant earthquakes had on the returns and volatility of total stock market indices throughout the course of thirty-five financial markets. One of the study's findings, which is that even small earthquakes can create shocks, is that financial markets around the world are resilient to them. This research, which also examines the 7.6-magnitude earthquake that struck Turkey in 1999, reveals that increased trade openness makes South Korea and Turkey more vulnerable to earthquakes while reducing the negative effects they have on Malaysian stock markets.

The effects of the 2011 Van, 1999 Marmara, and 1998 Ceyhan earthquakes on the stock returns of insurance, banking, non-metallic mineral products, and real estate investment trusts sector companies traded in Borsa Istanbul were examined by Yılmaz and Karan (2015). The findings indicate that the non-metallic mineral products sector was positively impacted by both the Van and Marmara earthquakes, while the insurance, banking, stone-land, and real estate investment trusts sectors only experienced negative abnormal returns as a result of the Marmara earthquake.

In their study, Valizadeh, Karali and Ferreira (2017) examined the short- and long-term effects of the 2011 earthquake in Japan on the returns of 19 stock market sectors in Japan and its trading partners. The results demonstrate that the effects of the earthquake were not limited to Japan or the sectors that were directly impacted, that the short-term effects of the earthquake in Japan were primarily negative while some sectors experienced positive effects, that the effects of the earthquake on abnormal returns did not differ systematically across trading partners, and that the long-term effects of the earthquake are demonstrated how it emerged after the date of the event.

In the 2011 sample of the Tohoku Earthquake off the Pacific Coast, different levels of short-term response from the entire market to individual stocks were examined in a study conducted by Tao, Han, Song, and Bai (2019). In the sectoral sense, it was concluded in this study that the directly and secondarily destroyed sectors reacted negatively, the negative reactions of the lightly damaged ones could be restored within 3-5 days, and only the construction sector gave a positive reaction.

A research study has been conducted on the impact of the 2011 Great East Japan Earthquake (GEJE), which is described as the most significant disruptive event for global supply chains, on the financial performance of companies (Hendricks, Jacobs, and Singhal, 2020). The article's conclusion states that firms suffering from GEJE-related supply chain disruptions lost value one month after the event, with the impact on Japanese firms being bigger than it was on non-Japanese firms.

The effects of the Kahramanmaraş earthquake, which is the subject of our study, on BIST 30 specifically were examined by Servet and Doğan (2023). The study shares the findings that there are positive abnormal returns on the event day and the first day after the event, negative abnormal returns on the second day, and that this effect cannot be detected after the third day.

Akkuş and Kışlalıoğlu (2023), in their study examining the effects of the Kahramanmaraş earthquake on BIST Sectoral indices between 30.11.2022 and 19.04.2023, state that there is no statistically significant difference between the returns of BIST sector indices before and after the earthquake.

In the study (Kırkağaç and Karpuz, 2023) investigating the impact of the Kahramanmaraş earthquakes on the stock returns of banks and insurance companies traded in BIST bank and insurance indices, it was determined that there were significant decreases in the cumulative abnormal returns of the examined companies, and although these decreases later trended upwards, the effects were negative.

The study by Kanat and Tetik (2023) researched how the earthquake on February 6, 2023, affected Borsa Istanbul. The findings indicate that there was no cumulative abnormal loss, that only the day after the earthquake and on February 15 had abnormal losses, and that the damages were avoided by the actions implemented.

Cilek and Ergun (2023) investigated the effects of the earthquakes that occurred in Kahramanmaraş on 6-7 February 2023 on the BIST 100 and Banking indexes. It is concluded that the Kahramanmaraş Earthquake was effective in causing the BIST 100 index and the banking index to fall during the earthquake dates.

3. Method

In this study, the case study method developed by Fama et al. (1969) is used. This method is used to measure the price reactions of securities to news, announcements, or unexpected events. It is based on the efficient market hypothesis (Fama, 1970; MacKinlay, 1997), which has the thesis that stock prices always contain and reflect all relevant information, and that prices are quickly adjusted to reflect the effects of unexpected events. In order to evaluate the effect of an event, it is necessary to calculate the differences between the returns of the examined asset and the returns of a basic reference market index, and the differences calculated in this method are expressed as abnormal returns (AR). The sum of the AR values calculated for the considered time period gives the cumulative abnormal return (CAR). The calculation steps are specified in the equations below.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

$$\varepsilon_{it} = R_{it} - \alpha_i - \beta_i R_{mt} \quad (2)$$

$$AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt} \quad (3)$$

$$CAR_{it} = \sum_{t1}^{t2} AR_{it} \quad (4)$$

R_{it}: It is the daily return of the stock market price index for sector i (P_{it})

$$(R_{it} = \ln\left(\frac{P_{it}}{P_{(i,t-1)}}\right))$$

R_{mt}: It is the daily return of the reference stock market price index (P_{mt})

$$(R_{mt} = \ln\left(\frac{P_{mt}}{P_{(m,t-1)}}\right))$$

α_i: It is regression coefficient of the daily return of stock market price index for sector i

β_i: It is regression coefficient of the daily return of the stock market price index

ε_{it}: It is the error term

AR_{it}: It is abnormal return of the daily return of the stock market price index for sector i

CAR_{it}: It is cumulative abnormal return of the daily return of the stock market price index for sector i

The impact of the earthquake on Borsa Istanbul was analyzed with the event study method, specific to non-metallic mineral products, basic metals, and construction and infrastructure sectors. In the study, the analysis data was created by using the hourly values in the 50-hour time interval in which the examined indices were traded in BIST, before and after the earthquake first occurred. In order to apply both parametric and non-parametric methods to variables, the paired-samples T-Test and The Wilcoxon Signed Ranks Test was performed to evaluate whether the cumulative abnormal returns (CAR) of the sector-specific indices differed statistically in the 5, 10, 15, 20, 25, 30, 35, and 50 hour time periods prior to and following the earthquake date. BIST100 is taken as the reference stock market price index. CAR values were calculated based on the occurrence time of the first earthquake.

In addition to all these analyzes, a regression-based event study approach was applied by adding the dummy variable as component (5) to the equation (1) in order to determine how the CAR values changed compared to before and after the event time. In this seemingly unrelated regression (SUR) model that heteroscedasticity and contemporaneous correlations are taken into consideration (Binder, 1985), the dummy variable (d_{it}) is defined as 1 for the event time and after, and 0 for before. CAR values of sector returns are tried to be modeled as a function of the dummy variable in the time interval examined in equation (6).

$$\sum_{t1}^{t2} \gamma_{it}\, d_{it} \qquad (5)$$

$$CAR_{it} = \sum_{t1}^{t2} \gamma_{it} \qquad (6)$$

γ_i: It is the AR on sector i's index on day t during the event window.

In this part of the analysis, both the first and the second earthquake are included in the model as dummy variables. In this case, equation (7) is formed from equation (6).

$$CAR_{it} = \sum_{t1}^{t2} \gamma_{i1t} + \sum_{t1}^{t2} \gamma_{i2t} \qquad (7)$$

Linear regression analysis was applied by determining the first and second earthquakes as independent variables and CAR evaluated in the first part of the analysis as the dependent variable. The dummy variables coefficients and their p-values are obtained for the cumulative abnormal returns (CARs) equations established according to equation (7) which based on out-of-the-ordinary return assessments from a model of regression that seems irrelevant.

4. Variables of the Study

In this study, Non-Metallic Mineral Products, Basic Metals and Construction and Infrastructure sectors in Borsa Istanbul (BIST, Istanbul Stock Exchange) were examined and BIST 100 index was used as a reference index to reflect the general trends of the stock market for analysis. Table 1 demonstrates some significant characteristics of the variables of the study.

Table 1. Characteristics of the Variables

Variables	Non-Metallic Mineral Products (BIST, 2023a)	Basic Metals (BIST, 2023b)	Construction And Infrastructure (BIST, 2023c)	Indicator Index (BIST, 2023d)
Index Name	BIST Nonmetal Min. Product	BIST Basic Metal	BIST Construction	BIST 100
Index Code	XTAST	XMANA	XINSA	XU100
Number of Constituents	19	24	12	100
Total Market Value, TRY	174,088,237,311.99	354,999,773,611.32	204,570,135,152.45	4,029,117,150,011.65
Weighted Free Float Market Value, TRY	47,904,485,322.68	128,792,710,730.56	31,177,365,138.92	1,271,792,680,356.59
Number of Investors (1/31/2023)	377,864	975,534	401,687	2,893,873

According to Table 1, the Basic Metals sector with 24 Constituents has the highest value among the three sectors examined in terms of Total Market Value, followed by the

Non-Metallic Mineral Products sector with 19 Constituents. In terms of the total number of investors, it is understood from the table that the Basic Metals sector has the highest number of investors, followed by the Construction and Infrastructure sector. The data of the variables were obtained from İŞ Investment web page (İŞ INVESTMENT, 2023).

5. Empirical Findings

The basic descriptive statistics of sector indices which are based on the prices of stocks of companies operating in the sectors subject to the study and traded in Borsa Istanbul, and BIST100 index are given in Table 2.

Table 2. Descriptive Statistics of Variables

	XTAST	XMANA	XINSA	BIST100
Mean	5159.232	11762.490	6471.354	4915.178
Median	4910.245	11607.610	6475.490	4943.190
Maximum	6453.760	13173.390	6995.620	5311.350
Minimum	4335.890	10754.200	5909.930	4493.500
Std. Dev.	642.940	639.599	262.948	170.162
Skewness	0.779	0.671	-0.035	-0.396
Kurtosis	2.241	2.419	2.270	2.799
Jarque-Bera	12.517	8.915	2.240	2.782
Probability	0.002	0.012	0.326	0.249
Sum	515923	1176249	647135	491518
Sum Sq. Dev.	40923851	40499555	6845020	2866543
Observations	100	100	100	100

Table 2 shows that the XTAST ranges from 6453.760 to 4335.890, with a mean value of 5159.232. The data also reveals that the XINSA index has a mean value of 6471.354 and a variation of 5909.930 to 6995.620, while the XMANA index has a mean value of 11762.490 and a range of 10754.200 to 13173.390. The minimum and maximum values of BIST100 index are 4493.500 and 5311.350 respectively and the mean value is 4915.178.

On examining the Skewness values for the variables in Table 2, it can be observed that XTAST and XMANA are right-skewed, while BIST100 and XINSA are left-skewed because they are smaller than zero. Examining the table's kurtosis values reveals that XTAST, XMANA, XINSA, and BIST are platykurtic (flatter than a normal distribution). Table 2's probability values show that the variables XTAST and XMANA do not have a normal distribution ($p<.10$), whereas XINSA and BIST100 have ($p>.10$).

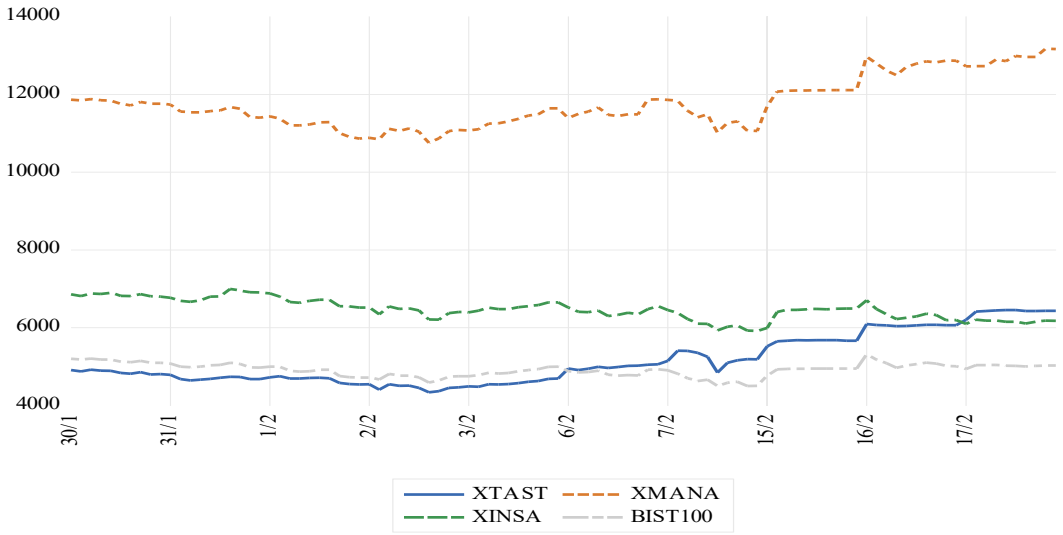

Figure 1. Graphs of Hourly Values of Indices

In Figure 1, the hourly values of the indices analyzed before and after the earthquake first occurred in the 50-hour period in which they were traded in BIST are shown. It is significant that the XTAST sector index began to rise immediately following the earthquake first occurred and has since continued to do so. It can be seen that following the earthquake first occurred, the XMANA sector index tended to move upward, whereas the XINSA sector index and BIST100 tended to trend downward.

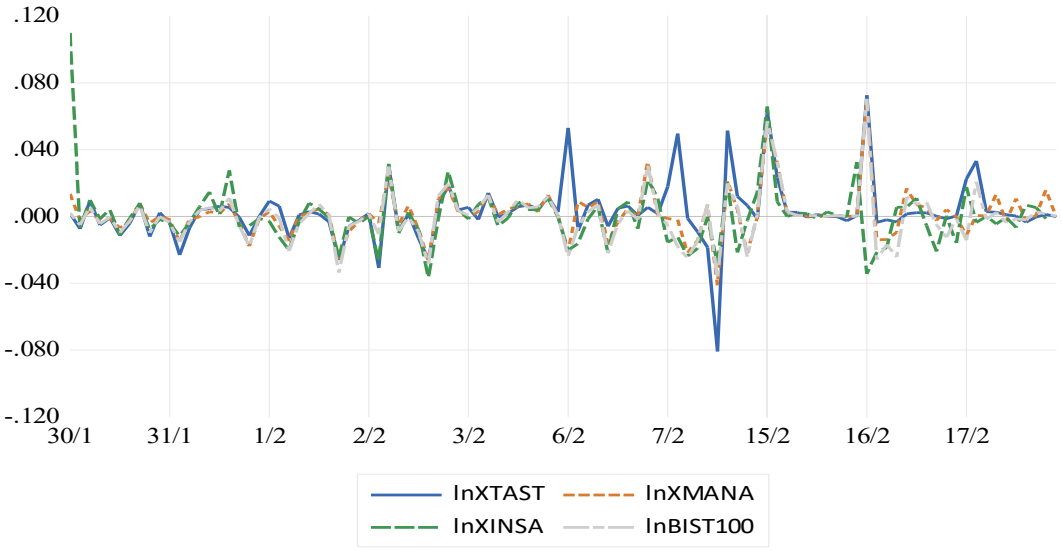

Figure 2. Graphs of Logarithmic Return Values of Indices

The graph obtained from the hourly logarithmic return values of the indices is given in Figure 2. It is understood from Figure 2 that the returns of the indices of the XTAST, XMANA and XINSA, which were mostly consistent with the BIST100 index before the earthquake first occurred, differed after the earthquake. In Figure 2, the positive differentiation in the XTAST index is seen more clearly compared to other indices.

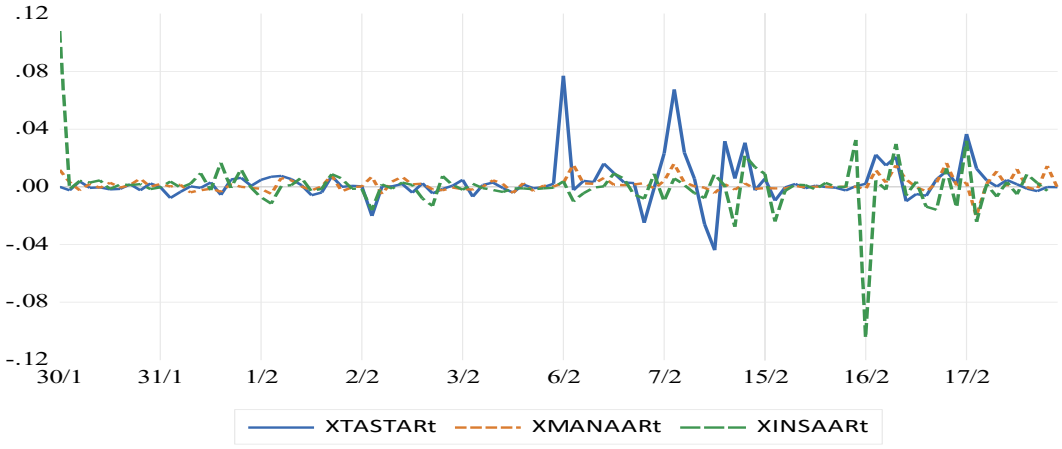

Figure 3. Graphs of Abnormal Return Values of Indices

The graph derived using the hourly abnormal return values of the index values is depicted in Figure 3. It is clearly seen from Figure 3 that the CAR values of the sector indices were affected by the earthquake first occurred. This effect is mostly above the vertical axis and positive for the XTAST and XMANA sector indices, and below the vertical axis and negative for the XINSA.

Table 3. Cumulative Abnormal Returns (CARs)

	XTAST			XMANA			XINSA		
Event Windows (hours)	Mean	p Paired Samples Test	p Wilcoxon Signed Ranks Test	Mean	p Paired Samples Test	p Wilcoxon Signed Ranks Test	Mean	p Paired Samples Test	p Wilcoxon Signed Ranks Test
(-5, 0)	**-0.003**	0.000	0.043	**-0.004**	0.013	0.043	**-0.004**	0.012	0.043
(0, +5)	**0.080**			**0.014**			**-0.013**		
(-10, 0)	**0.000**	0.000	0.005	**-0.001**	0.000	0.005	**-0.007**	0.003	0.005
(0, +10)	**0.091**			**0.024**			**-0.018**		
(-15, 0)	**-0.007**	0.000	0.001	**-0.001**	0.000	0.001	**-0.015**	0.000	0.001
(0, +15)	**0.112**			**0.032**			**-0.031**		
(-20, 0)	**-0.022**	0.000	0.000	**0.010**	0.000	0.000	**-0.026**	0.000	0.000
(0, +20)	**0.110**			**0.049**			**-0.046**		
(-25, 0)	**-0.020**	0.000	0.000	**0.010**	0.000	0.000	**-0.013**	0.000	0.000
(0, +25)	**0.121**			**0.053**			**-0.042**		
(-30, 0)	**0.008**	0.000	0.000	**0.012**	0.000	0.000	**-0.023**	0.000	0.000
(0, +30)	**0.155**			**0.059**			**-0.054**		
(-35, 0)	**0.015**	0.000	0.000	**0.006**	0.000	0.000	**0.004**	0.000	0.000
(0, +35)	**0.176**			**0.058**			**-0.036**		
(-40, 0)	**0.002**	0.000	0.000	**0.003**	0.000	0.000	**0.016**	0.000	0.000
(0, +40)	**0.173**			**0.060**			**-0.028**		
(-45, 0)	**0.000**	0.000	0.000	**0.011**	0.000	0.000	**0.016**	0.000	0.000
(0, +45)	**0.186**			**0.074**			**-0.032**		
(-50, 0)	**0.000**	0.000	0.000	**0.024**	0.000	0.000	**0.132**	0.000	0.000
(0, +50)	**0.198**			**0.093**			**0.080**		

Note: The numbers written in bold indicate the mean values that were found to be significant.

Estimated mean values and significance results of dependent sample t-test and Wilcoxon sign rank test applied to cumulative abnormal returns of XTAST, XMANA and XINSA sector indices before and after the event in 5, 10, 15, 20, 25, 30, 35, 40, 45 and 50 hour periods are given in Table 3. CAR values in this table were calculated based on the occurrence time of the first earthquake. Table 3 shows that there are 1% ($p<0.01$) and 5% ($p<0.05$) significant differences between pre-event and post-event cumulative abnormal returns for all time periods of both tests of all three sector indices. It is understood that there is compatibility between the dependent sample t-test and Wilcoxon sign rank test results.

According to Table 3, post-event mean values of cumulative abnormal returns for XTAST and XMANA sector indices increased compared to pre-event, but the opposite situation occurs in XINSA sector index and post-event mean values decreased compared to pre-event.

Table 4. Seemingly Unrelated Regressions (SUR) Model Cumulative Abnormal Returns (CARs)

	XTAST				XMANA				XINSA			
	1st Earthquake		2nd Earthquake		1st Earthquake		2nd Earthquake		1st Earthquake		2nd Earthquake	
Event Windows (hours)	γ_1	p	γ_2	p	γ_1	p	γ_2	p	γ_1	p	γ_2	p
(-5, +5)	**0.083**	0.000	-	-	**0.018**	0.003	-	-	**-0.009**	0.015	-	-
(-10, +10)	**0.082**	0.000	**0.019**	0.001	**0.018**	0.000	**0.014**	0.000	**-0.013**	0.000	0.005	0.160
(-15, +15)	**0.081**	0.000	**0.057**	0.001	**0.017**	0.000	**0.024**	0.000	**-0.016**	0.000	0.001	0.715
(-20, +20)	**0.079**	0.000	**0.070**	0.000	**0.019**	0.000	**0.027**	0.000	**-0.020**	0.000	-0.001	0.877
(-25, +25)	**0.075**	0.000	**0.082**	0.000	**0.021**	0.000	**0.028**	0.000	**-0.024**	0.000	-0.005	0.377
(-30, +30)	**0.073**	0.000	**0.089**	0.000	**0.023**	0.000	**0.029**	0.000	**-0.026**	0.000	-0.006	0.291
(-35, +35)	**0.075**	0.000	**0.099**	0.000	**0.025**	0.000	**0.032**	0.000	**-0.028**	0.001	**-0.014**	0.086
(-40, +40)	**0.077**	0.000	**0.109**	0.000	**0.025**	0.000	**0.037**	0.000	**-0.026**	0.006	**-0.021**	0.028
(-45, +45)	**0.077**	0.000	**0.123**	0.000	**0.026**	0.000	**0.041**	0.000	**-0.024**	0.022	**-0.027**	0.011
(-50, +50)	**0.077**	0.000	**0.135**	0.000	**0.027**	0.002	**0.047**	0.000	**-0.022**	0.052	**-0.033**	0.005

Note: The numbers written in bold indicate the coefficients that were found to be significant.

In this part of the analysis, both the first and second earthquakes are included in the established model. When the results of the XTAST sector index in Table 4 are examined, it is determined that only the first earthquake has a positive effect, since the second earthquake has not yet occurred in the first 5-hour period. It is seen that both earthquakes have positive effects after 10 hours and the positive effects of the first earthquake tend to decrease over time up to 40 hours, while the positive effects of the second earthquake tend to increase. Although the effects of the first earthquake increased by 0.002 after 40 hours, it is seen that this effect did not change afterwards. It is understood from Table 4 that the effects of the second earthquake persisted in the time intervals of 25 hours and after, by getting ahead of the first earthquake.

Examining the sector index XMANA's outcomes in Table 4, only the first earthquake has a positive impact because the second earthquake has not yet happened during the first five hours. It can be observed that the positive effects of both earthquakes are still being observed at 10 hours and beyond, and that at 15 hours and after, the effects of the second earthquake outweigh those of the first earthquake.

When the XINSA sector index data from Table 4 are analyzed, it is determined that only the first earthquake has negative effects in the time intervals up to 35 hours and these negative effects increase over time. It is understood that after 35 hours, the negative effect of the first earthquake continues to increase, and in addition, the negative effects of the second earthquake come into play and these negative effects continue to increase.

6. Discussion

As a result of the comparison of CAR values in different event windows, it is understood that negative market reaction existed for the Construction and Infrastructure sector after the earthquake first occurred, while positive reactions for the Non-Metallic Mineral Products and Basic Metals sectors. It is seen from the analysis results that the earthquake-affected aspects of the sector indices continue in the same way in the examined time intervals. It is thought that the reasons for this situation are the continuing uncertainty regarding the damages in the examined time period and the continuation of new earthquake occurrences and aftershocks.

According to SUR Model analysis, it has been determined that the direction of the effects of the first earthquake is consistent with the previous findings and the direction of the effects of the second earthquake is also compatible with the direction of the effects of the first earthquake, but there are differences in the magnitude and trend of the effects of both earthquakes over time. For Non-Metallic Mineral Products sector, both earthquakes have positive effects and the positive effects of the first earthquake tend to decrease over time, while the positive effects of the second earthquake tend to increase. For Basic Metals sector, both earthquakes have positive effects, and the positive effects of both earthquakes tend to increase over time. For Construction and Infrastructure sector, only the first earthquake has negative effects in the time intervals up to 35 hours and these negative effects increase over time; after 35 hours after the first earthquake, the negative effect of the first earthquake continues to increase, the negative effects of the second earthquake come into play and continue to increase. The findings obtained support the established hypotheses.

It is among the possible explanations that the construction & infrastructure sector companies may have some negligence, non-compliance with the laws and standards in the damage and destruction that occur. For these reasons, it comes to mind that construction & infrastructure sector companies can be held responsible for these events, and that sector companies may have obligations related to these responsibilities. It is thought that these issues, which came to the fore with the earthquakes, may have reduced confidence in the sector. As a result of these effects, it can be considered among the reasons for the results obtained that a negative perception may have occurred in terms of investors

regarding the sector and this perception may have been reflected negatively on investor behaviors.

There is a need for reconstruction for destruction and demolitions that occur after the earthquake. It is anticipated that the Non-Metallic Mineral Products and Basic Metals sectors will provide the majority of the input needed to complete the necessary activities to meet this need. From the perspective of the investor, this circumstance may be viewed as a possible buying opportunity because it will enhance the demand for the products produced by these industries and raise the stock prices on the stock market. It comes to mind that as a result of the impact-reaction and need-demand processes that may have been perceived by the investor as above, the positive effects obtained in the analysis results for the Non-Metallic Mineral Products and Basic Metals sectors may have occurred.

According to Yılmaz and Karan's (2015) research, the Van and Marmara earthquakes had a positive impact on the non-metallic mineral products industry, while the Marmara earthquake had a negative impact only on the insurance, banking, stone-land, and real estate investment partnerships industries. The findings of the study on the non-metallic mineral products industry are compatible with the findings obtained in this study in terms of the basic direction of movement.

It is understood that the studies researching the 7.7 and 7.6 Scale Earthquakes in Turkey in 2023 revealed a variety of results. Among these studies, the sectoral effects of the earthquake were examined in the sector group, including the XMANA and XTAST sectors, which are among the sectors examined in our study (Akkuş and Kışlalıoğlu, 2023); it is shared that there is no statistically significant difference between the pre-earthquake and post-earthquake returns of XMANA and XTAST sector indices. The outcome is not consistent with the findings of this research.

The lack of similar studies in the literature in which both the sectoral indices examined and the micro event window method, which is the way in which the effects of the earthquake on these indices are handled, are discussed together; makes it difficult to evaluate the full compatibility of the findings with the literature. Therefore, the differences that this study shows in terms of its qualities clearly demonstrate both the originality of the study and the importance of conducting more such research.

7. Conclusion

In particular, the 7.7 and 7.6 magnitude earthquakes that devastated Turkey in February 2023 are the primary objective of this study, which intends to shed light on whether stock markets are vulnerable to earthquake effects and how they are affected by them. Revealing the effects of a large and destructive earthquake of this scale is important in understanding the effects of natural disasters.

The use of hourly data at the level of micro event windows, which allows the short-term effects that are important for the stock market to be seen in the study; and the use of a method to analyze the effects of the earthquake at the sectoral level through this data set; are considered as the strengths and original aspects of the study.

Earthquakes create positive effects in the Non-Metallic Mineral Products and Base Metals sectors, but these effects are negative in the construction and Infrastructure sector in the micro-scale-based time interval examined in terms of CARs.

The study's findings are expected to contribute to the literature by shedding light on how non-metallic mineral products, basic metals, and the construction and infrastructure sectors can respond to catastrophes like earthquakes occurrences at the micro level.

It is thought that limiting the effects of the earthquake to certain sectors due to the scope of the study may create a constraint in evaluating the wider effects of the earthquake. In addition, the fact that the time interval considered is limited due to the study design again creates a limitation in terms of revealing the effects in a longer time period. New studies that will be designed with these considerations in mind will help to better understand the effects of the earthquake.

References

AFAD (Disaster and Emergency Management Presidency Authority) (2023). 06 February 2023 Preliminary Assessment Report on Pazarcık (Kahramanmaraş) MW 7.7, Elbistan (Kahramanmaraş) MW 7.6 Earthquake. 9 Şubat 2023. https://deprem.afad.gov.tr/assets/pdf/Kahramanmaras%20%20Depremleri_%20On%20Degerlendirme%20Raporu.pdf. (Accessed: 19.02.2023).

Akkuş, H. T. & Kışlalıoğlu, V. (2023). Investigating the Effects of Natural Disasters on the Stock Market on a Sectoral Basis: The Case of 2023 Kahramanmaraş/Türkiye Earthquake. *International Journal of Business and Economic Studies*, *5*(2), 141-151. https://doi.org/10.54821/uiecd.1296562

BIST (2023a). BIST Nonmetal Min. Product. https://borsaistanbul.com/en/index-detail/198/bist-nonmetal-min.-product. (Accessed: 19.02.2023).

BIST (2023b). BIST Basic Metal. https://borsaistanbul.com/en/index-detail/180/bist-basic-metal. (Accessed: 19.02.2023).

BIST (2023c). BIST Construction. https://borsaistanbul.com/en/index-detail/228/bist-construction. (Accessed: 19.02.2023).

BIST (2023d). BIST 100. https://borsaistanbul.com/en/index-detail/1000/bist-100. (Accessed: 19.02.2023).

Binder, J. J. (1985). On The Use Of The Multivariate Regression Model İn Event Studies. *Journal of Accounting Research*, 370-383. https://doi.org/10.2307/2490925.

Cılek, A. and Ergün, M. (2023). The Impact Of The 2023 Kahramanmaraş Earthquake On BIST 100 And BIST Bank Index: Evıdence From Toda-Yamamoto Causalıty Test. *PressAcademia Procedia*, *17*(1) , 92-100 . DOI: 10.17261/Pressacademia.2023.1760.

Fama, E. F. (1970). Efficient Capital Markets: A Review Of Theory And Empirical Work. *The Journal of Finance*, *25*(2), 383-417. https://doi.org/10.2307/2325486.

Fama, E. F., Fisher, L., Jensen, M. C., and Roll, R. (1969). The Adjustment Of Stock Prices To New Information. *International Economic Review*, *10*(1), 1-21. https://doi.org/10.2307/2525569.

Ferreira S, Karali B. (2015) Do Earthquakes Shake Stock Markets? *PLoS ONE*, *10*(7), e0133319. https://doi.org/10.1371/journal.pone.0133319.

Gundes, S. (2011). Exploring The Dynamics Of The Turkish Construction Industry Using Input–Output Analysis. *Construction Management And Economics*, *29*(1), 59-68. https://doi.org/10.1080/01446193.2010.529925.

Hendricks, K. B., Jacobs, B. W., and Singhal, V. R. (2020). Stock Market Reaction To Supply Chain Disruptions From The 2011 Great East Japan Earthquake. *Manufacturing & Service Operations Management*, *22*(4), 683-699. https://doi.org/10.1287/msom.2019.0777.

İş Investment (2023). Indexes. https://www.isyatirim.com.tr/en-us/analysis/stocks/Pages/indexes.aspx. (Accessed: 19.02.2023)

Kanat, E., & Tetik, N. (2023). 6 Şubat 2023 Kahramanmaraş Merkezli Depremlerin Bist (Borsa İstanbul) Üzerindeki Etkileri. *Kahramanmaraş Merkezli Depremler Sonrası için Akademik Öneriler*. Özgür Yayın Dağıtım. 113-122.

Kırkağaç, M., and Karpuz, E. (2023). 2023 Kahramanmaraş Depremlerinin BIST Banka ve Sigorta Piyasasına Etkisi Üzerine Bir Olay Çalışması Analizi. *Kırıkkale Üniversitesi Sosyal Bilimler Dergisi*, *13*(2), 387-401. Retrieved from https://dergipark.org.tr/en/pub/kusbd/issue/79236/1292504.

MacKinlay, A. C. (1997). Event Studies In Economics And Finance. *Journal Of Economic Literature*, *35*(1), 13-39. http://www.jstor.org/stable/2729691.

Miatto, A., Schandl, H., Fishman, T., and Tanikawa, H. (2017). Global Patterns And Trends For Non-Metallic Minerals Used For Construction. *Journal of Industrial Ecology*, 21(4), 924-937. https://doi.org/10.1111/jiec.12471.

Shan, L., and Gong, S. X. (2012). Investor Sentiment And Stock Returns: Wenchuan Earthquake. *Finance Research* Letters, *9*(1), 36-47. https://doi.org/10.1016/j.frl.2011.07.002.

Tao, Z. (2014). Short-Term Economic Effect Of The M7.0 Lushan Earthquake. *Natural hazards*, *70*, 1247-1261. https://doi.org/10.1007/s11069-013-0871-z.

Tao, Z., Han, L., Song, Y., and Bai, K. (2019). Stock Market Reactions To The 2011 Off The Pacific Coast of Tohoku Earthquake. *International Journal of Disaster Risk Reduction*, 41, 101294. https://doi.org/10.1016/j.ijdrr.2019.101294.

Valizadeh, P., Karali, B., and Ferreira, S. (2017). Ripple Effects Of The 2011 Japan Earthquake On International Stock Markets. *Research in International Business and Finance, 41*, 556-576. https://doi.org/10.1016/j.ribaf.2017.05.002.

Yılmaz, F. A., and Karan, M. B. (2015). Detection Of The Sectoral Effects Of The Greatest Earthquakes In Turkey On Borsa İstanbul/Türkiye'deki Büyük Depremlerin Borsa İstanbul'da Sektörel Etkisinin Test Edilmesi. *Journal of Insurance Research/Sigorta Arastirmalari Dergisi*, *11*, 3-21.

Çıkar Çatışması: Yoktur.

Finansal Destek: Yoktur.

Etik Onay: Yoktur.

Yazar Katkısı: Çağrı HAMURCU (%100)

Conflict of Interest: None

Funding: None

Ethical Approval: None.

Author Contributions: Çağrı HAMURCU (100%)