

## Do Earthquakes Affect Stock Market Index ?

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### Abstract

*While environmental challenges are being significantly linked with natural disaster such as the earthquake, other implications such as the financial market implication are being almost overlooked. The relationship between natural disasters and financial markets is an important situation for investors and markets. Hence the current study examines the shock impact of earthquake on the stock index of the Republic of Turkey over the period of 2000M2 to 2017M12. While the exchange rate and the global economic policy uncertainty (GEPU) were incorporated in the autoregressive distributed lag (ARDL) model, significant statistical inference that are relevant for policy suggestions were observed. The study found that there is a dynamic impact of earthquake and exchange rate on the Turkish index. Also, while the impact of earthquake is statistically not significant in the short-run, the long-run impact of earthquake, GEPU and exchange rate are all statistically significant and negative. Generally, the study posits a valuable policy direction to government and other related stakeholders.*

**Keywords:** Earthquake, Stock Index, Uncertainty, Republic of Turkey

## Depremler Borsa Endeksini Etkiler Mi?

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### Öz

Çevresel zorluklar deprem gibi doğal afetlerle önemli ölçüde bağlantılı olmakla birlikte, finansal piyasalarda neden olduğu sonuçlar neredeyse göz ardı edilmektedir. Doğal afetler ile finansal piyasalar arasındaki ilişki yatırımcılar ve piyasalar için önemli bir durumdur. Bu nedenle, söz konusu çalışma 2000/2 - 2017/12 döneminde depremin Türkiye'deki hisse senedi endeksi üzerindeki şok etkisini incelemektedir. Diğer yandan çalışmada, döviz kuru ve küresel ekonomi politikası belirsizliği (GEPÜ) otoregresif dağıtılmış gecikme (ARDL) modeline dahil edilirken, politika önerileri ile ilgili önemli istatistiksel çıkarım gözlenmiştir. Elde edilen bulgular ise deprem ve döviz kurunun Türkiye endeksi üzerinde dinamik bir etkisi olduğu yönündedir. Ayrıca, deprem etkisi kısa vadede istatistiksel olarak anlamlı olmasa da, deprem, GEPÜ ve döviz kurunun uzun dönemli etkisi istatistiksel olarak anlamlı ve negatif yönlü olduğu yönündedir. Genel olarak, çalışma hükümete ve diğer ilgili paydaşlara değerli bir politika yönelimi ortaya koymaktadır.

**Anahtar Kelimeler:** Deprem, Borsa Endeksi, Belirsizlik, Türkiye Cumhuriyeti

## Introduction

The global financial market for instance has vastly developed such that the understudying of the transmission of risk from associated shocks has become inevitable. Although the desire for cleaner environment and economic sustainable across the globe has further encouraged investigation into the causes of environmental degradation that incorporates a wholistic conceptual perspectives. The causes of environmental pollution has largely been associated with the impact of global warming resulting from the global dynamics of the greenhouse gasses (GhGs). As such, due to economic expansion and other major human economic activities, the world leading economies like the United States and China have consistently emerged the leading emitters of GhGs (Alola, 2019a&b; Saint Akadiri, Alola, Akadiri and Alola, 2019).

In retrospect, environmental degradation through the emissions of pollutant gasses into the atmosphere has been strongly linked with earthquake occurrences (Uprety et al, 2015; Zhou, Chen & Cui, 2016; Qi, Song, Peng and Li, 2019). For instance, several sources of air pollution such as the urbanization and population explosion is being associated with the Kathmandu Valley of Nepal (Uprety et al, 2015). These causes of high pollution risk especially in this Kathmandu Valley has also been significantly linked with the increasing consumption of the fossil fuel energy. However, the 7.8 Richter scale magnitude of earthquake that struck the large areas of the country in 2015 and that was attributed to the huge destruction is also being associated with air pollution within a significant area of the country. In the same vein, the financial implication of the impact of earthquake especially in the disaster-prone area is not likely to go unnoticed.

In view of the above motivation, the current study is targeted at investigating the impact of earthquake and exchange rate on the stock index of the Republic of Turkey. In doing, the study employs the Global economic policy uncertainty (GEPU) as an additional variable and as well considered the experimented (monthly) period of 2000M2 to 2017M12. Because no existing study have investigated the financial implication of earthquake on the stock index in Turkey especially within the current framework, therefore the current study is billed to make significant contribution to the related literature.

The remaining sections are presented as follow. An overview of the extant literature is discussed in section 2. Data description and methods are presented in section 3 while the results are discussed in section 4, it also contains the concluding remarks of the study.

## **Literature Review**

In this section, since there are not enough studies in the literature to test the relationship between earthquakes and financial indicators, studies investigating the effects of economic, political and social factors on stock market indices will be included.

Fifield et al. (2002) tested the impact of global and local economic factors on the stock market. The results obtained from the data of 13 emerging market countries in the period of 1987-1996 showed that the countries' GDP, interest rates and inflation rates, and world inflation and industrial production rates had a significant effect on the stock returns of developing countries.

Koutmos and Martin (2003) tested the effect of exchange rate fluctuations on stock returns, and their findings suggest that exchange rate fluctuations affect stock returns asymmetrically. Hassan et al. (2003) tested the impact of financial, political and economic data on stock market fluctuations and yield estimates by using data from 1984 to 1999 of 10 different Asian and African countries. As a result of the findings, it was found that these variables had a significant effect on stock fluctuations and yield estimates.

Mateus (2004) concluded that financial, economic and political risks have a significant and negative effect on stock returns.

Engle and Rangel (2004) tested the fluctuations in the stock markets of 50 developing and developed countries. The results showed that low growth rate and high inflation rates caused fluctuations in stock markets and this fluctuation was higher in developing countries.

Zügül and Sahin (2009), a study conducted in Turkey between tuff with positive Stock Exchange, the M1 money supply, has reached a negative relationship with the exchange rate and interest rate.

Sirucek (2012), Dow Jones and S & P500 indices showed a positive relationship with inflation and a negative relationship with inflation. While S & P500 had a positive relationship with the interest rate, it was found that the DJI index was in negative relation with the interest rate.

In the study conducted for Bekhet and Mugableh (2012), Malaysia, macroeconomic indicators such as M3, PPI, ER and CPI in the long run negatively affected SMI, while GDP variable was positively affected. In the short run, macroeconomic variables such as PPI, GDP and ER negatively affect SMI, while M3 and CPI variables affect the SMI variable positively.

Kaya, Çömlekçi ve Kara (2013), industrial production index, exchange rate, money supply and market interest rate, as well as macroeconomic variables were tested in relation to the BIST100 index. As a result of the multiple linear regression model applied, no significant relationship was found between stock returns and industrial production index and interest rates. However, there was a negative relationship between money supply and stock returns with positive USD / TRY and BIST100.

Mutuku and Ngeny (2014), in their study on the Kenya Stock Exchange, examined the relationship between stock prices, exchange rate, consumer price index, GDP growth and treasury debt ratio. Findings; While the variables such as exchange rate and treasury debt ratio and GDP are affected positively by the stock prices, the consumer price index affects the stock prices negatively.

Lehkonen and Heimonen (2015) tested the impact of variables such as democracy and political risk on stock returns. In the study, 49 developing countries data covering the period of 2000-2012 were used and the findings showed that the decrease in political risk caused high yields in the stock exchange.

Prathan et al. (2015) stated that in the study conducted for G-20 countries, there was no significant relationship between oil prices, economic growth, real effective exchange rate, stock market, inflation rate and real interest rate in the long term. It has been reached.

In Tükenmez and Kutay (2016) study, the findings are that the increase in economic, political and financial risks negatively affect stock prices.

In the Sadeghzadeh and Elmas (2018) study, the findings obtained were found to be the consumer confidence index, VIX fear index and BIST transaction amount, which have the most impact on stock returns in the BIST index.

In the study of Eyüboğlu and Eyüboğlu (2018), the relationship between Borsa İstanbul sector indices and exchange rates with the ARDL model tested. Findings indicate that there is a relationship between Euro exchange rate and BIST Textile and Leather index, while Dollar exchange rate shows

that there is a long term relationship between BIST Textile, Leather, Trade and Technology indices.

In the study of Akdağ and Yıldırım (2019), the relationship between the dollar exchange rate and the selected Turkish sector indices was tested. Findings have a causality from positive and negative shocks in dollar exchange rates to positive and negative shocks in both BIST Industry and BIST Finance index.

In the study of Akdağ, Yıldırım and Kesebir (2019), the effect of geopolitical risk factor on stock market indices was tested. As a result of panel data analysis applied for twelve different countries, it was found that increases in geopolitical risk indices caused decreases in stock market indices.

## **Data Set and Methodology**

In this section, information is given about the data set and the econometric models used to test the long term relationship among the monthly earthquake number, GEPU and XGMYO index.

### ***Data Set***

The current study examines the shock impact of earthquake on the stock index of the Republic of Turkey over the period of 2000M2 to 2017M12. While the exchange rate and the global economic policy uncertainty (GEPU) were incorporated in the autoregressive distributed lag (ARDL) model, significant statistical inference that are relevant for policy suggestions were observed.

Data pertaining to the number of earthquakes per month were obtained from <http://www.koeri.boun.edu.tr> and the monthly real estate investment index, USD/TRY and GEPU was obtained from [www.investing.com.tr](http://www.investing.com.tr).

### ***Methodology and Findings***

In this section, explanations about the ARDL test and its assumptions will be given.

**Stability Analysis:** When applying time series analysis, it is important to test stability. Most of the time series using macroeconomic data are non-stationary and include trends. The use of non-stationary time series leads to incorrect findings in econometric analysis. In this study, extended Dickey-Fuller (ADF) and test were used to investigate stationary stability. The statistical results obtained from the tests were compared with the critical values of MacKinnon (1996) and determined according to the established hypothesis.

**Table 1. ADF Unit Root Test**

Level I(0)				
	Index	Earthquake	GEPU	USD/TRY
Intercept	-1.424314	-0.986972	-4.365282*	0.886387
Intercept&Trend	-3.140499	-3.115823	-5.348185*	-0.308633
1st Difference I(1)				
	Index	Earthquake	GEPU	USD/TRY
Intercept	-14.74963*	-6.275910*	-12.37300*	-12.63826*
Intercept&Trend	-14.72633*	-6.304732*	-12.34278*	-12.68945*

\*It shows that it is stationary at 5% significance level.

H0: The series is not stationary. (Series contains at least one-unit root)

H1: Serial is stationary. (Serial unit does not contain root)

The unit root test results of the variables selected in Table 1 are shown. The results of the ADF test for the index, earthquake and USD / TRY variables show that each variable contains unit roots at a level value and is not stable. In this case, the hypothesis H0 cannot be rejected. However, it was found that the variables did not contain I (1) unit roots and were stationary. However, according to the results of the ADP test of the GEPU variable, the hypothesis H0 is rejected and the series is reached at the level I (0).

**Cointegration Analysis: ARDL Boundary Test:** Cointegration is the concept that states that the variables used are in balance in the long term. The long-term equilibrium relationship between determined variables is determined by applying cointegration tests. In this study, the ARDL (Autoregressive Distributed Lag) boundary test which was developed by Pesaran et al. (1996), Pesaran and Shin (1995) and Pesaran et al.

The model for the cointegration relationship, which is the first stage of the test to be applied, is adapted to the study as shown in equation (1) (Yıldırım, 2019, p.53).

$$\Delta index = \alpha_0 + \sum_{i=0}^k \Delta \alpha_{1i} \Delta index_{t-i} + \sum_{i=1}^k \Delta \alpha_{2i} \Delta Earthquake_{t-i} + \sum_{i=0}^k \Delta \alpha_{3i} \Delta GEPU_{t-i} + \sum_{i=0}^k \Delta \alpha_{4i} \Delta USD/TRY_{t-i} + \alpha_5 \Delta index_{t-1} + \alpha_6 \Delta Earthquake_{t-1} + \alpha_7 \Delta GEPU_{t-1} + \alpha_8 \Delta USD/TRY_{t-1} + C + \varepsilon_t \quad (1)$$

In order to apply the ARDL long-term relationship test, if the results show that there is a cointegration relationship between the variables, the equation in (2) is included in the analysis(Yıldırım, 2019: 53).

$$\Delta index = \alpha_0 + \sum_{i=0}^k \Delta \alpha_{1i} \Delta index_{t-i} + \sum_{i=1}^k \Delta \alpha_{2i} \Delta Earthquake_{t-i} + \sum_{i=0}^k \Delta \alpha_{3i} \Delta GEPU_{t-i} + \sum_{i=0}^k \Delta \alpha_{4i} \Delta USD/TRY_{t-i} + C + \varepsilon_t \quad (2)$$

The first stage of the ARDL test is to test the cointegration relationship between variables. The results of ARDL's long-term cointegration relationship are given in Table 2.

**Table 2. Cointegration Test Results**

F-statistic	Range F-statistic	Lag	Cointegration Availability
7.62	4.29-5.61	8	There is Cointegration

H0:  $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$  (No cointegration relationship)

H1:  $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 = 0$  (Has a cointegration relationship)

As a result of ARDL estimation model, F-statistic was obtained as 7.62 and the value obtained was higher than 4.58 which is considered as upper limit value when compared with 4.29-561 range. Because the F-statistic value was 7.62, H1 hypothesis was accepted. In the significance level of 0.05, it is determined that there is a long term relationship between the mentioned variables and cointegration is determined.

ARDL model estimation results are needed to estimate the long-term relationship after the cointegration has reached the existence of the variables. The values of the estimation results related to ARDL (1,3,0,4) model are indicated in Table 3.



**Table 3. ARDL Model Estimation Results**

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Index(-1)	-0.009520	0.069735	-0.136519	0.8915
Earthquake	-0.000493	0.000305	-1.617634	0.1073
Earthquake(-1)	-0.000893	0.000309	-2.890678	0.0043*
Earthquake(-2)	-0.000195	0.000313	-0.622589	0.5343
Earthquake(-3)	-0.000741	0.000306	-2.425256	0.0162*
GEPU	-0.013814	0.006270	-2.203122	0.0287
USD/TRY	-14.17476	2.146563	-6.603471	0.0000*
USD/TRY (-1)	1.765537	2.362756	0.747237	0.4558
USD/TRY (-2)	3.768369	2.085302	1.807110	0.0723
USD/TRY (-3)	-2.926568	2.187800	-1.337676	0.1825
USD/TRY (-4)	4.040502	2.098254	1.925650	0.0556*
C	0.258005	0.165389	1.559985	0.1204
Glejser (3)	0.66			
Jargue Bera	2.24			
Ramsey(1)	0.41			
<b>ARDL</b>	<b>1,3,0,4</b>			

As a result of the ARDL model estimation, H1 hypothesis was rejected as a result of Glejser test. ( $P > 0.05$ ). On the other hand, the Jargue-Bera value is 2.24, indicating that the error terms are normally distributed.

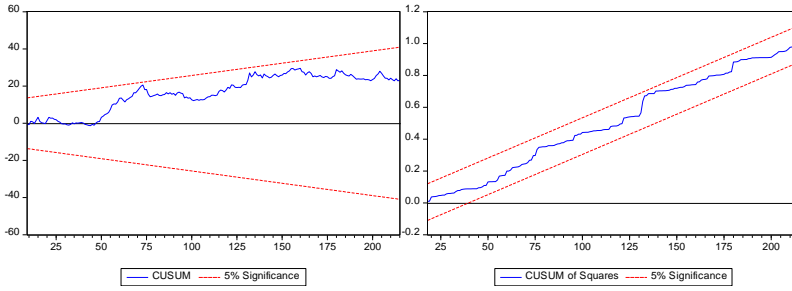
As a result of the normality test, the probability value is supported by the null hypothesis ( $p > 0.05$ ). As a result of achieving the results supporting the equal variance and normal distribution assumptions, the hypothesis that the model specification was true was not rejected by the RAMSEY test applied in the model ( $p > 0.05$ ). In this case, it is evident that there is no necessary variable not included in the model. As a result of the model, ARDL (1,3,0,4) was determined and the long-term effects of the indicators such as Earthquake, GEPU and USD / TRY on the index data were tested.

**Table 4. ARDL Long Term Forecast Result**

D.variable: Index				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
Earthquake	-0.002300	0.000851	-2.703661	0.0075*
GEPU	-0.013683	0.006237	-2.193940	0.0294**
USD/TRY	-7.455943	4.082357	-1.826382	0.0693***
C	0.255572	0.162786	1.569988	0.1180
<b>ARDL: 1,3,0,4</b>				

\*Indicates significance at 1% , \*\* at 5% and \*\*\* at 10% levels of significance, respectively

In Table 4, the results of ARDL long-term estimation results are given and the findings show that the indicators such as earthquake, GEPU and USD / TRY have a significant and negative effect on the stock market index in the long term.



*Figure 1. CUSUM and CUSUMQ Graph*

The CUSUM and CUSUMQ graphs shown in Figure 1 are graphs showing whether there is a structural break. When looking at the CUSUM and CUSUMQ charts, it is found that there is no overflow from the area where the confidence interval is determined. In this case, the long-term predictability of the model reveals the power and an artificial variable is predictable without joining the model has been found.

## Conclusion

The current study examined the impact of earthquake and uncertainty index on the Turkish stock market over the period of 2000M2 to 2017M12 by employing the ARDL approach. Considering that the environmental effect of earthquake occurrence has been investigated in previous studies, the study found that there is a dynamic impact of earthquake and exchange rate on the novelty of the current study explored the financial and stock market consequences of the earthquake disaster. Consequently, the impact of earthquake is found to be statistically not significant in the short-run. However, the long-run impact of earthquake, GEPU and exchange rate are all statistically significant and negative, thus implying relevant policy implications.

On policy direction, the Turkish stock market can be further internationalized such that the impact of earthquake and other unforeseen natural

shocks on the market performance can be minimized. The listing of the Turkish companies and the Turkish stock market in the international stock market such as the New York Stock Exchange (NYSE) could be further encouraged.

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