IMPACT OF MAJOR GLOBAL EVENTS ON THE TURKISH STOCK MARKET EFFICIENCY

Ceyda AKTAN[1]

Citation: Aktan, C. (2022). Impact of major global events on the Turkish stock market efficiency. *Hitit Journal of Social Sciences, 15*(2), 613-627. doi: 10.17218/hititsbd.1207180

Abstract: Market efficiency is of great importance to many investors, policy makers, as well as researchers. It provides them with information regarding the market and acts as a guide in their decision-making process. For this reason, there have been extensive amount of research done through the years. However, the World has witnessed several major events in the last couple of decades, which has been of great importance for financial markets, having both direct and indirect impacts. The Global Financial Crisis of 2008 and the COVID-19 pandemic can be the two most important events the World has experienced. Although past research shows that the impact of both events on the efficiency of the stock markets were looked at in separate studies, there is lack of studies involving both major events and analysing how the efficiency of the stock market is changing between these periods. The aim of this study is to analyse the weak-form efficiency of the Turkish stock market and how it has evolved over time. There are 4 different data sets used to observe the changes in market efficiency, with full sample ranging from February 1988 to September 2022. Monthly closing prices of the BIST100 Index are analysed using both the traditional linear Augmented Dickey-Fuller unit root test and 5 different non-linear unit root tests. Results show that different tests have different strengths in capturing the stationarity and due to the LNV test Turkish Stock Market was found not to be weak form efficient.

Keywords: *Market efficiency, unit root tests, BIST100, stationarity, global events*

Büyük Küresel Olayların Türkiye Hisse Senedi Piyasasının Etkinliği Üzerindeki Etkisi

Atıf: Aktan, C. (2022). Büyük küresel olayların Türkiye hisse senedi piyasasının etkinliği üzerindeki etkisi. *Hitit Sosyal Bilimler Dergisi, 15*(2), 613-627. doi:10.17218/hititsbd.1207180

Özet: Piyasa etkinliği, birçok yatırımcı, politika yapıcı ve araştırmacı için büyük önem taşımaktadır. Onlara piyasa hakkında bilgi sağlar ve karar verme süreçlerinde yol gösterici olur. Bu nedenle yıllar boyunca çok sayıda araştırma yapılmıştır. Bununla birlikte, Dünya, son yıllarda, finansal piyasalar için büyük önem taşıyan hem doğrudan hem de dolaylı etkileri olan birçok önemli global olaya tanık oldu. 2008 Küresel Finansal Krizi ve COVID-19 salgını, Dünyanın yaşadığı önemli olaylar arasında gösterilmektedir. Geçmiş araştırmalar, her iki olayın hisse senedi piyasalarının etkinliği üzerindeki etkisinin ayrı çalışmalarda ele alındığını gösterse de hem büyük olayları içeren hem de borsa etkinliğinin bu dönemler arasında nasıl değiştiğini analiz eden çalışmalar yetersizdir. Bu çalışmanın amacı, Türk hisse senedi piyasasının zayıf formdaki etkinliğini ve zaman içinde nasıl geliştiğini analiz etmektir. Şubat 1988'den Eylül 2022'ye kadar uzanan bir gözlem aralığı kullanılarak piyasa etkinliğindeki değişiklikleri gözlemlemek için çalışmada 4 farklı veri seti bulunmaktadır. BIST100 Endeksi'nin aylık kapanış fiyatları hem geleneksel doğrusal yapıdaki Genişletilmiş Dickey-Fuller birim kök testi hem de 5 farklı doğrusal olmayan birim kök testleri kullanılarak analiz edilmiştir. Sonuçlar,

Research Article
Submitted: 19.11.2022 Accepted: 28.12.2022

[1] Asst. Prof. Dr., University of Turkish Aeronautical Association, Faculty of Business Administration Department of Management Information Systems, caktan@thk.edu.tr, http://orcid.org/0000-0001-7040-4711

farklı testlerin durağanlığı yakalamada farklı güçlere sahip olduğunu ve LNV testi ile birlikte Türkiye Hisse Senedi Piyasasının zayıf formda etkin bulunmadığını göstermektedir.

Anahtar Kelimeler: *Piyasa etkinliği, birim kök testleri, BİST100, durağanlık, küresel olaylar*

1. INTRODUCTION

Knowing whether a stock market is efficient is of great importance to many actors found within the market, and does not matter whether they are investors, policy makers, consultants, or researchers. It provides them with information regarding the market and acts as a guide in their decision-making process. A market that is considered to be informationally efficient is expected to immediately transfer all the information received to stock prices. For this reason all actors will have access to all information at the same time and at all times (Ozdemir, 2008, p.633). This situation, hence, will prevent anyone of them to obtain abnormal returns.

The idea behind market efficiency relates to the Efficient Market Hypothesis (EMH), a theory put forth in the 70s (Fama, 1970, pp.383-384). It was Fama who described the characteristics of an efficient market and referred to this efficiency in three different levels: weak, semi-strong, and strong. Weak-form market efficiency relates to past information and says that markets that are weak form efficient when all past information is reflected in stock prices. Stock prices will follow a random walk and make future prediction impossible using fundamental and technical analyses. The semi-strong form involves information from the past as well as public ones. It incorporates the weak form inside it. At its ultimate level, the market will be strong form efficient. This level includes all past, public and private information (Yucel, 2016, p.109).

It is the strong form of market efficiency is believed to have started the debate as to whether if stock markets can be fully efficient. Some studies on the topic have found evidence of efficiency but there are also an important number of studies where markets are found to be inefficient. Beliefs against the Efficient Market Hypothesis have surfaced more with the increase in behavioral finance research. Traditional finance theories, such as the EMH, are based on the assumption that people behave rational when making decisions (Aktan et al., 2019, p.981). Rationality makes a clear separation between right and wrong, and gives a clear idea about investors' movements. However, behavioral finance principles argue against this situation and explain that people are guided by their thoughts and beliefs and cannot always be rational when making decisions. These deviations from the EMH are defined as an anomaly.

Anomalies in financial markets can exist in many different forms, whether they are fundamental, technical, or calendar anomalies (Latif et al., 2011, pp.3-7). However, following the EMH studies on behavioral finance have also introduced the Overreaction Hypothesis and the Uncertain Information Hypothesis to literature (Mehdian et al., 2008, p.338). The Overreaction Hypothesis put forward by DeBondt and Thaler (1985) mentions that investors tend to overreact when they face with news of events that are either dramatic or unexpected, and, hence, cause security prices to decrease in negative news and vice versa. On the other hand, under the Uncertain Information Hypothesis, Brown et al. (1988) argues that investors, as rational beings, will set security prices below their expected values if there is any uncertainty in the market. It does not matter if the information is positive or negative, the uncertainty itself will make the market riskier. As the uncertainty is resolved, the risk will lower, and the prices will adjust back to their normal fundamental values (Brown et al., 1993, pp.101-102). Overall, it could be said that investors reactions can be expected to differ in the times of major global events, whether they are political, economic, or related to natural disasters. Past research has looked at the effects of wars and terror on stock markets (Carter and Simkins, 2004, pp.539-558; Coleman, 2012, pp.4087-4099;

Hudson and Urquhart, 2015, pp.166-177), as well as natural disasters (Ramiah, 2013, pp.383-401; Kandil Goker et al., 2020, pp.14-41), and financial crises, and found that they do affect stock prices and cause spill-over effects. Most of these studies seem to base their arguments on the EMH and the role of new information.

As seen from the number of studies interest and research on the topic seem to be growing more and more in time. However, there is still no clear view on the efficiency of stock markets or on the prices of commodity items. Differences in time periods taken for observation or the methods utilized can be the determining factor behind the differences in findings. There is especially a clear shift in the types of tests utilized, such as applying more nonlinear tests and the utilization of machine learning techniques. Therefore, by specifically focusing on key global events (2008 crisis and the pandemic) the aim of this study is to analyze the efficiency of the Turkish stock market and how it has evolved over time, but focusing on the weak form. Contribution of this analysis to existing literature is through the use of different nonlinear tests that differ in their structures, and hence, abilities to identify stationarity. Also, by utilizing a long sample period with three different sub-periods will provide insight into understanding how efficient the market in different timeframes.

The study will be presented under following headings. With Introduction to the topic being Section I, Section II will be the Literature Review, followed by the specifics of the data used and the tests applied in Section III. Results of the study will be given in Section IV and, lastly, Section V will conclude the study.

2. LITERATURE REVIEW

In the Introduction part it was mentioned that there are many studies on the topic of market efficiency. It is possible to group these studies according to the region they cover, or according to the sample markets level of economic development, or even the sample periods they cover. However, besides having a primary focus on studies involving the Turkish Stock Market, in order to investigate how market efficiency studies have evolved in time, in this study, the focus will also be on the chronological order of studies to understand if findings show certain patterns.

There are many studies conducted on the Stock Market of Turkey to understand whether it is efficient. Among these studies, when looked chronologically, there are few patterns observed. While earlier studies were seen to utilize variance ratio tests (Ozdemir, 2008, p.633), runs tests (Balaban, 1995, pp.39-40; Ozdemir, 2008, p.633; Tas and Atac, 2019, p.48), or conventional linear unit root tests (Ergul, 2009, p.108; Korkmaz and Akman, 2010, p.42; Karadagli and Donmez, 2012, pp.63-65; Cevik, 2012, p.3), more recent studies started utilizing nonlinear unit root tests (Gozbasi et al., 2014, p.381; Kilic and Bugan, 2016, p.262; Aktan et al., 2019, pp.979-980; Aliyev, 2019, p.1) to measure markets efficiency. However, as much as there is an argument against the use of linear tests because of the nonlinear nature of time series data, ADF and PP are still among the most popular unit root tests to test for stationarity.

Another argument found in literature is on the inefficiency of developing countries. It is argued that information cannot be immediately incorporated in stock prices in these countries making these markets advantageous in the eyes of investors, because they can profit more here (Karadagli and Donmez, 2012, pp.61-62). However, as shown by Aktan et al. (2019), where European stock markets were investigated under three different headings: Frontier, Emerging, and Developed, it was found that using monthly data from 06:2006 to 06:2017, besides the European Frontier countries, all others were weak form efficient. It was interesting to observe from the results that,

by using the same methodology, taking data from 01:2011 to 06:2017, the findings reversed and only Frontier markets became weak form efficient.

Korkmaz and Akman (2010) have used daily opening prices of ISE100 from 8 December 2003 to 5 June 2009 and through various unit root and co-integration tests found them to be stationary, meaning inefficient in the weak form. Results of Malcioglu and Aydin (2016) supported this finding using Harvey et al. (2008) Linearity Test. Akgun and Sahin (2017) have also utilized the conventional unit root tests to find the same result. Study by Tas and Atac (2019) shows that, by using ADF unit root test and runs tests, there were mixed results. While the ADF test results translated as the market being inefficient, results of the runs test showed exaclt opposite by showing a unit root. Kilic and Bugan (2016) and Gozbasi et al. (2014) both used unit root tests with nonlinear structure. Their results supported one another and supported EMH.

The efficiency of the Turkish Stock Market was investigated in detail through the studies conducted by Ozkan (2020a, 2020b, 2020c, 2021a, 2021b). Each of the studies focused on different set of markets and through varying tests and timeframes taken the results pointed the Turkish Stock Market having different efficiency levels which varied with time. The impact of Covid 19 on market Dynamics was unquestionable and to observe this, Ozkan (2021b) focused on stock markets of six countries: US, Spain, UK, Italy, France, and Germany, to understand how COVID-19 has impacted the efficiency of their stock markets. The wild bootstrap automatic variance ratio test was applied to daily data covering a period from 29 July 2019 through to 25 January 2021. Results of the study showed deviations from market efficiency.

Chan et al. (1997) used monthly stock indices belonging to 18 national equity markets starting from January 1961 to December 1992. Findings pointed out that all of these markets were efficient. This result was supported by the work of Narayan (2005), who investigated the efficiency of the stock markets of Australia and New Zealand using the unit root test proposed by Caner and Hansen (2001). Data was taken monthly starting from June 1964 to April 2003 for the Australian stock price index and from January 1967 to April 2003 for the New Zealand price index. Results showed that both markets were not stationarity, which supported the EMH.

Study by Kan and O'Callaghan (2007) also focused on the markets located in Asia and Australasia. By using daily data and employing various tests including cointegration tests, these markets were found to be efficient, which supported the EMH. However, Lee et al. (2010) looked at the real stock prices of 58 countries, of which 32 were developed and the remaining 26 were developing. Panel data stationarity test of Carrion – I – Silvestre et al. (2005) were utilized to find that majority of these series rejected the EMH, including Australia.

Gumus and Zeren (2014) conducted a more comprehensive investigation on the weak form efficiency, which included stock markets of 17 of the countries that are members of the G-20. Results of the Fourier ADF and Fourier KSS tests pointed out that 9 of these markets, including Australia, supported the EMH and hence were efficient.

European stock markets have also attracted the attention of investors and policy makers, making it an ideal area to conduct market efficiency research to understand whether there can be arbitrage opportunities or neglected areas in policymaking. Borges (2010) analyzed the daily closing values from 6 European stock market indices using runs tests where only the stock market of Spain and Germany were found to be efficient. Tokic et al. (2018) have utilized serial autocorrelation, unit root, runs, and variance ratio tests to investigate the stock markets of Croatia, Serbia, Slovenia, and Slovakia. Sample included daily data taken starting from 1 January

2006 to 31 December 2016. Test results showed evidence of weak form efficiency for Croatia, Slovenia, and Slovakia.

Lin et al. (2021) wanted to observe whether news on macroeconomic announcements that are scheduled to air at 08:30am have any effect on the efficiency of the United States Treasury market. Sample period ranged from 5 January 2004 to 15 December 2015 and the results showed that in the first 5 minutes before the news aired, the efficiency of the market dropped, indicating that news on macroeconomic announcements definitely had impact on the efficiency of the market.

The conflict between Russia and Ukraine had many effects on World trade, economy, as well on the well being of many people. It also impacted many stock markets around the world. Gaio et al. (2022) have analyzed the stock markets of the US, UK, Spain, Germany, France, and Italy and how their efficiency was affected by the conflict between the two countries. Data used were taken daily and altogether consisted of 4 different sample periods. From the given results is was seen that EMH was rejected and that prices could be predicted during times of uncertainty and crises.

3. DATA AND METHODOLOGY

3.1. Data

For the study, data from BIST100, which is the major index of the Turkish stock market, was used. Data was obtained from investing.com, and natural logarithms calculated to be placed in the tests. Data consists of monthly closing values of the BIST100 index. There are altogether four different periods tested, including; a full sample period covering the time between February 1988 until September 2022, and also three different sub-samples arranged to observe the effects of the Global Financial Crisis of 2008 and the novel COVID-19 pandemic. These sub- samples are provided in detail in Table 1.

Table 1. Information on Samples Used in the Study

Sample	Starting Date	Ending Date
Full Period	February 1988	September 2022
Pre – Crisis	February 1988	January 2008
From Crisis Until COVID-19	February 2008	February 2020
COVID-19 Period	March 2020	September 2022

3.2. Methodology

Behavior of stock prices is known to be asymmetric and, for this reason, tests used should include different dynamics to be able to observe stationarity. The tests used in this study will be the ADF test proposed by Dickey and Fuller (1981), which is a linear type of unit root test, as well as five different unit root tests that are non-linear. LNV test of Leybourne et al. (1998), KSS test of Kapetanios et al. (2003), Sollis test developed by Sollis (2009), OY test put forward by Omay and Yildirim (2014) and, lastly, the OEH test put forward by Omay et al. (2018). Among these tests KSS and Sollis tests can be classified as state-dependent nonlinearity tests whereas LNV is a time-dependent nonlinearity test. On the other hand, OY and OEH tests together are known as hybrid tests and combine the characteristics of time and state dependent nonlinearity tests.

In the OEH test, gradual structural breaks are expressed as below:

$$y_t = \phi(t) + u_t \quad (1)$$

In Equation (1), $\phi(t)$ denotes the deterministic nonlinear trend function where both a logistic transition as well as a Fourier function are added, and u_t denotes the deviation from the trend.

The three logistic smooth transition are given in equations 2 (a-c), which makes up the three different models.

$$y_t = \alpha_1 + \alpha_2 S_t(\gamma, \tau) + \varepsilon_t \quad (2a)$$

$$y_t = \alpha_1 + \beta_1 t + \alpha_2 S_t(\gamma, \tau) + \varepsilon_t \quad (2b)$$

$$y_t = \alpha_1 + \beta_1 t + \alpha_2 S_t(\gamma, \tau) + \beta_2 t S_t(\gamma, \tau) + \varepsilon_t \quad (2c)$$

$S_t(\gamma, \tau)$ function given in Equation (3) is the logistic smooth transition function which allows to capture a singlr structural break. The size of the sample is T and is also continuous. The value of the function falls between the limits of 0 and 1.

$$S_t(\gamma, \tau) = [1 + exp\{-\gamma(t - \tau T)\}]^{-1} \quad (3)$$

Capturing only one may cause a problem when there are more structural breaks in the series. To solve this situation a Fourier function can be applied to approximate the deterministic components. Such a function is expressed below in Equation (4):

$$\phi(t) = \alpha_0 + \delta t + \sum_{k=1}^{n} a_k \sin(\frac{2\pi k t}{T}) + \sum_{k=1}^{n} b_k \cos(\frac{2\pi k t}{T})\, u_t \qquad ; N\frac{T}{2} \quad (4)$$

where n denotes the number of cumulative frequencies, k represents frequency, and both a_i and b_i are the amplitude as well as displacement belonging to the deterministic functions sinusoidal components.

For all values of i; a traditional linear model is obtained for function seen in Equation (4) if

$a_i = b_i = 0$ condition holds.

The following asymmetric exponential smooth transition autoregressive (AESTAR) model is also found in the OEH test. It contains a logistic function and an exponential function.

$$\Delta u_t = G_t(\theta_1, u_{t-1})\{F_t(\theta_2, u_{t-1})\rho_1 + \big(1 - F_t(\theta_2, u_{t-1})\big)\rho_2\}u_{t-1} + \epsilon_t \quad (5)$$

$$G_t(\theta_1, u_{t-1}) = 1 - \exp\Big(-\theta_1(u_{t-1}^2)\Big) \qquad \theta_1 > 0 \quad (6)$$

$$F_t(\theta_2, u_{t-1}) = \big[1 + \exp\big(-\theta_2(u_{t-1})\big)\ \big]^{-1} \qquad \theta_2 > 0 \quad (7)$$

The resulting function is expressed below in Equation (8):

$$\Delta u_t = \Big[1 - exp\Big(-\theta_1(u_{t-1}^2)\Big)\Big]\Big\{\big[1 + \exp\big(-\theta_2(u_{t-1})\big)\ \big]^{-1}\rho_1 + \Big(1 - \big[1 + \exp\big(-\theta_2(u_{t-1})\big)\ \big]^{-1}\Big)\rho_2\Big\}u_{t-1} + \epsilon_t \quad (8)$$

$\epsilon_t \sim iid(0, \sigma^2)$.

Equation (5) that represents a function with an AESTAR model, expects the conditions: $\theta_1 > 0$, $\rho_1 < 0$ and $\rho_2 < 0$ to hold. However, if $\rho_1 = \rho_2$, then the adjustment towards the equilibrium becomes a symmetrical process rather than AESTAR.

The hypotheses of the model are provided below in Equations (9) and (10):

H_0: $\theta_1 = 0$ (unit root) (9)

H_1: $\theta_1 > 0$ (stationary AESTAR process) (10)

The null hypothesis, however, contains noise parameters that are unidentified. Therefore, by applying the method of Luukkonen et al. (1988), transition functions were changed with their first-order Taylor approximation, converting Equation (5) to Equation (11).

$$\Delta u_t = \varphi_1 u_{t-1}^3 + \varphi_2 u_{t-1}^4 + \omega_t \quad (11)$$

The null hypothesis becomes $H_0: \theta_1 = \theta_2 = 0$.

To make the error term serially correlated:

$$\Delta u_t = G_t(\theta_1, u_{t-1})\{F_t(\theta_2, u_{t-1})\rho_1 + \big(1 - F_t(\theta_2, u_{t-1})\big)\rho_2\}u_{t-1} + \sum_{j=1}^{p} \delta_j \Delta u_{t-j}\, \epsilon_t \quad (12)$$

$\epsilon_t \sim iid(0, \sigma^2)$.

When the transition functions are replaced the following function, where the null hypothesis is tested, is obtained:

$$\Delta u_t = \varphi_1 u_{t-1}^3 + \varphi_2 u_{t-1}^4 + \sum_{j=1}^{p} \delta_j \Delta u_{t-j} + \vartheta_t \quad (13)$$

OEH test was the most comprehensive test among the tests used in the study. However, LNV test is known as a structural break test. Models A, B, and C are also used under the LNV test. The null hypothesis belonging to the test shows that this particular series contain a unit root, but the alternative is a logistic smooth transition around a nonlinear trend.

KSS test is a state-dependent test and involves a process with an ESTAR model. Equations (2a) through to (2c) are also applied in this particular test where the size of the symmetric adjustment towards the equilibrium is modeled. The existence of a unit root is once again is shown under the null hypothesis and the alternative hypothesis is the symmetric state-dependent nonlinearity with an intercept and a deterministic term.

Sollis test was formed by extending the KSS test and, hence, involves another state-dependent nonlinearity. To investigate the asymmetric nonlinearity that is state-dependent, functions found in Equations (5), (6), and (7) are utilized. The alternative hypothesis is the AESTAR nonlinear stationarity against the null hypothesis which indicates the existence of a unit root.

Similar to the OEH test, OY test proposed by Omay and Yildirim (2014) is also a hybrid test, which is derived from the combination of the LNV and KSS unit root tests. Once again, all the 3 models are utilized in this test, and Equation (3) which involves a transition is used for a smooth structural break or a nonlinear trend.

4. RESULTS

To analyze the weak-form efficiency of the Turkish stock market and how it has evolved over time data was collected from a large timeframe starting from February 1988 until September 2022, making it a total of 416 monthly observations. From this full period three more sub-periods based on the 2008 Global Financial Crisis and the Covid – 19 pandemic. Details of these periods are provided in Table 1.

In order to understand whether the BIST100 index of the Turkish Stock Market is weak-form efficient within these identified periods, a range of unit root tests are utilized. Results obtained from the tests are given in Table 2. Absolute value of these results obtained are taken and compared to the critical values found in relevant literature: Dickey and Fuller (1981) for the ADF test, Leybourne et al. (1988) for the LNV test, Kapetanios et al. (2003) for the KSS test, Sollis (2009) for the Sollis test, Omay et al. (2018) for the OEH test, and lastly, Omay and Yildirim (2014) for analyzing the OY test.

Table 2. Results of Applied Unit Root Tests

		Tests	Models	Pre-Crisis	From Crisis Until Covid-19	Covid-19 Period	Full Period
Linear Unit Root Test		**ADF**		-2.238	-1.295	0.046	-2.371
Nonlinear Unit Root Tests	**Time-Dependent**	**LNV**	Model A	-3.161	**-4.483****	-2.113	-3.294
			Model B	-3.188	-2.748	-3.93	-4.129
			Model C	-3.922	**-4.897****	**-5.046***	**-5.842****
	State-Dependent	**KSS**	Demeaned	-1.687	-2.636	-0.090	**-2.772***
			Detrended	-1.826	-1.959	-1.739	-2.301
		Sollis	Demeaned	1.893	1.230	0.263	1.268
			Detrended	1.768	1.990	1.561	2.981
	Hybrid	**OEH**	Model A	4.467	5.670	1.473	3.743
			Model B	3.626	2.421	0.365	4.988
			Model C	4.565	5.356	2.785	7.589
		OY	Model A	-2.532	-2.065	-1.433	-2.396
			Model B	-2.433	-2.173	-1.758	-2.974
			Model C	-2.693	-2.052	-1.717	-3.353

Note: Values in bold represent stationarity and * and ** indicate stationarity in the 10% and 5% significance levels respectively.

The results show that for the pre-crisis period all of the tests and related models failed to reject the null hypothesis and indicated that this series contained a unit root. For a series to contain a unit root means that the market was found to be weak form efficient during the dates February 1988 and January 2008. This is an interesting result as an developing economy, an emerging market, there has been a general understanding that the Turkish Stock Market should be inefficient and provide investors with an opportunity to obtain abnormal resturns.

However, during the period from the crisis until the declaration of the pandemic, Model A and Model C of the LNV was able to identify the stationarity and rejected the null hypothesis of a unit root. In other words, the market was not efficient. The fact that all other unit root tests fail to identify the stationarity means that it was the structure of the LNV test that was successful for this series. LNV test is also known as a structural break test which has a sharp movement from one regime to another. The hybrid models were not successful in capturing stationarity as they hold the state-dependent nonlinearity within their structures together with time-dependent nonlinearity. These were also supported with the results of the third sub-eriod, the covid-19 period, where the LNV test was the only one to capture stationarity. Again, the same result in the full period.

Yet again besides the pre-crisis period, all other periods can be concluded as inefficient in the weak form which supports the findings of Korkmaz and Akman (2010), Malcioglu and Aydin (2016), Akgun and Sahin (2017), and Tas and Atac (2019). However, the changing nature of the efficiency from pre-crisis towards the crisis and pandemic periods supports that of Ozkan (2021c) where there is a movement towards inefficiency and a deviation from market efficiency.

5. CONCLUSION

The study was conducted with the purpose of understanding the efficiency of the Turkish Stock Market and how major global events have affected this efficiency. To get a Picture pf this evolution from the full sample covering the period between February 1988 to September 2022, there were three subsamples taken. These samples were identified based on the two major global events which had a great affect in many areas. These events were firstly the global fiancial crisis and second the Covid-19 virus which was announced as a pandemic in March 2020.

Among the 6 tests applied, five are recently developed and nonlinear in its structure. The results obtained were interesting as besides the LNV test, no other test used was able to show stationarity. For the crisis to Covid-19 and the Covid-19 periods there has been a unit root test that supported the alternative hypothesis and showed that the series exhibit stationarity. Although all other five unit root tests, apart from the LNV test, supported the existence of efficiency, one single test is enough to conclude that the Turkish Stock Market is not efficient in the lowest level of market efficiency, the weak-form. Therefore, according to the EMH theory, future prices cannot be predicted through the use of past information. An investor who cannot predict prices and the one that knows information is reflected on stock prices as it arrives, is not likely to earn excessive returns from the market. A market that is not efficient will be more attractive to investors as it will also provide an oppportunity for arbitrage. However, effects of major events on stock markets may not always reflect immediately or stop instanteneously and for this reason this study can be further developed using different sub-periods that have different timeframes to observe the impact of such events. Also Covid-19 was announced as a pandemic on March 2020 which made the third sub-sample very small with only 31 monthly data points. This was one of the biggest limitations of this study.

Overall, important outcomes can be observed from the findings. Firstly, the market in question is not efficient in the full period because the LNV test rejected the null hypothesis. But the sub-periods showed that once an efficient market, after the Global Financial Crisis the Turkish Stock Market has become inefficient and created an opportunity for price prediction, obtaining higher returns and asymmetric information flow.

Although there are many different tests used and various timeframes tested with this study, there are certain limitations. One of the most important limitation is the unavailability of data in the Covid19 period. Only monthly data was utilized throughout the study, and since Covid 19 was announced as a pandemic in March 2020, it only allowed for a limited number of data to be tested. In the future more comprehensive studies can be conducted with a larger time frames, or by adjusting the frequency of the data to be daily or weekly, more observations can be obtained. It is also important to understand the times where the structural breaks occured and to be able to investigate the reasons behind these changes.

Hakem Değerlendirmesi: Dış bağımsız.
Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemiştir.
Finansal Destek: Yazarlar bu çalışma için finansal destek almadığını beyan etmiştir.
Etik Onay: Bu makale, insan veya hayvanlar ile ilgili etik onay gerektiren herhangi bir araştırma içermemektedir.
Yazar Katkısı: Ceyda Aktan (%100)

Peer-review: Externally peer-reviewed.
Conflict of Interest: The authors declare that there is no conflict of interest.
Funding: The authors received no financial support for the research, authorship and/or publication of this article.
Ethical Approval: This article does not contain any studies with human participants or animals performed by the authors.
Author Contributions: Ceyda Aktan (100%)

REFERENCES

Akgun, A. and Sahin, I. (2017). The testing of efficient market hypothesis in Borsa Istanbul. *Annals Constantin Brancusi U. Targu Jiu, Letters & Soc. Sci. Series, 2,* 35 - 48. Retrieved from: https://heinonline.org/HOL/LandingPage?handle=hein.journals/ancnbt2017&div=26&id=&page=

Aktan, C., Iren, P., and Omay, T. (2019). Market development and market efficiency: Evidence based on nonlinear panel unit root tests. *The European Journal of Finance, 25(*11), 979-993. doi: 10.1080/1351847X.2018.1560346

Aliyev, F. (2019). Testing market efficiency with nonlinear methods: Evidence from Borsa Istanbul. *International Journal of Financial Studies, 7*(2), 1-27. doi:10.3390/ijfs7020027

Balaban, E. (1995). Informational efficiency of the Istanbul Securities Exchange and some rationale for public regulation. *The Central Bank of The Republic of Turkey Research Department Discussion Paper,* 9502, 39-67. Retrieved from: https://core.ac.uk/download/pdf/7061411.pdf

Borges, M. R. (2010). Efficient market hypothesis in European stock markets. *The European Journal of Finance, 16*(7), 711-726. doi: 10.1080/1351847X.2010.495477

Brown, K. C., Harlow, W. V., and Tinic, S. M. (1988). Risk aversion, uncertain information, and market efficiency. *Journal of Financial Economics, 22*(2), 355-385. Retrieved from: https://faculty.mccombs.utexas.edu/keith.brown/Research/JFE-12.88.pdf

Brown, K. C., Harlow, W. V., and Tinic, S. M. (1993). The risk and required return of common stock following major price innovations. *Journal of Financial and Quantitative Analysis, 28*(1), 101-116. Retrieved from: https://www.jstor.org/stable/pdf/2331153.pdf

Caner, M. and Hansen, B. E. (2001). Threshold autoregression with a unit root. *Econometrica, 69*(6), 1555-1596. doi: 10.1111/1468-0262.00257

Carrion-i-Silvestre, J. L., del Barrio-Castro, T., and Lopez-Bazo, E. (2005). Breaking the panels: an application to the GDP per capita. *The Econometrics Journal*, 159-175. Retrieved from: https://www.jstor.org/stable/pdf/23113636.pdf

Carter, D. A. and Simkins, B. J. (2004). The market's reaction to unexpected, catastrophic events: the case of airline stock returns and the September 11th attacks. *The Quarterly Review of Economics and Finance, 44*(4), 539-558. doi: 10.1016/j.qref.2003.10.001

Cevik, E. İ. (2012). İstanbul Menkul Kiymetler Borsasi'nda Etkin Piyasa Hipotezinin Uzun Hafiza Modelleri İle Analizi: Sektörel Bazda Bir İnceleme. *Yaşar Üniversitesi E-Dergisi, 7*(26), 4437-4454. Retrieved from: https://dergipark.org.tr/en/download/article-file/179363

Chan, K. C., Gup, B. E., and Pan, M. S. (1997). International stock market efficiency and integration: A study of eighteen nations. *Journal of Business Finance & Accounting, 24(*6), 803-813. doi: 10.1111/1468-5957.00134

Coleman, L. (2012). Testing equity market efficiency around terrorist attacks. *Applied Economics, 44*(31), 4087-4099. doi: 10.1080/00036846.2011.587778

De Bondt, W. F. and Thaler, R. (1985). Does the stock market overreact?. *The Journal of Finance, 40*(3), 793-805. doi: 10.1111/j.1540-6261.1985.tb05004.x

Dickey, D. A. and Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica: *Journal of the Econometric Society,* 1057-1072. doi: 10.2307/1912517

Ergul, N. (2009). Ulusal Hisse Senetleri Piyasası'nda etkinlik. *Yönetim Bilimleri Dergisi, 7*(1), 101-118. Retrieved from: https://dergipark.org.tr/en/download/article-file/702274

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance, 25*(2), 383-417. doi: 10.2307/2325486

Gaio, L. E., Stefanelli, N. O., Júnior, T. P., Bonacim, C. A. G., and Gatsios, R. C. (2022). The impact of the Russia-Ukraine conflict on market efficiency: Evidence for the developed stock market. *Finance Research Letters, 50,* 103302. doi: 10.1016/j.frl.2022.103302

Gozbasi, O., Kucukkaplan, I., and Nazlioglu, S. (2014). Re-examining the Turkish stock market efficiency: Evidence from nonlinear unit root tests. *Economic Modelling, 38*, 381-384. doi: 10.1016/j.econmod.2014.01.021

Gumus, B. F. and Zeren, F. (2014). Analyzing the efficient market hypothesis with the fourier unit root tests: Evidence from G-20 countries. *Ekonomski Horizonti, 16*(3), 225-237. doi: 10.5937/ekonhor1403225G

Harvey, D. I., Leybourne, S. J., and Xiao, B. (2008). A powerful test for linearity when the order of integration is unknown. *Studies in Nonlinear Dynamics & Econometrics, 12*(3), 1-23. doi: 10.2202/1558-3708.1582

Hudson, R. and Urquhart, A. (2015). War and stock markets: The effect of World War Two on the British stock market. International *Review of Financial Analysis, 40*, 166-177. Doi: 10.1016/j.irfa.2015.05.015

Kan, D. and O'Callaghan, B. A. (2007). Examination of the efficient market hypothesis—the case of post-crisis Asia Pacific countries. *Journal of Asian Economics, 18*(2), 294-313. doi: 10.1016/j.asieco.2007.02.003

Kandil Goker, I. E., Eren, B. S., and Karaca, S. S. (2020). The impact of the Covid-19 (Coronavirus) on the Borsa Istanbul Sector Index returns: An event study. Gaziantep *University Journal of Social Sciences, 19*(Covid-19 Special Issue), 14-41. doi: 10.21547/jss.731980

Kapetanios, G., Shin, Y., and Snell, A. (2003). Testing for a unit root in the nonlinear STAR framework. *Journal of Econometrics, 112*(2), 359-379. doi: 10.1016/S0304-4076(02)00202-6

Karadagli, E. C. and Donmez, M. G. (2012). A nonlinear analysis of weak form efficiency of stock index futures markets in CEE emerging economies. *International Research Journal of Finance and Economics,* (95), 61-71. Retrieved from: https://www.researchgate.net/profile/Ece-Karadagli/publication/265126206_A_Nonlinear_Analysis_of_Weak_Form_Efficiency_of_Stock_Index_Futures_Markets_in_CEE_Emerging_Economies/links/53ffa97c0cf29dd7cb522a0d/A-Nonlinear-Analysis-of-Weak-Form-Efficiency-of-Stock-Index-Futures-Markets-in-CEE-Emerging-Economies.pdf

Kilic, Y. and Bugan, M. F. (2016). The efficient market hypothesis: Evidence from Turkey. *International Journal of Academic Research in Business and Social Sciences, 6*(10), 262-272. doi: 10.6007/IJARBSS/v6-i10/2356

Korkmaz, M. and Akman, G. (2010). Testing the weak form market efficiency on Istanbul Stock Exchange. *Trakia Journal of Sciences, 8*(3), 39-49. Retrieved from: http://www.uni-sz.bg/tsj/vol8N3_2010/M.Korkmaz.pdf

Latif, M., Arshad, S., Fatima, M., and Farooq, S. (2011). Market efficiency, market anomalies, causes, evidences, and some behavioral aspects of market anomalies. Research Journal of Finance and Accounting, 2(9), 1-13. Retrieved from: https://iiste.org/Journals/index.php/RJFA/article/view/1287/1208

Lee, C. C., Lee, J. D., and Lee, C. C. (2010). Stock prices and the efficient market hypothesis: Evidence from a panel stationary test with structural breaks. *Japan and the World Economy, 22(*1), 49-58. doi: 10.1016/j.japwor.2009.04.002

Leybourne, S., Newbold, P., and Vougas, D. (1998). Unit roots and smooth transitions. *Journal of Time Series Analysis, 19*(1), 83-97. doi: 10.1111/1467-9892.00078

Lin, H., Lo, I., and Qiao, R. (2021). Macroeconomic news announcements and market efficiency: Evidence from the US Treasury market. *Journal of Banking & Finance, 133*, 106252. doi: 10.1016/j.jbankfin.2021.106252

Luukkonen, R., Saikkonen, P., and Teräsvirta, T. (1988). Testing linearity against smooth transition autoregressive models. *Biometrika, 75(*3), 491-499. doi: 10.1093/biomet/75.3.491

Malcioglu, G. and Aydin, M. (2016). Borsa Istanbul'da piyasa etkinliginin analizi: Harvey Dogrusallik testi/Analysis of market efficiency at Borsa Istanbul: Harvey Linearity test. *Journal of Accounting, Finance and Auditing Studies, 2*(1), 112. Retrieved from: https://core.ac.uk/download/pdf/153557232.pdf

Mehdian, S., Nas, T., and Perry, M. J. (2008). An examination of investor reaction to unexpected political and economic events in Turkey. *Global Finance Journal, 18(*3), 337-350. doi: 10.1016/j.gfj.2007.06.002

Narayan, P. K. (2005). Are the Australian and New Zealand stock prices nonlinear with a unit root?. *Applied Economics, 37*(18), 2161-2166. doi: 10.1080/00036840500217887

Omay, T., Emirmahmutoglu, F., and Hasanov, M. (2018). Structural break, nonlinearity and asymmetry: A re-examination of PPP proposition. *Applied Economics, 50*(12), 1289-1308. doi: 10.1080/00036846.2017.1361005

Omay, T. and Y. Yildirim. (2014). Nonlinearity and smooth breaks in unit root testing. *Econometrics Letters 1*(1), 2–9. doi: 10.13140/RG.2.1.4569.6403

Ozdemir, Z. A. (2008). Efficient market hypothesis: evidence from a small open-economy. *Applied Economics, 40*(5), 633-641. doi: 10.1080/00036840600722315

Ozkan, O. (2020a). Hisse senedi piyasalarının zayıf formda piyasa etkinliğinin küresel ölçekte karşılaştırılması: G-20 üyeleri üzerine ampirik bir çalışma. *Celal Bayar University Journal of Social Sciences, 18*(2), 327-338. doi: 10.18026/cbayarsos.695125

Ozkan, O. (2020b). Hangi sektörlerde getiri öngörülebilirliği için tarihsel fiyatlar kullanılabilir? Otomatik Portmanteau Testi ile Borsa İstanbul üzerine ampirik bir çalışma. *Business and Economics Research Journal, 11*(3), 703-712. doi: 10.20409/berj.2020.278

Ozkan, O. (2020c). Time-varying return predictability and adaptive markets hypothesis: Evidence on MIST countries from a novel wild bootstrap likelihood ratio approach. *Bogazici Journal: Review of Social, Economic & Administrative Studies*, *34*(2). 101-113. doi: 10.21773/boun.34.2.1

Ozkan, O. (2021a). Döviz Piyasalarının Davranışlarını Açıklamada Etkin Piyasalar Hipotezi ile Adaptif Piyasalar Hipotezinin Karşılaştırılması: BRICS-T Ülkeleri Üzerine Ampirik Bir Çalışma. *Muhasebe ve Finansman Dergisi*, (89), 221-236. doi: 10.25095/mufad.852162

Ozkan, O. (2021b). Impact of COVID-19 on stock market efficiency: Evidence from developed countries. *Research in International Business and Finance, 58,* 101445. doi: 10.1016/j.ribaf.2021.101445

Phillips, P. C. and Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika, 75*(2), 335-346. doi: 10.1093/biomet/75.2.335

Ramiah, V. (2013). Effects of the Boxing Day tsunami on the world capital markets. *Review of Quantitative Finance and Accounting, 40*(2), 383-401. doi: 10.1007/s11156-012-0286-z

Sollis, R. (2009). A simple unit root test against asymmetric STAR nonlinearity with an application to real exchange rates in Nordic countries. *Economic Modelling, 26*(1), 118-125. doi: 10.1016/j.econmod.2008.06.002

Tas, O. and Atac, C. G. (2019). Testing random walk hypothesis for Istanbul stock exchange. *PressAcademia Procedia, 9*(1), 48-53. doi: 10.17261/Pressacademia.2019.1063

Tokic, S., Bolfek, B., and Peša, A. R. (2018). Testing efficient market hypothesis in developing Eastern European countries. *Investment Management & Financial Innovations, 15*(2), 281. Retrieved from: http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?C21COM=2&I21DBN=UJRN&P21DBN=UJRN&IMAGE_FILE_DOWNLOAD=1&Image_file_name=PDF/imfi_2018_15_2_27.pdf

Yucel, O. (2016). Finansal piyasa etkinliği: Borsa Istanbul üzerine bir uygulama. *International Review of Economics and Management, 4*(3), 107-123. doi: 10.18825/irem.16916

ÖZET

Piyasa etkinliği, birçok yatırımcı, politika yapıcı ve araştırmacı için büyük önem taşımaktadır. Onlara piyasa hakkında bilgi sağlar ve karar verme süreçlerinde yol gösterici olur. Bu nedenle yıllar boyunca çok sayıda araştırma yapılmıştır. Bilgi açısından etkin olduğu düşünülen bir piyasanın, alınan tüm bilgileri anında hisse senedi fiyatlarına aktarması beklenir. Bu nedenle tüm aktörler tüm bilgilere aynı anda ve her zaman ulaşabilecektir (Ozdemir, 2008, s.633). Dolayısıyla bu durum, herhangi birinin anormal getiri elde etmesini engelleyecektir.

Piyasa etkinliğinin arkasındaki düşünce, 70'lerde ortaya atılan bir teori olan Etkin Piyasa Hipotezi (EPH)'ne dayanmaktadır (Fama, 1970, ss.383-384). Etkin bir piyasanın özelliklerini tanımlayan ve bu etkinliği üç farklı düzeyde (zayıf, yarı güçlü ve güçlü) ifade eden Fama (1970) tüm bilgilerin hisse senedi fiyatlarına yansıdığında piyasanın etkin olduğunu söyler. Hisse senedi fiyatları rassal bir yürüyüş izleyecek ve temel ve teknik analizler kullanılarak geleceğe yönelik öngörüde bulunulmasını imkânsız hale getirecektir (Yucel, 2016, s.109).

Etkin Piyasa Hipotezine karşı olan inançlar, davranışsal finans araştırmalarındaki artışla birlikte daha fazla ortaya çıkmıştır. EPH gibi geleneksel finans teorileri, insanların karar verirken rasyonel davrandığı varsayımına dayanmaktadır (Aktan ve diğerleri, 2019, s.981). Rasyonellik, doğru ile yanlış arasında net bir ayrım yapar ve yatırımcıların hareketleri hakkında net bir fikir verir. Ancak davranışsal finans ilkeleri bu duruma karşı çıkmakta ve insanların düşünce ve inançları tarafından yönlendirildiğini ve karar verirken her zaman rasyonel olamayabileceğini açıklamaktadır. İster siyasi ister ekonomik ister doğal afetlerle ilgili olsun, önemli küresel olayların olduğu zamanlarda yatırımcıların tepkilerinin farklılık göstermesinin beklenebileceği söylenebilir. Geçmiş araştırmalar, finansal krizler ile savaşların ve terörün borsalar üzerindeki etkilerini ve doğal afetleri incelemiş ve hisse senedi fiyatlarında değişime neden olduklarını bulmuştur.

Bununla birlikte, 2008 Küresel Finansal Krizi ve COVID-19 salgını, Dünyanın yaşadığı önemli olaylar arasında gösterilmektedir. Geçmiş araştırmalar, her iki olayın hisse senedi piyasalarının etkinliği üzerindeki etkisinin ayrı çalışmalarda ele alındığını gösterse de hem büyük olayları içeren hem de borsa etkinliğinin bu dönemler arasında nasıl değiştiğini analiz eden çalışmalar yetersizdir. Dolayısıyla, bu çalışmanın amacı Türkiye hisse senedi piyasasının zayıf formdaki etkinliğini ve zaman içinde nasıl geliştiğini analiz etmektir. Bu analizin mevcut literatüre katkısı, yapıları ve dolayısıyla durağanlığı belirleme yetenekleri bakımından farklılık gösteren farklı doğrusal olmayan testlerin kullanılmasıdır. Ayrıca, üç farklı alt dönem içeren uzun bir örneklem periyodu kullanmak, piyasanın farklı zaman dilimlerinde ne kadar etkin olduğunun anlaşılmasına yardımcı olacaktır.

Çalışma için Türkiye borsasının majör endeksi olan BIST100'den alınan veriler kullanılmıştır. Veriler, investing.com'dan alınmış ve testlerde kullanılmak üzere doğal logaritmaları hesaplanmıştır. Veriler, BIST100 endeksinin aylık kapanış değerlerinden oluşmaktadır. Test edilen toplam dört farklı dönem vardır ve bu Şubat 1988'den Eylül 2022'ye kadar olan zamanı kapsayan tam bir örneklem dönemi ve ayrıca 2008 Küresel Finansal Kriz ve yeni COVID-19 salgınının etkilerini gözlemlemek için düzenlenmiş üç farklı alt örneklemdir.

Hisse senedi fiyatlarının davranışının asimetrik olduğu bilinmekte ve bu nedenle durağanlığın gözlemlenebilmesi için kullanılan testlerin farklı dinamikleri içermesi gerekmektedir. Bu çalışmada kullanılan testler, Dickey ve Fuller (1981) tarafından önerilen doğrusal bir birim kök testi olan ADF testi ve doğrusal olmayan beş farklı birim kök testidir. Leybourne ve diğerleri (1998)'nin geliştirdiği LNV testi, Kapetanios ve diğerleri (2003) tarafından geliştirilen KSS testi,

Sollis (2009) tarafından geliştirilen Sollis testi, Omay ve Yildirim (2014) tarafından geliştirilen OY testi ve son olarak Omay ve diğerleri (2018) tarafından geliştirilen OEH testidir. Bu testler arasında KSS testleri ve Sollis testleri duruma bağlı durağanlık testleri olarak sınıflandırılabilirken, LNV zamana bağlı durağanlık testidir. Öte yandan, OY ve OEH testleri birlikte hibrit testler olarak bilinir ve zamana ve duruma bağlı durağanlık testlerinin özelliklerini birleştirir.

Sonuçlar, kriz öncesi dönemde tüm testlerin ve ilgili modellerin sıfır hipotezini reddedemediğini ve bu serinin birim kök içerdiğini göstermiştir. Bu serinin birim kök içermesi Şubat 1988 ve Ocak 2008 tarihleri arasında piyasanın zayıf formda etkin olduğu anlamına gelmektedir. Gelişmekte olan bir ekonomi, gelişen bir piyasa olarak bu ilginç bir sonuçtur. Genel bir varsayım olarak, gelişmekte olan Türk Menkul Kıymetler Piyasası etkin olmamalı ve yatırımcılara anormal getiri elde etme fırsatı sağlamalıdır.

Ancak, krizden pandeminin ilanına kadar geçen süreçte, LNV'nin Model A ve Model C durağanlığı tespit edebilmiş ve sıfır hipotezini reddetmiştir. Diğer bir deyişle, piyasa bu dönemlerde etkin değildir. Diğer tüm birim kök testlerinin durağanlığı belirlemede başarısız olması, bu seri için başarılı olanın LNV testinin yapısı olduğu anlamına gelmektedir. LNV testi, bir rejimden diğerine keskin bir geçiş gösteren yapısal kırılma testi olarak da bilinmektedir. Hibrit modeller durağanlığı yakalamada başarılı olamamıştır. Bunlar, LNV testinin durağanlığı yakalayan tek test olduğu üçüncü alt dönem olan Covid-19 döneminin sonuçlarıyla da desteklenmiştir. Tam periyodda da aynı sonuç elde edilmiştir.

Genel olarak, bulgulardan önemli sonuçlar gözlemlenebilir. İlk olarak, LNV testi sıfır hipotezini reddettiği için söz konusu piyasa tam dönemde etkin değildir. Ancak alt dönemler, bir zamanlar etkin bir piyasa olan Türkiye Hisse Senedi Piyasası'nın 2008 Küresel Finansal Krizi sonrasında etkin olmadığını ve fiyatların tahmininin mümkün olabilmesiyle, daha yüksek getiri ve asimetrik bilgi akışı elde etme fırsatı yarattığını göstermiştir.