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RESEARCH ARTICLE

The Effects of Volatilities in Oil Price, Gold Price and VIX Index on Turkish BIST 100 Stock Index in Pandemic Period

Covid–19 Pandemi Döneminde Petrol fiyatı, Altın fiyatı ve VIX Endeksindeki Oynaklıkların Türkiye BİST 100 Endeksi Üzerindeki Etkileri

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ABSTRACT

This study examines the effects of volatilities in oil price, gold price and the VIX index on the Turkish BIST 100 stock index during the pandemic period. For this purpose, an econometric analysis has been carried out by using the oil, gold and VIX index data which consist of 363 daily observations between 11/03/2020 – 13/09/2021. In the econometrics analysis; the Toda-Yamamoto Causality test analysis was preferred because the variables were not stationary at the same level and an impulse-response analysis and variance decomposition methods were used. According to the Toda-Yamamoto Causality test, there is no casuality between oil price, gold price, VIX index and BIST100. The results of impulse-response functions and variance decomposition analyses were also similar to the Toda-Yamomoto causality test. The results of impulse-response functions and variance decomposition analysis; The effect of oil price, gold price and VIX index on BIST 100 decreases rapidly in a short time. In addition, the variances of BIST100 are mostly self-explained in all periods.

Keywords: Toda-Yamamoto Causality Test, BIST 100, Gold Price, Oil Price, VIX Index
JEL Classification: C58, E49, F30

ÖZ

Çalışmada, Covid – 19 pandemi dönemindeki petrol fiyatı, altın fiyatı ve VIX endeksindeki oynaklıkların Türkiye BİST 100 endeksi üzerindeki etkileri incelenmektedir. Bu amaçla, 11/03/2020 – 13/09/2021 tarihleri arasında 363 günlük gözlemden oluşan petrol, altın ve VIX endeksi verileri kullanılarak ekonometrik analiz uygulanmıştır. Değişkenlerin aynı derece durağan olmamaları nedeniyle Toda-Yamamoto Nedensellik testi çalışmada tercih edilmiş ve ayrıca etki-tepki fonksiyonu ve varyans ayrıştırma yöntemleri kullanılmıştır. Toda-Yamamoto Nedensellik testi sonucuna göre; petrol fiyatı, altın fiyatı ve VIX endeksi ile BİST100 endeksi arasında nedensellik ilişkisine rastlanılmamıştır. Etki-tepki fonksiyonları ve varyans ayrıştırma

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analizlerinin sonuçları da Toda-Yamomoto nedensellik testine benzerlik göstermektedir. Etki-tepki fonksiyonları ve varyans ayrıştırma analizi sonuçlarına göre; Petrol fiyatı, altın fiyatı ve VIX endeksinin BİST 100 endeksi üzerindeki etkisi kısa sürede azalmaktadır ve BİST100 tüm dönemlerde kendisi tarafından açıklanmaktadır.

Anahtar kelimeler: Toda-Yamamoto Nedensellik Testi, BIST 100, Altın Fiyatı, Petrol Fiyatı, VIX Endeksi
JEL Sınıflaması: C58, E49, F30

1. Introduction

The COVID-19 epidemic, which was seen for the first time in Wuhan - China in December 2019, did not stay in China due to the global movements of people. It has spread all over the world in epidemic form. Although the starting point of the epidemic is China, cases continue to be reported from many countries (Sarı and Kartal, 2020: s. 94). While the number of effectively treated cases is increasing, uncertainty remains about where and when new cases will appear. According to the data on 08 October 2021, the rapidly spreading disease seems to have infected 237 million people and caused the death of approximately 4 million 800 thousand people (WHO, 2021). The COVID19 outbreak, which caused the worst health crisis of the 21st century, was declared a pandemic by the WHO on March 11, 2020 (World Economic Forum, 2020)

In times of financial crises experienced from the past to the present, gold has been seen as a safe haven by financial actors and has provided profits to its investors. The price of oil decreases due to the decreasing demand for oil, especially in times of economic recession, and its price increases due to increasing demand during economic expansion. Therefore, it is considered to be an indicator of economic contraction and expansion times.

The common feature of epidemics is that they cause uncertainty and a deterioration of expectations. As uncertainty increases, decision-making processes on the consumption and production side become more difficult. Consumers postpone their needs other than their compulsory expenditures with the worry of losing their job and income. On the production side, due to the fluctuation in demand as well as supply problems in production, it has to stop production with missing capacity or completely. Short-term consumption decisions and long-term decisions on the production side cause supply and demand imbalances. Imbalance in supply and demand affects pricing behavior negatively. The Covid-19 epidemic differed from other epidemics due to its widespread effect and long duration. The epidemic, which started in China, spread rapidly to Europe and the Americas, and the economic consequences were extremely heavy. Despite the strict quarantine

measures of the countries, new waves began to emerge after the relaxation of the measures. Despite successful results in vaccine studies in many countries, the mutation of the virus played an important role in turning the epidemic into a long-lasting crisis. The fact that China has become the world's main production center in recent years and production has come to a standstill due to the epidemic has caused supply problems. In other words, the simultaneous deterioration in both the demand and supply sides negatively affected the expectations. On the other hand, despite the acceleration of vaccination in developed countries, the lack of progress in vaccination in underdeveloped countries increases the uncertainty about when the epidemic will end.

During the pandemic period, there were significant movements in gold and oil prices. Another indicator that helps financial actors to predict movements in global financial markets is the Chicago Options Exchange Volatility Index (Sarı and Kartal, 2020: s. 95). The VIX index is based on the S&P 500 index, one of the two important indices of the American stock market, it measures the 30-day volatility expectation of the stock market under the name of the Volatility Index (VIX) (Just and Echaust, 2020, p. 2).

There are many important reasons for monitoring gold and oil prices and the VIX index in times of crisis. Gold is a safe haven in crisis periods. Increasing uncertainty increases the demand for gold. If investors' expectations that the uncertainty will continue for a long time increases, the increase in gold demand and accordingly the increase in gold prices accelerates. Recently, gold prices rose to historical levels with the effect of monetary expansion after the 2008 global financial crisis. A similar situation took place during the Covid-19 outbreak. While the epidemic was expected to remain within the regional borders, the rapid spread of the epidemic increased the demand for precious metals, especially gold. What was the correlation between uncertainty and gold prices seen during the epidemic period. As uncertainty increases, gold prices rise, while gold prices decrease when uncertainty decreases.

The same is true for oil prices. In times of crisis, the slowdown in demand causes a decrease in production and employment. Petroleum is not only energy

but also an intermediate commodity for many sectors. The spread of the Covid 19 epidemic on a global scale caused demand to slow down and production stopped in many sectors. Unlike the financial crisis, due to the fact that Covid-19 is a health crisis, the measures taken by the production side caused a disruption in production. The rapid increase in the increasing number of fatal and sick cases caused the demand for oil to fall rapidly, and also caused the prices to fall. In order to prevent the rapid decline in oil prices, oil exporting countries had to impose supply restrictions. However, with the acceleration of vaccination and the partial control of the epidemic, economic activities began to accelerate with the effect of delayed demand. The main obvious effect of the recovery in the economy began to be seen in oil demand and oil prices. In the macroeconomic conjuncture, while oil prices decrease during contraction periods, oil prices increase due to demand during expansion periods.

The volatility in the prices of financial assets is one of the most difficult measures to predict. The volatility index (VIX) is an index that measures the volatility of the markets, called the fear index in the markets. The VIX index rises in situations where uncertainty is high, financial crisis, war and epidemic. As uncertainty decreases, the VIX index begins to decline. The VIX index is based on 0-100 points. As it approaches zero, it is interpreted that the fear in the market is less and the appetite is high. The VIX index, which increased during the Covid-19 epidemic, became an important indicator in terms of showing the magnitude of the crisis.

In this study, the effect of oil, gold and the VIX index, which is one of the most important economic indicators that are followed by all world financial markets and affecting these markets on the Turkish stock market index BIST100 index, and the data of the pandemic period between 11 March 2020 - 13 September 2021 are examined.

2. Literature

There are many studies in the literature examining the effects of oil and gold prices on the BIST 100 index. These studies were analyzed using different period intervals and different methods. Table 1 shows some selected studies. In most of

the study, the pre-Covid-19 period interval was used. In this study, the effects of the volatility of the variables during the Covid-19 pandemic period on the Turkiye BIST 100 index are examined. For this purpose, econometric analysis was applied using oil, gold and VIX index data consisting of 363 days of observations between 11/03/2020 – 13/09/2021. In this study, unlike other studies, the observation interval was taken between March 2020, when the first cases started to be seen in Turkiye, and September 2021, when the increase in cases continued.

Table 1: Summary for the Selected Literature

Author(s)	Period	Scope of The Study	Method	Finding
Akgün, Şahin ve Yılmaz (2013)	Jan 2000-April 2013	Examining the effect of oil and gold prices on the BIST 100 index	The Johansen co-integration Test	Gold and oil prices move with the BIST 100 index in the long run.
Gazel (2016)	January 2006 - February 2016	Examining the relationship between BIST 100 stock and gold price.	Engle-Granger Cointegration Test and Granger Causality Test	According to the Engle-Granger cointegration test result, BIST 100 index and gold prices are cointegrated.
Bildirici (2019)	January 02, 1990 - June 06, 2017	Examining the relationship between Borsa Istanbul returns and oil prices.	TAR - TR GARCH and TAR - TR TGARCH Copula Model	Stock markets and oil prices show an asymmetric dependency.
Toparlı, Çatık ve Balcılar (2019)	February 1988 - March 2017	Examining the effect of crude oil price shocks on Turkish stock market.	TVP-VAR	The impact of crude oil price shocks on the stock market index is lower than the interest rate and exchange rate.
Akkoç and Civciv (2019)	2008-2019	The relationship between gold, stock market and stock market returns has been examined.	SVAR-DCC-GARCH Model	Gold prices affect the stock market more strongly than oil prices
Polat (2020)	February 1988 -December 2018	Time-varying transmission mechanisms between oil price shocks and Borsa Istanbul are examined.	Bayesian TVP-VAR Model	Shocks in oil prices have a significant impact on the BIST 100 index returns.
İlhan and Akdeniz (2020)	September 13, 2019 - September 11, 2020	The effects of some selected variables before and during COVID-19 on the BIST 100 index are examined.	FLS Method	CDS premium and exchange rate directly affect BIST 100

Özdurak (2020)	Long Term (January 02, 2015– June 03, 2020 Short Term: December 31, 2019 – June 03, 2020 (the Covid-19 period)	The interaction between crude oil prices and the stock returns of airline companies in the Turkish Stock Exchange is examined.	A VAR-VECH-TARCH Model	The volatility between the crude oil price and the stock prices of the airline companies traded in the stock exchange varies according to the companies.
Güzel and Acar (2021)	February 02,2009 – November 11, 2020	The effects of Ebola, MERS and H1N1 outbreaks on the BIST 100 Index were examined.	ARCH, GARCH, T-GARCH and E-GARCH Models	It is emerging that the H1N1 pandemic has had a significant impact on the BIST 100 Index.
Çamoğlu (2021)	March 2020 – March 2021	In the study, the effects of exchange rates and oil prices on the BIST petrochemical sector during the COVID-19 pandemic period are analyzed.	VAR Model	In the study, it was concluded that the movements in oil prices and dollar exchange rates have significant effects on the BIST petrochemical index.
Sümer and Özorhon (2021)	2008-2021	The returns between the gold prices and the Turkish real estate investment trust (T-GYO) index are examined.	VAR model and Granger Causality Tests	In the 2008 global financial crisis, it outperformed the gold prices of the T-REIT index.

3. Data and Methods

In this study, the Vector Autoregressive Model (VAR) is used to explain the effect of volatilities on oil price, gold price and the VIX index on the BIST 100 index. Although Granger causality tests are quite simple to use and interpret, the non-stationary series must be integrated in the same order and there must be a cointegration relationship between the series in order to apply the Granger (1988) method. However, the method developed by Toda and Yamamoto (1995) allows the analysis of causality for an integrated series of the same or different degrees, without the need for the existence of a cointegration relationship.

In order to perform a Toda-Yamamoto causality test analysis, the variables must be stationary. Stationarity analyses are made with unit root tests. In this study, two methods were used in unit root test analysis: Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979: pp. 427-431) and the Philips Perron (PP) test (Philips and Perron, 1988: pp. 335-346). Test results are compared with the MacKinnon 5% critical value for stationarity (MacKinnon, 1996).

Toda and Yamamoto (1995) propose an simple procedure that requires an augmented VAR estimation that guarantees the asymptotic distribution of the Wald statistic (an asymptotic χ2-distribution) because the test procedure is robust for the test procedure, integration, and cointegration properties process.

A VAR (m + dmax) consisting of oil, gold and VIX index variables will be used to examine its impact on BIST100 following Yamada (1998). After the unit root test, Toda-Yamamoto causality test analyses are applied by using the following equations:

$$Xt = \omega + \sum \lambda i Xt-i\ k\ i=1 + \sum \lambda j Xt-j\ k+dmax\ j=k+1 + \sum \pi i Yt-i\ k\ i=1 + \sum \pi j Yt-j\ k+dmax\ j=k+1 + \varepsilon 2t \quad (1)$$

$$Yt = \mu + \sum \delta i Yt-i\ k\ i=1 + \sum \delta j Yt-j\ k+dmax\ j=k+1 + \sum \theta i Xt-i\ k\ i=1 + \sum \theta j Xt-j\ k+dmax\ j=k+1 + \varepsilon 1t \quad (2)$$

In the model, $\varepsilon 1t$ and $\varepsilon 2t$ represent unrelated errors and ω, θ's, δ's, ψ's, ϕ's, β's are parameters of the model.

There are two steps in implementing the analysis. The first step involves determining the lag length (m) and the second is choosing the maximum degree of integration (dmax) for the variables in the system.

4. Empirical Analyses and Discussions

The data were compiled by the author from the bloomberg data terminal and analyzed using the E-views 10 econometric program. The variables used in the study are presented in Table 2 below, and the summary of statistical information of the variables are presented in Table 3.

Table 2: Variables

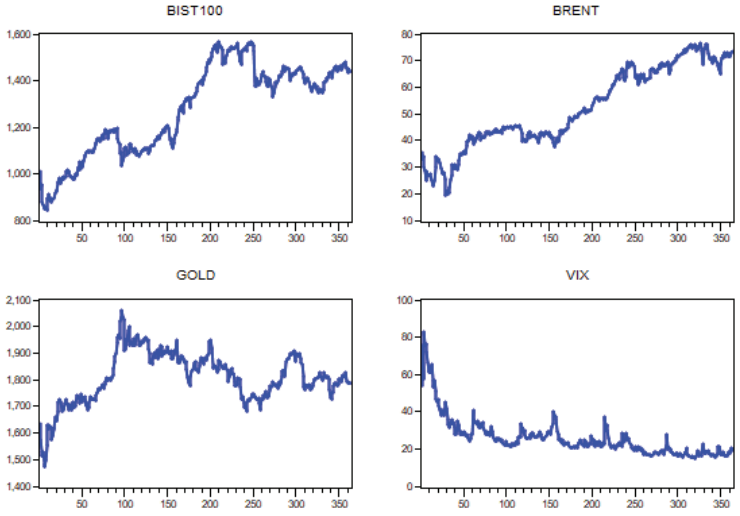
BIST100	Borsa Istanbul 100 Index
BRENT	American crude oil price
GOLD	Gold price
VIX	Volatility Index (Fear Index)

Table 3: The Summary of Statistical Information of Variables

	BIST100	BRENT	GOLD	VIX
Mean	1275.099	52.29931	1809.069	26.05689
Median	1330.870	48.86000	1807.760	23.19000
Max.	1570.420	76.49000	2063.540	82.69000
Min.	842.4600	19.33000	1471.240	15.07000
Std. Devia.	196.6813	15.23796	96.84782	10.78058
Skewness	-0.319299	-0.057480	-0.432166	2.487940
Kurtosis	1.880605	1.845198	3.646669	10.56947
Jarque-Ber.	25.12041	20.37009	17.62442	1241.101

The values of skewness and kurtosis in the table provide preliminary information about normality. The skewness value expresses the symmetry of the distribution with respect to the mean. The Kurtosis value indicates a flattening or bulging. Values less than 3 indicate a kurtosis in the distribution. Jarque-bera values give normal distribution test results. According to the probability values, the hypothesis of "H_0: Error terms are normally distributed" was accepted for all series.

Graph 1. BIST100, Brent, Gold, VIX Index Series



The series do not move around their mean rates except for the VIX variable. Therefore, this indicates that the series may contain a unit root. In this case, the series should be subjected to the ADF and PP unit root tests given in Table 4 to avoid the problem of false regression.

Table 4: Unit Root Test Results

	ADF TEST		PP TEST		Unit Root Results
	Test Stat.	P.V.	Test Stat.	P.V.	
BIST100	-1.605544	0.7893	-1.654544	0.7692	I(0)
BRENT	-3.332763	0.0626	-3.381328	0.5554	I(0)
GOLD	-2.303364	0.4306	-2.190611	0.4929	I(0)
VIX	-4.199971	0.0049	-3.568485	0.0340	I(0)

When the t-statistic and probability values in Table 5 are compared with the MacKinnon 5% critical value, the level values of the series are higher than the MacKinnon 5% significance values, except for the values of the VIX index. These results show that the series is not stationary and contains a unit root.

In order to get rid of the unit root of all series except the VIX index, the first differences were taken by applying the ADF and PP unit root tests. As a result of the analysis, the first difference values of the series are below the MacKinnon levels with a critical value of 5%. While these results were stationary at the level value of the VIX index, the other series became stationary when first differenced.

Table 5: Unit Root Test Results at First Order Difference

	ADF TEST		PP TEST		Unit Root Results
	Test Stat.	P.V.	Test Stat.	P.V.	
BIST100	-20.28789	0.0000	-20.24815	0.0000	I(1)
BRENT	-19.24649	0.0000	-19.44026	0.0000	I(1)
GOLD	-18.55909	0.0000	-19.02127	0.0000	I(1)
VIX	-4.199971	0.0049	-3.568485	0.0340	I(0)

In the study, the most frequently used Akaike information criterion (Akaike, 1974) was taken as the lag length. According to Table 6, the Akaike information criterion, Schwarz Information Criterion (SIC) and Akaike's Final Prediction Error (FPE) criterion show a delay of 1 for the series.

Table 6: Lag-Order Selection Criteria

Lag	LR	FPE	AIC	SC
0	NA	3.44e+11	37.91538	37.95901
1	4487.594	**1016956.***	**25.18383***	**25.40197***
2	13.82635	1069328.	25.23401	25.62667
3	18.48344	1108728.	25.27010	25.83728
4	28.83607	1114274.	25.27493	26.01663
5	**26.76313***	1125778.	25.28494	26.20116
6	17.05349	1170369.	25.32340	26.41414
7	14.72895	1224833.	25.36836	26.63362
8	13.49234	1286258.	25.41660	26.85638

According to a 1 lag, the maximum degree of integration (k+dmax) is 2. Thus, the equation of BIST100 variable;

$$BIST100 = C(1)*BIST100(-1) + C(2)*BIST100(-2) + C(3)*BRENT(-1) + C(4)*BRENT(-2) + C(5)*GOLD(-1) + C(6)*GOLD(-2) + C(7)*VIX(-1) + C(8)*VIX(-2) + C(9) \quad (3)$$

Since important criteria such as Akaike and the Schwarz criterion point to the lag length of 1, lag length 1 is used in the study. Subsequently, the (k+dmax) value is obtained as 2. The results of the Toda – Yamamoto causality test are shown in Table 7.

Table 7: Toda – Yamamoto Causality Test Results

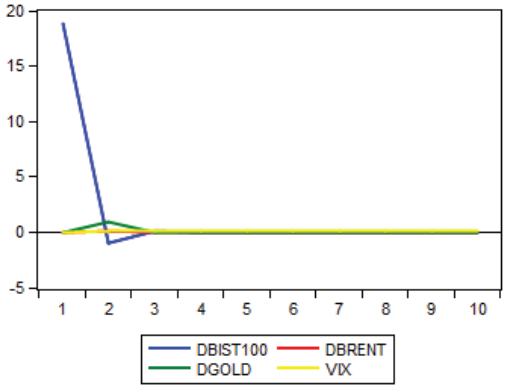
	Lag (k)	Lag (k+dmax)	Chi-square	Prob.	Results
BRENT	1	1+1	0.393066	0.530692	No Casuality
GOLD	1	1+1	1.138141	0.28604	No Casuality
VIX	1	1+1	2.361912	0.12433	No Casuality

According to Toda – Yamamoto causality test test analysis BIST 100 (dependent variable) is not effected by oil, gold prices and the VIX index (independent variables). Therefore there is a no causality relationship between the selected data.

Graph 2 indicates the impulse-response functions of the BIST 100 (dependent variable), oil, gold prices and VIX index. In the representation of these functions,

the time elapsed after the shock for each variable on the horizontal axes is shown as the number of days, and the response of the relevant variable on the vertical axes. As seen in the chart, the effect of oil, gold and the VIX index on the BIST 100 variable decreases rapidly in a short time and ends at the end of the 3rd day.

Graph 2. Impulse-Response Functions of BIST100



After the impulse-response functions analysis, variance decomposition analysis is performed to determine the source of the change in the variables. Variance decomposition analyses show how much of the change in the variables used in the model is due to itself and how much is due to other variables.

Table 8: Variance Decomposition of BIST100

Period	BIST100	BRENT	GOLD	VIX
1	100.0000	0.000000	0.000000	0.000000
2	99.75816	0.003617	0.231918	0.006307
3	99.75119	0.004294	0.232203	0.012310
4	99.74544	0.004640	0.232238	0.017684
5	99.74028	0.004966	0.232300	0.022456
6	99.73570	0.005254	0.232354	0.026693
7	99.73163	0.005510	0.232402	0.030454
8	99.72802	0.005737	0.232445	0.033794
9	99.72482	0.005938	0.232483	0.036759
10	99.72197	0.006118	0.232517	0.039391
11	99.71945	0.006276	0.232547	0.041729
12	99.71721	0.006418	0.232573	0.043804
13	99.71521	0.006543	0.232597	0.045646

14	99.71345	0.006654	0.232618	0.047282
15	99.71188	0.006753	0.232636	0.048734
16	99.71048	0.006841	0.232653	0.050024
17	99.70925	0.006918	0.232667	0.051169
18	99.70815	0.006988	0.232680	0.052186
19	99.70717	0.007049	0.232692	0.053088
20	99.70630	0.007103	0.232702	0.053890

In Table 8, variance decomposition is shown for 20 days by ordering the variables used in the model in the order of BIST100 BRENT GOLD and VIX. The variances of the BIST100 are mostly explained by itself in all period.

5. Conclusion

The VIX index, changes in oil and gold prices are important indicators in monitoring the course of the economy. Changes in these data have been observed in many crises in history and expectations have been interpreted. The .VIX index, also known as the fear index, measures the 30-day volatility expectation of the stock market under the Volatility Index, based on the S&P 500 index in the American stock market. Gold prices are followed by ounce, and for oil, the Brent barrel price of oil is followed. All three indicators have a direct relationship on the stock markets. While the demand for gold is shaped by the search for a safe haven, oil prices are affected by the change in economic activities. The pessimism in expectations reduces the demand for energy and intermediate goods due to consumption. Investors increase their investments in precious metals, especially gold, in times of crisis.

The fact that consumers can postpone their purchase requests other than their essential needs naturally causes a decrease in oil demand. The rise in the VIX index, on the other hand, indicates that investor appetite has decreased and expectations have worsened. Changes in these three indicators have an impact on the stock markets. It is observed that investor inflows to the stock markets decrease during periods of increased panic and fear. In the recent 2008 global financial crisis, these three indicators played an important role in monitoring the

course of the crisis. It was observed that the volatility of especially gold and oil prices increased at different stages of the crisis. Gold has been the most important investment tool during periods of war, financial crisis and epidemics. Investors prefer to invest their savings in safe investment instruments. Oil prices, on the other hand, have a direct relationship with demand and supply. While oil prices fell rapidly during economic contraction periods, it was observed that oil prices increased rapidly during economic expansion. The Covid-19 epidemic period has been an important experience in showing the effects of the volatility in all three indicators on the stock markets. The change in oil and gold prices during the onset, spread and vaccination periods of the epidemic draws attention. The lack of a clear date on when the epidemic can be brought under control causes the volatility in prices to continue. Especially the mutation of the virus and the differences between developed and developing countries in the number of vaccinations cause the uncertainty to continue.

In this study, the effects of oil price, gold price and volatility in the VIX index on the Turkiye BIST 100 index during the Covid-19 pandemic period were examined. In this context, an econometric analysis was applied using oil, gold and VIX index data consisting of 363 days of observations between 11/03/2020 – 13/09/2021.

A Toda-Yamamoto causality test was used as the main econometric method in the study and in order to support the results of the Toda-Yamamoto causality test, impulse-response and variance decomposition methods were also applied. According to the results of the Toda-Yamamoto causality test: It has been determined that the variables have no effect on the BIST100 index.

As a result of impulse-response functions: The effect of oil, gold and VIX index on the BIST 100 variable decreases rapidly in a short time and ends at the end of the 3rd day. After the impulse-response functions analysis, variance decomposition analysis is performed to determine the source of the change in the variables. A 20-day variance decomposition of the variables was done. A 20-day variance decomposition test of the variables was applied. The variances of BIST100, the main variable of the study, are mostly explained by itself in all periods.

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