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Article

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The Effect of Energy Prices on Stock Indices in the Period of COVID-19: Evidence from Russia, Turkey, Brazil, and India

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ABSTRACT

Petroleum and natural gas, which are among the most used energy sources in the world, have a significant impact on financial markets and macroeconomic indicators as they are used as raw materials in many fields. For this reason, Russia, Turkey, Brazil, and India, as energy importers and developing countries, may be affected positively or negatively by changes in energy prices. The main purpose of this study is to examine the correlation between Brent oil, crude oil (WTI), and natural gas (NG) prices and Moscow Stock Exchange Index (RTSI), Borsa Istanbul Index (XU100), Bovespa Brazilian Stock Exchange Index (BVSP), and Indian National Stock Exchange Nifty 50 Index (NSEI). In the study, weekly data between February 16, 2020 and December 26, 2021 were examined. Vector autoregressive (VAR) model was used to examine the correlation between the variables included in the analysis, and the direction of the correlation between the variables was determined by the Granger causality test. According to the results of the VAR model, Brent oil and crude oil prices have significant effects on the indices included in the analysis; however, natural gas price does not have a significant effect on indices, Brent oil, and crude oil prices. On the other hand, the results of the Granger causality test confirm the findings of the VAR analysis. Granger causality test results reveal that in Granger's sense, only BVSP and NSEI are the cause of Brent oil price, RTSI, BVSP, NSEI, and XU100 are the cause of WTI, and WTI is the cause of NSEI.

Keywords: Brent Oil, Crude Oil, Natural Gas, Stock Market İndex, VAR Analysis, Granger Causality
JEL Classifications: B26, C58, G14, G15, O16

1. INTRODUCTION

The interdependence experienced on a global scale today has gained more importance with the increasing demand for energy resources (Tutar et al., 2022. p. 332). The development of today's technology and the increasing needs with the rapid increase in the population also increase the energy demand. Today, although the search and detection of alternative energy sources that do not harm nature have gained importance, oil and natural gas continue to be preferred. The fact that energy resources such as oil and natural gas are both limited in nature and harmful to nature makes these resources important for countries that use them as raw materials. These most used energy sources are exhaustible sources and they constitute a large part of energy consumption in the world. For example, petroleum, which is used as a raw material in many fields such as petroleum asphalt, deodorant, carpet, shoes, aspirin, sunglasses, unbreakable glass, fertilizer, plastic, shampoo, is also used as a fuel for transportation and heating. Natural gas, like oil, is used as a fuel for transportation and heating. Natural gas is preferred by both industry and households in many countries due to its price.

Oil and natural gas, which are used in all areas of life, are also important in financial markets, as they can be bought and sold with the help of derivative instruments in spot and futures markets. Investors can create changes in oil prices by buying or selling oil and natural gas with derivative instruments. All these factors can have a major impact on businesses that use oil as a raw material or trade in oil. The increase in oil prices may affect the stocks by increasing the input costs of the companies that use oil as raw material. In addition, since oil is used as a fuel in transportation, it increases transportation costs, and this reduces vehicle sales and fuel consumption. Likewise, the increase in natural gas prices may affect the stocks by increasing the input costs of the enterprises that use natural gas as fuel. Moreover, since natural gas is also used as a fuel in transportation, it also increases transportation costs, and this also causes a decrease in vehicle sales and fuel consumption.

Apart from this, investors who aim to profit from oil and natural gas price movements in derivative markets can turn to stocks. Investors who think that oil and natural gas prices will decrease after the increase in oil and natural gas prices can sell their stocks and take a short position in energy resources.

Furthermore, natural gas, which is used as a raw material in various fields just like oil, is becoming increasingly important because it releases less carbon than other fossil fuels. In addition to heating, electricity generation, transportation, natural gas is used in the production of various products such as steel, paper, and fertilizer. Moreover, countries are making efforts to increase the use of electric vehicles as an alternative to this, and it is planned to fully switch to the use of electric vehicles towards the year 2040. For this reason, the demand for electricity generation will increase, and some of this electricity demand will certainly be met by natural gas. Therefore, the demand for natural gas will increase and this increase in demand may cause an increase in natural gas prices.

The effect of energy prices on national economies and financial markets varies depending on whether the country is an energy importer or exporter. Countries that import the majority of energy can be adversely affected by changes in energy prices. For this reason, the long and short-term correlations between energy prices (oil and natural gas) and stock market indices of four developing countries were examined in this study. In this direction, the study is important as it will help the investors who are present and who aim to invest in the Moscow Stock Exchange Index, BIST - Borsa Istanbul Index, BVSP - Brazilian Stock Exchange Index, and NSEI - Indian Stock Exchange Index in the decision-making process.

The study consists of two parts. In the first part of the study, a literature review was made. In other words, studies on the effects of shocks in energy prices on stock market indices and stocks have been examined. In the second part of the study, the findings obtained as a result of the analysis of dependent and independent variables were included and interpreted.

2. LITERATURE REVIEW

Stocks reflect the best estimate of the future profitability of firms. Therefore, the impact of oil shocks on the stock market is a meaningful and useful determinant of their economic impact. Since asset prices are the reduced value of the future net earnings of firms, it is necessary to reduce the effects of current and future oil shocks on stocks and returns without waiting for these effects to occur (Jones et al., 2004. p. 13). The summary of literature review is presented in Table 1.

3. DATASET AND ECONOMETRİC METHOD

3.1. Dataset

In this study, the correlation between Brent oil, crude oil (WTI), and natural gas (NG) prices and the indicators of four important capital markets was examined. These four capital market indicators include RTSI - Moscow Stock Exchange Index, XU100 - Borsa Istanbul Index, BVSP - Brazilian Stock Exchange Index, and NSEI - Indian Stock Exchange Index (in US dollars). To investigate the correlation between Brent oil, crude oil (WTI), and natural gas (NG) prices and RTSI - Moscow Stock Exchange Index, XU100 - Borsa Istanbul Index, BVSP - Brazilian Stock Exchange Index, and NSEI - Indian Stock Exchange Index, 97-week data for the period of February 16, 2020-December 26, 2021, when large price fluctuations were observed in energy prices, were used. Vector autoregressive model was used to examine the correlation between the variables, and the direction of the correlation between the variables was determined by the Granger causality test. In this study, all analyzes were carried out with the help of the EViews 12 software package.

3.2. Methodology

This section describes the methods used to choose the right model in studying the correlation between energy prices and stock market indices. An ordinary time series analysis may be appropriate if all the variables are stationary; however, if they are not stationary, a cointegration analysis, vector error correction (VEC) model, or vector autoregressive (VAR) model may be the appropriate model to test this correlation. Therefore, this section begins with an explanation of stationarity tests. After the stationarity tests, the VAR model and the Granger causality test are explained.

3.3. Stationarity Tests

Stationarity is one of the most critical properties of time series data. With non-stationary series, it is possible to conclude the analysis with a "spurious regression". On the other hand, having non-stationary data does not always mean that the correlation between these variables causes spurious regression. If the variables are cointegrated in their level form, the regression results will show their long-run equilibrium correlations.

There are several methods of testing whether the variables satisfy the stationarity condition. One of the methods of testing the stationarity of the said variables is the unit root test. The presence of a unit root in the variables proves that there is no stationarity. In this study, the Augmented Dickey-Fuller test, which is obtained from the Dickey-Fuller test, was used as a unit root test. The following three equations can be used in the traditional Dickey-Fuller test (Syzdykova and Azretbergenova, 2021:50):

Table 1: Summary of literature review

Works	Country	Variable	Period	Relationship status
Papapetrou (2001)	Greece	Oil	1989-1999	negative relationship
Maghyereh (2004)	22 developing countries	Oil	1998-2004	No relationship
Sarı and Soytaş (2006)	Turkey	Oil	1987:01-2004:03	No relationship
Çelik and Çetin (2007)	Turkey	Oil	1997:1-2006:3	Relationship exists
Cong et al. (2008)	Chinese	Oil price and stock market index	1996-2007	Relationship exists
Shaharudin et al. (2009)	USA, UK, India	Oil	2003-2008	Relationship exists
Kilian ve Park (2009)	USA	Oil	1973-2006	Relationship exists
Huang et al. (1996)	USA	Energy	1979-1990	no relationship
Kilian and Park (2009)		Oil		relationship is available
Kapusuzoğlu (2011)	Turkey	Oil	2000-2010	no relationship
Fayyad and Daly (2011)	Gulf Cooperation Countries (Kuwait, Oman, UAE, Bahrain, Qatar) USA and UK		2005-2010	Relationship exists
Berk and Aydoğan (2012)	Turkey	Oil	1990-2011	Relationship exists
Ünlü and Topçu (2012)	Turkey	Oil	1990:1-2001:2 ve 2001:3-2011:12	Relationship exists
Eryiğit (2012)	Turkey	Oil	2005-2008	Relationship exists
Acaravcı, Öztürk and Kandır (2012)	15 European countries	Natural gas	1990:1-2008:1	Relationship exists
Ratti and Hasan (2013)	Australia	Oil	31 Mart 2000-31 Aralık 2010	Relationship exists
Antonakakis ve Filis (2013)	USA, UK, Germany, Canada, Norway	oil	1988-2011	no relationship
Chortareas and Noikokyris (2014)	USA	Oil	1981-2006	Relationship exists
Zortuk and Bayrak (2015)	G-7	Oil	2002-2014	Relationship exists
Bolaman Avcı (2015)	Turkey	Oil	2003-2013	Relationship exists
Yalçın (2015)	Russia, Kazakhstan and Ukraine	Oil	2000-2013	Relationship exists
Yıldırım (2016)		Oil	2003:1-2016:1	Relationship exists
Bastianin, Conti and Manera (2016)	G-7	Oil	1973-2015	Relationship exists
Sandal et al. (2017)	Turkey	Oil	2005:01-2015:12	no relationship
Karhan and Aydın (2018)			05.01.2009-6.08.2018	no relationship
	Turkey	Oil		
Kumar et al. (2019)				Relationship exists
Dursun and Özcan (2019)			2005-2017	Relationship exists
Akbulaev and Rahimli (2020)	India	Oil and natural gas	2007-2019	Relationship exists
Suleymanli et al. (2020).		Oil and natural gas	2008-2019	Relationship exists
Sakinç (2021)	25 OECD member countries	Oil	21 Ağustos 2020	Relationship exists
Karakuş (2021)	Russia	Oil and natural gas	2010-2019	Relationship exists
Kumar et al. (2021)	Ukraine	Natural gas	1997-2019	One-way contact available
Geng et al. (2021)	Turkey	Oil and natural gas		Relationship exists
Mensi et al. (2021)	Turkey	Crude oil, natural gas and gasoline		Relationship exists

$$\Delta y_t = \beta_1 * y_t\text{-}1 + \varepsilon_t$$

$$\Delta y_t = \beta_0 + \beta_1 * y_t\text{-}1 + \varepsilon_t$$

$$\Delta y_t = \beta_0 + \beta_1 * y_t\text{-}1 + \beta_2 * Trend + \varepsilon_t$$

In all three tests, the hypothesis is as follows:
H_0: $\beta_1 = 0$ The variable has a unit root, the variable is not stationary.
H_1: $\beta_1 < 0$ The variable has no unit root, the variable is stationary.

3.4. Vector Autoregressive Model

The possibility of endogeneity can bias traditional multilinear model estimates. At this point, the vector autoregressive (VAR) model is a suitable model designed to deal with endogeneity problems. In the VAR model, all variables are considered endogenous and their effects on each other are taken into account. In these models, an equation is created for each variable. In these equations, each variable becomes the dependent variable, and the lagged values of the dependent variable and the lagged values of the independent variables are added to the equation. In the end, there will be as many equations as the number of variables. Thus, the effect of each variable on other variables can be tested. The VAR model will use the following systems of equations for the two variables (Syzdykova and Azretbergenova, 2021: 50):

$$Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-1} + \sum_{i=1}^{m} \beta_i X_{t-i} + \varepsilon_t$$

$$X_t = \alpha_0 + \sum_{i=1}^{m} \beta_i Y_{t-1} + \sum_{i=1}^{m} \beta_i X_{t-i} + \varepsilon_t$$

VAR analysis requires determining the optimal lag length. In the above equations, *m* refers to the optimal lag. Depending on the information criteria, the appropriate lag length is selected.

The information criteria used in this study are Likelihood Ratio (LR), Final Prediction Error (FPE), Hannan-Quinn (HQ), Schwarz (SIC), Akaike (AIC). The lower the information criteria of the model, the more appropriate the lag length used in that model. However, information criteria alone are not sufficient to decide the optimal lag length. Serial correlation is a very critical problem in VAR analysis, as the VAR model includes the lagged value of the dependent variable. Therefore, before determining the optimal lag, model results with that lag should be tested for serial correlation. The appropriate lag length can only be chosen after it has been found that the error terms are not serially related.

3.5. Granger Causality Test

The significant side in regression analysis is the dependence of one variable on other variables. However, this does not always mean that there is causality between these variables. In other words, causality or the direction of the effect cannot be proved by the existence of a correlation between the variables (Gujarati, 2013: 652).

The Granger causality test consists of estimating the following regression systems (Syzdykova and Azretbergenova, 2021: 51):

$$Y_t = \sum_{i=1}^{m} \beta_i Y_{t-i} + \sum_{i=1}^{m} \alpha_i X_{t-i} + \varepsilon_t$$

$$Y_t = \sum_{i=1}^{m} \gamma_i X_{t-i} + \sum_{i=1}^{m} \delta_i X_{t-i} + \varepsilon_t$$

Using these models, the Granger Causality test reveals not only the significance of the correlation between variables but also the direction of the correlation between these variables.

4. EMPIRICAL FINDINGS

To determine whether there is a multicollinearity problem between the variables used in the study, first of all, the correlation between the variables is examined. Table 2 below shows the correlation matrix between independent variables.

The bilateral correlation between the variables confirms that there is no multicollinearity in the model because the correlation between the independent variables is not greater than 90%. However, it is seen that Brent oil has a moderate correlation of 0.621 with RTSI and a low correlation of 0.325 with XU100, 0.494 with BVSP, and 0.345 with NSEI. Moreover, natural gas (NG) has a low correlation of 0.047 with RTSI, –0.066 (negative) with XU100, 0.145 with BVSP, and 0.201 with NSEI. Furthermore, crude oil (WTI) has a moderate correlation of 0.581 with RTSI, a low correlation of 0.325 with XU100, 0.451 with BVSP, and 0.289 with NSEI. In addition, it is seen that there is a moderate correlation of over 50% between the stock market indices included in the analysis. The correlation coefficient between Brent oil (BRENT) and crude oil (WTI) prices is strong at 0.906. However, the correlation between energy prices is not examined in the study.

Table 2: Correlation matrix

	BRENT	NG	WTI	RTSI	XU100	BVSP	NSEI
BRENT	1						
NG	0.08161	1					
WTI	0.906	0.083	1				
RTSI	0.621	0.047	0.581	1			
XU100	0.325	–0.066	0.325	0.547	1		
BVSP	0.494	0.145	0.451	0.645	0.590	1	
NSEI	0.345	0.201	0.289	0.602	0.577	0.748	1

4.1. Unit Root Tests

Since the data used in the study are time series, unit root status should be examined. For this purpose, the Augmented Dickey-Fuller (ADF) test was used. Tables 3 and 4 present the ADF unit root test results applied to the variables. According to these results, the ADF test shows that all variables are stationary at the level of 95%.

From the applied unit root test results, it is seen that all of the variables included in the analysis consist of stationary data. The first condition for searching for cointegration among variables is that all variables have the same order of integration. Therefore, there is cointegration between the variables of Brent oil, crude oil (WTI), and natural gas (NG) prices and RTSI, XU100, BVSP, and NSEI. In other words, a VAR model can be used with all the variables without taking the first or second differences of the prices of all the variables included in the analysis.

4.2. VAR Model Results

4.2.1. Lag length selection

The first step in econometric analysis in studying the VAR model is to determine the appropriate lag length. In the Table 4, the lag length is determined according to different models.

Information criterion statistics show that the appropriate lag length is 4 because 4 out of 5 information criteria selected the model with lag 4 as the appropriate model.

It is seen in Figure 1 that the estimated VAR(4) model satisfies the stability conditions. According to Figure 1, the inverse roots of the autoregressive characteristic polynomial are distributed within the unit circle.

4.2.2. VAR model estimates

The regression results of the VAR model with lag 4 in the analysis are as follows. Statistics inside parentheses are t-statistics, and statistics inside square brackets are the standard error of estimate (Table 5). The t-statistics are calculated by dividing the coefficient by its standard error.

VAR model regression results show that Brent oil and crude oil prices have a significant effect on XU100, BVSPO, NSEI, RTSI indices. It is seen that XU100 has a significant effect on Brent oil, crude oil, natural gas, BVSPO, NSEI, RTSI indices. However, it is seen that natural gas prices have a negative effect on XU100, BVSPO, NSEI, RTSI indices. Furthermore, VAR regression

Table 3: ADF Unit Root Test Results

Variable	Intercept		Trend and Intercept		None		Unit Root
	t	p	t	p	t	p	
BRENT	–8.620406	0.0000*	–8.599330	0.0000*	–8.642216	0.0000*	Yes
NG	–10.30502	0.0000*	10.27457	0.0000*	10.23452	0.0000*	Yes
WTI	–7.313230	0.0000*	–7.276336	0.0000*	7.326244	0.0000*	Yes
RTSI	–9.260341	0.0000*	–9.190983	0.0000*	–9.294616	0.0000*	Yes
XU100	–8.765485	0.0000*	–8.721981	0.0000*	–8.632597	0.0000*	Yes
BVSP	–8.999223	0.0000*	–8.946149	0.0000*	–9.049141	0.0000*	Yes
NSEI	–6.367401	0.0000*	–6.334017	0.0000*	–9.365006	0.0000*	Yes

*Represents stationarity at the 1% significance level, D (X): represents the first difference of the variable X.

Table 4: Information Criteria for Lag Length Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	–1770.346	NA	93863724	38.22249	38.41311*	38.29946*
1	–1720.496	91.12300	92439107	38.20422	39.72922	38.81997
2	–1669.920	84.83698	90882601	38.17033	41.02971	39.32486
3	–1619.604	76.82669	92324679	38.14202	42.33579	39.83535
4	–1546.550	100.5481*	60006149*	37.62472*	43.15287	39.85683

Table 5: VAR Model Regression Results

	BRENT	XU100	BVSPO	NSEI	RTSI	WTI	NG
BRENT(–1)	–1.135310	0.171144	–0.011515	0.099475	–0.232320	–1.360622	–0.206954
	(0.24329)	(0.16174)	(0.16037)	(0.13028)	(0.17785)	(0.25612)	(0.38337)
	[–4.66657]	[1.05817]	[–0.07181]	[0.76354]	[–1.30630]	[–5.31253]	[–0.53983]
BRENT(–2)	–0.538430	0.136089	–0.210098	0.151180	–0.035528	–0.556246	–0.153779
	(0.22984)	(0.15280)	(0.15150)	(0.12308)	(0.16802)	(0.24196)	(0.36218)
	[–2.34262]	[0.89065]	[–1.38674]	[1.22829]	[–0.21145]	[–2.29890]	[–0.42459]
BRENT(–3)	–0.808387	–0.076270	0.022697	0.184578	0.130102	–0.943141	0.470616
	(0.22649)	(0.15057)	(0.14930)	(0.12129)	(0.16557)	(0.23844)	(0.35690)
	[–3.56916]	[–0.50654]	[0.15202]	[1.52181]	[0.78578]	[–3.95552]	[1.31861]
BRENT(–4)	–0.279743	–0.097718	0.006933	0.255694	–0.131153	–0.355459	0.296619
	(0.23989)	(0.15948)	(0.15813)	(0.12846)	(0.17536)	(0.25254)	(0.37801)
	[–1.16614]	[–0.61274]	[0.04385]	[1.99042]	[–0.74790]	[–1.40754]	[0.78468]
XU100(–1)	–0.216556	0.247902	0.006172	–0.007888	–0.170215	–0.135470	–0.742526
	(0.20294)	(0.13492)	(0.13378)	(0.10868)	(0.14836)	(0.21365)	(0.31980)
	[–1.06707]	[1.83745]	[0.04614]	[–0.07258]	[–1.14734]	[–0.63408]	[–2.32186]
XU100(–2)	0.123094	0.154229	0.097510	0.111010	–0.154366	–0.042970	–0.369537
	(0.22012)	(0.14633)	(0.14510)	(0.11788)	(0.16091)	(0.23173)	(0.34686)
	[0.55921]	[1.05394]	[0.67203]	[0.94175]	[–0.95932]	[–0.18543]	[–1.06537]
XU100(–3)	–0.345002	–0.000264	–0.075101	–0.053635	–0.038918	–0.292331	–0.718519
	(0.23019)	(0.15303)	(0.15173)	(0.12327)	(0.16827)	(0.24233)	(0.36273)
	[–1.49878]	[–0.00173]	[–0.49495]	[–0.43511]	[–0.23128]	[–1.20635]	[–1.98088]
XU100(–4)	0.096109	0.173851	–0.117485	–0.003061	–0.014334	0.173983	0.093524
	(0.22086)	(0.14683)	(0.14558)	(0.11827)	(0.16145)	(0.23250)	(0.34802)
	[0.43516]	[1.18407]	[–0.80700]	[–0.02588]	[–0.08878]	[0.74830]	[0.26873]
BVSPO(–1)	–0.011158	–0.152018	–0.183983	–0.002906	0.165103	0.031399	0.173545
	(0.23250)	(0.15456)	(0.15325)	(0.12450)	(0.16996)	(0.24476)	(0.36636)
	[–0.04799]	[–0.98354]	[–1.20051]	[–0.02334]	[0.97143]	[0.12828]	[0.47370]
BVSPO(–2)	–0.323601	0.091979	0.264708	0.285344	–0.028330	–0.327744	–0.159072
	(0.23930)	(0.15909)	(0.15774)	(0.12815)	(0.17493)	(0.25192)	(0.37709)
	[–1.35228]	[0.57817]	[1.67813]	[2.22669]	[–0.16195]	[–1.30099]	[–0.42185]
BVSPO(–3)	–0.008808	–0.001947	0.114663	–0.068441	–0.105287	–0.060113	–0.169088
	(0.23670)	(0.15735)	(0.15602)	(0.12675)	(0.17303)	(0.24918)	(0.37298)
	[–0.03721]	[–0.01237]	[0.73491]	[–0.53995]	[–0.60849]	[–0.24124]	[–0.45334]
BVSPO(–4)	0.327939	0.048008	0.088514	–0.010121	0.230607	0.611851	–0.582247
	(0.23302)	(0.15491)	(0.15360)	(0.12478)	(0.17034)	(0.24531)	(0.36719)
	[1.40735]	[0.30991]	[0.57627]	[–0.08111]	[1.35380]	[2.49422]	[–1.58569]
NSEI(–1)	0.514754	–0.196277	–0.086537	–0.308385	–0.144821	0.349351	0.519183
	(0.30560)	(0.20316)	(0.20144)	(0.16365)	(0.22340)	(0.32171)	(0.48156)
	[1.68441]	[–0.96612]	[–0.42959]	[–1.88441]	[–0.64826]	[1.08590]	[1.07813]
NSEI(–2)	–0.354004	–0.592382	–0.496844	–0.612732	–0.259179	0.069551	0.899518
	(0.31720)	(0.21087)	(0.20909)	(0.16986)	(0.23188)	(0.33393)	(0.49984)
	[–1.11603]	[–2.80918]	[–2.37623]	[–3.60721]	[–1.11773]	[0.20828]	[1.79961]

(Contd...)

Table 5: (*Continued*)

	BRENT	XU100	BVSPO	NSEI	RTSI	WTI	NG
NSEI(–3)	0.748746	–0.417048	–0.284600	–0.068199	–0.046379	0.582693	0.096159
	(0.31578)	(0.20993)	(0.20816)	(0.16911)	(0.23084)	(0.33244)	(0.49761)
	[2.37107]	[–1.98659]	[–1.36724]	[–0.40330]	[–0.20091]	[1.75279]	[0.19324]
NSEI(–4)	0.098909	–0.147943	–0.276668	–0.128214	–0.111623	0.318317	–0.078670
	(0.32743)	(0.21768)	(0.21584)	(0.17534)	(0.23936)	(0.34470)	(0.51597)
	[0.30207]	[–0.67964]	[–1.28185]	[–0.73121]	[–0.46634]	[0.92346]	[–0.15247]
RTSI(–1)	0.282413	–0.142877	–0.021726	0.002995	–0.084574	0.285710	–0.162027
	(0.24397)	(0.16219)	(0.16082)	(0.13065)	(0.17835)	(0.25683)	(0.38444)
	[1.15758]	[–0.88093]	[–0.13510]	[0.02292]	[–0.47421]	[1.11243]	[–0.42146]
RTSI(–2)	0.574807	0.064017	–0.105619	0.012802	0.195241	0.525778	–0.505347
	(0.23299)	(0.15489)	(0.15358)	(0.12477)	(0.17032)	(0.24527)	(0.36714)
	[2.46713]	[0.41331]	[–0.68772]	[0.10261]	[1.14634]	[2.14365]	[–1.37645]
RTSI(–3)	0.039336	0.178545	0.096273	0.138606	0.068904	0.137718	0.413027
	(0.23307)	(0.15495)	(0.15364)	(0.12481)	(0.17038)	(0.24536)	(0.36727)
	[0.16877]	[1.15230]	[0.62663]	[1.11051]	[0.40441]	[0.56128]	[1.12457]
RTSI(–4)	–0.182545	0.162701	0.147346	0.002606	–0.114428	–0.064348	0.016591
	(0.22518)	(0.14970)	(0.14844)	(0.12059)	(0.16461)	(0.23706)	(0.35484)
	[–0.81064]	[1.08683]	[0.99266]	[0.02161]	[–0.69513]	[–0.27144]	[0.04676]
WTI(–1)	0.915186	–0.055113	0.025601	–0.002184	0.216797	1.054877	0.192022
	(0.18143)	(0.12062)	(0.11960)	(0.09716)	(0.13263)	(0.19100)	(0.28590)
	[5.04421]	[–0.45693]	[0.21406]	[–0.02248]	[1.63459]	[5.52289]	[0.67164]
WTI(–2)	0.224449	–0.126511	0.224743	–0.098200	–0.005834	0.170060	0.340976
	(0.19399)	(0.12896)	(0.12787)	(0.10388)	(0.14181)	(0.20422)	(0.30568)
	[1.15702]	[–0.98099]	[1.75757]	[–0.94531]	[–0.04114]	[0.83274]	[1.11545]
WTI(–3)	0.417235	–0.032958	–0.093549	–0.152703	–0.147647	0.672098	–0.404519
	(0.19222)	(0.12779)	(0.12670)	(0.10293)	(0.14051)	(0.20235)	(0.30289)
	[2.17063]	[–0.25791]	[–0.73833]	[–1.48350]	[–1.05076]	[3.32138]	[–1.33551]
WTI(–4)	0.278475	0.166696	0.071389	–0.098500	0.120525	0.100354	–0.258128
	(0.20908)	(0.13899)	(0.13782)	(0.11196)	(0.15284)	(0.22010)	(0.32946)
	[1.33192]	[1.19930]	[0.51800]	[–0.87976]	[0.78857]	[0.45594]	[–0.78348]
NG(–1)	–0.073943	–0.007760	–0.013843	0.054529	0.034980	–0.128140	–0.119563
	(0.07873)	(0.05234)	(0.05190)	(0.04216)	(0.05756)	(0.08289)	(0.12407)
	[–0.93914]	[–0.14826]	[–0.26673]	[1.29330]	[0.60774]	[–1.54597]	[–0.96368]
NG(–2)	–0.064272	0.116922	0.015964	0.066558	–0.013186	–0.032565	–0.223724
	(0.08139)	(0.05411)	(0.05365)	(0.04359)	(0.05950)	(0.08569)	(0.12826)
	[–0.78964]	[2.16080]	[0.29755]	[1.52700]	[–0.22162]	[–0.38005]	[–1.74430]
NG(–3)	–0.054734	0.046877	–0.020576	–0.013633	–0.028747	–0.043091	–0.064974
	(0.08210)	(0.05458)	(0.05412)	(0.04397)	(0.06002)	(0.08643)	(0.12937)
	[–0.66667]	[0.85888]	[–0.38021]	[–0.31008]	[–0.47899]	[–0.49857]	[–0.50223]
NG(–4)	–0.094258	–0.039546	–0.048747	–0.053059	–0.015839	–0.089460	–0.097343
	(0.07977)	(0.05303)	(0.05258)	(0.04272)	(0.05831)	(0.08398)	(0.12570)
	[–1.18161]	[–0.74572]	[–0.92705]	[–1.24207]	[–0.27162]	[–1.06529]	[–0.77439]
C	1.330715	0.962242	1.114464	1.015718	1.164553	1.449738	1.772540
	(0.61575)	(0.40935)	(0.40589)	(0.32974)	(0.45013)	(0.64823)	(0.97030)
	[2.16112]	[2.35066]	[2.74575]	[3.08035]	[2.58716]	[2.23647]	[1.82680]
R–squared	0.668629	0.350247	0.365036	0.423649	0.289698	0.656087	0.264219
Adj. R–squared	0.523655	0.065981	0.087239	0.171495	–0.021059	0.505625	–0.057685
Sum sq. resids	1506.301	665.7155	654.4981	431.9608	804.9495	1669.362	3740.311
S.E. equation	4.851387	3.225183	3.197895	2.597958	3.546454	5.107229	7.644761
F–statistic	4.612046	1.232109	1.314040	1.680121	0.932235	4.360487	0.820800
Log likelihood	–261.4551	–223.4855	–222.6953	–203.3730	–232.3167	–266.2346	–303.7474
Akaike AIC	6.246346	5.429796	5.412802	4.997268	5.619713	6.349130	7.155858
Schwarz SC	7.036081	6.219531	6.202538	5.787004	6.409448	7.138866	7.945593
Mean dependent	1.138482	0.830656	0.480152	0.736873	0.587264	1.300951	0.907428
S.D. dependent	7.029187	3.337155	3.347231	2.854201	3.509692	7.263687	7.433368

results show that XU100, BVSP, NSEI, RTSI indices and natural gas price do not have a significant effect on the variables other than themselves.

4.3. Granger Causality Test

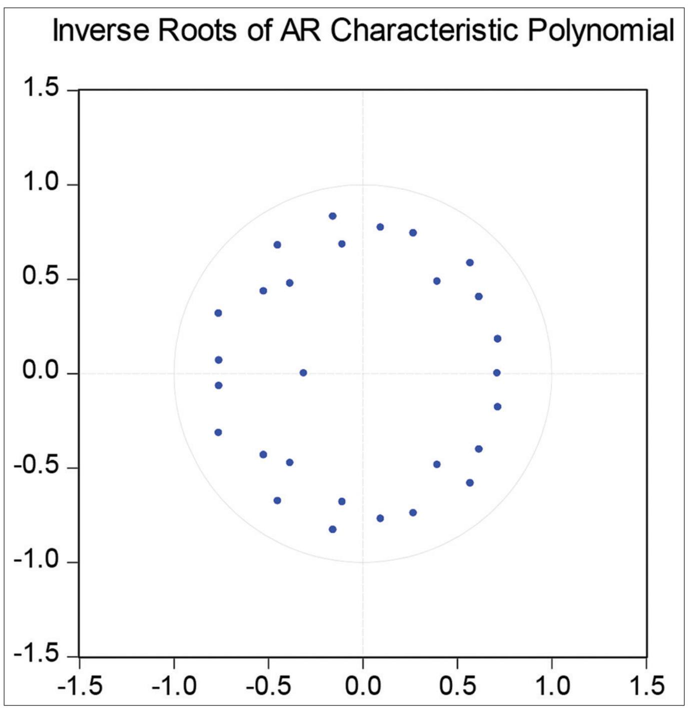
The Granger causality test determines the direction of causality between the variables. It is possible to make a Granger causality interpretation among the variables. Using the Granger Causality test, the results about the direction of the correlation between energy prices and stock market indices are given in the Table 6.

According to the results of the Granger causality test, the XU100 index, which is the indicator of the Borsa Istanbul, is not the cause of the Brent oil price (P > 0.1902); similarly, the Brent oil price is not the cause of the XU100 index (P > 10% - 0.8308). Brent oil price is not the cause of the BVSP (P > 10% - 0.5117). The

Table 6: Granger causality test results

Null hypothesis	Obs	F-Statistic	Prob.
XU100 → BRENT	3	1.56858	0.1902
BRENT → XU100		0.36805	0.8308
BVSP → BRENT	93	2.78621	0.0316
BRENT → BVSP		0.82695	0.5117
NSEI → RENT	93	6.16748	0.0002
RTSI → BRENT	93	1.59256	0.1838
BRENT to RTSI		0.40563	0.8041
WTI → XU100	93	0.68555	0.6039
XU100 to WTI		3.86291	0.0063
NG → XU100	93	1.36775	0.2521
XU100 → NG		1.30462	0.2750
WTI → BVSP	93	1.33272	0.2646
BVSP → WTI		5.44651	0.0006
GAZ → BVSP	93	0.99079	0.4172
BVSP → NG		0.75571	0.5570
WTI → NSEI	93	2.72164	0.0348
NSEI → WTI		3.99995	0.0051
NG → NSEI	93	1.71833	0.1535
NSEI → NG		0.19724	0.9392
WTI → RTSI	93	1.22796	0.3052
RTSI → WTI		3.27696	0.0151
NG → RTSI	93	0.35471	0.8401
RTSI → NG		0.63581	0.6384

Figure 1: The stability graph of the VAR model



Moscow Stock Exchange (RTSI) index is not the cause of Brent oil price (P > 10% - 0.1838); similarly, the Brent oil price is not the cause of the RTSI (P > 10% - 0.8041). The crude oil (WTI) price is not the cause of the XU100 index (P > 10% - 0.6039). The natural gas (NG) price is not a cause of the XU100 index (P > 10% - 0.2521); similarly, the XU100 index is not the cause of the NG price (P > 10% - 0.2750). The WTI price is not the cause of the BVSP (P > 10% - 0.2646). The NG price is not the cause of the BVSP (P > 10% - 0.4172); similarly, the BVSP is not the cause of the NG price (P > 10% - 0.5570). The Indian National Stock Exchange Nifty 50 Index (NSEI) is not the cause of the NG price (P > 10% - 0.9392); similarly, the NG price is not the cause of the NSEI (P > 10% - 0.1535). The crude oil (WTI) price is not the cause of the RTSI (P > 10% - 0.3052). The NG price is not the cause of the RTSI (P > 10% - 0.8401); similarly, the RTSI is not the cause of the NG price (P > 10% - 0.6384).

According to the Granger causality test results, while the Brent oil price does not affect the BVSP index, the BVSP is the cause of the Brent oil price in Granger's sense. The p-value of the test statistics for the BVSP is 0.0316, which is lower than the 5% significance level. The NSEI index is the cause of the Brent oil price. The p-value of the test statistics for the NSEI is 0.0002, which is lower than the 1% significance level. Therefore, the null hypothesis is accepted that BVSP and NSEI are the cause of Brent oil prices. The RTSI index, which belongs to the country that owns the oil resources, is also the cause of the WTI price (p < 5% - 0.0151). The XU100 index, which belongs to the oil-importing country, is also the cause of the WTI price (p < 1% - 0.0063); similarly, the BVSP is the cause of the WTI price (p < 1% - 0.0006). Furthermore, the WTI price is the cause of the NSEI (p < 5% - 0.0348); similarly, the NSEI is the cause of the WTI price (p < 1% - 0.0051). As a result, it can be said that the Granger causality test results confirmed the findings of the VAR analysis during the COVID-19 pandemic.

5. CONCLUSION

The relationship between energy and capital market indicators is very important for investors as it can affect their diversification decisions. In this study, the correlation between Brent oil, crude oil, and natural gas prices and Moscow Stock Exchange Index, Borsa Istanbul Index, Bovespa Index, and Indian Stock Exchange Index has been studied. In the study, weekly data between 16.02.2020-26.12.2021 were examined. Vector autoregressive model was used and the direction of the correlation between variables was determined by the Granger causality test.

According to the results of the VAR model and Granger causality test, the XU100 index, which is the indicator of the Borsa Istanbul, and the Moscow Stock Exchange Index (RTSI) are not the cause of the Brent oil price. Likewise, it has been determined that Brent oil price is not the cause of the XU100 index, the BVSP, and the RTSI. Also, it has been concluded that crude oil (WTI) price is not the cause of the XU100, the BVSP, and the RTSI. Furthermore, the natural gas (NG) price is not the cause of the XU100, the BVSP, the Indian National Stock Exchange Nifty 50 Index (NSEI), and RTSI. Likewise, it has been concluded that the XU100, the BVSP, the RTSI, and the NSEI are not the cause of the NG price.

It has been found that the BVSP and the NSEI are the cause of the Brent Oil price. The RTSI, the BVSP, the NSEI, and the XU100 are the cause of the WTI price. It can also be said that the WTI is the cause of the NSEI. On the other hand, the Granger causality test results have confirmed the findings of the VAR analysis.

The result obtained from this study shows that energy and capital market investors should carefully follow both Brent oil, crude oil, and natural gas price changes and stock market indices during pandemic periods. Although the results provided some valuable information regarding the correlation between stock market indices and Brent oil, crude oil, and natural gas prices, it would be useful to analyze other periods and compare the results with the findings of this study. In other words, an extended analysis, at least compared to the economic and financial crisis periods, will help to see whether the results in question are specific to the periods used or whether they can be generalized. Apart from this, although the findings of this study are generalized, since many factors affect the capital markets, investors should not forget that the dynamics in the capital markets may change.

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