Erratic Crude Oil Prices Fluctuations Effects on the Economic Development of Turkey: The Case of Coronavirus Pandemic (Covid-19)

Authors

Duaa BARAKAT[1] *

Affiliations

[1]Doctoral Program in Economics, Yeditepe University Graduate School of Social Sciences, 34755, Istanbul, Turkey

*To whom correspondence should be addressed; E-mail:duaa.barakat@std.yeditepe.edu.tr

Abstract

As an oil-importing nation, Turkey's economy is examined in the thesis by looking at its macroeconomic aggregate's response to oil price fluctuations. Furthermore, the thesis will discuss the post pandemic coronavirus effects on energy and stock markets. Moreover, the thesis will analyze many aspects including crude oil types, production, and its relationship with other markets. On the one hand, macroeconomic aggregates will be represented by the total industrial production index, CPI, nominal exchange rate, total petroleum and other liquids production, and natural gas import prices. Error correction Model utilized for model 1: Analyzing the impact of shocks to the price of Brent oil on Turkey's macroeconomic aggregates. Model 2: examines the effects of coronavirus cases of infection on crude oil prices, stock price volatility (VIX), and the Borsa Istanbul Index (BIST-100) using an autoregressive distributed lag model. The research has econometrical and analytical areas which will use information of Brent oil prices in two models. Firstly, the correlation between Brent crude oil price and Turkish economic aggregates that will analyze monthly observations from Nov/2000 to July/2021. Secondly, estimating COVID-19 daily infected cases influence on oil and stock markets covering the period from the first infected case in Turkey 11/March/2020 until 12/April/2021. This study will add to the existing literature by bringing awareness to the significance of oil prices shocks on the Turkish economy, taking into consideration COVID-19 pandemic alterations.

Keywords: ARDL; BIST-100 Index; Brent Oil Price; COVID-19; CPI; VIX Index

INTRODUCTION

Economic development incorporates a vital part in industrial advancement, as of the primary erratic oil price shocks in 1973 (Hamilton, 1983). Many analysts advised that changes in the price of oil had an impact on cyclical changes in the economy. These effects may be different between countries that import and export oil. Financial specialists look at the highlights of oil price fluctuations on the inclusive economies, since oil has been an essential asset for industrial businesses, price stability, exchange rate fluctuations, and oil substitute's prices as natural gas, which is an important alternative for oil in Turkey, and countries' economic growth.

These effects may be different between countries that import and export oil. The converse should be true when the price of oil decreases, while an increase in oil prices can be considered as great news in oil exporting countries and it will be terrible news for oil importing countries. The increase in oil price moves through trading the profits from importing to exporting nations. The global economic development has continuously affected the consumption elasticity of net importing nations. The negative effect of high oil prices appears in the long run. The oil and energy markets as factor in supply, demand, and price level have an impact on economic activity. In economic Hamilton (1983) is the first contributor in the field of crude oil price shocks on the economic situation of USA after World War II. The researcher confirmed the negative relationship between the increase in oil prices and US economic activities, which cause the seven downturns of US eight crises. Because of its position as an input in other industries, crude oil is one of the most important energy sources. It can also be said that oil price fluctuations have a potential effect on the input and production costs. For example, oil imports have become one of the most imperative import items in Turkey, an oil importing state, with a level of 422,595 barrels per day. As detailed by the Organization of Petroleum Exporting Countries, 90 % of Turkey's oil needs are met by imports (OPEC, 2020).

Moreover, the latest important event of coronavirus spreads across the world at the beginning of 2020, limiting travel and universal economic activity, global oil demand decreased. In recent March, 40-60 percent fewer flight movements were recorded as the pandemic spread. More than 80% of travel trips between all countries were restricted in April, as stated by the International Energy Agency (IEA, 2020). Oil price changes started to respond to COVID-19 in the beginning of March 09, 2020, which is 49 days after the first case of infection was recorded according to the checking report by WHO. This pandemic leads to a growing perception of risk and uncertainty in financial markets. As a result, spontaneous decision-making is becoming less precise in determining the duration and depth of the economic impacts

of the health crisis. COVID-19 breaks out in Wuhan, China, and quickly spreads throughout the world. On March 11, 2020, the virus had infected over 100,000 persons in over 100 nations, killing thousands of people. WHO (2020) declared the new coronavirus pandemic based on those findings. The first infected case in Turkey was announced on March 11, 2020. In this period, the government poised a curfew on the whole country which negatively affect export and import trading, tour sector, agriculture, manufacturing and transportation, leads to poverty and overloading hospitals. In addition, beginning in February 2020, crude oil and stock markets exposed to multiple shock waves, and financial volatility in BIST-100 stock exchange rise.

The research objectives are to organize a hypothetical and explanatory examination to illustrate the impact of Brent oil price variances on CPI, Total petroleum and other liquids production, natural gas import prices, Total industrial production index, and nominal exchange rate in Turkey by employing ECM model. Furthermore, the present research examines how cases of COVID-19 crisis influence the Turkish stock exchange and energy markets. Here, in order to represent the stock market, BIST-100 and VIX indexes will be used and for the energy market the research will use daily Brent oil prices. The Autoregressive Distributed Lag Model which allows investigating if the relationship among the indicators converges towards a long-term balance will be used. The study concentrated on these indexes as they are the most affected during the pandemic period. A tremendous decrease in crude oil prices with low demand as of the curfew restrictions applied in Turkey, lead not only to depreciation in Turkish lira, but also to a downturn in all economic sectors. Moreover, the pandemic leads to high uncertainty in economic activities which affected investors and traders' financial and economic expectations.

Several economists had analyzed various facts of Turkish economy at different periods of time, corresponding to crude oil prices fluctuations. In earlier research with various economic elements, the specific effect of crude oil price shocks on the Turkish economy has not been described. The research will be done basically by measurable and econometrical strategies. This study will add to the existing literature by bringing awareness to the significance of crude oil price shocks on the Turkish economy, by comprehensively analyzing most essential indicators economically and econometrically. Moreover, after comprehensive reviewing of previous literatures, this paper will be the first in literatures who studies COVID-19 impact on stock and energy markets after July/2020. We did not come across another research investigating a similar relationship for the same time period from the first announced case in

Turkey in March 11, 2020, until the beginning of vaccination in April 12, 2021, in the literature. As a result, we expand on (Albulescu, 2020a) and broaden his approach in several ways.

Based on our findings, it's critical to examine COVID-19's impact on a country's public health and well-being as well as its economics. Because following these economic shocks country's public health systems fail and result in the death of many citizens. According to McKibbin and Fernando (2020), if illnesses are caused by population growth in poor nations, poor public health may kill individuals, unless governments realized the need for public health and developed investment improvements, as a driver of GDP growth. Central banks must ensure that world economies should produce in the short term, while the long-term effects of the pandemic are more important. Moreover, most sectors have realized negative returns specially tour sector, transport, and sport sectors losing the most from BIST indexes during the pandemic (Karaca, et al.,2020).

The article summarizes the thorough and comprehensive analysis of the relationship among crude oil price fluctuations and Turkey's five important economic indicators. The second is focused on how the energy and stock markets are related, as well as how susceptible the coronavirus pandemic was. Comprehensive survey for previous litterateurs related to energy and stock market and their effect on the economic development of countries, especially for Turkey and detailed econometric models were estimated to illustrate Brent oil price shocks on economic development of Turkey.

RESULTS

The paper will examine in the *research model part 1*: the connection between crude oil price shocks and Turkey's economic indicators in the long-short run by estimating ECM models. Monthly Data of Analysis:

- Independent variable: (Brent_OP): Brent Crude Oil Price is calculated in US dollars per barrel.
- Dependent variables:
    1. (CPI): Inflation measured by Consumer Price Index is a measure that examines the weighted average of prices of a basket of consumer goods and services.

2. (TIP): Total Industrial Production Index is a monthly economic indicator that evaluates real output in manufacturing, mining, electricity, and gas to a base year.
3. (EX): Nominal Exchange Rate is measured per US dollar in national currency TRY/USD.
4. (TPP): Total Petroleum and Other Liquids Production (Crude oil, Natural gas, and other liquids).
5. (NG_IP): Natural Gas Import Price is calculated in US dollars per barrel.

Period of study is between Nov/2000–July/2021 with monthly basis of 249 observations; the period under consideration is 21 years. Brent oil prices, CPI and Total Industrial Production Index data were collected from the Federal Reserve Bank of St. Louis, nominal exchange rate TRY/USD were collected from Investing.com, Natural gas import prices data were collected from (Ychart, 2021), and Total Petroleum and Other Liquids production data were collected from US Energy Information Administration (EIA, 2021).An Auto Regressive Distributed Lag model (ARDL) is used to describe the impact of Brent oil price shocks on energy and Turkey's economic growth in the short and long run by estimating an error correction model (ECM). E-views software was used to analyze the data. Hypothesis of the study:

Hypothesis 1:

H_{01}: Brent crude oil price has no effect on CPI

H_{11}: Brent crude oil price has a positive effect on CPI

Hypothesis 2:

H_{02}: Brent crude oil price has no effect on Total Industrial Production Index

H_{12}: Brent crude oil price has a negative effect on Total Industrial Production Index

Hypothesis 3:

H_{03}: Brent crude oil price has no effect on exchange rate of TRY/USD

H_{13}: Brent crude oil price has a positive effect on exchange rate of TRY/USD

Hypothesis 4:

H_{04}: Brent crude oil price has no effect on Total petroleum and other liquids production

H_{14}: Brent crude oil price has a positive effect on Total petroleum and other liquids production

Hypothesis 5:

H_{05}: Brent crude oil price has no effect on natural gas import price

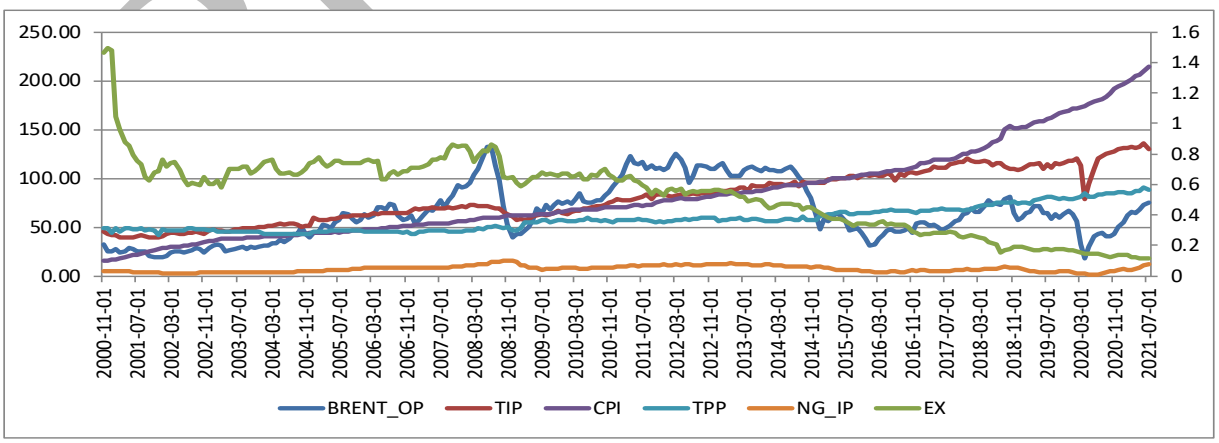
H_{15}: Brent crude oil price has a positive effect on natural gas import price

Marquez theory is the economic theory that supports this research (Marquez, 1986). Jaime Marquez created this model in 1986 as a follow-up to Metzler's (1950) work on worldwide oil price transmission routes (Tekgül, 2017). The model modifies Gökmenoğlu, et al. (2015) and Husaini and Lean, H. (2021) who examined oil price, CPI and exchange rate. The models are specified using Pesaran (2001), Shin, and Smith's ARDL technique to evaluate the short and long run connection between Brent oil prices and the studied economic indicators.

As shown in Figure 1, Brent oil price and CPI are moving together in the long run. Brent oil prices faced two crises, a financial crisis in 2008 and Saudi Arabia oil war with COVID-19 crisis in 2020. Moreover, CPI increased by 20% recently in 2021.Through the studied period total industrial production index have an upward trend with downturns followed by the increase in crude oil prices and other financial and health crisis as COVID-19 pandemic. The most affected indicator was the Turkish currency, which faced a decrease trend in nominal exchange rate of Turkish Lira (an increase in nominal exchange rate of dollar), that leads to reduce its real purchasing power. During the studied period Turkish lira was depreciated against US dollar sharply in 2018 and 2021. TPP has an upward trend with the increase in crude oil price in the long run, furthermore, natural gas import prices are moving together with Brent oil prices, with slightly downturns in extraordinary periods.

Figure 1

Evolution of Brent Oil Price with Economic Indicators of Turkey



Note. From Investing.com, Ychart.com, Bloomberg.com, and Federal Reserve Bank of Saint Louis, accessed on June 202020.

Section 1: Empirical Analysis of Stationarity of the Targeted Series

Following series are integrated of order one I (1), according to the Augmented Dickey Fuller and Phillips-Perron unit root tests. Brent oil price, CPI, EX, NG_IP, TPP, and TIP are all significant at 5% significant level at the first difference. Table 1 displays the results of the two tests.

Table 1

Unit Root Test for Each Economic Indicator

	Brent	CPI	EX	NG_IP	TIP	TPP
ADF level	-2.642719	5.084965	-5.211795	-2.230755	-4.876192	-2.495797
ADF first I (1)	-10.49003*	-4.560335*	-13.03655*	-5.247630*	-11.72970*	-20.77690*
Phillips-Perron level	-2.025282	5.901684	-5.278448	-2.027194	-4.741560	-2.023372
Phillips-Perron I (1)	-9.960151*	-9.925828*	-13.17350*	-11.30000*	-20.23768*	-22.62136*

Note. * t-statistic means significance at 1%, 5% and 10%; created by using Eviews 10

Section2 : Autoregressive Distributed Lag Model Estimation Procedure

1- Lag Selection of ARDL Model

In the first step the ARDL Model order is determined. ARDL models are devoid of residual correlation, according to Pesaran (2001) theory. As a result, there are no endogeneity difficulties with proper lag selection. Theory employs a linear transformation to incorporate short-run changes into the long-run equilibrium, and perhaps an Error Correction Modulation. As in table 2, the model with the minimum value of both information criteria AIC and SIC is chosen.

Table 2

Lag Structure Criteria Selection of ARDL Model

Model	Number of lags	Lag Structure Criteria	
		AIC	SIC
CPI	P = 6	2.418670*	2.592187
TIP	P = 4	5.196410*	5.312354
NG_IP	P = 5	1.435814*	1.586357
TPP	P =2	3.366403*	3.476312
EX	P =2	-4.567534*	-4.456852

Note. AIC information criterion using VAR model estimate is the foundation for selecting the best lag, created by using Eviews 10

F-statistic of Wald and Bound tests are used to confirm the presence of long-run correlation. To assess for residual serial correlation, a set of post-estimation tests are conducted (Breusch-Godfrey LM test) and CUSUM test check the stability of the models.

2- Testing for Cointegration Relationship

The second step in estimating the best ARDL model is to check for the presence of a long-run connection. Bound test assumes a lower bound for I (0) series and an upper bound for I (1) series, with critical values determined from Narayan (2005), as shown in Table 3. Moreover, Wald test assumes that the null hypothesis is:

H_0: $P_1 = P_2 = P_3 = P_4 = P_5 = P_6 = 0$

H_1: at least one of the p parameters not equal to zero

Table 3

Robustness Analysis for Long-Run relationship

Wald test

Model specification	F-statistic	Probability	Conclusion
CPI	F_{CPI}= 1360.787	0.0000	cointegration
EX	F_{EX}= 249.8974	0.0000	cointegration

NG_IP	F_{NG_IP}= 129.3845	0.0000	cointegration
TIP	F_{TIP}= 524.4918	0.0000	cointegration
TPP	F_{TPP}= 879.4072	0.0000	Cointegration

Bound test

Model specification	F-statistic	Critical values		Conclusion
		Lower bound I (0)	Upper bound I (1)	
CPI	F_{CPI}= 18.95157	2.62	3.79	Cointegration
EX	F_{EX}= 10.60152	2.62	3.79	Cointegration
NG_IP	F_{NG_IP}= 9.771838	2.62	3.79	Cointegration
TIP	F_{TIP}= 2.544455	2.26	3.35	Cointegration at 10% significant level
TPP	F_{TPP}= 4.802198	2.62	3.79	Cointegration

Note. (i) Probability at 5% significance level, created by using Eviews 10

3. Autoregressive Distributed Lag Model (ARDL) Estimation

1- ECM Equation for CPI is:

$$\Delta CPI_t = 1.25652751\Delta CPI_{t-1} - 0.45349160\Delta CPI_{t-2} + 0.33076479\Delta CPI_{t-3} - 0.31386299\Delta CPI_{t-4} + 0.148162802\Delta CPI_{t-5} + 0.0610112103\Delta CPI_{t-6} - 5.14314505\Delta EX_{t-1} - 1.35324865\Delta EX_{t-2} + 0.728841702\Delta EX_{t-3} - 1.1239078024\Delta EX_{t-4} - 2.677958196\Delta EX_{t-5} - 0.25446029\Delta EX_{t-6} - 0.85888689ECT1_{t-1} + \varepsilon_t \quad (1)$$

Where:

- The error term is denoted ε
- Short-run terms are represented byΔ
- The largest number of lags is (i = 6)
- The adjustment speed parameter is θ, which stands for the error correction term (ECT), should be significant and negatively skewed in order to support the long-term relationship. The residual that needs to be taken out of the long run model is ECT.

Where, ECT1 means that the deviations of CPI need 8.58% speed toward long run equilibrium. There is a positive long-run correlation between Brent oil prices and CPI controlling for EX, TPP, TIP, and NG_IP was observed in Model 1. Moreover, the positive direction of the causal effect of the exchange rate on CPI was observed by Johansen cointegration test with a negative sign of its coefficient (-192.7611).

2- ECM Equation for Total Industrial Production Index is:

$$\Delta TIP_t = 0.17564\Delta Brent\_op_{t-1} - 0.024395\Delta Brent\_op_{t-2} + 0.0058\Delta Brent\_op_{t-3} - 0.071251\Delta Brent\_op_{t-4} + \ 0.440080\Delta TIP_{t-1} - 0.171496\Delta TIP_{t-2} - 0.149775\Delta TIP_{t-3} - 0.071130\Delta TIP_{t-4} - 0.634615ECT2_{t-1} + \varepsilon_t \quad (2)$$

ECT2 means that the deviations of TIP need 6.34% speed toward long run equilibrium. Brent oil price has a negative impact on TIP index in the long run and the short run. The causal effect direction between Brent oil price and TIP index was observed by Johansen cointegration test by the normalized cointegration coefficients opposite sign (0.207837). The lags of Brent and TIP, on the other hand, all had F values higher than 1.96 and were jointly significant for the short run lagged variables.

3- ECM Equation for Natural Gas Import Price is:

$$\Delta NG\_IP_t = -0.631767\Delta EX_{t-1} - 1.496637\Delta EX_{t-2} + 0.42682\Delta EX_{t-3} + 0.73413\Delta EX_{t-4} - 0.437423\Delta EX_{t-5} - 0.723058ECT3_{t-1} + \varepsilon_t \quad (3)$$

Brent oil price has a rather positive impact on natural gas import prices in the long run, whereas the effect is insignificant in the short run. The causal effect direction between Brent oil price and NG_IP was observed by Johansen cointegration test by the normalized cointegration coefficients opposite sign (-0.060675). In Model 3, the long run relationship can be approved by looking at the lag of the error correction term (ECT3) probability 0.0006 at 5% significant level with a negative sign for its coefficient (-0.723058). Moreover, a positive ceteris paribus effect of the exchange rate on NG_IP was observed by Johansen cointegration test with the opposite negative sign of its coefficient (-82.01635).

4- ECM Equation for TPP is:

$$\Delta TPP_t = -0.338062ECT4_{t-1} + \varepsilon_t \quad (4)$$

There is a positive correlation between Brent oil price and total petroleum and other liquid production of Turkey in the long run. ECT4 means that the deviations of TPP needs 3.38% speed toward long run equilibrium. The causal effect direction between Brent oil price and TPP was observed by Johansen cointegration test by the normalized cointegration coefficients opposite sign (-0.031379).

5- ECM Equation for Exchange Rate (TRY/USD) is**:**

$$\Delta EX_t = 0.000966\Delta Brent\_op_{t-1} + 0.000376\Delta Brent\_op_{t-2} + 1.743502\Delta EX_{t-1} - 0.028286\Delta EX_{t-2} - 1.944663ECT5_{t-1} + \varepsilon_t \quad (5)$$

Brent oil price has a positive impact on exchange rate (TRY/USD) in the long run and short run. The causal effect direction between Brent oil price and EX was observed by Johansen cointegration test by the normalized cointegration coefficients opposite sign (-0.00033). As Brent oil prices increase, the Turkish lira is depreciated against the US dollar.

Research Model Part 2: investigates the relationship among COVID-19 with oil price, Volatility of Stock Price Index, and Borsa Istanbul. The Period of study is between Mar 11/2020 – April 12/2021 with daily basis of 284 observations. The COVID-19 data were collected from (WHO, 2021) and other data were from (Federal Reserve Bank of St. Louis, 2021), (Bloomberg, 2021), and (Investing, 2021). An Auto Regressive Distributed Lag model (ARDL) is used to describe the impact of COVID-19 on energy and stock markets in the short and long run. Daily Data of the model:

- Independent variable: COVID-19 is the number of confirmed infected cases in Turkey.

- Dependent variables:
    1. Oil price: Brent crude oil prices
    2. Volatility of stock price index (VIX): the fear or uncertainties about the markets influence the sectors operating in Turkey on each specific day.

3. Borsa Istanbul index (BIST-100): the major stock exchange index comprised of 100 industry leading companies in Turkey.

Hypothesis of the study:

Hypothesis 6:

H06: coronavirus active cases do not affect crude oil prices.

H16: coronavirus active cases affect crude oil prices.

Hypothesis 7:

H07: coronavirus active cases do not affect VIX

H17: coronavirus active cases affect VIX

Hypothesis 8:

H08: coronavirus active cases do not affect BIST-100

H18: coronavirus active cases affect BIST-100

Modeling the Effect of COVID-19 on Brent Oil Price, VIX, and BIST-100 Indexes:

Section 1: Empirical Analysis of Stationarity of the Targeted Series

Following series are integrated of order one I (1), according to the Augmented Dickey Fuller and Phillips-Perron unit root tests. Brent oil price, VIX, COVID-19, and BIST-100 are all significant at 5% significant level at the first difference. Table 4 lists the outcomes of the two tests.

Table 4

Unit Root Tests of Brent/VIX/BIST-100/COVID-19

	BRENT	COVID-19	VIX Index	BIST-100 Index
ADF level	-2.6859	-1.5406	-3.1046	-1.6416
ADF first I (1)	-8.3685*	-4.5897**	-5.8196***	-7.2358***
Phillips-Perron level	-2.382087	-0.757342	-3.968922	-2.098817
Phillips-Perron I (1)	-18.28814*	-14.15927**	-23.3035***	-17.43453***

Note. t-statistic ***, ** and * means significance at 1%, 5% and 10%, created by using Eviews 10

Section 2: Autoregressive Distributed Lag Model Estimation Procedure Steps

1- Lag Selection of ARDL Model

In the first step the ARDL Model order is determined. As in Table 5, the model with the minimum value of both information criteria AIC and SIC is chosen. The following Table 5 gives the values of the two criteria for the different three models at p = 2, 4, and 6 lags. As can be seen in Table 5 all three models are of lag 4.

Table 5

Lag Structure Criteria Selection of ARDL Model

Number of lags	Model 1: Brent Oil Price		Model 2: VIX Index		Model 3: BIST-100 Index	
	AIC	Schwartz	AIC	Schwartz	AIC	Schwartz
P = 6	3.584484	3.950811	5.232386	5.598713	8.756333	9.122660
P = 4	3.538118*	3.79842	5.193960*	5.454262	8.714908*	8.975210
P = 2	3.566290	3.721665	5.248638	5.430850	8.735304	9.047666

Note. AIC information criteria serves as the foundation for choosing the best lag; all ARDL models are consist of 4 lags, created using Eviews 10

2-Testing for Cointegration Relationship

Bound tests were utilized in the study with critical values determined from Narayan (2005), as shown in Table 6. Wald test assumes that the null hypothesis is:

H_0: $p_1 = p_2 = p_3 = p_4 = 0$

H_1: at least one of the p parameters not equal to zero

Table 6

Robustness Analysis for Long-Run relationship

Wald test

Model	F-statistic	Probability	Conclusion
Brent	F_{BRENT}=3.981369	0.0037	Cointegration
VIX Index	F_{VIX}= 5.419569	0.0003	Cointegration
BIST100 Index	$F_{BIST100}$=1.772855	0.1347	No cointegration

Bound test

Model	F-statistic	Critical values		Conclusion
		Lower bound I (0)	Upper bound I (1)	
Brent	F_{BRENT}=3.123709	2.72	3.77	Cointegration at 10% significance
VIX Index	F_{VIX}= 3.467316	2.72	3.77	Cointegration at 10% significance
BIST100 Index	$F_{BIST100}$=0.744198	2.72	3.77	No cointegration

Note. Probability is at 5% significance level.

3- Autoregressive Distributed Lag Model (ARDL) Estimation:

1. ECM Model Equation for Brent oil price is:

$$\Delta \text{Brent}_t = -0.066100 \text{ECT}_{1t-1} + \varepsilon_t \quad (6)$$

The lagged ECT_1 probability 0.0006 at 5% level with a negative sign for its coefficient, which means that the deviations of Brent oil prices need 6.61% speed toward long run equilibrium. There is a negative long-run correlation between Brent oil prices and coronavirus daily infected cases controlling for VIX and BIST-100 index was observed in Model 1.

2- ECM Model Equation for VIX Index is:

$$\Delta \text{VIX}_t = 0.00617\Delta \text{BIST100}_{t-1} + 0.0142\Delta \text{BIST100}_{t-2} + 0.0084\Delta \text{BIST100}_{t-3} - 0.0264\Delta \text{BIST100}_{t-4} - 0.268\Delta \text{vix}_{t-1} + 0.2118\Delta \text{vix}_{t-2} + 0.2204\Delta \text{vix}_{t-3} - 0.04251\Delta \text{vix}_{t-4} - 0.09688\text{ECT}_{2t-1} + \varepsilon_t \quad (7)$$

ECT_2 of 9.6% with a probability of 0.0007 suggests that the coefficient is significant at 5% level with a negative sign, which indicates a positive long run relationship between VIX Index and COVID-19.For short run coefficients in Model 2, Wald test results illustrates that, the F-statistics = 2.54 and 14.03 > 1.96 for BIST-100 and VIX indexes, respectively, which indicated that there is a negative ceteris paribus impact from BIST-100 to VIX in the short run.

3- Short-run ARDL Model Equation for BIST-100 Index is:

$$\Delta BIST100_t = 0.987135\Delta BRENT_{t-1} - 0.247846\Delta BRENT_{t-2} + 2.308225\Delta BRENT_{t-3} + 0.777118\Delta BRENT_{t-4} - 0.0010035\Delta COVID19_{t-1} - 0.00098859\Delta COVID19_{t-2} + 0.00039\Delta COVID19_{t-3} - 0.00044226\Delta COVID19_{t-4} + \varepsilon_t \quad (8)$$

There are two short run ceteris paribus effects, a direct effect from Brent oil prices to BIST-100 index and another negative effect from COVID-19 number of infected cases to BIST-100 Index. This result was tested by Wald test for joint significance and shows F-statistic values of 2.75, 2.55 > 1.96 for Brent and COVID-19, respectively.

DISCUSSION

The paper suggests new topics for future research and better managerial implications for policy makers. For instance, Turkey must look forward to alternate energy sources for long-term macroeconomic performance in order to control the impact of oil-gas price shocks on economic growth and price inflation. Turkey can increase domestic renewable energy sources and nuclear power in the national energy market, to reduce its reliance on imported energy, natural gas and oil pipeline projects will help to achieve this goal. However, exchange rate has a greater impact on price inflation than the price of oil. As a result, monetary policy aimed at strengthening the currency is beneficial to price stability's strong currency boosts export competitiveness by lowering the cost of imported inputs. For that, Economies of Scale will result in the ability of creating more units of product on a greater scale with lower input costs. Moreover, the government should support the Turkish lira including the launch of new programs to protect deposits against currency depreciation. Furthermore, government must measure the risks and costs of natural gas imports to reduce risk of investment and ensure the security of natural gas supply. This study contribution is to cover a large period to get data on COVID-19 that is to give strong policy implications for policymakers, investors, and companies in their decision-making process. The pandemic caused Turkey's government to implement both urgent short-

term loan possibilities and long-term alternatives for direct income support, tax deferrals, and interest rate modifications in response to the crisis.

However, the paper had some limitations. The study estimated Turkey's total industrial production index, as a proxy for GDP sine monthly data for Turkish GDP is unavailable. European natural gas import prices were estimated as a proxy for Turkey's natural gas import prices since Turkey's data are unavailable. After comprehensive research, there are scarcity in studies in the literature which studied the total petroleum and other liquids production of Turkey. That is probably because Turkey is highly dependents on oil imports as an oil importing country. Moreover, the study examines the daily infected cases impact on stock and energy indexes, for that reason the study chose only VIX and BIST-100 indexes as they are available in daily basis, as most variables are afforded in monthly or quarterly basis. Since data for BIST-100, VIX, and Brent oil price, could not be accessed for weekends, only weekday data is used. As a result, the weekends and official holidays are not included in the study. As can be seen that the effect of this pandemic is continued but with less announcements, and this is other limitation of the study is that this pandemic is endless until this period. The crisis of COVID-19 pandemic is still hitting Asia and Europe economies more than other countries (McKinsey and Company, 2022), which make it argent to shed a light on the economic risk responses of the pandemic for these countries. Prospective research should be used to develop long-term solutions, such as identifying oil alternatives, to reduce the industrial sector's reliance on fossil fuels. Future studies may look at the link between these variables while accounting for any structural and extraordinary outbreaks. Moreover, researchers should put an eye on greenhouse projects and make more research for circular economy, besides socioeconomic development studies. For example, one of the achievements of the Turkish Government is TOGG vehicles in Oct 2022 (Ozbek, 2022), which is the first electric car domestically produced in Turkey. This achievement helps in reducing the consumption of oil and fossil fuels, makes a defense against depreciation in Turkish lira and the huge inflation in Turkey. Looking Forward for positive effects of COVID -19, specially in circular economy, and study the period of 2022 and how the pandemic still indirectly affect price inflation and national currency are from the essential future economic topics.

CONCLUSION

PART 1: Brent oil price Impact on Economic Indicators of Turkey

Crude oil price shocks have an impact on economic growth over such a lengthy period, through manufacturing inputs that has a long-term impact on economic development of Turkey, which lacks energy resources. The paper investigates a positive relationship between Brent oil price and inflation rate in the long run. This result is consistent with previous literatures of Al Rasasi and Yilmaz. (2016); Bhattacharjee (2013); Gökmenoğlu, et al. (2012); Çelik, and Akgül (2011); and Aktaş, et al. (2010). Moreover, the exchange rate positively affects CPI in the short run. Exchange rate acts as an intermediate among oil prices and inflation. Recently, Turkish currency depreciated against US dollar significantly that increases the price inflation in Turkey.

Oil price variations negatively affect Turkey's total industrial production index. Findings are like those of Serletis and Shahmoradi (2005); Ewing and Thompson (2007). Turkey lacks sufficient fossil fuel resources, and its economy is largely reliant on importing crude oil, for which there is currently no substitutes. The industrial sector's reliance on imported crude oil puts the country sensitive to fluctuations in oil prices. Brent oil price and exchange rate showed positive impact on natural gas import prices. These results are consistent with Geng, et al (2016) and Panagiotidis and Rutledge (2007). This depends on the impact of inflation in increasing oil price and the degree to which natural gas import prices are increasing in response to an increase in oil price. Other factor is the elasticity of natural gas demand in response to changes in crude oil price and the impact of higher prices of other types of alternative energy.

A positive long run relationship between Brent oil price and total petroleum and other liquids production was investigated. After comprehensive research, the literature scarce studies about this indicator, probably because Turkey is highly dependents on oil imports as an oil importer. A positive long run correlation between Brent oil price shocks and the exchange rate (TRY/USD). This result is consistent with Al Rasasi and Yilmaz (2016), Akçelik and Ogünç (2016), Eryigit (2012), Köse and Emre (2021), and Doğan, et al. (2012). The results proved by the short-run deviations that are around two periods away from reaching the long-run equilibrium. Secondly, Turkish currency depreciation versus US dollar has recently intensified, which is associated with rising crude oil and commodity prices.

PART 2: COVID-19 Impact on Stock and Energy Markets

The research found that oil market is adversely affected by the increase in COVID-19 infections in the long run. In this way the negative results for previous literatures, such as Albulescu (2020b) can be explained. On the other hand, Aydın and Ari (2020); Mckibbin and Fernando (2020); Mzoughi, et al (2020); and Gherghina, et al. (2020), investigated a negative short run relationship between oil prices and COVID-19. During pandemic, oil importing countries like Turkey benefited from the reduction in oil prices to import and fill its inventory of oil, the pandemic affected oil exporters by reducing the supply, and importers in a way that demand declined because of the restrictions applied by the government to reduce infected cases. As the supply and demand decreased and the inventories of energy saturated, these reasons lead crude oil prices to take positive trend to reach pre-pandemic prices at 62$ per barrel.

The new COVID-19 conditions had a greater effect on stock market uncertainty compared to Brent oil price shocks (Sarı and Kartal, 2020). Investors' propensities are likely to shift as more information about the number of infections, vaccinations, and treatment for the virus become more reachable in Turkey. The Turkish stock market's declining VIX index in the long run has a strong and important relationship with other sectors. This because the foreign market's growing uncertainty draws foreign investors to the Turkish market as it is considered as more stable economy with high level of tourism returns. However, the increase in the number of infected cases has a temporary reduction effect on BIST-100 index, the markets mostly valued the effects of the pandemic in the second period, and then the index began to rebound. That can be approved by the significance of the second lag of COVID-19 indicator in the short run ARDL model, matching results with Özkan (2020).

REFERENCES AND NOTES

Aktaş, E., Özenç, Ç, and Arıca, F. (2010). The Impact of Oil Prices in Turkey on Macroeconomics. *Research Gate*. Retrieved on April 8, 2020 https://www.researchgate.net/publication/48375482_The_Impact_of_Oil_Prices_in_Turkey_on_Macroeconomics

Akçelik, F. and Ogünç, F. (2016). Pass-through of crude oil prices at different stages in Turkey. *Central Bank of the Republic of Turkey*, *Research and Monetary Policy Department,* Central Bank Review,16(1), 41-51. Retrieved on April 9, 2020 doi.org/10.1016/j.cbrev.2016.03.004

Al Rasasi, M. and Yilmaz, M. (2016). The Effects of Oil Shocks on Turkish Macroeconomic Aggregates. *International Journal of Energy Economics and Policy*, 2016, 6(3), 471-476. Retrieved on March 30, 2020, https://econpapers.repec.org/article/ecojourn2/2016-03-12.htm

Albulescu, C. (2020a). Coronavirus and oil price crash. *Hal Open Science*, Hal archives-ouvertes 02507184. Retrieved on April 3, 2020, https://hal.archives-ouvertes.fr/hal-02507184v2

Albulescu, C. (2020b). COVID-19 and the United States financial markets' volatility. *Finance Research Letters,* 38, January 2021, 101699. Retrieved on June 20, 2020, doi.org/10.1016/j.frl.2020.101699

Aydın, L. and Ari, I. (2020). The impact of Covid-19 on Turkey's non-recoverable economic sectors compensating with falling crude oil prices: A computable general equilibrium analysis. *Energy Exploration and Exploitation*, 38(5). Retrieved on Nov 27, 2020, doi.org/10.1177/0144598720934007

Bhattacharjee, P. (2013). *A study of the impact of crude oil prices on Indian economy*. Doctoral dissertation, DY Patil University, established under section 3, no. f.9-21/2000-u.3, India. Retrieved on April 2, 2020 http://www.dypatil.edu/schools/management/wp-content/uploads/2015/05/a-study-of-the-impact-of-crude-oil-prices-on-indian-economy-pankaj-bhattacharjee.pdf

Bloomberg (2021). Erdogan unveils extraordinary steps to protect Turkish lira savings. Retrieved on Dec 21, 2021 https://finance.yahoo.com/news/erdogan-unveils-extraordinary-steps-protect-175311977.html?guccounter=1

Çelik, T. and Akgül, B. (2011). Changes in Fuel Oil Prices in Turkey: An Estimation of the Inflation Effect Using VAR Analysis. *Journal of Economics and Business*, volume XIV-2011, Erciyes University, No. 2 (11-21). Retrieved on April 2, 2020 https://www.semanticscholar.org/paper/Changes-in-Fuel-Oil-Prices-in-Turkey%3A-An-Estimation-%C3%87elik-Akg%C3%BCl/51a329b98ebd5ba3104ce4d9c60d82ef558f4a18

Doğan, S., Ustaoğlu, M., and Demez, S. (2012). Relationship between Real Oil Price and Real Exchange Rate: The Case of Turkey. *Procedia - Social and Behavioral Sciences*, *Science Direct*, volume 58, 12 October 2012, Pages 1293-1300. Retrieved on 9 Nov, 2020 from doi.org/10.1016/j.sbspro.2012.09.1112

Eryigit, M. (2012). The Dynamical Relationship between Oil Price Shocks and Selected Macroeconomic Variables in Turkey. *Economic Research Journal*, 25, 263-276. Retrieved on April 4, 2020, doi.org/10.1080/1331677X.2012.11517507

Ewing, B. and Thompson, M. (2007). Dynamic Cyclical Co-movements of Oil Prices with Industrial Production, Consumer Prices, Unemployment, and Stock Prices. *Energy Policy*, 35 (11), pages 5535-5540. Retrieved on April 4, 2021, doi.org/10.1016/j.enpol.2007.05.018

Federal Reserve Bank of St. Louis (2021). Economic Research. Retrieved on 30 Nov, 2021 from https://fred.stlouisfed.org

Geng, J., Qiang Ji, and Fan, Y. (2016). How regional natural gas markets have reacted to oil price shocks before and since the shale gas revolution: A multi-scale perspective. *Journal of Natural Gas Science and Engineering*, 36, Part A, November 2016, Pages 734-746, Elsevier. Retrieved on April 4, 2021doi.org/10.1016/j.jngse.2016.11.020

Gherghina Ș., Armeanu D., and Joldeș, C. (2020). Stock market reactions to covid-19 pandemic outbreak: quantitative evidence from ARDL bounds tests and granger causality analysis. *Int J Environ Res Public Health*, 2020 Sep 15; 17(18):6729. Retrieved on 3, Nov, 2021 from doi.org/10.3390/ijerph17186729

Gokmenoglu, K., Azin, V., and Taspinar, N. (2012). The Relationship between Industrial Production, GDP, Inflation and Oil Price: The Case of Turkey. *Procedia Economics and Finance*, 25, Pages 497-503. Retrieved on April 25, 2020 doi.org/10.1016/S2212-5671(15)00762-5

Hamilton, J. (1983). Oil and the Macro Economy since World War II. *Journal of Political Economy,* volume 91(2):228-48. Retrieved on April 3, 2020 from doi.org/10.1086/261140

Husaini and Lean, H. (2021). Asymmetric Impact of Oil Price and Exchange Rate on Disaggregation Price Inflation. *Resources Policy*, 73, 102175. Retrieved on Nov, 2021 doi.org/10.1016/j.resourpol.2021.102175

International Energy Agency (2020). Oil 2020, Fuel report, March 2020. Retrieved on March 30, 2020 https://www.iea.org/reports/oil-2020

Investing (2021). Exchange Rate Lira to Dollar Data. Accessed on Nov 2021 https://www.investing.com/currencies/try-usd-historical-data

Karaca, S., et al. (2020). The Impact of the COVID-19 (Coronavirus) on the Borsa Istanbul Sector Index Returns: An Event Study. *Gaziantep University Journal of Social Sciences*, PP. 14-41. Retrieved on June 12, 2021 https://doi.org/ 10.21547/jss.73198

Köse, N. and Emre, Ü. (2021). The effects of the oil price and oil price volatility on inflation in Turkey. *Energy Journal*, 226, 120392. Retrieved on Nov 12, 2021 doi.org/10.1016/j.energy.2021.120392

Marquez, J. (1986). Oil-price effects in theory and practice. *Journal of Development Economics,* 24 (1), November 1986, Pages 1-27. Retrieved on Nov 5, 2020 doi.org/10.1016/0304-3878(86)90142-2

McKibbin,W.and Fernando, R. (2020). The global macroeconomic impacts of covid-19: seven scenarios. *CAMA Working Paper*, March 2, 2020, No. 19. Retrieved on Jan 12, 2021 https://ssrn.com/abstract=3547729 or dx.doi.org/10.2139/ssrn.3547729

Mckinsey and Company (2022). The Coronavirus Effect on Global Economic Sentiment. Sep 2022. Retrieved on Nov 5, 2022 https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/the-coronavirus-effect-on-global-economic-sentiment

Mzoughi, H., Urom, C., Uddin, G., and Guesmi, K. (2020). The effects of covid-19 pandemic on oil prices, co_2 emissions and the stock market: evidence from a VAR model. University of Tunis Carthage-Carthage Business School, Tunisia, ssrn.com/abstract=3587906. Retrieved on Nov. 2, 2020 doi.org/10.2139/ssrn.3587906

Narayan, P. (2005). Reformulating Critical Values for the Bounds F- statistics Approach to Cointegration. Retrieved on May 25, 2021 https://www.researchgate.net/figure/Critical-values-for-the-F-test_tbl1_268048533

OPEC (2020). The OPEC Award for the Best Energy Research Institute 2023. Retrieved on April 10, 2020 https://www.opec.org/opec_web/en/

Organization of the Petroleum Exporting Countries (2020). Turkey Crude Oil, Production 1960 – 2018, Yearly Barrel/Day. Retrieved on April 2, 2020 https://www.ceicdata.com/en/indicator/turkey/crude-oil-production

Organization of the Petroleum Exporting Countries (2020). Turkey Crude Oil: Imports. Retrieved on May, 2020 https://www.ceicdata.com/en/indicator/turkey/crude-oil-imports

Ozbek, I. (2022). Erdogan rolls out first Turkish EV ahead of elections. Bloomberg. Retrieved on Nov 3, 2022 https://www.bloomberg.com/news/articles/2022-10-29/erdogan-set-to-roll-out-first-turkish-ev-ahead-of-elections?leadSource=uverify%20wall

Özkan, O. (2020). Volatility Jump: The Effect of COVID-19 on Turkey Stock Market. *Gaziantep University Journal of Social Sciences*, 19, COVID-19 Special Issue, P. 386 - 397. Retrieved on March 30, 2021 https://doi.org/10.21547/jss.766890

Panagiotidis, T. and Rutledge, E. (2007). Oil and gas markets in the UK: Evidence from a co integrating approach. *Energy Economics*, 29, pp. 329-347. Retrieved on May 16, 2021 doi.org/10.1016/j.eneco.2006.10.013

Peseran (2001). *Bound Test and ARDL cointegration Test*. Retrieved on April 30, 2021 https://www.researchgate.net/publication/322208483_Peasaran_et_al_2001_Bound_Test_and_ARDL_cointegration_Test

SARI, S. and Kartal, T. (2020). The Relationship of COVID-19 Pandemic with Gold Prices, Oil Prices and VIX Index. *Erzincan University Journal of Social Sciences Institute*, Vol. 13, No. 1, P. 93-109. Retrieved on Nov 30, 2020 from doi.org/10.46790/erzisosbil.748181

Serletis, A. and Shahmoradi, A. (2005). Business Cycles and Natural Gas Prices. *OPEC Review*, P.75-84. Retrieved on Nov 30, 2020 from https://doi.org/10.1142/9789812770462_0007

Tekgül, Y. (2017). The Herberger-Laursen-Metzler effect: an econometric analysis on Turkish economy. *Yönetim Ve Ekonomi*, 24(2), Manisa Celal Bayar University. Retrieved on Nov 1, 2020 from https://dergipark.org.tr/tr/download/article-file/336228

U.S. Energy Information Administration EIA (2021). Retrieved on Nov 7, 2021 from https://www.eia.gov/international/data/country/TUR

World Health Organization (2020). Coronavirus Disease. Retrieved on April 10, 2020 from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen

World Health Organization (2021). Coronavirus disease (COVID-19): Vaccines, Oct 28, 2020. Retrieved on April 10, 2021 from https://www.who.int/news-room/q-a-detail/coronavirus-disease-(covid-19)-vaccines

Ychart (2021). European natural gas import prices. Accessed on Nov, 9, 2021 from https://ycharts.com/indicators/europe_natural_gas_price

NOTE 1. Econometrical Results of Brent Oil Price and Economic Indicators

Table 1

Estimation of Model 1: CPI ARDL Specification

Model 1: Consumer Price Index (CPI)		
Long-Run Equation		
	coefficient	Prob.
CPI (-1)	1.009626	0.0000
BRENT_OP (-1)	-0.004882	0.1974
EX (-1)	-0.333691	0.4905
NG_IP (-1)	0.013080	0.7046
TIP (-1)	-0.006696	0.3488
TPP (-1)	0.016309	0.2086
Short-Run Equation		
	ECM Model (long-run)	
D (CPI (-1))	1.256528	0.0000*
D (CPI (-2))	-0.453492	0.0000*
D (CPI (-3))	0.330765	0.0001*
D (CPI (-4))	-0.313863	0.0004*
D (CPI (-5))	0.148163	0.0746*
D (CPI (-6))	0.061011	0.4020*
D (EX (-1))	-5.143145	0.0142*
D (EX (-2))	-1.353249	0.5202*
D (EX (-3))	0.728842	0.7304*
D (EX (-4))	-1.123908	0.4500*
D (EX (-5))	-2.677958	0.0709*
D (EX (-6))	-0.254460	0.8586*
ECT1(-1)	-0.858887**	0.0000**
Test		
Serial correlation	NO	
Stability	YES	

Notes: (i) ** denotes the long-term relationship's significance of the error correction term at 5%.; (ii) * Wald test for the variable lags' combined significance in the short-run relationship; (iii) For serial correlation, the Breusch-Godfrey LM test is utilized; (iv) CUSUM tests are performed to assess stability; (v) The residuals will be extracted using long-run equations to build the ECT.

Table 2

Estimation of Model 2: TIP ARDL

Model 2: Total Industrial Production Index (TIP)		
Long-Run Equation		
	Coefficient	Prob.
CPI (-1)	0.040930	0.0886
BRENT_OP (-1)	0.026715	0.0582
EX (-1)	-2.349962	0.2635
NG_IP (-1)	-0.177190	0.1684
TIP (-1)	0.913637	0.0000
TPP (-1)	-0.028812	0.6918
Short-Run Equation		
	ECM Model (long-run)	
D (BRENT__OP (-1))	0.175644	0.0000*
D (BRENT__OP (-2))	-0.024395	0.5771*
D (BRENT__OP (-3))	0.005808	0.8928*
D (BRENT__OP (-4))	-0.071251	0.0933*
D (TIP (-1))	0.440080	0.1608*
D (TIP (-2))	-0.171496	0.0147*
D (TIP (-3))	-0.149775	0.0298*
D (TIP (-4))	-0.071130	0.2935*
ECT2 (-1)	-0.634615**	0.0458**
Test		
Serial correlation		NO
Stability		YES

Notes: (i) ** denotes the long-term relationship's significance of the error correction term at 5%.; (ii) * Wald test for the variable lags' combined significance in the short-run relationship; (iii) For serial correlation, the Breusch-Godfrey LM test is utilized; (iv) CUSUM tests are performed to assess stability; (v) The residuals will be extracted using long-run equations to build the ECT.

Table 3

Estimation of Model 3: NG_IP ARDL Specification

Model 3: Natural Gas Import Price (NG_IP)		
Long-Run Equation		
	coefficient	Prob.
CPI (-1)	0.007412	0.0599
BRENT_OP (-1)	0.010754	0.0000
EX (-1)	1.248453	0.0003
NG_IP (-1)	0.885671	0.0000
TIP (-1)	0.004237	0.3456
TPP (-1)	-0.015556	0.1920
Short-Run Equation		
	ECM Model (long-run)	
D (EX (-1))	-0.631767	0.6228*
D (EX (-2))	-1.496637	0.2622*
D (EX (-3))	0.426829	0.6464*
D (EX (-4))	0.734134	0.4286*
D (EX (-5))	-0.437423	0.6237*
ECT3(-1)	-0.723058**	0.0006**
Test		
Serial correlation	NO	
Stability	YES	

Notes: (i) ** denotes the long-term relationship's significance of the error correction term at 5%.; (ii) * Wald test for the variable lags' combined significance in the short-run relationship; (iii) For serial correlation, the Breusch-Godfrey LM test is utilized; (iv) CUSUM tests are performed to assess stability; (v) The residuals will be extracted using long-run equations to build the ECT.

Table 4

Estimation of Model 4: TPP ARDL Specification

Model 4: Total Petroleum and Other Liquid Production (TPP)
Long-Run Equation

	coefficient	Prob.
CPI (-1)	0.034682	0.0009
BRENT_OP (-1)	0.000282	0.9627
EX (-1)	0.039111	0.9654
NG_IP (-1)	-0.041603	0.4506
TIP (-1)	0.006163	0.6005
TPP (-1)	0.865900	0.0000
Short-Run Equation		
	ECM Model (long-run)	
ECT4 (-1)	-0.338062*	0.0000*
Test		
Serial correlation	NO	
Stability	YES	

Notes: (i) * means significance of the error correction term at 5% in the long-run relationship; (ii) Breusch-Godfrey LM test for serial correlation is used; (iii) CUSUM tests are used to check the stability; (iv) long-run equations are to extract the residuals to create the ECT.

Table 5

Estimation of Model 5: EX (TRY/USD) ARDL Specification

Model 5: Exchange Rate (TRY/USD)		
Long-Run Equation		
	coefficient	Prob.
CPI (-1)	0.000192	0.4520
BRENT_OP (-1)	0.000353	0.0189
EX (-1)	0.853223	0.0000
NG_IP (-1)	-0.001216	0.3735
TIP (-1)	-0.000700	0.0169
TPP (-1)	-0.001869	0.0162
Short-Run Equation		

	ECM Model (long-run)	
D (BRENT__OP (-1))	0.000966	0.0083*
D (BRENT__OP (-2))	0.000376	0.3052*
D (EX (-1))	1.743502	0.0000*
D (EX (-2))	-0.028286	0.5850*
ECT5(-1)	-1.944663**	0.0000**
Test		
Serial correlation	NO	
Stability	YES	

Notes: (i) ** denotes the long-term relationship's significance of the error correction term at 5%.; (ii) * Wald test for the variable lags' combined significance in the short-run relationship; (iii) For serial correlation, the Breusch-Godfrey LM test is utilized; (iv) CUSUM tests are performed to assess stability; (v) The residuals will be extracted using long-run equations to build the ECT.

NOTE 2. Econometrical results of COVID-19 effect on stock and energy indicators

Table 6

Estimation of the COVID-19's ARDL Model

	Model 1: Brent Oil Price		Model 2: VIX Index		Model 3: BIST-100 Index	
Long-Run Equation						
	coefficient	Prob.	coefficient	Prob.	coefficient	Prob.
VIX (-1)	-0.026197	0.0085	-0.056405	0.0135	0.238965	0.0713
BRENT (-1)	-0.070191	0.0004	-0.074820	0.0969	0.130454	0.6178
BIST100 (-1)	0.003314	0.0003	0.004204	0.0443	-0.009757	0.4207
COVID19 (-1)	-4.56E-06	0.6451	-3.09E-05	0.1730	0.000141	0.2855
Short-Run Equation						
	ECM Model (long-run)		ECM Model (long-run)		ARDL Model (short run)	
DBRENT (-1)	-	-	-0.250093	0.0612	0.987135	0.2124*
DBRENT (-2)	-	-	-0.192299	0.1543	-0.247846	0.7570*

DBRENT (-3)	-	-	-0.053056	0.6913	2.308226	0.0039*
DBRENT (-4)	-0.012481	0.8339	0.045202	0.7367	0.777118	0.3308*
DCOVID (-1)	-1.61E-05	0.6878	1.57E-05	0.8610	-0.001004	0.0617*
DCOVID (-2)	2.36E-05	0.5647	-1.95E-05	0.8328	-0.000989	0.0731*
DCOVID (-3)	5.49E-06	0.8938	2.57E-05	0.7811	0.000391	0.4786*
DCOVID (-4)	3.72E-05	0.3609	6.41E-05	0.4845	-0.000442	0.4181*
DBIST100(-1)	-0.002064	0.6559	-0.006180	0.5543*	0.006470	0.9178
DBIST100(-2)	0.005376	0.2271	0.014230	0.1601*	0.027935	0.6447
DBIST100(-3)	-0.006369	0.1521	0.008418	0.4035*	-0.015097	0.8022
DBIST100(-4)	-0.004624	0.2795	-0.026419	0.0065*	0.020457	0.7242
DVIX (-1)	0.007025	0.7881	-0.269000	0.0000*	0.050234	0.8859
DVIX (-2)	0.040404	0.1372	0.211854	0.0008*	0.611660	0.0943
DVIX (-3)	0.041058	0.1275	0.220447	0.0004*	-0.074141	0.8348
DVIX (-4)	0.002223	0.9306	-0.042512	0.4670*	0.002856	0.9933
ECT (-1)	-0.066100	0.0006**	-0.096882	0.0007**	-0.014948	0.3020
Test						
Serial correlation		NO		NO		NO
Stability		YES		YES		YES

Note. (i) **denotes the long-term relationship's significance of the error correction term at 5%.; (ii) * Wald test for the variable lags' combined significance in the short-run relationship; (iii) For serial correlation, the Breusch-Godfrey LM test is utilized; (iv) CUSUM tests are performed to assess stability; (v) The residuals will be extracted using long-run equations to build the ECT.