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The Effect of Oil Prices on the Economic Growth of Oil Exporting Countries Bordering the Caspian Sea: Panel Data Analysis

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ABSTRACT

Oil price volatility has increased tremendously in the last decade and has become the most difficult commodity to predict. The price of Brent crude oil was 42 US dollars in 2020, whereas it is 72 dollars today. All countries are adversely affected by this volatility. But the severity of it differs between countries. Especially oil-exporting countries are expected to be affected more negatively. Among the countries bordering the Caspian Sea, the national incomes of Russia, Iran, Kazakhstan, and Azerbaijan are largely based on oil exports; therefore they are heavily affected by the volatility in oil prices. Therefore, energy security, which is one of the most important international security topics, is a political and economic priority for the countries bordering the Caspian Sea. In this study, the effects of the price changes in Brent crude oil on the economic growth and energy security of these countries were examined using Panel data analysis with the quarterly data for the period 2007-2020. The order of integration of the variables discussed in the study is examined using the Peseran (2007) panel unit root test, which takes the cross-sectional dependence into account. The long-term relationship between Brent oil price and economic growth is examined using the Westerlund (2007) cointegration test. The results show that oil prices affect economic growth.

Keywords: Countries Bordering the Caspian Sea, Oil Prices, Economic Growth, Panel Cointegration Test
JEL Classications: C33, O47, P42, Q41

1. INTRODUCTION

The most cited work on the impact of oil prices on economic growth is Hamilton's (1983). Hamilton states that seven of the eight economic recessions in the United States happened due to overpricing of oil. This finding has led to a rapid increase in empirical studies on oil-importing developed countries.

Until 1991, only two countries were bordering the Caspian Sea. But the disintegration of the USSR in 1991 led to the emergence of new independent states and the number of bordering states rose to five. Since only Kazakhstan and Azerbaijan have oil wells in the Caspian Sea, and the oil wells of Russia and Iran are in another region, some authors have not considered Iran and Russia within the scope of the Caspian region.

According to the Trademap database, these four countries accounted for 17% of global oil exports in 2020. They also own 17.3% of the world's oil reserves with 299.8 billion barrels. Iran has the richest oil reserves with a global share of 9% (155.6 billion barrels). The next largest reserve is in Russia (6.2%, 107.2 billion barrels), followed by Kazakhstan (1.7%, 30 billion barrels) and Azerbaijan (0.4%, 7 billion barrels).

In this study, the effect of Brent oil prices on the GDP of the countries bordering the Caspian Sea is examined within the framework of Panel Data Analysis using quarterly time series data for the period 2007-2020 (Figure 1).

Many economic approaches attempted to explain the decrease in oil price from the supply and demand sides. Thanks to new technological developments, shale gas and shale oil extraction costs have decreased, thus production has increased. This affects the balance of supply and demand in the global oil market and caused the oil price to decrease. We can list the effects on the demand side as the continuing global stagnation, the increased share of renewable energy due to high oil prices, and the appreciation of the US dollar. In addition, the COVID-19 pandemic, which started in 2020, caused the world economy to shrink, so the demand for petroleum products fell.

While a decrease in oil price is good news for oil-importing countries, it is bad for oil-exporting countries. Because their economies have become dependent on high oil prices, the countries bordering the Caspian Sea are not very happy with this situation. While low oil prices have a positive impact on the global economy, they negatively affect the economies of these countries, leading to the depreciation of local currencies, a decrease in oil revenues, and a slowdown in economic growth (Figure 1).

In Table 1, the GDP and oil exports of the countries bordering the Caspian Sea are given. The table shows that oil exports are not only a source of foreign exchange for these countries but also constitute a large part of their budget revenues.

Table 1: GDP and oil exports of countries bordering the Caspian Sea (2020)

Countries	GDP (M USD)	Oil Exports (K USD)	Share in Global Exports (%)
Russia	1,483.5	72,564,294	21.5
Iran	491.7	1,335,102	11.6
Kazakhistan	169.8	23,703,746	50.48
Azerbaijan	42.6	9,363,571	68.1

Source: Worldbank and Trademap Databases

2. DEVELOPMENT OF THE LITERATURE: THEORETICAL EXPLANATIONS AND EMPIRICAL FINDINGS

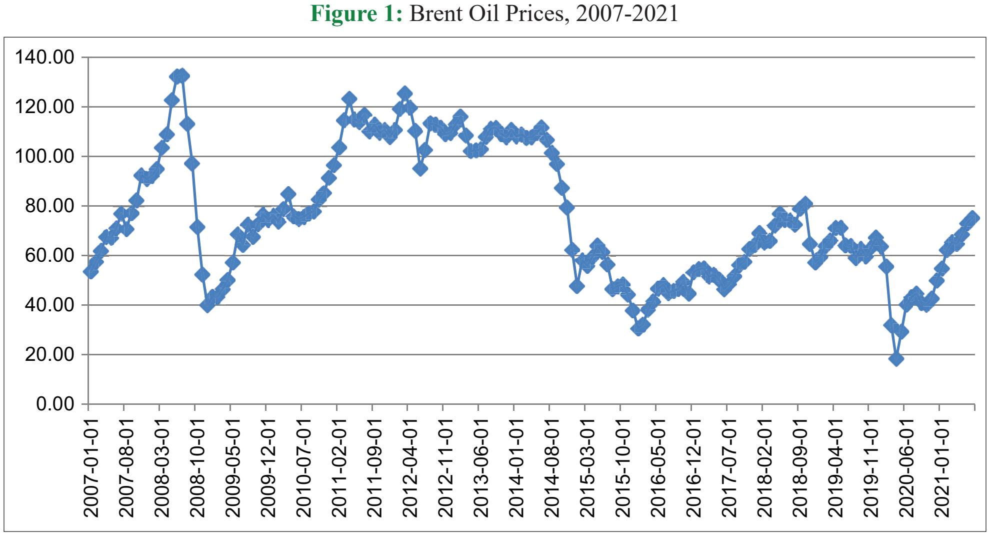
Oil revenues make a significant contribution to the economic performance of developing countries by providing financial resources for investments. Therefore, oil revenues are the main source of economic growth for oil-exporting countries, and price shocks have dramatic effects on their economic growth. On the other hand, the excessive growth in the incomes of oil-exporting countries during periods of oil price booms may result in the appreciation of their national currencies. Moreover, while booms in oil prices support growth in the oil sector and non-tradable sectors, it may cause recessions in the tradable sectors and agriculture sector.

In their study, Lescaroux and Mingo (2008) examined countries under three groups (OPEC member countries, major oil-exporting countries, and oil-importing countries) using panel analysis. They used GDP, CPI, unemployment rate, and stock values as variables, and Granger causality and panel cointegration methods. They proved the existence of a long-term relationship between the variables.

In their study, Jayataman and Lau (2011) investigated the effects of oil prices on economic growth by using the data of 14 countries in the Pacific Islands within the framework of panel data analysis. Of these countries, 13 are net oil importers. In the study, Panel unit root, Panel causality, and Panel cointegration methods and variables such as real GDP, annual average oil price, and percent of international reserve GDP were used. It has been determined that there is a long-term relationship between GDP, oil price, and international reserve share.

Mehrara and Mohaghegh (2011) examined the effect of oil prices on macroeconomic variables of developing oil-exporting countries using the Panel VAR method. Using the annual data of 1989-2005, the variables of GDP, CPI, M2, and annual average oil price were

Figure 1: Brent Oil Prices, 2007-2021



Source: Energy Information Administration Database examined by using the unbalanced Panel VAR method for OPEC member countries and 8 non-OPEC member countries. The results of variance decomposition and impulse-response analysis show that oil crises are not caused by inflation. They are effective on GDP and money supply, and the most effective shocks on oil prices are output and money supply shocks.

Akıncı et al. (2012) investigated the effect of oil prices on economic growth by using the data of oil-exporting OPEC members and 116 oil-importing countries. The order of integration of the variables was determined using panel unit root tests. To test whether there is a long-term relationship between oil price and economic growth, the panel cointegration test was performed, and then the direction of the relationship was determined using the Granger causality test. Results showed that while oil prices are the Granger-cause of GDP for OPEC members, the opposite is true for importers.

Mohammadi and Mohammadi (2013) examined the causal relationship between oil export volume and GDP per capita using annual data of 13 OPEC members for the period 2003-2011. They found that the volume of oil exports and GDP per capita are correlated in the long term.

Demiral et al. (2016), on the other hand, studied 12 developing, oil-exporting countries to examine the relationship between oil revenues and economic growth. Data for the period 2000-2010 were subjected to panel regression analysis. There was a positive relationship between GDP per capita, which is representative of economic growth, and crude oil price, and a positive relationship between CPI, which is the representative of inflation, and crude oil exports. Regression analysis showed that a one-unit increase in crude oil exports increases GDP per capita by 0.14 units.

Baimaganbetov et al. (2019), in this study, the long-term relationship between oil price and regional real income per capita of 14 regions of Kazakhstan and 2 cities with special status has been investigated for 2008-2015 period by using Westerlund cointegration test (2007). Also Baimaganbetov et al. (2021), in this study, they assessed empirically the effects of real oil price shocks on the food infation in Kazakhstan for the monthly period 2004-2019 by using a VAR model. According to the model, there was a double-chance causality between oil prices and food prices. The short-term effect of the variables is investigated with the help of the VAR model. As a result, crude oil prices have an indirect impact on food prices.

Kose and Unal (2020) examined the impact of oil price shocks on the stock exchanges of three countries in the Caspian Basin (Iran, Kazakhstan, and Russia) using the structural vector autoregression (SVAR) model. They collected monthly data between March 2005 and June 2018 from the stock exchanges, the oil price, inflation, industrial production, and exchange rates. Variance decomposition showed that the impact of negative oil price shocks on the stock exchanges is stronger than that of positive shocks, and is the cause of great volatility. Furthermore, the impulse response functions showed that the response of the stock exchanges to negative oil shocks is highly significant. Consequently, these countries should avoid macroeconomic imbalances and should instead focus on industrial production as a stabilizing factor. In this way, they can avoid the negative impacts of the oil price shocks on their stock exchanges.

3. METHODS

3.1. Analysis: Data Set and Model

In the analysis, quarterly data for the period 2007-2020 belonging to 4 countries bordering the Caspian Sea are used. Our variables were real Gross Domestic Product (Local Currency) and real Brent oil (US Dollar) barrel price. Country data are obtained from the IMF's database, IFS, and the Iranian central bank database, and the barrel price of Brent oil is obtained from the Energy Information Administration database. Logarithmic transformations are applied to the variables and the estimation model used in the study is given below:

$$RGSYH_{it} = \alpha_{it} + PF_{t} + u_{it}$$

The first study to consider cross-section dependency is the study of O'Connell (1998). Using the Monte Carlo simulation method, he proved that, when there is a cross-sectional dependence, the significance and power of the LLC test decreases. Therefore, when cross-sectional dependence is not considered, the results from these series can be misleading (Pesaran, 2004). In panel data analysis, whether there is a cross-section dependency between the series is important for the selection of the type of generation unit root test. Cross-section dependence indicates that the series is affected by the same shock, and such data like countries, regions, states, and cities are frequently encountered in studies (Tatoğlu, 2012). The result for developing oil-exporting countries was T=58 and N=4. The LM tests proposed by Breusch and Pagan (1980) and Peseran and Yamagata (2008) are used to test the cross-sectional dependence. The presence of a unit root between the series was determined by the Expanded Cross-Sectional Dependency Dickey-Fuller test proposed by Peseran (2007). The existence of a long-term relationship between the series was tested with the Westerlund Panel cointegration test, which is based on the Error Correction Model developed by Westerlund (2007) and takes the cross-section dependence into account. The next step was to find long-term predictors. For this, we used the DOLS (Dynamic Least Squares) method from the study of Kao and Chang (2000).

3.2. Cross-Sectional Dependence Test

The results from the series can be misleading when cross-sectional dependence is not considered (Pesaran, 2004). In panel data analysis, whether there is a cross-section dependency between the series is important for the selection of the type of generation unit root test.

Peseran and Yamagata (2008) proved that biased results are obtained when the group means are zero and the individual mean is different from zero, and he introduced a new method where the mean is centered to zero for the case where T is small. To eliminate the deviation, he added variance values and mean values to the

Table 2: Cross-sectional dependency results

Breusch and Pagan (1980) LM Test	241.8	0.000
Peseran and Yamagata (2008) LM Test	291.5	0.000

Breusch Pagan LM equation, assuming that x_it is solidly external and u_it is normally distributed. This test remains consistent even when the CD test is inconsistent (Peseran and Yamagata, 2008). The corrected LM equation is as follows:

$$LM_{adj} \quad \sqrt{\frac{}{N(N \quad 1)}\sum_{i=1}^{N}\sum_{j=i+1}^{N}\frac{(T-K)\hat{\rho}_{ij}-\mu_{T_{ij}}}{_{ij}}}$$

The hypothesis test is as follows:

$H_0 = p_{ij} = p_{ji} = cor(u_{it}, u_{jt}) = 0$

$H_1 = p_{ij} = p_{ji} \neq 0$ for all T' s and when i≠j.

The existence of cross-sectional dependence proves that the series is affected by the same shock and is often encountered in studies with variables such as country, region, state, and city (Tatoğlu, 2012). The results were T=58 and N=4 for oil-exporting countries bordering the Caspian Sea. Breusch and Pagan (1980) and Peseran and Yamagata (2008) LM tests were used to test cross-sectional dependence.

As can be seen in Table 2, the probability value calculated for the Gross Domestic Product variable is <0.05 and the H0 hypothesis is rejected. This reveals that there is a cross-section dependency problem in the series. According to the data, all the countries that make up the panel are affected by the shocks. As a result, we should resort to the tests that take the Cross-Section Dependency into account in the panel unit root and panel cointegration tests, which are the next level of the analysis.

3.3. Panel Unit Root Test

Before statistical analysis of a series can be made, it is necessary to examine whether the process that creates that series is constant over time. Analyzes using non-stationary series can produce misleading results (Tatoğlu, 2012). We can use the first and second generations of Panel Unit Root Tests to determine whether the series that make up the panel contains a unit root. The main difference between the two groups is that they take cross-sectional dependence into account.

Peseran (2007) tried to eliminate the cross-section dependency problem with a different approach. Like Phillips and Sul (2003), he used heterogeneous factor loadings and the single-factor model for residual terms. Unlike the others, he proposed Dickey-Fuller and ADF tests, which are applied to the first rank differences of individual series and the cross-sectional means of the lag order, instead of the unit root test based on the deviations from the estimated common factors. Simple CADF regression is given below:

$$\Delta Y_{it} = a_i + \rho_i^{*} Y_{it-1} + d_0 \bar{Y}_{t-1} + d_1 \Delta \bar{Y}_t + \varepsilon_{it}$$

Here, $\bar{Y}_t$ is the mean of all N observations over time t. If there is autocorrelation in the error term or factor, the regression can be extended by adding the lagged first differences of Y_{it} and $\bar{Y}_t$ in the univariate case.

$$\Delta Y_{it} = a_i + \rho_i^{*} Y_{it-1} + d_0 \bar{Y}_{t-1} + \sum_{j=0}^{p} d_{j+1} \Delta \bar{Y}_{t-j} + \sum_{k=1}^{p} c_k \Delta Y_{i,t-k} + \varepsilon_{it}$$

CIPS can be calculated using the following equation.

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} CADF_i$$

In the Table 3, CADF test results are given for the case where the number of lags with the constant term and the constant term and trend is 2. $\bar{t}$ (t bar) statistic produces critical values at %90 (cv10) and %95 (cv5). According to these results, this series is stationary with a first-order difference.

3.4. Westerlund Panel Cointegration Test

Cointegration is a stable relationship between variables containing two or more unit roots (Sevüktekin and Çınar, 2014).

Westerlund (2007) suggested using 4-panel cointegration tests based on an error correction model to test the existence of cointegration when working with panel data. In the following regression, t is the deterministic elements (constant and trend) vector; λ_i is the long-term parameter and γ_i and ϕ_i are short-term parameters.

$$\Delta Y_{it} = \delta_i^{'} d_t + \lambda_i^{'} \Delta X_{it} + \gamma_i Y_{it-1} + \varphi_i X_{it-1} + e_{it}$$

Pa and Pt parameters are calculated using the entire panel. Our working hypotheses are:

H_0: $p_i = 0$ (for all i's)

H_a: $p_i < 0$ (for all i's)

And parameters are calculated by the formulas given below:

P_a parameter: $P_a = (\sum_{i=1}^{N} L_{i11})^{-1} \sum_{i=1}^{N} L_{i12}$

P_t parameter $P_t = \sigma^{-1} (\sum_{i=1}^{N} L_{i11})^{-1/2} \sum_{i=1}^{N} L_{i12}$

Obtaining the group means statistics Ga and Gt begin by calculating the estimated pi's for each unit and the weighted average of the t ratios of the pi's. The hypotheses are:

Table 3: Peseran (2007) panel unit root test results

Variables	Level				First order difference			
	Model	$\bar{t}$	%5 KD	%10 KD	Model	$\bar{t}$	%5 KD	%10 KD
CPI	Constant term	−1.570	−2.330	−2.210	Constant term	−5.842*	−2.330	−2.210
	Constant term and trend	−2.776	−2.830	−2.720	Constant term and trend	−5.995*	−2.830	−2.720

*Statistically significant at 5% level. **Statistically significant at 10% level.

Table 4: Westerlund panel co-integration test results

Variable	Parameter	Value	Z-value	P-value	Safe P value
Real GDP	Gt	−4.015	−4.133	0.000	0.003
	Ga	−1.367	−5.854	0.000	0.002
	Pt	−7.255	−3.528	0.000	0.014
	Pa	−24.006	−5.040	0.000	0.009

Table 5: Estimation of long-term cointegration coefficients

Dependent variable	Real GDP			
Variable	Coefficient	Standard error	Z-value	P-value
Real oil price	0.6873644	0.0564318	12.18	0.000

H_0: = 0 (for all i's)
H_a: <0 (at least for one i)

And parameters are calculated as below:

Ga parameter: $G_a = \sum_{i=1}^{N} L_{i11}{}^2 L_{i12}$

Gt parameter: $G_t = \sum_{i=1}^{N} \sigma_i{}^{-1} L_{i11}{}^{-1/2} L_{i12}$

Westerlund (2007) recommends using 4-panel cointegration tests based on the error correction model using the Robust method in case of cross-sectional dependence between the series forming the panel. Using the Westerlund Panel cointegration test, the H0 hypothesis is established as "no cointegration." Westerlund Panel Cointegration test results are given below.

According to the results given above (Table 4), the H_0 hypothesis is established as "no cointegration." For the cointegration test, the lag length and the antecedent length are chosen as 1. In addition, safe probability values with 1000 repetitions are given by using fixed and trend models. According to the results, there is a long-term relationship between the real GDP and the price of Brent oil.

3.5. Estimating Long-Term Relationships

If a long-term relationship is found between the variables as a result of the panel cointegration test, these relationships can be used to estimate long-term parameters using methods such as Panel Dynamic Least Squares.

The Table 5 shows the estimation of the long-term relationship between Real GDP and Brent crude oil price. The results indicate that if the oil price increases by 1%, the real GDP will increase by 0.69%.

DOLS results also reveal that oil price is effective on economic growth. DOLS also shows that a 1% increase in oil price will increase economic growth by 0.69%. The coefficients of the variables are statistically significant.

4. CONCLUSION

This study investigated the long-term relationship between the Real GDPs of 4 oil-exporting countries bordering the Caspian Sea and the Brent oil price using the Westerlund (2007) cointegration test and Pedroni (2001) DOLS methods for the 2007-2020 period. The presence of CSC among the countries making up the panel was investigated using the LMadj test developed by Berusch-Pagan (1980) and corrected by Peseran and Yamagata (2008). The existence of CSC is established in the crude oil price, real GDP, and real oil price series, and in the cointegration equation. The presence of unit root in the series is analyzed using the CADF test (Peseran, 2007), which takes CSC into account, and the series was only stationary when their first-order difference is taken. The fact that the series is not stationary indicates that the shocks to the real GDP do not disappear over time and destabilize the economies of the countries significantly.

The long-term relationship between the series is examined using Westerlund cointegration tests and it is concluded that they had a long-term cointegration relationship. In this context, a positive and significant relationship is found between the real oil price and economic growth variables in the long term. DOLS results also show that a 1% increase in oil price causes a 0.69% increase in economic growth.

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