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Exploring the Relationship Between Oil Prices and Economic Growth in Türkiye

Türkiye'de Petrol Fiyatları ve Ekonomik Büyüme Arasındaki İlişkinin Araştırılması

Abdulmecit YILDIRIM[*]
Gökhan KONAT[**]

Abstract

This study investigates the existence of a long-run relationship between economic growth and oil prices in Türkiye, using annual data for the period 1987-2019. First, the stationarity of the variables is evaluated using the Residual Augmented Least Squares (RALS) based ADF unit root test. Second, the RALS-based cointegration test is used to investigate the long-run relationship between the variables. The findings indicate that there is no long-run relationship between economic growth and oil prices in Türkiye. As a result, it is concluded that the series does not return to equilibrium in the long run and oil price shocks during the financial turmoil may affect economic growth.

Keywords: Economic growth, oil prices, unit root, cointegration, RALS, asymmetric causality.

JEL Codes: O10; O13; Q4

Öz

Bu çalışmada, 1987-2019 dönemi yıllık verileri kullanılarak Türkiye'de iktisadi büyüme ile petrol fiyatları arasında uzun dönemli bir ilişkinin varlığı araştırılmıştır. İlk olarak, değişkenlerin durağanlığı artıklarla genişletilmiş en küçük kareler (RALS) tabanlı ADF birim kök testi ile değerlendirilmiştir. İkinci olarak, fark durağan olan değişkenler arasındaki uzun dönemli ilişkiyi araştırmak için RALS tabanlı eşbütünleşme testi kullanılmıştır. Bulgular, Türkiye'de ekonomik büyüme ile petrol fiyatları arasında uzun dönemli bir ilişkinin olmadığını göstermektedir. Sonuç olarak, serinin uzun vadede dengeye dönmediği ve finansal çalkantı sırasında yaşanan petrol fiyat şoklarının ekonomik büyümeyi etkileyebileceği sonucuna varılmıştır.

Anahtar Kelimeler: Ekonomik büyüme, petrol fiyatları, birim kök, eşbütünleşme, RALS, asimetrik nedensellik.

JEL Kodları: O10; O13; Q4

1. INTRODUCTION

The 1956 research "A contribution to the theory of economic growth" by Robert Solow allowed us to grasp the process of economic growth. Subsequent studies have examined the economic growth process by using different inputs such as human capital (Mankiw, Romer and Weil, 1992) and energy (Stern, 2010) in addition to physical capital and labor. These studies emphasize that the inclusion of inputs such as knowledge, the skill level of the labor, and energy resources in the production function as well as physical capital and labor better explains the economic growth process. The main opinion is that an increase in the level of the human capital of a country will increase its labor productivity. Similarly, the availability, diversity, and ease of access to energy resources, which are significant input of the production process, are closely related to the economic growth process of a country. In addition, the extent to which energy, as an input of the production

[*] Dr. Öğr. Üyesi, Muş Alparslan Üniversitesi İktisadi ve İdari Bilimler Fakültesi, İktisat Bölümü, a.yildirim@alparslan.edu.tr, ORCID: https://orcid.org/0000-0002-6228-6601
[**] Dr. Öğr. Üyesi, Bolu Abant İzzet Baysal Üniversitesi İİBF, Ekonometri Bölümü, gokhan.kanat@ibu.edu.tr, ORCID: https://orcid.org/0000-0002-0964-7893

process, will affect the country's economic growth may vary depending on its substitutability or complementarity feature of it with other inputs such as physical capital and labor (Han, 2022, p. 798). All of this shows that there is a complex dynamic at play in the relationship between energy and economic growth. In theory, economic growth is conceptualized as the increase in the monetary value of goods and services generated in an economy. But the idea of economic growth is also defined as the measurement of a society's capacity for production or the rise in the level of welfare (Yılmaz, 2022, p. 21). Macroeconomic indicators such as economic growth and average income level are in correlation with concepts such as absolute poverty and social welfare levels (Çoban, 2020, p. 468).

Although countries have taken important steps towards the discovery of alternative energy forms to diversify their energy sources, the weight of non-renewable energy resources such as oil continues in economic activities. Since the price elasticity of oil is small and the widely available substitutes are inadequate, an increase in oil prices in oil-importing countries raises the cost of energy and reduces the budget available for other products and services. This situation deteriorates the balance of payments of the countries and causes a slowdown in economic activities. The severe economic consequences of the 1973 oil crisis, also known as the first oil crisis, spurred scholars to study the relationship between oil prices and macroeconomic factors. To this date, many studies have been conducted to investigate the link between the price of energy and economic growth. We contribute to the existing literature by adopting RALS based cointegration and Hatemi-J asymmetric causality using Turkish data. The 1973 oil crisis, also known as the first oil crisis, had severe economic consequences that prompted scholars to investigate the connection between oil prices and macroeconomic factors. As a result, numerous studies have been conducted to explore the relationship between energy prices and economic growth. In line with this existing literature, our study contributes by utilizing RALS-based cointegration and Hatemi-J asymmetric causality techniques with Turkish data.

Even though the amount of energy acquired from renewable sources is rising, nonrenewable energy sources such as oil, coal, and natural gas continue to account for a major share of overall energy consumption. Much of the economic activity of the countries becomes dependent on oil because of this predicament. Oil, which is among the primary energy sources and used by many sectors in the production process, can affect the economy in many ways. Based on the country's level of development, its oil reserves, and whether it is an oil exporter or importer, it can be positively or negatively affected by possible oil price shocks. Furthermore, the economic harm produced by unfavorable conditions might differ depending on the political state of the country. In other words, even though fluctuations in oil prices are one of the causes of poor performance in macro variables such as economic contraction, inflation, and unemployment; political instability, poor governance, and level of corruption in a country may exacerbate it. In this context, institutional structure plays a constructive role in alleviating the effect of unfavorable situations on economic activities. According to Jarrett, Mohaddes, and Mohtadi (2019), the strength and quality of financial institutions mitigate the detrimental impacts of oil price fluctuation on economic growth.

Over the last half-century, turmoil in the Middle East substantially reduced crude oil production. The Suez Canal closed in 1956, disrupting worldwide trade and transportation. Subsequently, Arab OPEC members enforced an oil embargo in 1973, which had far-reaching economic consequences. The Middle East has experienced several other significant events in the past 50 years that have impacted the global oil market. These include the Iranian Revolution (1978), Iran-Iraq War (1980), Persian Gulf wars (1990 and 2002), Libyan revolution (2011), and Syrian civil war (2011). From the supply side, such events lead to unexpected fluctuations in crude oil prices. On the demand side, on the other hand, the primary cause of the fluctuations is oil demand of emerging economies (Hamilton, 2013, p. 18). These occurrences have renewed concerns among academics and authorities about how oil prices affect macroeconomics.

Many countries do not have sufficient oil reserves. At the same time, oil is the main export product for many countries. Hence, crude oil has been a prominent topic among policymakers and researchers due to its importance in ensuring economic stability and growth. Since the price of crude oil is highly volatile, the precise forecast of the price, supply, and demand of oil are difficult. Furthermore, as technology advances, accurate prediction of supply levels becomes more challenging (Kurihara, 2015, p. 40). The world has changed significantly due to various factors, such as the oil shocks after the collapse of the Bretton Woods system, globalization initiated with the Washington Consensus, and advancements in communication, transportation, and informatics. These global transformations have made the world more interconnected and integrated. With the globalization process, in which competition between countries is defined, underdeveloped, and developing countries are concerned about economic growth and development (Ozturk, 2020, p. 46). Therefore, growth rates in oil-dependent countries are affected by oil prices. It is obvious that large increases in oil prices will damage the economies of oil-dependent countries (Yılancı, 2017, p. 52).

The contributions of our study to the related literature are significant in two ways. Firstly, we utilized RALS-based unit root and cointegration techniques, which offer several advantages over traditional methods using the data on the Turkish economy. By utilizing RALS-ADF and RALS-EG techniques, we may produce consistent and more powerful findings even when residuals are nonnormally distributed. This increases the reliability and accuracy of the findings. Secondly, we incorporated the asymmetric causality technique developed by Hatemi-J (2012) to account for possible asymmetric causal linkages between oil prices and economic growth in Türkiye. This method offers information on the direction of causality, enabling a more precise interpretation of the relationships between variables. In sum, the contributions of our study are significant in enhancing the reliability and accuracy of the findings. By utilizing advanced techniques such as RALS-based unit root and cointegration methods and asymmetric causality analysis, we might provide a more solid understanding of the relationships between variables in the study.

The study is organized as follows: First, Section 2 examines the literature on the relationship between economic growth and oil prices. Then, in Section 3, the data and empirical methodology used in the study are introduced. Moving on to the empirical analysis, Section 4 presents the findings of the study, while Section 5 evaluates the robustness of these results. Finally, the study concludes with the last section, summarizing the key findings and implications of the study.

2. LITERATURE REVIEW

Rasche and Tatom (1977), which consider energy as a third input of production in addition to labor and capital, and Hamilton (1983), which examines the causal link between oil prices and macroeconomic factors, are regarded as pioneering studies on the energy-economic growth nexus. Following them, the relation between macroeconomic variables and the price of oil has been the focus of interest, and the related literature has developed in several ways with the contributions made by researchers. While the initial research centered on the symmetric link between oil price fluctuations and macroeconomic indicators, the subsequent studies concentrated on the asymmetric effect between these variables. One of the common points emphasized in contemporary studies focusing on asymmetric effects is that the adverse effects of increasing oil prices outweigh the positive impact of falling oil prices.

As emphasized above, the research discussing the nexus between economic growth and oil prices proceed in several axes based on the method, sample size, and data used. Some studies investigate symmetric effects using data for single or multiple countries, while others examine asymmetric effects using a similar framework. In addition, another group explores the relationship between oil price and macroeconomic factors by classifying countries as developed, developing, oil-importing, and oil-exporting countries. Awunyo-Vitor, Samanhyia and Addo Bonney (2018); Benli, Altintaş and Kaplan (2019); Ftiti, Guesmi, Teulon and Chouachi (2016); Hanabusa (2009); Kırca, Canbay and Pirali (2020); Zulfigarov and Neuenkirch (2020) are among the studies that investigate the effect of oil prices on economic growth in the context of a single country. Ahmed and Azam (2016); Akinsola and Odhiambo (2020); Chatziantoniou, Filis, Eeckels and Apostolakis (2013); Jarrett et al. (2019); Nusair (2016); Sarwar, Chen and Waheed (2017); Timilsina (2015) examine the link between oil prices and macroeconomic factors such as economic growth in the context of multiple country/group or various country classifications. Due to different methods, data set, classifications, and specific characteristics of countries, the results of these studies vary.

Hamilton (1983) examined the recession in the United States of America's (US) economy from the Second World War to the First Oil Crisis. His findings confirmed that the fluctuation in oil prices has a causal effect on the output. Mork Olsen and Mysen (1994) extended Hamilton's (1983) approach by incorporating the asymmetric effect of oil prices and contemporaneous changes in oil prices. Their results confirm the presence of an asymmetric effect of oil prices on macroeconomic variables. Al-mulali (2010) used Norwegian data over the period 1975-2008 and showed that a rise in oil price increased gross domestic product (GDP). Thus, the results confirmed that oil price granger causes the gross domestic product in the long run for the Norwegian economy. Iwayemi and Fowowe (2011) used the quarterly data of Nigeria from 1950 to 1990. The findings reveal that negative oil price shocks have a considerable impact on output and the real exchange rate, which indicates the existence of an asymmetric effect of oil price on the selected macroeconomic indicators in Nigeria. Using monthly data from 2000 to 2008, Hanabusa (2009) investigates the causal link between economic growth and oil prices in Japan. The results of the Exponential General Autoregressive Conditional Heteroskedastic (EGARCH) model show bidirectional causality between oil price and economic growth in mean and variance. Awunyo-Vitor et al. (2018) conducted a study that aimed to investigate the correlation between oil prices and economic growth in Ghana, covering a period of 51 years from 1970 to 2021. They employed the Johansen cointegration and Granger causality tests for the analysis. The study found that economic growth and oil prices have a unidirectional relationship. The direction of causality is from oil prices to economic growth. Zulfigarov and Neuenkirch (2020) investigate the effect of oil price changes on the selected macroeconomic indicators for the Azerbaijan economy using quarterly data over the period 2002-2018. The result of Vector Autoregression (VAR) analysis shows that GDP growth decreases after oil price shocks. Azerbaijan's economy depends on oil revenues; thus reduction in oil revenues affects the whole economy. Since oil-exporting countries' economies depend on oil revenues, they are more affected by price fluctuations. Van Eyden, Difeto, Gupta and Wohar (2019) underline that the predicted sensitivity measure for Norway is roughly twice that of the United States, which is also a major oil producer.

Ftiti et al. (2016) evaluated the monthly data of selected OPEC countries from 2000 to 2010. Engle-Granger cointegration relationship between crude oil price and economic growth is confirmed for all examined countries (United Arab Emirates, Kuwait, Saudi Arabiya, and Venezuela). Moreover, the evolutionary co-spectral analysis results show that during fluctuations in the global economy, oil price shocks have a substantial influence on the link between oil and real economic activity in OPEC countries. Nusair (2016) investigated 6 Gulf Co-operation countries (GCC) using different periods for each country. The researcher confirmed a non-linear relationship between oil price shocks and real GDP in all countries. That is, rises in oil prices lead to increases in real GDP in all 6 GCC countries. Whereas, oil price decreases are only significant in the case of Qatar and Kuwait with the expected positive signs, suggesting that falling oil prices lower real GDP.

Sarwar et al. (2017) used the data of 210 countries, which are classified into income, Organisation for Economic Co-operation and Development (OECD), regional level, renewable energy consumption level, and oil import/export countries, from 1960 to 2014. The researchers confirmed that different relationships, such as bidirectional, unidirectional, inverse, and no-causal relationships exist in different country classifications. For example, the bidirectional and unidirectional relationship running from oil price to GDP growth is found in the whole panel and low-income countries, respectively. Ahmed and Azam (2016) employed the Granger causality test in frequency domain context using available data for 119 countries for the time span 1960–2012. The countries are classified into high-, middle-, and low-income groups. The empirical results warranted the causal, reverse causal, bidirectional causal, and no causal relationship between economic growth and energy consumption across different frequencies. Yardimcioğlu and Gülmez (2013) studied the 10 OPEC countries from 1970–2011 and confirmed a bidirectional causality between oil prices and economic growth.

Timilsina (2015) investigated the effect of oil prices on 28 sectors and commodities from 25 countries/regions using a computable general equilibrium model. Since the agricultural sector of high-income countries is relatively energy-intensive than that of low-income countries, a rise in oil prices has a larger effect on the agricultural sector of high-income countries. However, the results are reversed when the manufacturing sector is considered. The effect on oil importer countries with relatively energy-intensive manufacturing sectors is more severe. Chatziantoniou et al. (2013) examined the relationship between oil prices, tourism income, and economic growth for European Mediterranean countries using monthly data over the period 2001-2010. The supply-side and demand-side effects of an oil price shock are analyzed separately and confirmed that only demand-side oil price shocks have a significant effect on tourism and economic growth.

A study conducted by Akinsola and Odhiambo (2020) explored the potential asymmetric effects of oil prices on economic growth in Sub-Saharan Africa (SSA). The researchers analyzed data from seven low-income oil-importing SSA countries over the period of 1990-2018. The results of the panel ARDL and NARDL model show that a decrease (increase) in oil price has a positive and statistically significant (a negative and statistically significant) impact on economic growth. Cuñado and Pérez de Gracia (2003) used quarterly data from 1960 to 1999 to analyze the influence of oil prices on inflation and industrial production indexes in 15 European nations. The results confirmed the asymmetric effect of oil price shocks. Oil price increases have a negative and statistically significant effect on industrial production index growth rates, the opposite result does not hold for oil price decreases. Moreover, the results reported that oil prices are Granger cause economic activity. Lardic and Mignon (2006) applied asymmetric cointegration analysis to examine the effect of oil prices on GDP in 12 European countries using the quarterly data over the period 1970-2003. For most of the European countries under consideration, the results revealed an asymmetric cointegration between oil prices and GDP. Lardic and Mignon (2008) obtained similar results via the same methodology and data for the US, G7, Europe, and Euro area economies.

Although the results of studies examining the relationship between oil prices and economic growth in Türkiye are mixed, oil price increases in recent years have adversely affected the Turkish economy (Benli et al., 2019; Kamaci and Göktaş, 2020; Öksüzler and İpek, 2011). The government tries to protect the purchasing power of the consumers by reducing the increases in fuel prices from the special consumption tax (SCT) after 2018. However, hikes in oil prices and exchange rates put pressure on the ability of authorities to mitigate increases in oil prices from SCT. If the increases in oil prices continue, it will be reflected in the pump prices. While this program positively affects the economy by supporting the consumers and producers, it is likely to expand the budget deficit.

Öksüzler and İpek (2011) attempted to investigate the effect of oil price shocks on economic growth and inflation in Türkiye using monthly data over the period 1987–2010 and confirmed a unidirectional causality from oil prices to economic growth. The results of impulse response functions showed that positive oil price shocks lead to an increase in GDP growth. A similar result was obtained by Özsağır et al. (2011). Kırca et al. (2020) investigate the causal linkage between the oil-gas price index and economic growth for Türkiye using quarterly data over the period 1998-2019 utilizing Granger and Toda-Yamamoto causality tests with structural breaks. Further, the authors investigate the permanence of this relationship using the frequency domain causality test based on the previous two tests. According to the Toda-Yamamoto causality test results, there is a causal relationship between oil-gas prices and economic growth. The casual relationship between oil-gas prices and economic growth is one-way relation running from oil-gas prices to economic growth. That is changes in oil-gas prices can have a significant impact on economic growth. In addition, the results of the Frequency Domain Causality test indicate that the causal relationship is permanent with a duration of approximately five years. Kamaci and Göktaş (2020), on the other hand, found a unidirectional causality from economic growth to oil prices in the case of Türkiye for the quarterly data over the period 2003–2019. Benli et al. (2019) attempted to investigate the relation between oil prices and economic growth in Türkiye using quarterly data over the period 1987–2010 and confirmed a significant negative relationship between economic growth and oil price rise in the long run. On the other hand, oil price declines are found to be statistically insignificant. Thus, the authors confirmed that the output growth does not respond to oil price reductions but, it decreases in oil price increases. Yılancı (2017) conducted a study on Turkish data over the period from 1990 to 2016 to examine the relationship between oil prices and economic growth in Türkiye. Using the Fourier cointegration technique, Yılancı found that there is no significant long-run relationship between economic growth and oil prices in Türkiye. Therefore, based on Yılancı's findings, it can be concluded that oil prices do not have a significant impact on the economic growth of Türkiye.

In this study, we investigate the relationship between economic growth and oil prices in Türkiye. Specifically, we utilize a RALS-based unit root and cointegration technique. In addition, we consider the potential possibility of asymmetric effects of oil prices. By doing so, we aim to provide a more comprehensive understanding of how changes in oil prices may impact economic growth in Türkiye.

3. METHOD

This section provides information related to the data set and its sources, and the methodology that forms the empirical basis of the research.

3.1. Data and Its Sources

In this study, the relationship between oil prices and economic growth is examined by studying Turkish data over the period 1987-2019. Data on economic growth (GDP growth) and oil prices (OP) are obtained from the official database of the Central Bank of the Republic of Türkiye. Before the cointegration analysis, the stationarity of the series is examined. In addition to the standard ADF unit root test, the RALS-ADF unit root test based on the Residual Augmented Least Squares (RALS) method proposed by Im and Schmidt (2008) is applied to analyze the stationarity of the series. The long-run relationship between the series is investigated by using Engle-Granger (EG) and RALS-EG cointegration methods.

3.2. ADF Unit Root Test

Dickey-Fuller (1979) and Augmented Dickey-Fuller (1981) unit root tests were developed to test stationarity in time series. Later on, many unit root tests were developed based on DF and ADF. The ADF unit root test is based on the following equations:

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + e_t \quad (1)$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + e_t \quad (2)$$

Equations (1) and (2) exhibit the ADF unit root test regression equations with constant, and constant and trend respectively. Lagged values of the dependent variable were introduced to the model to prevent the autocorrelation problem. The null and alternative hypotheses of the ADF unit root test are defined as follows. The derived test statistics are compared to the MacKinnon (2010) critical values, and the series' unit root structure is determined.

$H_0: \delta = 0$, the series has a unit root

$H_1: \delta \neq 0$, the series is stationary

3.3. RALS-ADF Unit Root Test

RALS-ADF unit root test, which produces consistent findings when residuals are not normally distributed, is developed by Im et al. (2014). They empirically showed that the RALS-ADF test outperforms standards unit root tests in the case of non-normal residuals. When the residuals are not normally distributed, the higher moments of the residuals contain information about the nature of the residuals, and the RALS-ADF method is used to incorporate this information into the model. Let $\hat{e}_t$ being the residuals obtained from ADF models, the ADF model is extended to the RALS-based structure with the term $\widehat{w}_t$ and defined as:

$$\widehat{w}_t = h(\hat{e}_t) - \bar{K} - \hat{e}_t \widehat{D}_2, \ \ t = 1,2,\dots,T \tag{3}$$

where $\bar{K} = \frac{1}{T}\sum_{t=1}^{T} h(\hat{e}_t)$ and $\widehat{D}_2 = \frac{1}{T}\sum_{t=1}^{T} h'(\hat{e}_t)$. To capture the information embedded in non-normally distributed errors $h(\hat{e}_t)$ is defined as $h(\hat{e}_t) = [\hat{e}_t^2, \hat{e}_t^3]'$ where $\hat{e}_t^2$ and $\hat{e}_t^3$ are specified as the second and third moments. For $m_j = T^{-1}\sum_{t=1}^{T} \hat{e}_t^j$, $j = 2,3$, $\widehat{w}_t = [\hat{e}_t^2 - m_2, \hat{e}_t^3 - m_3 - 3m_{2t}\hat{e}_t]'$ (Im et al., 2014: 321). Hence, two new series are obtained by using second and third moments of residuals. The ADF testing process based on Residual Augmented Least Squares (RALS) regression can be illustrated as follows:

$$\Delta y_t = \alpha_1 + \beta y_{t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \widehat{w}_t'\gamma + v_t, \ t = 1,2,\dots,T \tag{4}$$

$$\Delta y_t = \alpha_1 + \alpha_1 t + \beta y_{t-1} + \sum_{j=1}^{p} \delta_j \Delta y_{t-j} + \widehat{w}_t'\gamma + v_t, \quad t = 1,2,\dots,T \tag{5}$$

The null hypothesis of the test expresses the existence of a unit root in the series as in the standard ADF test. The long-run correlation coefficient is calculated for the appropriate critical values. The calculated test statistics are compared with the critical values obtained by Hansen(1995) to determine if the series have unit-roots.

3.4 Engle-Granger Cointegration Analysis

The essential idea behind Engle and Granger's (1987) cointegration technique is that the error components of a linear combination of two non-stationary time series have the feature of stationarity. Engle and Granger defined the single equation cointegration model as follows:

$$y_t = \beta x_t + u_t \tag{6}$$

For the series to be cointegrated, two requirements must be met. First and foremost, both series must be difference stationary. Second, the residuals from the cointegration regression should be stationary at the level. The following linear equation is established to determine the long-run relationship between the series using the EG cointegration approach.

$$\Delta \hat{u}_t = \alpha_0 + \phi \hat{u}_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta \hat{u}_{t-j} + e_t \tag{7}$$

The parameters in equation (7) are estimated by OLS, and the residuals generated from the model are tested using the ADF unit root test. The null hypothesis of the EG approach is as follows:

H_0: x_t and y_t are not cointegrated (i.e. $\phi = 0$)

As in the ADF test, the t-statistic of the ϕ coefficient is calculated, and the decision is made by comparing the ϕ coefficient with the critical values calculated by Engle-Granger.

3.5. RALS-EG Cointegration Analysis

Lee et al. (2015) propose the RALS-EG cointegration test, in which the RALS technique is utilized instead of OLS to increase the power of the EG test. As in the RALS-ADF unit root test, the EG test is extended to the RALS-based structure with the term $\widehat{w}_t$ and expressed as follow.

$$\Delta \hat{u}_t = \alpha_0 + \phi \hat{u}_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta \hat{u}_{t-j} + \widehat{w}_t{}'\gamma + v_t \tag{8}$$

The null hypothesis is identical to the null hypothesis of the standard EG test and is evaluated using the usual t-statistic. The correlation coefficient between RALS-EG and EG test statistics is calculated with the following equation:

$$t^* \to pt + \sqrt{1 - p^2}Z \quad (9)$$

In this equation, t^* and t denote the RALS-EG and EG test statistics, respectively, and Z defines a standard normally distributed random variable. p shows the long-run correlation between the residues obtained from equations (7) and (8), respectively. The calculated test statistics are compared to the critical values to determine the presence of a long-run relationship between the series.

3.6. Asymmetric Effect

Granger and Yoon (2002) stated that the cointegration relationship may vary when the positive and negative shocks of the series are considered. According to Hatemi-J (2012), besides the symmetric effect between variables, the asymmetric effect should be considered in the causality analysis. He extended the work of Granger and Yoon (2002) to examine asymmetric effects in causality analysis. Let $j \in (1,2)$ the random walk process of series y_j is defined as follows:

$$y_{jt} = y_{jt-1} + \varepsilon_{jt} = y_{j0} + \sum_{i=1}^{t} \varepsilon_{ji} \quad (10)$$

where y_{j0} and ε_{jt} represent the initial value of the series and disturbance term respectively, and $t = 1,2, \dots, T$. $\varepsilon_{ji}^{+} = Max(\varepsilon_{ji}, 0)$ and $\varepsilon_{ji}^{-} = Min(\varepsilon_{ji}, 0)$ shows positive and negative shocks of the variables, respectively. The sum of the positive and negative shocks of the disturbance term ε_{ji} is defined as:

$$\varepsilon_{ji} = \varepsilon_{ji}^{+} + \varepsilon_{ji}^{-} \quad (11)$$

hence, equation (10) can be rewritten as:

$$y_{jt} = y_{jt-1} + \varepsilon_{jt} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{ji}^{+} + \sum_{i=1}^{t} \varepsilon_{ji}^{-} \quad (12)$$

The positive and negative cumulative shocks of the y_{jt} variable is defined as $y_{jt}^{+} = \sum_{i=1}^{t} \varepsilon_{ji}^{+}$ and $y_{jt}^{-} = \sum_{i=1}^{t} \varepsilon_{ji}^{-}$, respectively. The existence of an asymmetric causal relationship between oil price and economic growth will be examined by using the positive and negative shocks of the series.

4. EMPIRICAL FINDINGS

The link between oil prices and economic development continues to pique the curiosity of researchers. In this study, the cointegration and asymmetric causality relationship between economic growth and oil prices for Türkiye have been investigated. First, the stationarity of the series is examined using the ADF and RALS-ADF unit root tests. Then, the long-run relationship between the series is examined by EG and RALS-EG Cointegration methods. The results are presented in Table1 and Table 2.

Tablo 1: ADF Unit Root Test Results

Variables	Test Statistics
GDP	-1.628 (0.759) [0]
ΔGDP	-3.847 (0.029) [5] **
OP	-3.217 (0.105) [8]
ΔOP	-6.819 (0.000) [0] ***

Notes: *** and ** indicate significance at 1% and 5% level, respectively. Probability values are in parentheses optimal lag lengths are in square brackets. The appropriate lag length was determined by the general-to-specific t-significance method.

ADF unit root test results show that the GDP growth and oil price series are stationary at the first difference. The results of the RALS-ADF unit root test are similar to the ADF test results, and hence it can be concluded that both series are I (1). The positive and negative components of the series are also stationary at the first difference. The results of the ADF unit root test for the positive and negative components of the series are reported in Table A1 in the appendix.

Table 2: RALS-ADF Unit Root Test Results

Variables	Test Statistics	Rho	Critical Values		
			%1	%5	%10
GDP	2.824	0.59	-3.24	-2.64	-2.32
ΔGDP	-4. 972***	0.96	-3.39	-2.81	-2.50
OP	-1.996	0.98	-3.39	-2.81	-2.50
ΔOP	-2.687**	0.38	-3.14	-2.51	-2.17

Note: *** and ** indicate significance at 1% and 5% level, respectively. For critical values, see Hansen (1995). The appropriate lag length was determined by the general-to-specific t-significance method.

Table 3 shows the results of cointegration analysis of the series that are stationary at the first difference. The analysis using EG and RALS-EG methods shows that there is no long-term correlation between oil prices and economic growth. The cointegration results are in line with Yılancı (2017).

Table 3: EG and RALS-EG Cointegration Results

Variables	Test Statistics	Rho	k	Critical Values		
				%1	%5	%10
EG	-1.404 (0.798)	-	7	4.32	3.67	3.28
$RALS-EG$	-0.878	0.57	7	-3.67	-3.04	-2.73

Note: Probability values in parentheses and k is optimal lag lengths. The appropriate lag length was determined by the general-to-specific t-significance method.

The causal relationship between the series is explored both symmetrically and asymmetrically, and the findings are reported in Table 4. According to the results of the symmetric causality analysis reported in Table 4, while a causal relationship is obtained from oil prices to economic growth, there is no symmetrical causal effect from economic growth to oil prices. When standard symmetric causality is utilized, a unidirectional causality effect running from oil prices to GDP growth is observed for Türkiye.

Table 4: Symmetric and Asymmetric Causality Test Results (Dependent Variable: GDP growth)

H_0 Hypothesis	W Stat.	W Critical Values		
		%1	%5	%10
$OP \nrightarrow GDP$	7.674***	7.530	4.065	2.827
$GDP \nrightarrow OP$	0.673	7.481	4.190	2.959
$OP^+ \nrightarrow GDP^+$	1.254	26.205	11.768	7.709
$OP^- \nrightarrow GDP^-$	0.508	15.319	6.734	4.166
$OP^- \nrightarrow GDP^+$	2.841	10.961	5.438	3.601
$OP^+ \nrightarrow GDP^-$	6.941**	12.352	6.162	4.079
$GDP^+ \nrightarrow OP^+$	0.484	30.027	13.567	8.867
$GDP^- \nrightarrow OP^-$	0.508	10.812	5.252	3.462
$GDP^- \nrightarrow OP^+$	2.522	11.968	5.113	3.446
$GDP^+ \nrightarrow OP^-$	0.031	15.750	5.846	3.548

Notes: *** and ** indicate statistical significance at the 1% and 5% levels, respectively. H_0 represents the null hypothesis, which asserts that there is no causal relationship. OP^+ and OP^- represent the postive and negative components of oil price, and GDP^+ and GDP^- represent the postive and negative components of GDP growth series.

When asymmetric causation is considered, the results showed that increasing oil prices leads to a decrease in GDP growth in Türkiye. The asymmetric causality findings are consistent with Korhonen and Ledyaeva (2010) and Jiménez-Rodríguez and Sánchez (2005). Thus, changes in oil prices affect the oil-dependent Turkish economy. However, only increases in oil prices impact the GDP growth of Türkiye. Oil price declines have no direct influence on Türkiye's GDP growth rate. As a result, it appears that the Turkish economy does not significantly respond to oil price decreases.

5. ROBUSTNESS CHECKS

The Granger and Yoon (2002) approach is used to examine the cointegration relationship between positive and negative shocks of GDP growth and oil price series. The findings are consistent with the EG and RALS-EG findings, and no cointegration relationship exists between the positive and negative components of GDP growth and the oil prices series. In addition, the EG cointegration relationship is examined by using the industrial production index (IPI) as a dependent variable. The findings provide evidence that there is no long-run relationship between the industrial production index and oil prices as in the GDP growth and oil price series.

We implement a hidden cointegration analysis developed by Granger and Yoon (2002) to examine the cointegration and causality relationship between the positive and negative components of the industrial production index and the oil price series. Additionally, we performed Hatemi-J's (2012) asymmetric causality analysis to investigate the same relationship. By using these two different analytical methods, we aimed to handle a comprehensive understanding of the relationship between oil prices and the industrial production index. Granger and Yoon (2002) hidden cointegration[1] results show that the cointegration relationship between positive shocks of the series are obtained only for the model with a constant term. When the trend is included in the model, no long-run cointegration relationship between positive and negative shocks of the series is obtained.

Table 5: Symmetric and Asymmetric Causality Test Results (Dependent Variable: IPI)

H_0 **Hypothesis**	**W Stat.**	**W Critical Values**		
		%1	**%5**	**%10**
$OP \nrightarrow IPI$	8.727***	8.033	4.330	2.951
$IPI \nrightarrow OP$	0.619	8.176	4.413	2.997
$OP^{+} \nrightarrow IPI^{+}$	0.982	12.797	5.491	3.412
$OP^{-} \nrightarrow IPI^{-}$	0.328	15.452	6.898	4.273
$OP^{-} \nrightarrow IPI^{+}$	3.554*	10.824	5.189	3.389
$OP^{+} \nrightarrow IPI^{-}$	5.400*	13.561	6.357	4.115
$IPI^{+} \nrightarrow OP^{+}$	1.793	11.423	5.375	3.492
$IPI^{-} \nrightarrow OP^{-}$	0.397	11.202	5.382	3.446
$IPI^{-} \nrightarrow OP^{+}$	2.810	12.673	5.211	3.426
$IPI^{+} \nrightarrow OP^{-}$	0.003	20.232	6.473	3.625

Notes: ***, ** and * denote significance level at 1% and 5% and 10%, respectively. H_0 is the null hypothesis, which states that there is no causality.

When the industrial production index is used as the dependent variable besides GDP Growth, similar causality results are obtained. For example, a causal relationship is obtained between the industrial production index and oil prices, and the direction of causality is from the positive shocks of oil prices to the negative shocks of the industrial production index series. This result supports the previous findings. Moreover, a causal relationship is obtained from the negative shocks of oil prices to the positive shocks of the industrial production index. The results of the symmetric causality analysis are also similar. While there is a causality relationship from oil prices to the industrial production index, no symmetric causality relationship from the industrial production index to oil prices is found.

6. CONCLUSION AND POLICY IMPLICATIONS

The long-term link between Türkiye's economic development and oil prices is examined in this study for the years 1987 to 2019. Additionally, an asymmetric causality test is employed to examine the causal relationship between oil prices and Türkiye's economic development. First, ADF and RALS-ADF are used to test the stationarity of the series. Since the series are integrated in the

[1] Table A2 in the appendix summarizes the findings.

first order, the long-run relationship is investigated by Engle-Granger and RALS-EG cointegration analysis proposed by Lee et al. (2015). The results of the two cointegration studies show that for the period of 1987 to 2019, there was no significant correlation between Türkiye's economic development and oil prices.

The economic theory states that, while productivity is constant, an increase in energy prices affects growth negatively. The results of the study provide evidence that there may have been an increase in productivity and technological progress in production factors in Türkiye. Despite the ongoing fluctuations in energy prices, there might be a variety of reasons why economic growth is not severely affected by these changes. Improvements in production techniques, increased efficiency in production factors, and the quality of financial institutions are important factors that may be alleviating the adverse effects of energy price increases. During the period covered in this study, the average schooling rate and the number of university graduates increased steadily in Türkiye. These advances lead to a rise in the country's human capital stock, which is required for economic growth. Furthermore, even with a low level of education, developments in information and communication technology have boosted labor productivity. Apart from these factors, the efficiency of the capital stock has increased in many sectors, and it has evolved to consume less energy per unit of production. Furthermore, the relatively low levels of oil prices after 2014 favored oil-dependent countries. It seems that the government's strategy of decreasing the tax burden on oil prices in order to avert price hikes and the downward trends in oil prices suppress a parallel or inverse relationship between oil prices and economic growth for the majority of the period. The series do not, therefore, attain long-term equilibrium, and oil price shocks associated with financial instability have an impact on the correlation between economic growth and oil prices.

According to the RBC theory, economic fluctuations result from crises. The results of the study support this theory. The results suggest that positive oil price shocks are essential factors in maintaining the economic growth of the oil-dependent Turkish economy. External positive oil shocks have crucial effects on GDP growth rates possibly through investment and consumption channels. Countries that are heavily dependent on oil, such as Türkiye, might mitigate these detrimental consequences by diversifying their energy sources.

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APPENDIX

Table A1 shows the ADF unit root test results for the positive and negative components of the industrial production index (IPI), GDP growth, and oil prices (OP) series. According to the results, all components of the variables are found stationary at first difference, except positive oil price shocks. Due to the multiple breaks in OP^+ series ADF unit root test did not produce the results. However, when using unit root test that allow multiple breaks, OP^+ series also found stationary at first difference.

Table A1: ADF Unit Root Test Results

Variables	Test Statistics
IPI	-1.312 (0.867) [0]
ΔIPI	-4.729 (0.003) [0]***
GDP^-	-1.975 (0.592) [0]
ΔGDP^-	-6.317 (0.000) [0]***
GDP^+	-2.041 (0.557) [0]
ΔGDP^+	-4.749 (0.003) [0]***
OP^-	-1.573 (0.781)[0]
ΔOP^-	-4.970 (0.002) [4]***
OP^+	-1.673 (0.739) [0]
ΔOP^+	n/a
IPI^-	-2.729 (0.232) [0]
ΔIPI^-	-5.739 (0.000) [0]***
IPI^+	-1.482 (0.814) [0]
ΔIPI^+	-4.258 (0.011) [0]**

Note: *** and ** indicate significance at 1% and 5% level, respectively. Values in parentheses are probability values, appropriate delay lengths.

Table A2: Granger and Yoon (2002) Hidden Cointegration Test Results

		Without Trend		With Trend	
Dependent Variables	**Independent Variables**	**Test Statistics**	**Decision**	**Test Statistics**	**Decision**
GDP^{-}	OP^{-}	-1.646 (0.704)	No cointegration	-3.736 (0.101)	No cointegration
GDP^{+}	OP^{+}	-3.085 (0.120)	No cointegration	-2.480 (0.561)	No cointegration
IPI^{-}	OP^{-}	-2.016 (0.527)	No cointegration	-2.795 (0.405)	No cointegration
IPI^{+}	OP^{+}	-3.664 (0.040)**	Cointegration	-2.057 (0.764)	No cointegration

Note: Probability values in parentheses.

Ethics Statement: The authors declare that ethical rules are followed in all preparation processes of this study. In case of detection of a contrary situation, BİİBFAD Journal does not have any responsibility and all responsibility belongs to the authors of the study.

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