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Using the NARDL Model to Examine the Relationship between Oil Prices and Economic Growth: The Case of Turkey *

Petrol Fiyatları ile Ekonomik Büyüme Arasındaki İlişkinin NARDL Modeli ile İncelenmesi: Türkiye Örneği

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ÖZ

Günümüzde ürünlerin imalatında kullanılan ana hammaddelerden birinin ham petrol olması nedeniyle, bu önemli kaynağın fiyatlarındaki dalgalanmalar, nihai ürünlere girdi maliyetleri olarak yansımaktadır. Özellikle son yıllarda yaşanan ham petrol fiyatlarındaki artış ve dalgalanmaların ekonomik büyüme üzerinde olan etkisinin ne düzeyde olduğu da büyük önem taşımaktadır. Petrole olan bağımlılığın artmasıyla birlikte bir kısır döngüye dönüşen bu sürecin etkileri, kuşkusuz tüm dünya ekonomileri gibi Türkiye ekonomisinde de hissedilmektedir. Petrol fiyatlarındaki artış veya düşüşlerin küresel ekonomi üzerindeki öneminden yola çıkarak, bu çalışmada petrol fiyatları ile Türkiye ekonomisinin büyümesi arasındaki eşbütünleşme ilişkisinin ampirik olarak araştırılması amaçlanmıştır. Bu sebeple, Türkiye'de 1976-2021 döneminde uzun dönem bütünleşmeyi incelemek için Doğrusal Olmayan ARDL (NARDL) modeli kullanılmıştır. Çalışmanın sonuçları, ham petrol fiyatlarındaki pozitif ve negatif şokların Türkiye'de Gayri Safi Yurtiçi Hasıla üzerinde asimetrik bir etkiye sahip olduğuna işaret etmektedir. Çalışmadan elde edilen bulgular, akademisyenlere, profesyonellere ve karar vericilere politika alanında tavsiyelerde bulunmak açısından önemlidir. Ham petrol fiyatlarının hem yurt içinde hem de dünyada istikrarlı bir ekonomik büyüme sürecinde oynadığı rolün daha iyi anlaşılması ile Türkiye'nin bu alandaki politikalarının irdelenmesi ve gerekli politika değişikliklerin yapılması önerilmektedir.

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A B S T R A C T

Crude oil is one of the main raw resources used to produce commodities today; therefore, changes in the price of this essential resource are reflected as input costs in the final costs of the products. The impact of fluctuating crude oil prices on economic growth, particularly in recent years, is significant. Actually, fluctuations in the price of oil can have an impact on both the global economy's structure and the economy of Turkey. Given the significance of either rising or falling oil prices to the global economy, the aim of this paper is to investigate and determine the co-integration relationship between oil prices and economic growth in the Turkish economy. The nonlinear ARDL (NARDL) model was employed in order to evaluate the long-term integration of the Turkish economy throughout the years 1976–2021. The findings demonstrate that Turkey's GDP is asymmetrically affected by both positive and negative shocks to crude oil prices. This research's conclusions are essential for counseling academics, professionals, and policymakers. It is recommended that Turkey reevaluate its policies in this area and make any necessary modifications in light of a deeper understanding of the role that crude oil prices play in a process of stable economic growth both inside the country and outside the world.

1. Introduction

The expansion of usage areas and purposes, such as (i) being one of the primary raw materials used in production, (ii) being the primary raw material of the petrochemical and fertilizer industries, and (iii) the use of fuels obtained by

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liquefaction for energy and transportation purposes, demonstrate the continued importance and priority of crude oil in the global economy from the past to the present.

As a result, crude oil is still a crucial component of production and continues to be the most significant global commodity despite the emergence of electric vehicles, severe global climate targets, and the increasing utilization of renewable sources of energy. Therefore, fluctuations in the price of oil affect the employment rate and inflation rate, which affect the economy's growth pace and trigger austerity measures from the government. Furthermore, it is one of the most significant macroeconomic factors affecting the world economy, acting as a barometer for Middle Eastern political turmoil, inflation, and economic outlooks, as well as fluctuations in currency (Al-Sasi et al., 2017; Lang & Auer, 2020; Kriskkumar et al., 2022).

Since the 1970s crude oil crises, scholars and policymakers have focused on the shocks to crude oil prices and how they affect macroeconomic indicators. Although understanding this relationship has advanced greatly, the unpredictability of the effect of oil price shocks on macroeconomic indicators over time presents a significant barrier to the evaluation of the relationship between them (Wen et al., 2018; Zhang & Chen, 2018).

Oil-importing nations are impacted by price changes in two ways. First off, countries that import oil benefit from lower oil prices since their trade terms and balance of payments improve. Moreover, a price increase for oil could result in a sharp decline in income, particularly for nations whose economies are heavily reliant on oil (Deaton, 1999; Akinsola & Odhiambo, 2020).

Increases in oil prices often have an impact on both the supply and demand sides. From the perspective of the supply side effect, the increase in crude oil prices, a production input, raises production costs, which results in a reduction in overall output. On the other hand, the consumption and investment facets of aggregate demand can be used to explain demand's side effects. In this instance, the rising cost of transportation leads to higher consumer product prices while also raising the company's production costs and harming investment (Prasad et al., 2007). In addition, policymakers keep an eye on an essential parameter called the demand-side elasticity of the crude oil price. Nevertheless, it determines all of the main determinant indicators, like demographic, economic, environmental, and technological factors, the usage of fuel-efficient vehicles, and consumer driving habits (Al-Sasi et al., 2017).

Every economy in the world suffered from the four significant oil shocks that occurred from 1960 to 1999. There are widespread opinions that, since the 1970s, the Organization of the Petroleum Exporting Countries (OPEC) has been able to affect the price of crude oil globally and that its oil embargo, in particular, was the cause of the first oil crisis. That's why the price of a barrel of oil increased from 3.4 to 13.4 dollars during 1973 and 1974. The Iranian revolution, which had an impact on the oil supply, caused oil prices to rise from $20 to $30 per barrel in the four years following the crisis, from 1978 to 1979. Following Iraq's invasion of Kuwait in 1990, the third oil crisis began, with a spike in oil prices from 16 to 26 dollars having an impact on world economies. Until 1999, one of the most noticeable oil price changes was the jump from 12 to 24 dollars a barrel (Cuñado, J., & de Gracia, 2003; Lang & Auer, 2020). By investigating occurrences like the 1986 counter-oil shock, OPEC's dissolution in November 2014, and the price war that occurred in March and April 2020 as a result of disputes between Russia and the Kingdom of Saudi Arabia (KSA) over how to deal with the impending decline in oil demand brought on by the COVID-19 pandemic, Nazer and Pescatori (2022) argued that the oil price exhibits excessive volatility around the dates of OPEC meetings and even before the meetings. In other words, they support the hypothesis that OPEC-related changes might significantly affect oil prices.

Not long ago, in 2022, the beginning of hostilities between the two biggest producers of world energy markets, Ukraine and Russia, had far-reaching consequences for global energy markets, particularly crude oil and natural gas prices (Huang et al., 2023). The Russia-Ukraine war also generated a large cost, equal to 1% of world GDP in 2022, as a result of the breakdown of supply chains, the export of Ukrainian goods, and the decline in trade with Russia (Liadze et al., 2022).

In actuality, changes in global oil price fluctuations can have an impact on the structure of the worldwide economy as well as the Turkish economy.

Being current with crude oil analysis is crucial since, unlike in natural sources, conclusions pertaining to the economic and financial causal linkages of crude oil are not precise and are prone to changes over time as underlying factors alter (Lang & Auer, 2020).

As an emerging country, Turkey's GDP increased from 1976 to 2021 from 170.35 billion US dollars to 1.13 trillion US dollars, according to data from the World Bank. Energy consumption increased along with the country's expanding economy in both industrial output and transportation. Additionally, non-renewable resources, particularly crude oil, provide for roughly 88% of its energy needs. Turkey struggles to satisfy its oil needs nonetheless, as a result of the absence of domestic oil supplies. Therefore, Turkey, like many emerging countries, meets its expanding oil demands through high volumes of imports, causing the Turkish economy to face energy supply restrictions. Being a net importer of oil makes Turkey vulnerable to outside shocks, as does its huge foreign debt and imported export structure. As a result, there are several policy implications for the link between the price of oil and the growth of the Turkish economy (Gorus et al., 2019; Samour and Pata, 2022).

With this motivation, the aim of this study is to contribute to the existing literature in two ways: (i) This study investigates, utilizing the most recent available data, the relationship between oil prices as a natural resource and economic growth in the case of Turkey for the 1976-2021 time interval. (ii) This study uses the nonlinear augmented autoregressive distributed lag model (NARDL) as evidence that results can be misinterpreted if nonlinearities are ignored. The findings of the empirical analysis demonstrate the asymmetric impacts of oil prices on economic growth. Furthermore, by concentrating on the Turkish economy as a growing, oil-dependent, and importer country, this study aims to draw conclusions that may be used to inform policymakers about other major and energy-reliant countries.

The rest of the paper is designed as follows: The relevant literature review on oil price-economic growth is detailed in Section 2. Section 3 describes the data and methodology of the study. The findings obtained from the econometric analysis are reported in Section 4. Section 5 concludes and highlights policy implications.

2. Review of Literature

The results of several studies that have been conducted on the relationship between natural resources, their price, and economic growth in industrialized and emerging nations have been inconsistent and conflicting (Shahbaz et al., 2019). Due to the ongoing dispute in the literature, it is still essential for researchers and policymakers to stay up-to-date on the impacts of oil price changes on economic growth by periodically reviewing studies carried out in different countries using various empirical techniques. Therefore, the literature review in this study, following the study of Akinsola & Odhiambo (2020), aims to review previous studies, including both country-specific ones and multi-country studies.

From the extensive corpus of research examining the impacts of oil price variations on macroeconomic variables, primarily economic development, one of the most well-known pioneering studies, Hamilton’s (1983) study, focused on the recession period process in the United States (USA) between World War II and the 1973 oil shock. His conclusion was based on the study’s findings, which showed that rapid fluctuations in oil supplies had a direct effect on the amount of total production and the recession. In addition to creating external pressures on the macroeconomic structure generally, the changes in the price of oil also caused a reduction in US economic growth from 1948 to 1972.

In his study, conducted using a VAR model, Mork (1989) also investigated the economic effects of oil price on the US economy and concluded that the drop in the oil price has a favorable influence on the recovery of the economy. Based on his study’s outcome, there was no statistically strong effect on the economic growth as the rise of oil prices did, drawing attention to the asymmetric impact of oil prices and for the first time the symmetrical causal relation between oil prices and economic growth was being questioned in the scientific literature. In support of the findings of Mork's earlier study, a subsequent study by Mork et al. (1994) demonstrated an asymmetric impact of oil price in the majority of OECD nations.

Jiménez-Rodrguez and Sánchez (2005) come to the conclusion that there is a nonlinear correlation between economic growth and oil prices in certain of the major industrialized OECD nations after conducting a multivariate VAR analysis on data from the period 1972Q3 to 2001Q4. For the years 2000-2010, the G-7 countries' economic growth was positively impacted by oil prices, according to a different study from Ghalayani (2011) that used the Granger causality test to come to this conclusion. The study, however, failed to find a correlation between oil prices and the growth of countries that export petroleum.

Contrary to the findings of the majority of the literature, Prasad et al. (2007) concluded that an increase in oil prices has a positive impact on growth in the economy based on the findings of the research conducted in the Fiji Islands by applying the Granger Causality test over the period of 1970 to 2005.

Significant findings in the literature emerge from yet another investigation of the volatility of the oil price, this time focused on an oil exporting economy. The sample span covers the period 2006-2016. The findings of the study by Al-Sasi et al. (2017) show that Saudi Arabia, a country that exports oil, saw an almost doubling of its annual rate of increase in domestic oil consumption between the years of 4.93 and 2.46% GDP growth, respectively. This result brought to light the fact that price changes have less of an impact on gasoline demand than Saudi Arabia's economic growth.

In another study, with the motivation to investigate how volatile the price of oil is and how much of an impact it has on the growth of the Middle East and North Africa (MENA) countries’ economies, including oil-exporter and importer ones, Abdelsalam (2020) conducted a panel quantile regression to focus on the asymmetric relationship between them for the period 1970–2018. The findings suggest that the fluctuations in oil prices have an uneven impact on economic development and that the link between oil price volatility and uncertainty differs across quantiles.

By using the NARDL model and splitting down the oil price into negative and positive shifts, Akinsola & Odhiambo (2020) investigated the economic growth of seven low-income, oil-importing nations in Sub-Saharan Africa (SSA) from 1990 to 2018. And the findings of the study supported the investigation by revealing that a decline in oil prices has a positive impact on growth, whereas an incrase in oil prices has a negative effect on economic growth.

Kriskkumar et al. (2022) demonstrate how price changes in oil have an asymmetrical impact on Malaysia's economic growth by employing the NARDL model and the ARDL model to investigate the effect of shocks to the oil price on the Malaysian economy over the period 1981–2017.

It is now commonly accepted that carrying out a study that focuses on a single country is a reasonable course of action since it gives a genuine image of the economy, identifies the phenomena it is facing, and has significant policy consequences that are appropriate for the economy being evaluated (Shahbaz et al., 2019). With this motivation, this study also focuses on a single country, an oil importing and newly industrialized country: Turkey.

Recent research that examines how the price of oil affects Turkey's economic growth is also reviewed in this study. For the period between 1996 Q1 and 2017 Q9, Gorus et al. (2019) employed both the Fourier Toda-Yamamoto and Fourier Shin cointegration test techniques to analyze how fluctuations in income and oil prices impacted Turkey's demand for imported crude oil. According to the study's conclusions, long-term changes in income have a greater long-term impact on oil imports than do fluctuations in oil price. Additionally, energy-conserving measures don't have a negative impact on actual economic activity.

Kırca et al. (2020) conducted causality tests for the quarters of 1998 Q1 through 2019 Q4 to ascertain the long-term validity of the relationship between Turkey's oil-gas price index and economic development. The results of their analysis suggest that there is a causal correlation between oil and gas prices and economic development, depending on the Toda-Yamamoto causality test with a structural break; however, the Granger and frequency domain causality tests failed to find such a link. An additional study, Kamacı & Göktaş (2020), focusing on the correlation between oil prices and economic growth in Turkey from 2003 Q1 to 2019 Q4, finds a long-lasting co-integrated connection between oil prices and economic growth, with a one-way causality from economic growth to oil prices.

Samour and Pata's (2022) analysis confirms that the price of oil has an adverse effect on renewable energy consumption via real income channel between 1985 and 2016. The study recommends that policymakers revise the present economic growth model in order to increase its resilience to external shocks like the oil prices, currency rate, and US interest rate. This will help Turkey achieve sustainable development.

Using the asymmetric ARDL test, Sengül's (2023) study revealed that while an improvement in Turkey's economic growth—using the manufacturing industry production index as a proxy—between 2000 and 2021 increased oil prices based on demand, a decline in that growth had the opposite effect. On the other hand, the Turkish economy is more impacted by the decline in oil prices than by the rise in oil prices. The findings indicate that oil prices and economic growth have an asymmetrical relationship in this case.

3. Data and Methodology

Based on the importance of hikes and drops in the oil price on the global economy, the main purpose of this paper is to empirically examine the co-integration relationship between oil prices and economic growth for the Turkish economy, utilizing the data within the time frame 1976-2021. Given that previous studies on the relationship between the price of oil and Turkey's economic growth often use linear time series models in the applied analysis, this study, which was carried out using nonlinear time series methods, intends to advance our understanding in this field.

For this motive, the model's variables include the price of crude oil (OIL) and the gross domestic product (constant, 2015), an indicator of economic growth. In order to determine the series' growth rate, this data was gathered from the BP database and the World Bank's World Development Statistics. The data was then converted into its natural log form.

In order to investigate the long-term integration over the period 1976–2021 in the Turkish economy, the nonlinear ARDL (NARDL) model was utilized. Initially, before the analysis, the econometric model equation of the study is given as follows:

$$Ln\mathrm{GDP_i} = \alpha_0 + \alpha_1 LnOIL_\mathrm{t} + u_\mathrm{t} \quad (1)$$

In equation 1, where the α_0 represents the intercept of the model, while the α_1 is the estimate of the parameter, which stands for the elasticity coefficient of oil price (OIL), and the final term, ut, represents the error term.

At first, to investigate the series' stationarity, although "many unit root tests have been developed for testing the null hypothesis of a unit root against the alternative of stationarity" (Ng-Perron, 2021), the traditional unit root test of the NG-Peron (2001) test was chosen for this study. Specifically, because of the substantial negative moving-average component, Perron and Qu (2007) claim that this traditional test is a group of unit root tests without having to give up power for local alternatives. It also has a local asymptotic power function and an exact size that is close to nominal size.

In order to not to be skeptical about the conclusions drawn from the NG-Perron test and to consider the structural break of the series, the Zivot Andrews (1992) test is performed, respectively. According to Zivot-Andrews (1992); their test, as a variation of Perron's test, "is more appropriate than Perron's because it circumvents the problem of data mining." And "the asymptotic distribution of the estimated breakpoint test statistic is determined". The emprical result of their study indicates that "by treating the breakpoint as endogenous, there is less evidence against the unit root test hypothesis than Perron finds for many of the data series but stronger evidence against it for some of the series".

Following the stationarity analysis, the BDS test, established by Brock et al. (1996), is used to determine whether the series' linearity properties are sufficient to evaluate deviations against a broad class of linear, non-linear, and non-stationary models. A measure of spatial correlation between two vectors is also established by the BDS test statistic, which is based on the correlation integral (Fernandes, 1998). In other words, the non-parametric BDS test investigates the autocorrelation between the time series' present and past values as a nonlinearity test (Akgül et al., 2018).

Following the results of the BDS tests, the bounds testing conintegration method proposed by Pesaran et al. (2001) was used to ascertain whether there was cointegration between the variables. With this aim, an ARDL equation called the Unconstrained Error Correction Model (UECM) by Pesaran et al. (2001) was modified for this research in equation (2).

$$\Delta LKBGDP_t = \alpha_0 + \alpha_{1,i} \sum_{i=1}^{m} \Delta LKBGDP_{t-i} + \alpha_{2,i} \sum_{i=0}^{m} \Delta LKBOIL_{t-i} + \varepsilon_t \quad (2)$$

Due to the nature of the series integration, it was essential for this study to employ the NARDL bound testing to cointegration relationships proposed by Pesaran et al. (2001), an enhanced version of the ARDL model developed by Shin et al. (2014). Through partial sums, the NARDL cointegration approach enables the known ARDL model's short-and long-run asymmetries to be eliminated in the relevant variable (Akgül et al., 2018). To put it in perspective, the NARDL model divides the explanatory variable into positive and negative components, allowing both the short- and long-term consequences of positive and negative shocks on the dependent variable to be evaluated independently (Güler, 2021). The NARDL model is used to the model due to the nonlinearity of the series, which is the advantage of the ARDL model over the conventional approaches. The Markov Switching Regression Model, or MSR, comes after the NARDL model.

Shin et al. (2014) proposed the nonlinear ARDL model by running nonlinear limit tests on the ARDL model. Positive changes and negative changes are the two categories into which variations of the independent variable are split in the NARDL model.

By performing nonlinear bounds tests on the ARDL model, Shin et al. (2014) presented the nonlinear ARDL model. Positive and negative changes are the two distinct forms of dynamic changes that the NARDL model distinguishes between for the main independent variable. These two distinct changes may have asymmetrical impacts on the dependent variable (Zheng et al., 2022). To determine whether the NARDL model's independent variable(s) have a nonlinear effect on the dependent variable, they are divided into positive and negative parts (Chowdhury et al., 2020). Oil prices are split into negative and positive components in the study and provided in an equation (3).

$$LnOIL_t^+ = \sum_{m=1}^{t} \Delta LnOIL_t^+ = \sum_{m=1}^{t} \max\left(\Delta LnOIL_t^+, 0\right)$$

$$LnOIL_t^- = \sum_{m=1}^{t} \Delta LnOIL_t^- = \sum_{m=1}^{t} \min\left(\Delta LnOIL_t^-, 0\right) \quad (3)$$

The updated version of the nonlinear unconstrained error correction model proposed by Shin et al. (2014) is illustrated in equation (4).

$$\Delta LnGDP_t = \alpha_0 + \alpha_{1,i} \sum_{i=1}^{m} \Delta LnGDP_{t-i} + \alpha_{2,i} \sum_{i=0}^{m} \Delta LnOIL^+{}_{t-i} + \alpha_{3,i} \sum_{i=0}^{m} \Delta LnOIL^-{}_{t-i} + \alpha_4 LnGDP_{t-1} + \alpha_5 LnOIL^+{}_{t-1} + \alpha_6 LnOIL^-{}_{t-1} + \varepsilon_t \quad (4)$$

After establishing the cointegration relationship with the nonlinear bounds test model and adopting the nonlinear UECM for this study, the NARDL model was estimated to acquire the long-term coefficients.

Subsequent to establishing the NARDL model, the Markov Switching Regression (MSR) model (Simple exogenous probability models are extended by the first-order Markov process known as the MSR model (Kartal et al., 2022). The MSR model's structure contains a number of equations to describe the temporal behavior of a number of prices in various regimes. Additionally, this model detects dynamic patterns (Moutinho et al., 2022)). was employed to evaluate the relationship between economic growth and oil prices in order to test the validity of the findings. The MSR model, developed by Hamilton (1989), "assumes different regimes or states to which each observation belongs a priori and identifies the breaks as switching between regimes. This is the switching model" (In-Moo Kim, 1993). In other words, MSR models, which support regime transitions, are able to recognize alterations in the interrelationship of variables. Furthermore, the model's coefficients rely on the variables' states and are time-dependent (Fallahi, 2011).

Two regimes—a low volatility regime and high volatility regime—are identified in the MSR model. Equations (5) and (6) present the modified MSR model for this study.

Low Volatility Regime:

$$LnGDP_t = \alpha_{1,0} + \alpha_{1,1} LnOIL_{t-i} + \varepsilon_{1,t} \quad (5)$$

High Volatility Regime:

$$LnGDP_t = \alpha_{2,0} + \alpha_{2,1} LnOIL_{t-i} + \varepsilon_{2,t} \quad (6)$$

In equations (5) and (6), $\alpha_{1,0}$ and $\alpha_{2,0}$ represent the regime-dependent constant terms, while $\alpha_{1,1}$ and $\alpha_{2,1}$ are parameter estimates, which stand for the autoregressive coefficients, and also $\varepsilon_{1,t}$ ve $\varepsilon_{2,t}$ represent error terms (Kartal et al., 2022).

4. Findings

Initially, the traditional stationary test of Ng-Perron (2001) is conducted, as described in the methodology. As a second step, considering the structural break of the time series, the Zivot Andrews (1992) test is performed. The LnGDP and LnOIL data are stationary after I (1), or the first difference, according to the outcomes of the Ng-Perron (2001) and Zivot Andrews (1992) tests.

Following the analysis of stationarity, no lineal dependences on the data will be identified. Therefore, the most commonly used technique based on the correlation dimension, the BDS test, was used to detect nonlinear structure in a time series. The outcomes of the BDS test are displayed in Table 1.

Table 1. The Outcomes of the BDS Tests

	LnGDP	LnOIL
Dimension	**BDS Statistics**	**BDS Statistics**
2	0.186 [0.000]	0.135 [0.000]
3	0.308 [0.000]	0.247 [0.000]
4	0.392 [0.000]	0.312 [0.000]
5	0.447 [0.000]	0.347 [0.000]
6	0.489 [0.000]	0.371 [0.000]
Observation	46	46

Note: Data independence and uniform distribution are the null hypotheses for the BDS test. Probability values are indicated by parentheses.

A careful inspection of Table 1 demonstrates that the linearity of the variables, the null hypothesis, cannot be accepted. The BDS test demonstrates that the variables in the analysis are not linear as a result.

The asymmetric co-integration between the variables is evaluated using the NARDL test developed by Shin et al. (2014).

Table 2 represents the findings from the nonlinear boundary test analysis. In the absence of cointegration, the null hypothesis is confirmed. In other words, the variables' asymmetric co-integration is supported.

Table 2. Results of the Non-Linear Bounds Test

F Statistics	Critical Value with 1% Significance	
	Alt Sınır	Üst Sınır
8.74	4.13	5.00

Note: According to Narayan & Narayan (2004), the nonlinear boundaries test analysis's F statistic is compared with the table's crucial lower and higher values. The null hypothesis that there is no cointegration is rejected if the estimated F statistic exceeds the higher value. The null hypothesis can't be rejected if it is less than the lower bound. If the determined F statistic falls within either of the higher or lower bounds, no conclusion can be established.

Due to the calculated F statistic exceeding the upper bound, Table 2 demonstrated that the null hypothesis that there was no cointegration was rejected. The variables were found to have a long-term cointegration relationship. The primary assumption of the NARDL model is that the use of linear methods to examine the relationship between variables is insufficient due to unforeseen occurrences like economic crises, political shifts, and other disasters. Additionally, the model separates the influence of exogenous variables on dependent variables into their short-term and long-term effects (Baz et al., 2020). Thus, the overall outcome signified cointegration, which informed the study to adopt the NARDL bound test as the most suitable method. The cointegration equation is derived by estimating the NARDL model. In Table 3, the NARDL model's long-run coefficients and the coefficient of error correction are displayed.

Table 3. NARDL Model Long-Run Coefficients and Error Correction Coefficient

Long-Run Coefficients from the NARDL (1, 2, 1) Model		
Variables	**Coefficient**	**T Statistics**
LOIL_POS	0.260	3.363*
LOIL_NEG	-0.147	-2.978*
C	25.951	21.835**
Error Correction Coefficient from NARDL (1,2,1) Model		
Variables	**Coefficient**	**T Statistics**
ECT(1)	-0.194	-2.423*
Tests of the Error Term		
$X^2{}_{BG}$		0.081 [0.922]
χ^2_{WHITE}		0.136 [0.714]
$X^2{}_{RAMSEY}$		1.209 [0.234]

Note: The NARDL model error term tests show no evidence of autocorrelation, changing variance, or misidentification problems. 1% and 5% significance levels are shown by the symbols * and **, respectively.

The outcome of the NARDL model, statistically, indicates that a 1% positive shock in oil prices accounts for about a 0.26% gain in GDP, whereas a 1% negative shock results in a 0.15% decline in GDP. The findings prove that oil price shocks, both positive and negative, have asymmetric effects on GDP.

The MSR model has the advantage of allowing for the inclusion of a rapid, unexpected change in a time series' behavior as a switching regression model (In-Moo Kim, 1993). On account of this, for the robustness of the outcome of the NARDL model, the relationship between economic growth and oil prices was again evaluated using the MSR model. Table 4 displays the empirical findings of MSR models.

Table 4. Estimating Results of the MSR Model

Variable / Model	**Coefficients**
First Regime: Low Volatility	
LOIL	0.486*
C	25.223*
Second Regime: High Volatility	

LOIL	-0.098*
C	26.361*

Note: * indicates the significance level of %1.

In accordance with the outcomes of the MSR model shown in Table 4, under a low volatility regime, one-percentage-point rise in oil prices results in an increase of 0.49 percentage-point in GDP, while one-percentage-point increase in oil prices in a high volatility regime causes in a 0.09 percentage-point drop in GDP.

The majority of the outcomes are in line with those of the MSR model, indicating that the outcomes of the NARDL model are also reliable and demonstrate the statistical significance of each variable included in this study. In this sense, the conclusions drawn from the NARDL and MSR models are dependable and robust. As a result, the outputs of the NARDL and MSR models indicate that both positive and negative shocks to oil prices have an asymmetric effect on Turkey's GDP.

As a recommendation, Turkey should evaluate the influence of the different regimes, as the coefficients and signs of the coefficients for each of the variables in the present analysis vary.

5. Conclusion

With previous research finding either a positive or negative association and no agreement in the argument, the relationship between oil prices and the health of the economy has become a matter of growing concern. In other words, in the literature, the conclusions reached in research studying the effects of fluctuations in oil prices on growth in the economy are different from each other. In numerous studies, the findings show that the cost of oil has an impact on economic growth (Hamilton, 1983; Jiménez-Rodrguez and Sánchez, 2005; Prasad et al., 2007; Al-Sasi et al., 2017; Akinsola & Odhiambo, 2020). In addition, as the direction of the impact of oil prices on the country's economy varies from country to country, it also varies by country importing oil from the oil-exporting country.

In accordance with the findings of the research conducted in the Fiji Islands, Prasad et al. (2007) concluded that an increase in oil prices had a positive effect on economic growth by applying the Granger Causality test over the period from 1970 to 2005. Using the NARDL and ARDL models to investigate the impact of shocks to the oil price on the Malaysian economy during the period 1981–2017, Kriskkumar et al. (2022) highlight how fluctuating oil prices have an asymmetrical impact on the growth of the Malaysian economy. In other words, the results of their research show that an increase in oil prices had a negative impact on economic growth, while a drop in oil prices had a positive effect.

Al-Sasi et al. (2017) focused the volatility of the oil price on Saudi Arabia's economic growth as an oil exporting economy for the period 2006-2016. The findings of the study indicate that price changes have less of an impact on oil demand than Saudi Arabia's economic growth. On the other hand, using the NARDL model and dividing the changes in the price of oil into positive and negative shifts, Akinsola & Odhiambo (2020) concentrated on the economic growth of seven low-income, oil-importing countries in Sub-Saharan Africa (SSA) from 1990 to 2018. And the study's findings confirmed the research demonstrating that a rise in oil prices has an adverse effect on economic growth while a decline in oil prices has a positive effect.

It is now widely accepted that conducting a study focusing on a single country is acceptable due to the fact that it provides a true picture of the economy, identifies the phenomena it is dealing with, and has significant policy implications that are appropriate for the economy being evaluated (Shahbaz et al., 2019). With this motivation, this research focuses on a single country, Turkey, an oil importer and recently industrialized country.

This study also reviews recent research that investigates the relationship between oil prices and Turkey's economic growth by different oil price proxy measures; oil demand (Gorus et al., 2019); oil price index (Kırca et al. 2020); and economic growth proxy measure; the manufacturing industry production index (Sengül, 2023).

In light of the aforementioned, the primary goal of this study is to examine the integration of oil price shocks with a focus on economic growth in Turkey from 1976 to 2021 using nonlinear time series methods and annual time series data.

In order to identify the relationship between the price of oil and the growth of the economy, initially the stationary part of the data set is analyzed by the traditional unit root test, the Ng-Perron test. Taking into account the structural break of the series, the Zivot-Andrews test with structural break is performed. In addition, for the linearity assumption of the data set, the BDS test is performed. According to the outcome of the BDS test, the variables in the analysis are not linear as a result. By dividing the fluctuations in the price of oil into negative and positive shifts, the NARDL test, developed by Shin et al. (2014), is employed to investigate the asymmetric co-integration between the variables.

Based on the findings of the NARDL model test, it can be concluded that both positive and negative shocks to the price of oil have asymmetric impacts on Turkey's economic growth. This study suggests similar outcomes to those of Sengül's (2023) study conducted in Turkey. In addition, for the robustness of the outcome of the NARDL model, the relationship between economic growth and oil prices was again evaluated using the MSR model. The outcome of the MSR model test, the conclusions of the NARDL model, and evidence from other sources, to mention a few (Mork (1989); Mork et al. (1994); Narayan & Narayan (2007)), as well as a more recent study by Akinsola & Odhiambo (2020), support the idea that oil prices have asymmetrical impacts on economic growth.

As Turkey is an energy-dependent nation, being an energy importer and consuming energy in a rising trend, its current account deficit is negatively impacted, which harms the stability of the growth in the Turkish economy. In other words, the study's conclusions can provide valuable insights for Turkey's policymakers. Developing and implementing effective energy policies is currently the responsibility of policymakers. Therefore, in order to determine effective energy regulations, policymakers must consider the long-term effects of oil prices on the growth of the economy.

In addition, many macroeconomic indicators of performance are fragile in terms of the country's economic growth due to the significant volatility of oil prices and exchange rates in nations where imports depend on energy, such as Turkey. For sustainable economic growth, the country's reliance on oil should be reduced by (i) enhancing national energy production within the framework of technological advancement policies; (ii) switching to renewable alternative energy sources to assure their macroeconomic performance over the long run and prevent the ongoing impact of the fragilities generated by rising oil prices on economic growth (Kırca et al., 2020); and (iii) financing new alternative energy sources in order to sustain green growth in Turkey.

In conclusion, the economy of the country must be protected from the asymmetric impacts of fluctuations in global oil prices in order to sustain stable growth in the Turkish economy.

In light of this, the results highlight some of the concerns that have the most potential for additional research while also providing academics and professionals just starting out in the field of oil research with an overview of what is known about the volatility of the price of oil. Future research might concentrate on how changes in the price of oil affect numerous macroeconomic variables in nations that are both oil exporters and importers. More specifically, while this study focuses solely on Turkey, future research can broaden its scope to include more countries. Research can also compare other economies using alternative empirical approaches over a longer period of time.

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