JOEEP

e-ISSN: 2651-5318
Journal Homepage: http://dergipark.org.tr/joeep

Araştırma Makalesi ● Research Article

Do Oil Prices Still Matter for Macroeconomic Performance? An ARDL Model for Turkey

Petrol Fiyatları Makroekonomik Performans İçin Hala Önemli Mi? Türkiye İçin ARDL Modeli

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M A K A L E B İ L G İ S İ

Makale Geçmişi:
Başvuru tarihi: 23 Ağustos 2023
Düzeltme tarihi: 7 Ekim 2023
Kabul tarihi: 17 Ekim 2023

Anahtar Kelimeler:
Petrol fiyatı
ARDL sınır testi
Reel döviz kuru
Sanayi üretimi
Türkiye

ÖZ

Petrol fiyatlarındaki değişimin makroekonomik performans üzerindeki etkisinin anlaşılması politikacıların analizleri için oldukça hayatidir. Birinci OPEC ambargosundan bu yana, söz konusu ihtiyaç araştırmacıları detaylı analizleri gerçekleştirmeye sevk etmiştir. Son yıllarda gelişmiş ve gelişmekte olan ülkelerde petrol fiyatları ile makroekonomik performans arasındaki klasik doğrusal ilişki analizleri, doğrusal olmayan, asimetrik ve ARDL yöntemlerince de sürdürülmüştür. Bu çalışma aylık veriler kullanarak 2001:07- 2023:05 dönemi için reel petrol fiyatları, sanayi üretim endeksi, tüketici fiyat endeksi ve reel döviz kuru arasındaki kısa ve uzun dönem ilişkiyi ARDL eş bütünleşme modeli yardımıyla araştırmayı amaçlamaktadır. Elde edilen sonuçlara göre Türkiye'de, 2001:07 ila 2017:08 dönemi arasında reel petrol fiyatları ile sanayi üretimi indeksi arasında hem kısa dönemde hem de uzun dönemde pozitif bir ilişki görülmektedir. Ancak 2017:09 ila 2023:05 arasında bu ilişki hem kısa hem de uzun dönemde negatife dönmektedir.

A R T I C L E I N F O

Article history:
Received: Agust 23, 2023
Received in revised form: Oct 7, 2023
Accepted: Oct 17, 2023

Keywords:
Oil price
ARDL bound test
Real exchange rate
Industrial production
Turkey

A B S T R A C T

Understanding the effect of oil price swings on macroeconomic performance is decisive in the analysis for policy makers. This need has made it necessary to conduct sophisticated investigations for researchers since the first OPEC embargo. Analyses that focused on the traditional linear relationship between oil price changes and macroeconomic performance were followed by nonlinear and asymmetrical analyses, as well as ARDL methods, both in developed and developing countries in recent years. To that end, this study aims to investigate the existence of a long-run and short-run relationship between oil prices and economic growth, proxied by industrial production index, consumer price index, and real exchange rates applying ARDL cointegration analysis to monthly data for the 2001:07 and 2023:05 period in Turkey. Results of our empirical model show that industrial production is positively related to oil prices between 2001:07 and 2017:08. However, the relationship between real oil prices and the industraial production index shifts a negative correlation from 2017:09 to 2023:05.

1. Introduction

Since national resources are separate production factors, just like capital and labor, price movements of natural resources are strictly monitored and analyzed by policymakers and researchers. To this end, numerous theoretical and empirical studies investigating the relationship between oil price changes and economic activity since oil price shocks in the 1970s have claimed that oil price increases have a negative impact on production, inflation, and unemployment.

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Atıf/Cite as: Deniz Karakoyun, H. & Karagöz Özenç, F. (2023). Do Oil Prices Still Matter for Macroeconomic Performance? An ARDL Model for Turkey. *Journal of Emerging Economies and Policy*, 8(2), 279-300.

However, the influence of oil price swings on macroeconomic performance differs based on the economy, whether it is oil-importing nations or exporting ones. While a positive oil price shock raises the cost of energy in oil-importing economies, it increases income owing to rising exports in exporting economies.

Early studies demonstrated a negative relationship between positive oil price shocks and economic growth. They explain the relationship between oil and production depending on the supply-side view by putting forward that an oil price shock causes a staggered economy and leads to a decline in GDP by resulting in higher production costs in the short run and productivity slowdown in the long run (Rasche and Tatum, 1981; Bruno and Sach, 1982; Hamilton, 1983 and 2003; Gisser and Goodwin, 1986). For, following an oil price shock, firms start to cut their production because of higher input costs. Moreover, it can lead to a retardation in production by leaving some capital and labor temporarily idle with the sectoral reallocation of resources (dispersion hypothesis) from energy-intensive sectors to energy-efficient ones (Mork, 1989; Lee et al., 1995; Hamilton 2003; Rimenez, Rodriquies, and Sanches, 2004, Chang et al. 2011, Gokmenoglu, 2015; Algahtanai, 2016; Fititi et. al 2016; Sadeghi, 2017; Kırca et al, 2020, Von Dinh, 2022).

However, the diminishing oil prices would not react to economic growth as the linear model predicts (Mork, 1989; Lee et al. 1995; Hamilton 2003,; Jimenez-Rodriguez & Sanchez, 2004; Cunada and Garcia, 2005; Lardic and Migron, 2008; Due et al, 2010; Mendoza and Vera, 2010; Iwayemi and Fowowe, 2011; Çatık and Önder, 2013; Altıntaş et al, 2016; Morona 2017, Akinsola and Odhiambo, 2020; Von Dinh, 2022). The economic growth reaction to a drop in oil prices has been limited due to sectoral reallocation of labor and capital in the opposite direction. Lower oil costs, however, encourage consumer consumption and business production. Additionally, production costs remain high because of the high costs associated with labor market adjustment brought on by the nominal wage's downward rigidity. That's why the drop in oil price cannot lead to stimulating production in the economy.

The pioneering papers of Bohi (1989), Hooker (1996), Bernanke and Gali (2004), Bernanke et. al. (1997) started to question the validity of the negative impacts of oil price changes on total production. Bohi (1989), Bernanke (1997) and Bernanke and Gali (2004), pointed out the implemented tightening monetary policy by the FED as the main reason for the recession in the 1970s rather than oil price hikes. Hooker (1996) represented that oil prices are no longer a cause of economic activity after 1986 in the US. After the 2000s, the view of the impacts of oil price fluctuations on economic activity was somewhat less than they were in the 1970s-1980s and was affirmed by many economists, including Hooker (2002), Bernanke and Gali (2004), Jimenez-Rodriguez and Sanchez (2004), Rogoff (2005), Blanchard and Gali (2007), Killian (2009), Cashin et al. (2014), Rasassi and Yılmaz (2016), Akinsolo and Odhiambo (2020); Von Dinh (2022) discussing the validity of the traditional hypothesis that links oil price hikes to economic growth. Blanchard and Gali (2007) put forward that the global economy was not affected by the two positive oil price shocks in the 1990s, with the sign and magnitude comparable to those of the 1970s. On contrary both GDP growth and inflation showed stable patterns in many advanced economies. Those studies led to a possibility of a loosening significance fort he relationship between oil price and total production level. Hence, with the changing structure of economies after the 2000s, the nexus between oil price fluctuations and economic growth raised a reexamination of the existing relationship in the literature, and the topic of oil prices has again come to the fore.

In this framework, the subject of the paper is to revisit and analyze the impact of oil price fluctuations on economic performance in Turkey. As one of the net oil-importing economies, Turkey, with ongoing economic growth and development, and the industrialization process, the demand for crude oil in the country continued to rise every passing year. According to Organization of the Petroleum Exporting Countries (OPEC) data, Turkey is the world's twenty-fifth largest oil-importing country with 521.500 barrels per day, while it is the world's twenty-seventh largest oil consumer country with 989.000 barrels per day in 2017 (OPEC, 2018). However, domestic production of crude oil in Turkey is limited to 5.5% of its total oil consumption in 2017. On the other hand, oil production in Turkey has been slightly stable for more than three decades, while oil consumption has more than doubled (Turkish Energy and Natural Resources Ministry). As a result of this situation, Turkey's economic growth heavily relies on crude oil imports. Its dependence on foreign crude oil is alarming because it exceeds 50% of the international warning level. Besides, Turkey, as a small open economy, can influence neither the world crude oil demand nor the world crude oil supply when compared with the US, UK, Canada, Japan, or Norway. For this reason, the effects of oil prices on economic activity are crucial for itself. Any fluctuation in crude oil prices might have strong effects on the Turkish economy, especially on GDP.

The study asks the question of whether oil prices still matter for industrial production in Turkey, contrary to recent empirical analyses and regardless of asymmetrical relationships. Besides, the present paper extends the existing empirical literature in a way that, unlike many previous studies that use nominal oil prices directly as an independent variable, this study attempts to investigate the impacts of real oil price movements in terms of the Turkish Lira rather than world market prices dominated in USD on industrial production in Turkey. Since Turkey is a small and open oil-importing country, oil prices are given. In addition, after adopting inflation targeting policy in the early 2000s, a floating exchange rate regime has been implenting since the early 20002. From this point, If world oil prices increase and the nominal exchange rate appreciates in Turkey at the same time, it would be ambiguous in terms of the direction of oil prices in terms of Turkish Liras. To prevent this uncertainty, we investigated the effect of real oil prices dominated by the Turkish Lira on industrial production.

The aim of this study is to reexamine the existence of a long-run and short-run relationship between oil prices and industrial production. conducting ARDL cointegration analysis of monthly data spanning from the 2001:07 to 2023:05 periods in Turkey. As known well macroeconomic stability started to deteriote due to political tensions with the USA in 2017, followed by the COVID-19 pandemic in 2019 and adoption of a new unorthodox monetary policy aimed at raising production level in 2021. For that reason, we investigated the impact of real oil prices on economic activity by dividing whole sample into two distinct sub-periods. We intent to compare results of the macroeconomic stability period spanning from 2001:07- 2017:08 with those of macroeconomic instability from 2017:09 to 2023:05.

In line with Jimenez-Rodriguez and Sanchez (2004), we include the consumer price index and real effective exchange rate in the model to obtain the influence of oil price changes on total production through indirect transmission channels that cover the effects of oil prices on the consumer price index and the real exchange rate, which then lead to changes in economic activity. Oil price increases pass through into domestic inflation via first-round and second-round effects, directly and indirectly. In the first round, the direct impact occurs via refined petroleum products consumed by final consumers like heating and transportation fuels. Its impact is gauged by the contribution of consumer energy prices to CPI. In the first round, indirect effects occur via the increase in the cost of producing goods and services that use intermediate goods made of petroleum products and their derivatives as input. Additionally, an unexpected oil price shock shifts the total aggregate supply curve to the left, leading to stagflation, which means a contraction in GDP and an increase in the price level emerge simultaneously. If real wages do not decrease in line with decreasing production and productivity, the adjustment arises via inflation. In the second round, effects are seen through inflation expectations. Based on expectations, wage and price settings in response to an oil price upswing to compensate for the loss of real purchasing power in the past cause inflation as well as determine the persistence of the shock (Blanchard & Gali, 2007, Alvarez et al., 2011, Conflitti and Luciani, 2017). Higher oil prices cause real depreciation in the domestic currency when the tradable sector is more oil-dependent relative to the non-tradable sector (Ji et al., 2020). In the face of the oil price hike, the local currency depreciates with the deteriorating trade balance in oil-importing countries (Fratzcher et al., 2014). Another transmission channel of oil price to the real exchange rate is wealth transmission, which refers to a wealth transfer from oil-importing countries to oil exporters after a positive oil price shock (Krugman, 1983).

The rest of the study is organized as follows: Section one summarizes related literature review. Section two presents data descriptions used in the ARDL model. Section three explains the non-Autoregressive Distributed Lag (ARDL) methodology employed in the study. Section four represents empirical results. Section five concludes.

2. Literature Review

The impact of the two consecutive oil shocks in the 1970s and early 1980s on the macroeconomy in the USA continued to attract the attention of both researchers and policymakers since then. Many economic studies have focused on understanding the causal relationship between oil prices and macroeconomic interactions. One of these research field is the relationship between oil prices and the economic growth nexus. Oil price shocks impact economic activity through direct or indirect transmission channels (Bruno & Sach, 1982; Kibritçiglu, 1999; Brown & Yucel 2002; Hamilton 2003; Barks and Kilian, 2004; Rogoff, 2006; Lardic and Mignon, 2008, Cashin et al. 2014). First, firms start to cut their production because of higher input costs. Second, an increase in pricing reflects the scarcity of fundamental production factors and immediately leads to a drop in potential output. In other words, when oil prices rise, economic performance slows. The third channel can arise in terms of trade for oil-importing economies. Positive price shocks, combined with a worsening current account, would cause a wealth transfer from oil-importing economies to oil-exporting ones, which contradicts domestic demand due to decreasing purchasing power of firms and households in oil-importing economies. Fourth, the real balance impact indicates that when oil prices rise, money demand begins to increase as well. If the monetary authority is unable to meet the increased demand for money, interest rates begin to rise, and economic activity in oil-importing countries starts to slow. Fifth, consumption and stock prices might be affected by oil price hikes. While consumption is affected adversely through its positive relation with disposable income, stock prices start to fall in line with diminishing profits. Hence, total consumption and aggregate demand would decline through income and wealth effects. Sixth, a surge in oil prices suppresses profitability, incentives to produce and invest due to decreasing Tobin-q value, so it would jeopardize aggregate supply rather than aggregate demand. Seventh, in the case of permanent oil price increases, it can cause a change in production structure as well as have an impact on unemployment. In oil-intensive sectors, firms are faced with the need for adopting and constructing new production methods that require fewer oil inputs. This change generates capital and labor reallocations across sectors. But costly reallocation of labor and capital in production causes a contradiction in real GDP and unemployment in the long run.

As seen in Table 1, a large number of the early studies investigating the impact of oil prices on economic growth were conducted for the United States economy and concluded a significant negative correlation between oil prices and economic growth (Rasche and Tatom, 1981;

Darby, 1982; Bruno and Sachs (1982); Hamilton (1983); Gisser and Goodwin (1986). In Hamilton's seminal paper (1983), he pointed out that oil price hikes are one of the main contributors to almost all US recessions since World War II. Until the mid-1980s, the prevailing belief in the literature was that oil prices had a linear and symmetric impact on economic activity. However, the negative oil price shocks in the mid-1980s did not lead to any boom in production as predicted by linear models. With this paradox, later studies tried to show that the relationship between oil prices and macroeconomic aggregates followed an asymmetrical (Mork, 1989; Lee et al. 1995; Hamilton 2003; Jimenez-Rodriguez & Sanchez, 2004; Cunada and Garcia, 2005; Lardic and Migron, 2008; Due et al, 2010; Mendoza and Vera, 2010; Iwayemi and Fowowe, 2011; Çatık and Önder, 2013; Altıntaş et al, 2016; Morona 2017, Akinsola and Odhiambo, 2020; Von Dinh, 2022) or insignificant pattern, especially when applied to developing countries or oil-exporting countries (Bohi, 1989; Hooker 1996, 2002; Bernanket et al. 1997; Bernanke and Gali, 2004; Jimenez-Rodriguez and Sanchez, 2004; Rogoff, 2005; Blanchard and Gali, 2007; Killian, 2009; Cashin et al., 2014; Rasassi and Yılmaz, 2016; Akinsola and Odhiambo, 2020; and Von Dinh, 2022).

Mork (1989), Lee et al. (1995), and Hamilton (1996) conducted three different approaches, namely asymmetric, scaled, and net specification, to investigate the nonlinear relationship between oil price changes and GDP. Mork (1989) found that the negative correlation between oil prices and total production turns into an insignificant relation when decreasing prices in 1986 are included in the model. Then he divided oil prices into two groups, namely, real price increases (group 1) and real price decreases (group 2) as separate variables. Conducting the analysis with two separate groups, he affirmed Hamilton's negative correlation result in group 1, whereas he reached an insignificant relation in group 2. Lee et al. (1995) used a volatility-based specification to create a new series called Scaled Oil Price Increases (SOPI) and verified the nonlinear oil-production relationship. They discovered that the effects of oil price increases in a setting with stable prices were more severe than those in a setting with frequent price changes. To put it differently, decreasing oil prices do not stimulate aggregate economic activity, while oil price increases sluggish output growth. Hamilton (1996) revealed that only persistent oil price increases are able to adversely affect economic activity. Following Lee et al (1995), introducing a new series called Net Oil Price Increase (NOPI), which means the positive difference between current oil prices and the maximum price over the previous four quarters, he investigated the effect of oil price increases over a long period of stable prices on GDP. He proceeded to conclude the negative effect of an oil price hike on real economic activity. Then Hamilton took the discussion a step further and asserted that increases that come after a long period of stable prices have a bigger effect than those that simply correct previous decreases (Hamilton 2003).

On the other side, the global economy witnessed two oil shocks since the 1990s that their signs and magnitudes are comparable to those of the 1970s. However, their effects on production and the price level were not similar to previous ones. The relationship between oil price shocks and economic activity appears to have broken down statistically, making it possible to disregard the impact of oil prices on economic activity since the 1990s. Moreover, the usual and largely accepted this mentioned negative relationship between increasing oil prices and macroeconomic production began to disappear. In line with this state of affairs, there were many studies like Bohi (1989), Bernanke et al (1997), Barksy and Killian (2001, 2004), Rogoff (2005), Hooker (2002), Blanchard and Gali (2007) started to claim that oil price changes and real economic activity nexus ceased to exist in the industrialized countries (the USA, France, the UK, Germany, Italy, and Japan). They attributed this situation to the changing monetary policy reaction after the oil price shocks as the main reason for this structural break among oil and macroeconomic variables. After having the adoption of an explicit inflation targeting regime and a stronger commitment to low and stable inflation, central banks may have reacted to the economy in a way that led to a smaller impact of an oil price rise on inflation and economic activity. Moreover, more flexible wage contracts, a smaller share of petroleum in production, and smaller shocks with less frequency to output other than earlier take place among other explanations. Rogoff (2005) noted deeper financial markets, more energy efficiency, and more concentrated oil use in final demand as other reasons for the diminishing causality from oil price to economic performance.

A great number of studies have attempted to quantify the effects of changes in oil prices on macroeconomic indicators for a number of economies. Cunado and Garcia (2003) examined the impact of oil prices on inflation and growth rates by utilizing the cointegration test, including 15 European countries during the period of 1960 to 1999. They found out that rising oil prices have permanent effects on inflation and asymmetric effects on industrial production and growth rates. Jimenez-Rodriguez and Sanchez (2004) assessed empirically the effects of oil price shocks on real economic activity of the seven OECD countries without excepting oil-exporting countries. Their results may vary according to whether the countries are oil importers or exporters. Asserting the scaled model has better performance than all other asymmetrical approaches, they made out that price hikes for oil have a significant negative impact on the GDP growth in all oil-importing countries, apart from Japan. Taking oil price decreases into account, Narayan (2005) and Leung (2010) come to a conclusion that falling oil prices affect significantly only the US and UK economies while harming the Canadian economy. Lardic and Mignon (2008) investigated the long-run relationship between oil prices and economic activity in the U.S.

economy and G-7 countries by using the asymmetrical cointegration method. They affirmed the asymmetrical relationship by rejecting the standard linear cointegration tests. Du et al. (2010) analyzed the same relationship for China's economy. By using a VAR model, they found out that the world oil price has a non-linear impact on economic activity and inflation in China. Morana (2017) researched the financial and macroeconomic effects of oil price shocks for the Eurozone with a special focus on post-2009 price dynamics (especially on post-2009 price dynamics). According to the results obtained from the large-scale parameter model applied by Morana (2017), a strong asymmetric real effect of oil price changes in the early and mid-2000s was observed for the Eurozone. Additionally, evidence of recessionary effects resulting from oil price slumps was detected. Akinsolo & Odhiambo (2020) asserted that the effects of oil price shocks vary depending on the time horizon for Ethiopia, Gambia, Mozambique, Senegal, Tanzania, and Uganda. They showed that, while there is no significant impact on economic growth in the short-term, a significant negative impact exists in the long-run, as indicated by their ARDL model. However, when conducting the NARDL model, they found that a drop in oil prices has a positive and significant impact on growth. Van Dinh (2022) demonstrated that oil price shocks are closely correlated with Vietnam, China, and South Korea over the period from 1990M1 to 2020M09. However, oil prices show weak correlation with Singapore, Indonesia, Malaysia, Japan, the United States, and Thailand.

As stated by Cashin et al. (2014), the effects of oil price shocks on the economy can vary significantly depending on several factors, including the type of shock that occurs in the economy, whether the country is a net oil importer or exporter, and the time period under consideration. As pointed out by Killian (2008, 2009), Cashin et al. (2014), Sotoudeh and Worthington (2017), Baumeister and Hamilton (2019), and Tausif et al. (2023), it is crucial to distinguish between the effects of supply driven shocks and demand-driven changes in oil prices on the overall economy. Supply shocks or exogenous oil price increases tend to have direct negative effects on oil-importing countries. On the other hand, endogenous oil price hikes, driven by rising consumer demand, can be accompanied by robust industrial production growth and thriving stock markets in both developed and developing oil-consuming countries, such as Germany, Italy, the Netherlands, and Sweden (Sotoudeh and Worthington, 2017). Baumeister and Hamilton (2019) found that supply-driven increases in oil prices lead to a decline in economic activity, but this impact occurs with a significant lag. Conversely, increases in oil prices due to rising consumer demand have no discernible impact in the USA over the period 1958-2014.Cashin et al. (2014), using a Global VAR model for 38 countries from 1979Q2 to 2001Q2, reported that oil-importing countries suffer long-lasting contractions in economic activity when faced with supply-driven surges in oil prices. In contrast, energy-exporting countries with substantial oil and gas reserves experience positive economic impacts from rising oil prices. However, in the presence of oil demand shocks, nearly all countries in their sample grapple with long-term inflationary pressure, increases in real output and interest rates, and a decline in equity prices. Tausif et al. (2023) conducted research on oil-exporting Saudi Arabia, employing an SVAR model spanning from 1995 to 2020. They found that demand-driven increases in oil prices had a considerable and positive impact on economic growth. The results for supply-driven price shocks were similar to those of demand-driven oil price increases, but demand-driven shocks had a more significant effect on Saudi Arabia's economic growth.

When examining the relationship between oil prices and economic activities in oil-exporting countries, it's important to note that results may differ from those in oil-importing countries. However, there is no consensus on the direction of this impact. Mendoza and Vera (2010) noted an asymmetric impact of oil price increases on economic activity in oil-exporting countries. Similarly, Algahtani (2016) found a positive and significant relationship between oil prices and GDP in the long run and short run for Saudi Arabia during the period 1970-2015, employing VAR and VEC models. Ftiti et al. (2016) investigated the interaction between oil prices and economic growth in four OPEC countries: the United Arab Emirates, Kuwait, Saudi Arabia, and Venezuela, using evolutionary co-spectral analysis from August 2001 to February 2010. Their results indicated that oil price shocks had both short-term and medium-term effects on economic growth. However, the impact of medium-term effects was greater than that of short-term effects. In contrast, Iwayemi and Fowowe (2011) found that positive oil price shocks did not significantly affect macroeconomic variables, such as output, inflation, and real exchange rates when analyzing data for Nigeria from 1985 to 2007. Elafif et al. (2017) examined Saudi Arabia and Turkey using ARDL models spanning from 1970 to 2020. They found that Saudi Arabia's real GDP increased by 0.17% when the oil price increased by 1% in the long term, but fell by 0.086% when the oil price decreased by 1%. Additionally, the positive effect of oil price shocks exceeded the negative effect for Saudi Arabia. Sadeghi (2017) investigated the importance of government size in 28 oil-importing countries between 1990 and 2016 in the context of oil price shocks. He found that the size of the government played a significant role in transmitting oil shocks to non-oil output increases. In countries with larger governments, unexpected oil price swings led to greater increases in production.

While there are many studies on the relationship between oil price shocks and inflation in Turkey, there are relatively few that examine the real effects of oil price changes. Studies by Alper and Torul (2008, 2010) were among the first to investigate the relationship between oil price and economic activity. Alper and Torul (2008) used monthly data for Turkey from 1991 to 2007 in an SVAR model and reported that the negative impact of oil price increases on real output had diminished since the early 2000s, but this negative effect persisted when considering global liquidity conditions.

Table 1. The Summary of Literature Review

Author(s)	Period	Country	Method	Results
Bruno & Sachs (1982)	1960-1978	United Kingdom	Single Equation Estimation	Decreasing profitability based on input price hike adversely affects manufacturing production.
Hamilton (1983)	1948-1980	USA	VAR-Granger Causality Test	Oil price increases have a significantly strong causal and negative correlation in seven out of eight recessions after World War II.
Gisser & Goodwin (1986)	1961Q1-1982Q4	USA	Granger Causality, Sims Causality, Chow Test	The effects of oil prices on the macroeconomy exceed those of monetary policy and fiscal policy. Oil prices have real and inflationary effects.
Mork (1989)	1949Q1-1988Q2	USA	VAR	There is a negative correlation between oil price increases and real GNP, with a strong asymmetry in effects. Real GNP has a negative correlation with price hikes but an insignificant correlation with price decreases.
Lee et al. (1995)	1950Q1-1992Q3	USA	GARCH, VAR	A surprising real oil price increase is significant for the period of 1949:Q1-1986:1. There is an asymmetry in effects: Positive shocks are significant, but negative shocks are not.
Hamilton (2003)	1949Q2-2001Q3	USA	Non-linear approach	Oil price shocks that occur when oil prices exceed their 3-year peak are more important for predicting GDP than decreases.
Jimenez-Rodriguez & Sanchez (2004)	1972Q3-2001Q4	Main Industrialized OECD Countries, G7 Countries, Norway, Euro Area	VAR, Granger Causality	Apart from Japan, oil price increases have a negative impact on economic activity. They find an asymmetric effect of oil prices on growth.
Hooker (1996)	1948-1980	USA	Granger Causality	Although surges in oil prices have a large impact on real GDP, the impact gradually diminishes over time. Oil prices no longer Granger cause economic growth after 1973.
Bernanke et al. (1997)	1965-1995	USA	VAR	There is no effect of oil price increases on real GDP but tightening monetary policy.
Blanchard & Gali (2007)	1973Q3-2005Q3	USA, Germany, France, Italy, Japan	Rolling SVAR	Oil prices have a weak impact on industrial production levels in all countries.
Cunado & Garcia (2003)	1960-1999	15 European Countries	Granger Causality	Short-run and asymmetric effects of oil price increases on economic growth exist, but there is no cointegration except for the UK and Ireland.
Lardic & Migron (2008)	1970:Q1-2004:Q3	USA, G7, Europe, Euro Area	Asymmetric Cointegration	Asymmetric cointegration between oil price and economic growth exists.
Du et al. (2010)	1995:1-2008:12	China	VAR	GDP growth is positively correlated with oil price hikes in a linear model. In the asymmetrical model, the effect of positive oil price shocks on growth is not significant, but negative shocks decrease economic activity.
Morana (2017)	1999:M1-2015:M6	Euro Area	Time-varying parameter model	Oil price hikes lead to a decrease in industrial production in the entire sample, but the drop in oil prices has a limited expansionary effect on it in the early and mid-2000s.
Mendoza & Vera (2010)	1984:Q1-2008Q3	Venezuela	GARCH, OLS	Unexpected oil price increases have more positive and significant effects on growth than unexpected price falls.
Algahtani (2016)	1970-2015	Saudi Arabia	VAR & VEC	There is a positive and significant relationship between oil prices and GDP in the long run and short run.
Ftiti et al. (2016)	2000:M9-2010:M12	UAE, Kuwait, Saudi Arabia, Venezuela	Time Frequency, Engle Granger	Oil price shocks have short-term and medium-term negative effects on aggregate demand, economic growth, productivity, and potential output, with the medium-term effects being greater.
Iwayemi & Fowowe (2011)	1985Q1-2007Q4	Nigeria	VAR	Linear and positive oil price shocks do not cause output change, but asymmetrical effects of negative oil price shocks exist.
Sadeghi (2017)	1990-2016	28 Oil Exporting	VAR	The size of the government is important in transmitting positive

Author(s)	Period	Country	Method	Results
		Countries		oil shocks to non-oil output increase. Unexpected oil price hikes increase production more with a large government size.
Chang et al. (2011)		17 Countries in ASEAN, the Asian-Oceanic region, and South Asia	VECM, VAR	Stable oil prices are important for strong macroeconomic performance. Oil price volatility harms macroeconomic activities in oil-importing countries. Consequences of oil price shocks on GDP are positive for oil-exporting countries, limited export-led recovery for small open economies, but ambiguous effects for fast-growing large economies in the long run.
Killian (2009)	1975-2007	USA	SVAR	The reason for the oil price increase has different impacts on real economic activity. Demand-driven price hikes cause immediate and long-lasting increases in real oil prices and aggregate demand, while supply-cut-driven price increases cause small and transitory increases in real oil prices.
Cashin et al. (2014)	1979:Q2-2011-Q2	38 countries	GVAR	Economic results of supply-driven oil shocks differ greatly from demand-driven oil shocks caused by global economic activity. Oil-importing economies experience a long-term decline in GDP as a result of supply-driven shocks. All countries experience long-run inflation pressure, an increase in real GDP, a rise in interest rates, and a fall in equity prices.
Baumeister and Hamilton (2019)	1958:M1-2014:M12	USA	SVAR	Rises in oil prices due to supply shocks result in a decline in economic activity with a large lag, whereas increases due to rising oil consumer demand have no discernible impact on the economy.
Tausif et al. (2023)	1995Q1-2020Q2	Saudi Arabia	SVAR	Demand-driven increases in oil prices have had a considerable and positive impact on economic growth. The results of supply-driven price shocks are similar to demand-driven oil price hikes, but demand-driven shocks are more important for economic growth.
Elafif et al. (2017)	1970-2014	Turkey and Saudi Arabia	NARDL	In the long term, Saudi Arabia's real GDP increases by 0.17% when the price of oil increases by 1% and falls by 0.086% when the price of oil increases by 1%. The long-term positive and negative shocks to oil prices for Turkey are -0.033 and -0.22, respectively. Accordingly, a 1% rise in the price of oil results in a 0.026% drop in real GDP. Similarly, a 1% drop in oil prices results in a 0.22% increase in real GDP. The negative shock has a higher impact on Turkey than the positive shock.
Van Dinh (2022)	1990:M1-2020:M09	China, Thailand, Vietnam, Singapore, Indonesia, Malaysia, Japan, Korea, America	ARDL	GDP growth is closely correlated with Vietnam, China, and South Korea. Oil price changes are weakly correlated with the rest of the sample. Some countries are less dependent on oil price changes.
Akinsola & Odhiambo (2020)	1990-2018	Ethiopia, Gambia, Mali, Mozambique, Senegal, Tanzania, Uganda	ARDL, NARDL	In the ARDL model, the effects of oil price change vary based on the term length. In the short run, there is no significant impact on economic growth, but a significant negative impact in the long run. In the NARDL model, a drop in oil prices has a positive and significant impact on growth.
Alper & Torul (2008)	1991-2007	Turkey	SVAR	Oil price shocks persist and significantly affect real output after the 2000s. They also raise Turkish overnight interest rates. There is no significant relationship between oil price hikes and the volatility index (VIX).
Alper & Torul (2010)	1990-2007	Turkey	VAR	Oil product price increases impede the output of sub-manufacturing sectors, covering wood and wood products, furniture, chemicals and chemical products, rubber and plastic products, electrical machinery, radio TV, and communication apparatus.
Barışık & Yayar (2012)	1998:01-2010:12	Turkey	VAR	There is a positive relationship between oil prices and the industrial production index, and oil prices Granger cause industrial production.
Çatık & Önder	1983:M1-	Turkey	TVAR	Oil prices and macroeconomic analysis are nonlinear and

Author(s)	Period	Country	Method	Results
(2013)	2008:M12			exhibit an asymmetrical pattern. The impact of oil price change on output is important when the change exceeds a certain threshold level.
Gökçe (2013)	1987:Q1-2011Q4	Turkey	EGARCH – SVAR (Blanchard-Quah)	Quarterly economic growth declines by 0.0164 percent after a structural shock in real oil price volatility.
Gokmenoglu et al. (2015)	1961-2012	Turkey	Johansen Cointegration, Granger Causality	Oil price increases affect output in Turkey.
Altıntaş et al. (2016)	1987Q1-2010Q4	Turkey	ARDL, NARDL	An asymmetric relationship exists between oil price increases and economic growth. In the NARDL model, the negative impact of oil price shocks on total production is significant in the long run, while the impact of price decreases is statistically insignificant on economic growth.
Rasasi & Yılmaz (2016)	1987Q1-2015Q2	Turkey	Johansen & Juselius Cointegration, SVEC	Only in the first quarter does GDP show a positive rapid reaction to a one-standard deviation shock to the real price of oil. Starting in the second quarter, GDP growth slows until it stabilizes for the remainder of the term.
Kırca et al. (2020)	1998:Q1-2019Q4	Turkey	Granger Causality; Toda Yamomato & Frequency domain causality	There is permanent causality from oil price to GDP level.

Torul and Alper (2010) found that neither crude oil nor oil product price increases significantly hindered overall production growth in Turkey, except for specific sub-sectors using VAR analysis for the period 1990-2007. Çatık and Önder (2013) analyzed linear and non-linear two-regime Threshold VAR models for Turkey from 1988:1 to 2011:03. They found that the relationship between oil prices and macroeconomic activities followed an asymmetrical pattern. If oil price changes exceeded a certain threshold, they had a significant effect on inflation and GDP. Barışık and Yayar (2012) identified a linear and positive relationship between oil prices and industrial production in Turkey between 1998:01 and 2010:12. They also found that oil prices Granger caused changes in industrial production during this period. Like Torul and Alper (2010), Çatık and Önder (2013) discovered an asymmetrical pattern in the relationship between oil prices and macroeconomic activities, where significant effects on inflation and GDP occurred when oil price changes surpassed a certain level. They also determined that Turkey had a lower tolerance level for positive oil price shocks compared to Canada, Japan, and the USA. Gokçe et al (2013) investigated the oil price volatility derived from EGARCH approach on economic growth by estimating SVAR Blanchard Quah model for Turkey from 1987 to 2011. They found that quarterly economic growth declined by -0.0164 percent after structural shocks in real oil price volatility. Gokmenoglu et al. (2015) analyzed long-run causality relationships among oil prices, GDP, inflation, and industrial production in Turkey from 1961 to 2012. They concluded that all variables were cointegrated with each other, and the Granger causality test affirmed that oil price changes affected industrial production. Altıntaş et al. (2016) tested linear and non-linear ARDL approaches to detect an asymmetrical relationship between oil prices and economic growth, both in the short run and long run, for Turkey over 1987Q1-2010Q4. They found evidence of an asymmetric relationship in the long run, with the NARDL model supporting the negative impact of oil price shocks on production in the long term. However, the impact of price decreases was statistically insignificant on economic growth. Rasisi and Yılmaz (2016), using the cointegration test of Johansen and Juselius and the SVEC model, concluded that the duration of the impact of oil price shocks on GDP in Turkey was limited to only the first quarter, which showed a positive rapid reaction to a one-standard deviation shock in real oil prices. Elafif et al. (2017) showed that the long-term positive and negative shocks to oil prices for Turkey were -0.026 and 0.22, respectively. Consequently, a one percent (1%) increase in the oil price resulted in a 0.026% decrease in real GDP, while a 1% decrease in oil prices led to a 0.22% increase in real GDP. As a result, it was argued that the negative shock had a greater impact on Turkey than the positive shock. Kırca et al. (2020) found a permanent causality from oil prices to GDP levels, using causality tests in Toda Yamamoto, Granger, and the frequency domain.

3. Data

We estimate a model to investigate the impact of oil prices on industrial production in Turkey using monthly time series data for the period from 2001:07 to 2023:05. The model is specified as follows:

$$lnipi = a_0 + a_1 lncpi + a_2 \, lnrer + a_3 lnroptl + a_4 D + \varepsilon_t \quad (1)$$

Following the approach of Jiménez-Rodríguez and Sanchez (2004), we include the series for industrial production (ipi), real oil prices (roptl), the consumer price index (cpi), and the real effective exchange rate (rer) in our analysis. We account for the cost-driven effects on industrial production with the variable roptl, while demand-driven effects are represented by cpi and rer. In this model, we use only one economic activity variable, ipi, while the other variables are employed to assess the influence of oil price changes on ipi through indirect transmission channels. These channels capture the effects of oil prices on inflation and exchange rates, which subsequently impact real economic activity (Jimenez Rodriguez-Sanchez 2004).

The dataset used in this study spans from 2001:07 to 2023:05, comprising a total of 272 monthly observations. We begin in 2001 to avoid the disruptive efects of financial crises that occurred during that year. Besides, macroeconmic stability prevails during the period from 2001 and 2017. Conversely, starting 2017, macroeconomic instability emerges due to some various domestic and global factors such as political tensions with the USA in 2017, the Covid-19 pandemic and implementaion a new unconventional monetary policy in 2021. For this reason our study aims to explore the relationship between real oil prices and industrial production index using two distinct models individing entire dataset into two sub- periods. The first period, characterized by macroeconomic stability, spans from 2001:07 to 2017:08, while second period, marked by macroeonomic instability, spans from 2017:08 to 2023:05.

Regarding the variables, we note that monthly GDP data is not available for Turkey; therefore, we use ipi as a proxy for real GDP, following the precedent set by Cunado and Garcia (2003), Blanchard and Gali (2007), Alper and Torul (2008), and Torul and Alper (2010). The oil price series is defined in real terms, representing the spot prices of West Texas crude oil denominated in US dollars per barrel, in line with Cunado and Garcia (2003), Blanchard and Gali (2007), and Rasasi and Yılmaz (2016). These prices are then converted into Turkish lira using the official nominal exchange rates announced by the Central Bank of the Republic of Turkey and subsequently transformed into real values by taking the ratio of the nominal oil price in Turkish lira to the consumer price index (with a base year of 2015=100). The real effective exchange rate (rer) is defined as the ratio of the foreign price level to the domestic price level, with the domestic price level converted into domestic currency using the nominal exchange rate. We also introduce a dummy variable (D) to account for the global financial crisis, which is set to 1 for May 2008 and 0 for all other periods in model I; and for the Covid-19 lockdown is set to 1 for April 2020 and 0 for all other periods in model II. All the data series utulized in this study are sourced from the Federal Reserve Economic Data provided by the St. Louis Fed.

Furthermore, all the series in our analysis are transformed using natural logarithms. This transformation is applied to achieve homoskedasticity in the series and to facilitate the identification of patterns in the data, following the approach outlined by Lütkepohl and Xu (2012).

The variables are explained respectively as follows:

Industrial Production (ipi): The Turkstat measures the total economic production of Turkey on a quarterly basis, with a base year of 2015=100. Due to the unavailability of monthly GDP data, we use the industrial production index (ipi) as a proxy for GDP. Ipi measures changes in production across manufacturing, mining, electricity, gas, and water industries in Turkey. We apply natural logarithms to this series and adjust the data to eliminate seasonal fluctuations, following the Census 12 method. This series is retrieved from the St. Louis Fed.

Consumer Price Index (cpi): The consumer price index (cpi) is employed as a proxy for inflation. It reflects changes in the consumption basket compared to the previous month, with a base year of 2015=100. After applying natural logarithms to this series, we use the Census 12 method to remove seasonal fluctuations. This series is retrieved from the St. Louis Fed.

Oil Price (roptl): Turkey meets its oil demand by importing from OPEC countries. Given the unavailability of OPEC basket price data for common use, we use the spot price per barrel of West Texas Intermediate Crude Oil denominated in US dollars as a proxy for real oil prices. We convert this series into Turkish lira using the monthly average nominal exchange rate declared by the Central Bank of the Republic of Turkey. Finally, we deflate the series using the Turkish Consumer Price Index (CPI). After applying natural logarithms, we adjust the data to remove seasonal fluctuations using the Census 12 method. This series is retrieved from the St. Louis Fed.

Real Exchange Rate (rer): The real broad effective exchange rate is used as a proxy for the exchange rate. Real effective exchange rates are calculated as weighted averages of bilateral exchange rates adjusted by relative consumer prices, with a base year of 2015=100. An increase in the value of the real effective exchange rate indicates a real appreciation of the Turkish Lira, potentially affecting Turkey's external competitiveness. After applying natural logarithms, we adjust the data to remove seasonal fluctuations using the Census 12 method. This series is retrieved from the St. Louis Fed.

Dummy Variable (D): A dummy variable is introduced to account for the global financial crisis that occurred in 2008-09 in Model I. It takes the value 1 for May 2008 and 0 for all other months. A dummy variable is introduced in the second model, as well. It takes the value 1 for April 2020 and 0 for all other months.

there are two important limitations to note: (1) the ARDL procedure may yield invalid results in the presence of I(2) series, and (2) it allows for only one level-relationship among the variables under consideration, not accommodating a greater number of long-run relationships (Pesaran et al., 2001; Shimul et al., 2009).

Table 2. List of Variables Employed in ARDL Model

Variable	Definition	Description	Data Source
ipi	Industrial Production Index	Sum of industrial production, including mining and quarrying, manufacturing, and electricity, gas, steam, and air conditioning supply. Not seasonally adjusted. (2015=100)	St. Louis Fed
roptl	Real Oil Prices	West Texas spot oil prices converted to Turkish lira using the nominal exchange rate of the Central Bank of the Republic of Turkey and deflated by the Consumer Price Index. Not seasonally adjusted. (2015=100)	St. Louis Fed
cpi	Consumer Price Index	All items. Not seasonally adjusted. (2015=100)	St. Louis Fed
rer	Real Effective Exchange Rate	The ratio of the price level abroad to the domestic price level, with the domestic price level converted into domestic currency using the nominal exchange rate. Not seasonally adjusted. (2015=100)	St. Louis Fed
D	Dummy Variable	Observations: May 2008 = 1, Otherwise = 0 in Model I	-
D	Dummy Variable	Observations: April 2020 = 1, Otherwise = 0 in Model II	

4. Methodology

This paper investigates the impact of changing oil prices on Turkey's industrial production using the linear Autoregressive Distributed Lag (ARDL) bounds testing approach for cointegration with the help of two different models. The first model covers the period from July 2003 and August 2017. The second model covers the period from September 2017 to May 2023. This method allows us to gain insights into both short-term and long-term effects of oil price changes, and enables a comparative assesment of the relative significance of real oil price on industrial production with two distinct subü-periods, covering over two decades in turkish economy.

The ARDL model was originally developed by Peseran and Shin (1999) and later expanded by Peseran et al. (2001) to test cointegration when the series do not share the same order of integration. The ARDL cointegration technique surpasses traditional methods like Johansen (1988, 1995), Engle-Granger (1987), or Johansen & Juselius (1990) tests in terms of flexibility. Firstly, it is valuable in identifying long-run relationships between variables with the same order of integration, be it I(0) or I(1), as well as a combination of both, but not I(2). Secondly, this technique provides efficient and consistent test results in both small and large sample sizes (see Pesaran et al., 2001). Thirdly, all variables in the model are considered endogenous, and fourthly, short and long-run coefficients are estimated simultaneously. The error correction model (ECM) can be derived from ARDL through linear transformations. Finally, this technique yields robust empirical results when there is a single long-run relationship among the underlying variables in the sample.

Despite the numerous advantages of employing ARDL,

In this study, we followed six steps to conduct the ARDL model:

1. Unit Root Test: To determine that the order of integration of the variables does not exceed I(1), we conducted traditional unit root tests, namely ADF (1981) and PP (1989), as well as the Lee and Strazicich (2003) unit root test with two structural breaks.
2. Optimal Lag Length: We decided on the optimal lag lengths based on the Akaike Information Criterion (AIC).
3. Cointegration Test: To test the cointegration relationship between dependent and independent variables, we applied the F-bounds test. If the results suggest a long-run relationship, the estimation of the ARDL model is deemed valid.
4. Error Correctiom Model (ECM): We run the ECM to estimate the long run and the short run coeefficients of the variables in our model.
5. Diagnostic Tests: We utilized diagnostic tests to check for serial correlation through the Breusch-Godfrey test, heteroskedasticity through the Breusch-Pagan test, and normality of residuals through the Jarque-Bera test.
6. Stability Tests: We assessed the stability of short-run and long-run parameters through the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of square recursive residuals (CUSUMSQ) tests.

The ARDL model comprises two steps to capture the long-run relationship between variables. The first step is to assess whether a long-run relationship exists among all variables. The log-linear specification of the long-run relationship between oil prices, the consumer price index, industrial production, and the exchange rate is represented in Equation

2 as follows:

$$\Delta lnipi_t = \beta_0 + \sum_{i=1}^{n} \beta_1 \; \Delta lnipi_{t-i} + \sum_{i=0}^{n} \beta_2 \; \Delta lncpi_{t-i} + \sum_{i=0}^{n} \beta_3 \; \Delta lnrer_{t-i} + \sum_{i=0}^{n} \beta_4 \; \Delta lnroptl_{t-i} + \Phi_1 \; lnipi_{t-1} + \Phi_2 \; lncpi_{t-1} + \Phi_3 \; lnrer_{t-1} + \Phi_4 \; lnroptl_{t-1} + \varepsilon_t \qquad (2)$$

Where Δ is the first difference operator. The first part of the equation with β_1 to β_4 represents the short-run dynamics of the model, while the second part with φ_1 to φ_4 represents the long-run relationship. β_0 is a drift component, n is the lag length, and ε_{1t} represents the white noise residuals. Before running the model, the optimal lag length must be determined using either the Akaike (AIC) or Schwartz information criteria (SIC). As mentioned above, the ARDL approach involves two main stages.

In the first stage, the ARDL model of interest is estimated using the ordinary least squares (OLS) method to determine whether there is a long-run relationship among the variables of interest. The long-run relationship among the underlying variables is identified using the F-statistic Wald Test. The joint null hypothesis for the test is as follows:

$$H_0: \Phi_1 = \Phi_2 = \Phi_3 = \Phi_4 = 0 \text{ (no cointegration)} \qquad (3)$$

$$H_1: \Phi_1 \neq \Phi_2 \neq \Phi_3 \neq \Phi_4 = 0 \text{ (cointegration)} \qquad (4)$$

The test provides two sets of critical values. The first set assumes that all variables in the sample are I(0), indicating no cointegration among variables, generating the lower critical bound. The second set assumes that all variables in the sample are I(1), indicating cointegration among variables, generating the upper critical bound. If the calculated F-statistic exceeds the upper critical bound, then a long-run relationship between variables is established (Nkoro and Uko, 2016). If the computed F-statistic falls below the lower critical bound, H_0 is not rejected, suggesting there is no long-run relationship among the underlying variables. If the computed F-statistic falls between the upper and lower critical bounds, the inference is inconclusive. In this ambiguous situation, the order of integration of variables is required. Peseran et al. (2001) and Narayan (2005) have provided the upper and lower bound F critical values for both large and small samples (30-80).

If the F-statistics satisfy the condition mentioned above, indicating cointegration among variables, the second step is to estimate the long-run and short-run elasticity coefficients in the model using the ARDL approach. The long-run ARDL model is specified in the following equation:

$$lnipi_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \; lnipi_{t-i} + \sum_{i=0}^{n} \beta_{2i} \; lncpi_{t-i} + \sum_{i=0}^{n} \beta_{3i} \; lnrer_{t-i} + \sum_{i=0}^{n} \beta_{4i} \; lnroptl_{t-i} + u_t \qquad (5)$$

Finally, the short-run coefficients are derived from the ECM through a simple linear transformation of the ARDL model. The standard ECM involves estimating the following equation:

$$\Delta lnipi_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \; \Delta lnipi_{t-i} + \sum_{i=0}^{n} \beta_{2i} \; \Delta lncpi_{t-i} + \sum_{i=0}^{n} \beta_{3i} \; \Delta lnrer_{t-i} + \sum_{i=0}^{n} \beta_{4i} \; \Delta lnroptl_{t-i} + \lambda EC_{t-1} + u_t \qquad (6)$$

Where $EC_{(t-1)}$ denotes the error correction coefficient, obtained from the residuals of the estimated cointegration model above. λ represents the error correction parameter, indicating the speed od correction of *lnipi* in converging to its long-run equilibrium as independent variables change. It is expected to be negative and statistically significant to bring the dependent variable back to its long-run equilibrium.

5. Empirical Results

In this section, we delve into the empirical results of the ARDL models discussed in the previous section . Our primary focus is on examining the long-run and short-run interactions between oil prices and industrial production. Subsection IV.I provides the outcomes of the first model, which was conducted from 2001:07 to 2017:08.Subsection IV.II on the other hand, presents the resuts of the second model, which was conducted from 2017:09 to 2023:05.

5.1. Empirical Results of the First Model

First, we present the results of the unit root tests, then provides an overview of the ARDL model estimation for the model I.

5.1.1. Unit Root Test

Although the ARDL approach does not necessitate pre-testing of the series, the presence of I(2) series violates the prerequisites outlined in the ARDL model and the critical value tables proposed by Pesaran et al. (2001) and Narayan (2005). To confirm the suitability of the ARDL technique for our series and to ensure that the order of integration is not I(2), we perform standard unit root tests (Augmented Dickey Fuller (ADF) (1979) and Phillips-Perron (1988)) on each individual series at both the level and first-difference levels.

Table 3 presents the unit root test results for all series in their level form. The tests are conducted with both intercept and intercept-trend models, and the number of lags used in the tests is determined using the Schwartz Information Criterion (SIC). ADF and PP tests are based on the null hypothesis that the series have a unit root. If the test results greater than the critical values, then null hypothesis can be rejected. And we can conclude that the serie is stationary.

Table 3: Test for Stationarity

	ADF (Intercept)	ADF (Trend+Int)	PP (Intercept)	PP (Trend+Int)
roptl	-3.19 (1)**	-3.25 (1)***	-2.85 ***	-2.87 *
cpi	-4.08 (1)*	-3.79 (1)**	-2.95 **	-2.46
rer	-1.65 (1)	-2.21 (1)	-1.84	-2.47 *
ipi	0.10 (12)	-4.97 (12)*	-3.99 *	-12.85 *

Not: (ADF: Augmented Dickey Fuller Test, PP: Phillips-Perron Test, -The number of lags in ADF regressions is given in parentheses. *, **, *** denote rejection of the null hypothesis at 1%, 5%, and 10% significance levels, respectively.)

As shown in Table 3, the null hypothesis indicating non-stationarity can only be rejected for "*roptl.*" in both tests. For the remaining series, "*cpi*," "*rer*," and "*ipi*," the unit root tests yield mixed results. To address this inconsistency, structural break unit root tests are conducted for all variables in our model, given the possibility of structural breaks in non-stationary series. Table 4 presents the results of the Lee and Stradizich (2003) one-break unit root tests:

Table 4: Lee and Stradizich (2003) One Break LM Unit Root Test Results

	Model A	Time Break	Model C	Time Break
roptl	3.3817 (1)***	2014:11	-4.1136 (5)***	2013:09
cpi	-0.8343 (12)	2004:09	-2.4247 (12)	2004:10
rer	-1.4752 (12)	2013:12	-6.2612 (11)*	2008:11
ipi	1.8431 (1)	2004:12	-3.2782 (5)	2004:12

Not: (The optimal number of lags is shown in parentheses. T_B denotes the estimated break points. See Lee and Strazicich (2003) for the critical values. *, **, *** indicates the two-tailed significance level of the break date at 1%, 5%, and 10%, respectively. LM: Lagrange Multiplier.)

As indicated in Table 4, the null hypothesis of a unit root is rejected for "roptl" in both Model A and Model C, consistent with previous test results. Additionally, for "rer," Lee and Stradizich's test provides evidence against the unit root null hypothesis, suggesting that "rer" is integrated as I(0) with a single structural break at 1% significance level. However, for "cpi" and "ipi," the test does not provide additional evidence against the unit root null hypothesis relative to traditional unit root tests without structural breaks, so the null hypothesis for these variables cannot be rejected.

Table 5 presents the unit root test results for the first differences of the "cpi" and "ipi" series:

Table 5: Unit Root Test for First Differences

	ADF (Intercept)	ADF (Trend+Int)	PP (Intercept)	PP (Trend+Int)
Δcpi	-4.44 (11)*	-3.86 (11)**	-7.28 *	-7.86 *
Δipi	-16.77 (0)*	-16.80 (0)*	-16.86 *	-16.99 *

(ADF: Augmented Dickey Fuller Test, PP: Phillips-Perron Test,. The number of lags in ADF regressions is given in parentheses. *, **, *** denote rejection of the null hypothesis at 1%, 5%, and 10% significance levels, respectively.)

As presented in Table 5, the null hypothesis of a unit root can be rejected at the 1% significance level for the first differences of both "cpi" and "ipi" series. This implies that the new series are stationary. Hence, no series in the model has a order of integrated greater than (1) meeting the prerequisites for the ARDL model. However, in the subsequent ARDL estimation in the next section, we will use all series in their level form.

5.1.2. ARDL Model Estimation and Bounds Test for Model I

To determine the existence of a cointegration relationship among the underlying variables with different orders of integration, we conducted an ARDL F-bounds test. ARDL and its associated Error Correction Model (ECM) were estimated using the Ordinary Least Squares (OLS) method. We used the Akaike Information Criteria (AIC) to select the optimal lag lengths (k) from a maximum of 8 lags. As shown in Figure 1, the selected model is ARDL (2, 0, 0, 1). This implies that the optimal lag lengths for the variables ipi, cpi, rer, and roptl are p=2, q=0, r=0, and s=1, respectively.

Figure 1. Model Selection Graph

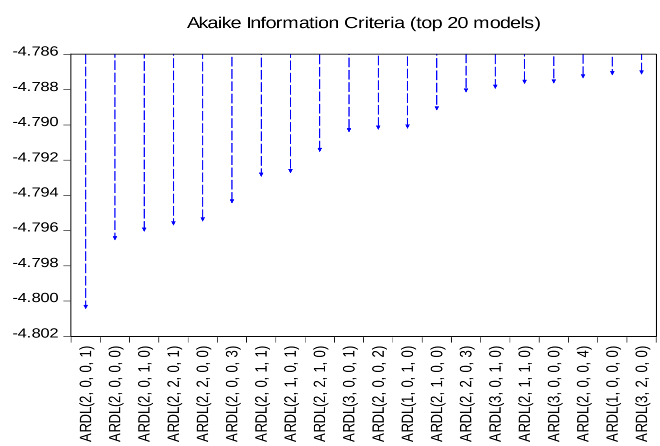


Table 6 presents the results of the ARDL bounds test for cointegration with the selected lag lengths. The estimated F-statistic value (9.45) exceeds the critical upper bound values (6.36) at the 1% significance level, as proposed by Pesaran et al. (2001) and Narayan (2005). Therefore, we can reject the null hypothesis of no cointegration. These results indicate a long-run cointegration relationship between ipi and the independent variables cpi, rer, and roptl during the period from 2001:07 to 2017:08 in Turkey.

Table 6. ARDL Bounds Test for Cointegration

k	F-statistic	Significance Level	I (0)	I (1)	Result
3	9.45	10%	3.47	4.45	Cointegration
		5%	4.01	5.07	
		1%	5.17	6.36*	

Note: a Asymptotic critical value bounds of the F statistic and t-statistic were retrieved from Table CI Case V: Unrestricted intercept and unrestricted trend on p. 302 and on 306 in Pesaran et al. (2001). * represents the 1% level of significance, k is the number of the variables.

Having established the existence of a cointegration relationship, we proceed to estimate the long-run and short-run coefficients using Equation 4 and Equation 5, respectively. Table 7 below presents the estimated coefficients of the long-run analysis for the ARDL(2, 0, 0, 1) model.

Table 7. Estimated Coefficients of Long-Run Analysis ARDL(2, 0, 0, 1)

Variable	Coefficient	t-Statistics	Probability
cpi	0.102	0.725	0.468
Rer	0.380*	5.565	0.000
Roptl	0.101*	4.369	0.000

Not: (* indicates significance at the 1% level)

Table 7 shows that both oil prices (roptl) and the exchange rate (rer) have a long-run impact on industrial production (ipi) in Turkey during the specified period. Specifically, roptl has a positive and statistically significant impact at the 1% confidence level, indicating that a 1% increase in roptl leads to a 0.10% increase in industrial production in the long run. Similarly, rer has a statistically significant coefficient of 0.38 at 1% confidence level, implying that a 1% increase in rer results in a 0.38% increase in industrial production in Turkey. However, the coefficient of cpi is positive but statistically insignificant in the long run, suggesting that changes in consumer prices do not have a significant long-run impact on industrial production. This aligns with the monetarist view that nominal variables do not affect real variables in the long run.

The short-run coefficients estimated using the Error Correction Model (ECM) represented in Equation 4, as shown in Table 8.

Table 8. Estimated Coefficients of Short-Run Analysis ARDL(2, 0, 0, 1)

Variable	**Coefficient**	**t-Statistics**	**Probability**
Δ(ipi)t-1	0.571*	7.843	0.000
Δ(ipi)t-2	0.132***	1.952	0.052
Δ(cpi)t	0.030**	2.276	0.047
Δ(rer)t	0.113*	4.475	0.000
Δ(roptl)t	0.064*	3.509	0.000
Δ(roptl)t-1	-0.033***	-1.809	0.072
D	-0.048*	-5.067	0.000
EC_{t-1}	-0.296*	-6.198	0.000
Constant (Sabit)	1.009*	4.593	0.000
Trend	0.001*	3.401	0.000
R^2: 0.991 ; $\hat{\sigma}$: 0.021 AIC: −4.791	SIC:-4.693	F-stat: 2578.3 (0.000).	

Not: (R^2 is the adjusted square multiple correlation coefficiant, $\hat{\sigma}$, is standard error of regression, AIC and SIC Akaike's and Schwar are Akaike and Schwartz's. Bayesian Criteria Information Criteria, *, **, *** represent significance levels at 1%, 5%, and 10%, respectively).

Table 8 reveals the short-run effects of the variables on industrial production with the help of the ERM represented in equation 4 above. Notably, real oil prices (roptl) have a positive and statistically significant effect at the 1% level, indicating that a 1% change in roptl leads to a 0.064% increase in industrial production. However, the lagged effect of real oil prices on industrial production is negative at the 10% significance level, implying that a 10% increase in real oil prices reduces industrial production by 0.3% after one period.

The consumer price index (cpi) has a statistically significant impact of 0.031% at the 5% significance level in the short run. Real exchange rates (rer) have the most significant effect, with a 1% increase in rer resulting in a 0.11% increase in industrial production. Additionally, the dummy variable (D) representing the global financial crisis of 2008 has a negative and statistically significant impact on industrial production in the short run.

The error correction parameter (EC_{t-1}) has a negative coefficient of -0.296, as expected, and is statistically significant at the 1% level. This indicates that nearly 30% of the disequilibrium level in the industrial production index that occurred in the previous month will be corrected in the current month. In other words, industrial production converges to its long-run equilibrium by about 30% with a speed of adjustment. This implies that it takes approximately three and a half months for the industrial production index to reach its long-run equilibrium level after a shock.

We conducted diagnostic tests to ensure the robustness of our proposed model, as presented in Table 9. These diagnostic tests indicate that the model adheres to econometric principles and does not violate basic assumptions. Specifically, the model is free from serial correlation and heteroskedasticity issues and fulfills the normality condition for the distribution of disturbances, with all probability values exceeding the 10% significance level.

Table 9. Model Diagnostic Test Results

Test	χ^2	**Probability**
Breusch-Godfrey Serial Correlation LM test	0.684	0.564
Breusch-Pagan-Godfrey Heteroskedasticity test	0.689	0.701
Jarque-Bera Normality test	0.133	0.115

These diagnostic tests confirm that the model is a good fit and satisfies the fundamental assumptions of a classical linear regression model.

Since ARDL is sensitive to structural breaks, we also conducted stability tests using the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of the square of recursive residuals (CUSUMSQ) suggested by Pesaran and Pesaran (1997). The results are displayed in Figure 3 and Figure 4, respectively. If the plots of recursive residuals and squares of recursive residuals do not cross the 5% critical bounds (upper and lower bands) over the sample, it can be concluded that the coefficients of the model are stable. In this case, no systematic changes were identified over the studied period, indicating the absence of recursive residuals issues in terms of both mean and variance. Consequently, the results obtained from this study can be utilized for policy inference.

Figure 3. Stability Test Result (CUSUM)

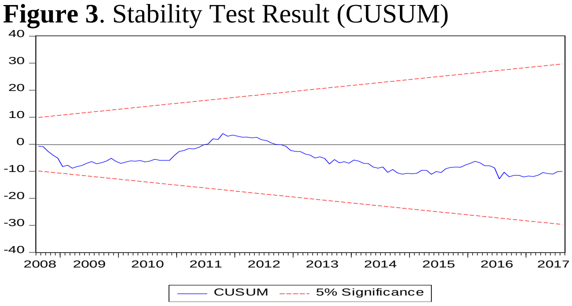
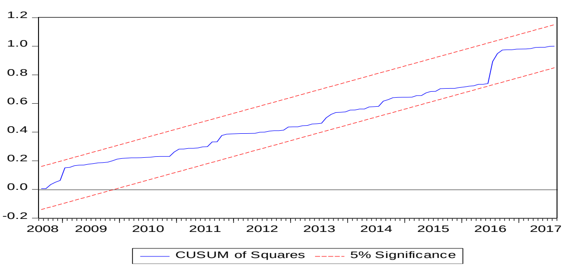


Figure 4. Stability Test Result (CUSUMSQ)



5.2. *Empirical Results Of Model II*

In this section, we analyze the empirical results of Model II, which covers the period from 2017:09 to 2023:05, using the ARDL model discussed in the previous section. Our primary focus is to investigate the long-run and short-run interactions between oil prices and industrial production after 2017. Subsection IV.I. I presents the outcomes of the unit root tests and subsection IV.II.II provides an overview of the ARDL model estimation.

5.2.1. *Unit root test results*

Table 10 displays the results of the ADF and PP unit root test for all series in both their level and first difference forms.

Table 10. Test for Stationarity in Model II

LEVEL				
	ADF		PP	
Variables	Intercept	Intercept& Trend	Intercept	Intercept &Trend
ipi	-1.845(0)	-3.294(0)**	-1.564	-2.025
cpi	1.005 (1)	-1.026(1)	1.987	-0.569
rer	-1.863(2)	-3.819(1)*	-1.826	-2.650
roptl	-1.789(2)	-2.758(1)	-1.754	-3.150

Not: (ADF: Augmented Dickey Fuller Test, PP: Phillips-Perron Test, -The number of lags in ADF regressions is given in parentheses. *, **, *** denote rejection of the null hypothesis at 1%, 5%, and 10% significance levels, respectively.)

These tests are conducted with intercept-trend models, and the number of lags used is determined using the Schwartz Information Criteria (SIC). Both ADF and PP tests are designed around the null hypothesis that the series has a unit root. If the test results exceed the critical values, the null hypothesis can be rejected, indicating that the series is stationary.

The results, as shown in Table 10, indicate that the null hypothesis of non-stationary can only be rejected for *ipi* at the 5% confidence level and for *rer* at the 1% confidence level in the ADF test with intercept and trend model. For the remaining series, namely "*cpi*," and "*roptl*," they are found non-stationary in their level forms according to the ADF test. In Both ADF test with intercept model and the PP tests, all series are identified as non-stationary in their level forms.

To address this inconsistency, we have conducted structural break unit root tests for all variables in our model, taking into consideration the possibility of structural breaks in non-stationary series. Table 11 presents the results of Lee and Stradizich (2003) with two-break unit root tests based on the null hypothesis that the series has a unit root.

Table 11: Lee and Stradizich (2003) Two-Break LM Unit Root Test Results

	Model AA	TB	Model CC	TB
roptl	-3.196 (1)	2020:06 /2021:01	-9.080(17)*	2020:01/ 2022:01
cpi	-2.982 (12)	2019:06 /2022:11	-12.362 (15)*	2020:05 / 2021:10
rer	-3.940 (1)**	2022:01 / 2022: 12	-5.751 (1)	2019:07 / 2022:01
ipi	-3.886 (0) **	2020:05 / 2021:07	-7.960 (17)*	2020:03 /2022:05

Not: (The optimal number of lags is shown in parentheses. TB denotes the estimated break points. See Lee and Strazicich (2003) for the critical values. *, **, *** indicates the two-tailed significance level of the break date at 1%, 5%, and 10%, respectively. LM: Lagrange Multiplier.)

The unit root test results of the Model AA, which allows the break at crash, show that only the *ipi* and *rer* series are stationary at the 5% significance level in their level values, while the *roptl* and *cpi* have a unit root. In Model CC, on the other hand, *roptl, cpi, and rer* series are found to be stationary at the 1% significance level, while rer only exhibits a unit root.

As represented in Table 10, when we take the first differences of all series, we can reject the null hypothesis of a unit root can be rejected at the 1% significance level for the first differences. This indicates that the new differenced series are stationary, satisfying the necessary conditions for the ARDL model. However, in the subsequent ARDL estimation in the next section, we will use all series in their level form.

5.2.2. ARDL Model Estimation and Bounds Test in Model II

We used the Akaike Information Criteria (AIC) to select the optimal lag lengths (k) from a maximum of 8 lags. As depicted in Figure 6 the selected model is ARDL(4, 4, 3, 3). This indicates that the optimal lag lengths for the variables ipi, cpi, rer, and roptl are p=4, q= 4 r=3, and s=4, respectively.

Figure 5. Model Selection Graph in Model II

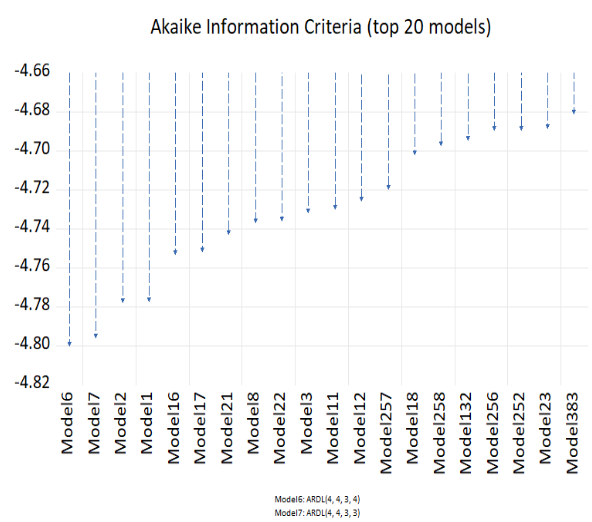


Table 12 displays the results of the ARDL bounds test for cointegration with the selected lag lengths. The estimated F-statistic value (14.17) exceeds the critical upper bound values (5.80) at the 1% significance level, in accordance with the criteria proposed by Pesaran et al. (2001) and Narayan (2005). Therefore, we can reject the null hypothesis of no cointegration. These results signify the presence of a long-run cointegration relationship between ipi and the independent variables cpi, rer, and roptl during the period from 2017:08 to 2023:05 in Turkey.

Table 12: ARDL Bounds Test for Cointegration in Model II

k	F-stat.	Sig. Level	I (0)	I (1)	Result
3	14.169	10%	3.09	3.92	Cointegration
		5%	3.06	4.512	
		1%	4.76	5.798*	

Note: a Asymptotic critical value bounds of the F statistic and t-statistic were retrieved from Table CI Case IV: Urestricted intercept and restricted trend on p. 302 and on 306 in Pesaran et al. (2001). * represents the 1% level of significance, k is the number of the variables.

Table 13 below presents the estimated coefficients of the long-run analysis for the ARDL (4, 4, 3, 4) model. According to the results of the model, in contrast to the pre-2017 period, roptl exhibits a negative and statistically significant impact on industrial production at 1% confidence level. This implies that a 1% rise in crude oil price reduces industrial production by 0.282% in the long run after 2017.

The consumer price index (cpi) has a statistically significant impact on the industrial production index at 1% significance level in the long run. A 10% increase in the consumer price index stimulates the industrial production index by 0.38%. Similarly, the real effective exchange rate (rer) has positive impact on industrial production; however, the coefficient of real exchange rate is statistically insignificant.

Table 13. Estimated Coefficients of Long-Run Analysis ARDL (4, 4, 3, 4)

Variable	Coefficient	t-Statistics	Probability
cpi	0.038*	3.300	0.001
rer	-0.239	-1.240	0.228
roptl	-0.282***	-1.872	0.067
trend	0.008*	3.446	0.012

Note: (* and ** indicates significance at the 1% and 5% level, respectively)

Concerning the error correction form, Table 14 reveals the short-run effects of the variables on industrial production using the Error Correction Model (ERM) as represented in Equation 4 above. It is noteworthy that, real oil prices (roptl) have a positive and statistically significant effect at the 1% level, indicating that a 1% change in real oil prices results in a 0.116% increase in industrial production. Furthermore, the lagged effects of real oil prices on industrial production diminish over time.

The consumer price index (cpi) has a statistically significant impact of 0.424% at the 5% significance level in the short run. However, it's worth it that the impact of the one-lagged consumer price index on production turns negative. This pattern of volatility in the consumer price index appears to persist across all lags. Nevertheless, the positive impact of an increase in the consumer price index appears to outweigh its negative impact on industrial production, indicating a net positive effect overall.
Real exchange rates (rer) have a negative impact in line with

the economic expectations, where a 1% increase in rer corresponds to a -0.04% decrease in industrial production. However, it is important to note that, the coefficient of rer is statistically insignificant. Moreover, only the two-lagged value has a negative and statistically significant impact at -0.203 with a 5% confidence level.

Additionally, the dummy variable (D) representing the Covid-19 national lockdown in 2020 has a negative and statistically significant impact on industrial production in the short run. This indicates that the lockdown had an adverse effect on industrial production during that period.

Finally, the error correction parameter (EC_{t-1}) has a negative coefficient of -0.289, as anticipated, and is statistically significant at the 1% level. This indicates that approximately 29% of the disequilibrium level observed in the industrial production index in the previous month will have corrected in the current month. In other words, industrial production converges towards its long-run equilibrium by about 28.9% with a speed of adjustment. This implies that it takes roughly three and a half months for the industrial production index to return to its long-run equilibrium level following a shock or disturbance.

Table 14. Estimated Coefficients of Short-Run Analysis ARDL(4, 4, 3, 4)

Variable	Coefficient	t-Statistics	Probability
Δ(ipi)t-1	-0.169**	-3.171	0.002
Δ(ipi)t-2	-0.104***	-1.952	0.059
Δ(ipi)t-3	-0.153**	-3.131	0.003
Δ(cpi)t	0.424**	2.522	0.015
Δ(cpi)t-1	-0.046**	-2.438	0.018
Δ(cpi)t-2	0.752**	4.100	0.002
Δ(cpi)t-3	-0.577*	-3.389	0.001
Δ(rer)t	-0.040	-0.617	0.540
Δ(rer)t-1	-0.005	-0.444	0.659
Δ(rer)t-2	-0.203**	-2.568	0.013
Δ(roptl)t	0.116*	4.828	0.000
Δ(roptl)t-1	0.083*	2.670	0.010
Δ(roptl)t-2	0.066**	2.080	0.043
Δ(roptl)t-3	0.044*	1.323	0.192
EC_{t-1}	-0.289*	-8.783	0.000
Constant	0.694*	8.996	0.000
Trend	-0.326*	-13.354	0.000
R^2 : 0.925	Prob (F-Stat): 0.00		
F-statistics:37.993	Durbin-Watson:2.199		

We have performed diagnostic tests to verify the robustness of our proposed model, as outlined in Table 15. These diagnostic tests confirm that the model adheres to fundamental econometric principles and does not violate essential assumptions. In particular, the model is devoid of serial correlation and heteroskedasticity problems and satisfies the normality assumption condition for the distribution of disturbances, with all p-values surpassing the 10% significance level. This reinforces the reliability of our model and the validity of our results.

Table 15. Model Diagnostic Test Results

Test	χ^2	Probability
Breusch-Godfrey Serial Correlation LM test	0.445	0.775
Breusch-Pagan-Godfrey Heteroskedasticity test	0.697	0.704
Jarque-Bera Normality test	0.770	0.680

Finally, as illustrated in Figure 7 and Figure 8, we have conducted the stability tests for the ARDL model employed. These figures reveal that were no discernible systematic changes observed over the studied period, signifying the absence of issues related to recursive residuals, both in terms of mean and variance. Therefore, we can conclude that the results obtained from this study are reliable and can be utilized for policy analysis and decision-making.

Figure 7: Stability Test Results (CUSUM)

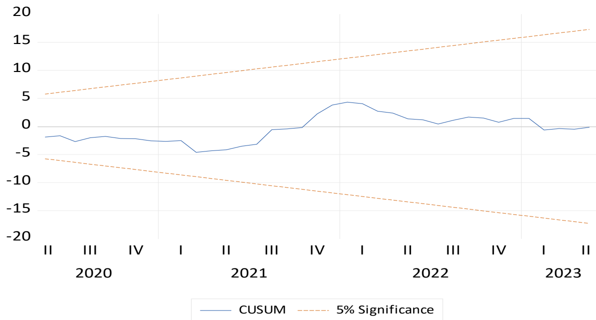
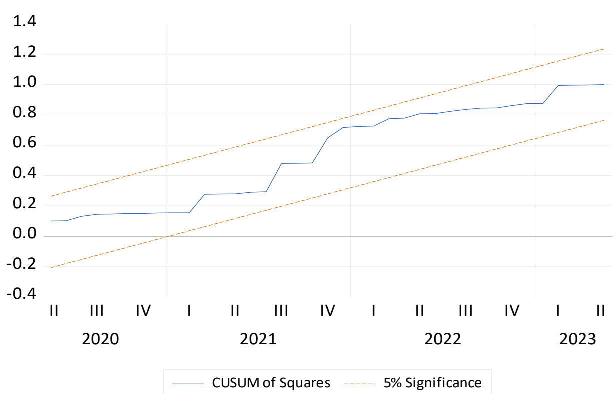


Figure 8: Stability Test Result (CUSUMSQ)



6. Conclusion

Oil prices always have a significant impact on economic activity, whether in oil-importing or exporting countries. Despite changes in their significance and magnitude, many researchers are keenly interested in understanding the effect of oil prices on total production in an economy.

There are two predominant claims in the literature regarding the relationship between oil prices and economic growth. The first one addresses the changing nature of this relationship, both in terms of magnitude and direction, in response to various shocks. Early studies suggested that oil price spikes had detrimental effects on macroeconomic performance. However, subsequent research identified an asymmetric relationship, indicating that only price increases harm total production, while price declines fail to stimulate the economy. In the 2000s, some researchers introduced a new perspective, suggesting no long-term relationship between oil prices and economic growth. As many countries adopted inflation-targeting policies, some scholars argued that policymakers should prioritize low inflation and directly counteract sharp oil price movements to mitigate their negative effects on the economy.

The second significant assertion concerns the origins of oil price increases. Some argue that when oil price swings result from increased demand, they do not harm production. Conversely, if price hikes result from exogenous oil supply shocks, such as those in oil-exporting countries like OPEC, they can temporarily reduce economic growth in G7 countries, as suggested by macroeconomic theory (Killian, 2008).

In this study, we have examined the effect of oil prices on industrial production in Turkey employing the ARDL approach to cointegration analysis proposed by Pesaran et al. (2001). Our analysis is based on two distinct subsamples spanning from July 2001 to May 2023. The first model encompasses the period from July 2001 to August 2017, while the second model covers the period from September 2017 to May 2023. Through these models, we have sought to understand the relationship between oil prices and industrial production in Turkey over thsese different time periods.

Our empirical results of both models indicate that the industrial production index is cointegrated with the consumer price index, real exchange rate, and real oil prices in the long run. The long-run model of the model I reveals that the coefficients of the real exchange rate and real oil prices are positive and statistically significant, contrary to our expectations. The coefficient of the consumer price index is also positive, as expected, but statistically insignificant. In the short run, the empirical results show that all variables have a positive relationship with industrial production. Only the one-lagged value of real oil prices accounts for a decrease in industrial production in the short run. The estimated error correction term, which is -0.296, in line with our negative expectation, indicates that approximately 29.6 percent of the deviation from the long-run equilibrium can be corrected in about three and a half periods, reflecting a rapid adjustment speed.

The empirical results of Model II exhibit notable differences when compared to those of Model I. After 2017, the consumer price index (cpi) has a positive and statistically significant impact on industrial production in Turkey in the long run. A 10% rise in prices leads to a 0.38% increase in industrial production. This result is compatible with the expansionary monetary policy implemented in Turkey since the early 2020s. However, real oil prices now have a negative effect on industrial production, with a 1% increase in oil prices causing a -0.282% decrease in the production index. These results indicate the changing relationship between oil prices and industrial production. Compared to Model I, we observe that both the direction and magnitude of the impact of the coefficient of the oil prices' impact on the economic performance have changed. This suggests that the Turkish economy has become more sensitive to oil prices after 2017 compared to the previous period. This heightened sensitivity can be attributed in part to supply-driven shortages due to OPEC's production cuts between 2017-202 and the Ukraine invasion by Russia in 2021.

Regarding the short-run analysis, the results of Model II are similar to those of Model I. Coefficients of the consumer price index and real oil price in the current period in Model II has a positive relationship with industrial production. The consumer price index (cpi) has the most substantial impact on production in Turkey, with a coefficient of 0.424. Furthermore, the relative importance of real oil prices in Model II is slightly higher than in Model I in the short run. The real effective exchange rate affects production negatively, but this effect is statistically insignificant. Additionally, in line with economic theory, the two-lagged value of the real effective exchange rate negatively impacts production. Finally, the error correction parameter (ECt-1) has a negative coefficient of -0.289, as anticipated, and is statistically significant at the 1% level. This indicates that approximately 29% of the disequilibrium level observed in the industrial production index in the previous month will be corrected in the current month.

In light of the arguments mentioned above, we would like to reconsider the results of the empirical analysis conducted. Firstly, we found that the industrial production index in Turkey has a positive relationship with real oil prices from 2001 until 2017, contrary to expectations, aligning with previous studies such as Cunado and Garcia (2005), Du et al. (2010), Torun and Alper (2010), Çatık and Önder (2013), Yıldırım et al. (2015), Barısık and Yayar (2015), and Rasisi & Yılmaz (2016). Higher real oil prices lead to increased industrial production in Turkey. However, our results do not support studies by Bohi (1989), Bernanke et al. (1997), Hooker (2002), and Blanchard and Gali (2007), which claim that oil prices do not affect the macroeconomic performance in countries adopting an inflation-targeting regime. Similarly, our results are inconsistent with Gökçe (2013) and Altıntaş et al. (2016), who found a negative relationship between economic growth and oil price increases. But we found that industrial productiın index has a negative relationship with real oil prices after 2017.

Our results are consistent with the findings of Killian (2008, 2009) and Sotoudeh and Worthington (2017). As discussed in section two, they evaluated the effects of oil prices on overall economies based on the origin of price movements (composition of shocks). They argued that endogenous oil price hikes can be accompanied by robust industrial production growth and thriving stock markets in net oil-consuming developed countries, including Germany, Italy, the Netherlands, Sweden, as well as developing ones. This situation raises questions about the origin of oil price increases during the sample period. According to World Bank statistics, global output was around 51 billion USD, 64 billion USD, and 77 billion USD in 2001, 2008, and 2016, respectively. Apart from the global recession in 2009, global output did not contract, even as oil prices rose from 25 USD in 2001 to almost 100 USD in 2008. The sustained growth in global production during the early 2000s resulted from an increase in demand for oil. The oil price swing followed the oil demand shock because the elasticity of oil production is lower than unity in the short run. From this perspective, we can conclude that the oil price surge did not harm total production in Turkey due to strong demand conditions resulting from the influx of cheap foreign currency mainly from the USA and the EU. Monetary easing following the burst of the Nasdaq bubble in the early 2000s, increased confidence in political stability under a single-party rule, institutional and structural reforms supported by the EU and the USA, and substantial capital flows resulting from expansionary monetary policies in the USA and the EU after the 2008 financial crisis were the main factors contributing to the strong demand conditions in Turkey. Capital inflows into emerging markets like Turkey boosted global production by increasing demand, except in 2009. Therefore, oil price hikes due to increasing global demand conditions explain why they did not harm production in Turkey. In light of this explanation our results of Model II are also not incompatible with the existing literature. The fact that oil price hikes during this period were not driven by demand but rather supply-side factors, including the uncertainty surrounding the COVID-19 pandemic, OPEC's oil production cuts between 2017 - 2020, and Russia's invasion of Ukraine in 2021, explain the change in the relationship between oil prices and industrial production in Turkey. These supply-driven increases in real oil prices can have different economic implications compared to demand-driven price changes, and our findings reflect this shift in the dynamics between oil prices and industrial production. The nuanced understanding of the impact of oil prices on the economy is valuable for policymakers and researchers, as highlighted the need to consider the specific drivers behind oil price fluctuations when analyzing their effects on economic performance.

Regarding the real exchange rate, we found a positive impact on industrial production in model I. As the domestic price decreases relative to foreign products, the real exchange rate appreciates. Although theory suggests that appreciation should harm net exports, our results show that real exchange rate appreciation has a positive contribution to industrial production, consistent with Ozlale and Karakurt (2012). Since the production structure of the Turkish economy heavily relies on imports, the appreciation of the domestic currency enables investors and firms to acquire relatively cheap capital goods and intermediates, leading to an increase in industrial production. According to Ozlale and Karakurt (2012), a 1% appreciation in the exchange rate contributes to a 0.38% increase in industrial production, primarily due to the heavy import dependence of Turkish industrial production. However, our results do not support the findings of Barışık and Yayar (2012), who identified a negative relationship between the nominal exchange rate and industrial production. However, our results of Model II are completely different from the previous model. We found the negative coefficient of the real exchange rate, as expected, in both long-run and short-run analyses. the differences between Model I and Model II highlight the importance of considering economic conditions and factors when analyzing the relationship between variables. The outbreak of the COVID-19 pandemic led to significant capital outflows from Turkey's capital markets due to heightened uncertainty and decreased risk appetite of foreign investors, which contributed to the depreciation of domestic currency. The depreciation of the domestic currency has a positive effect on industrial production, as it makes exports more competitive and stimulates domestic manufacturing. This effect along with the ongoing industrial production in Turkey, may explain the positive relationship between the real exchange rate and industrial production during the global COVID-19 lockdown. Furthermore, a new unorthodox monetary policy aimed at boosting Turkish exports by leveraging the depreciated domestic currency likely played a role in the changing relationship between the real exchange rate and industrial production Model II. These findings underscore the dynamic nature of economic relationships and the importance of considering economic conditions when conducting empirical analyses.

Our finding of the positive but limited relationship between consumer price index and the industrial production index in model I is similar to results of studies by Hooker (2002), Blanchard and Gali (2004), Cashin et al. (2014), Gokmenoglu (2015), Conflitti and Luciani (2020). Raising credibility of monetary policy implementing by central bank after adopting the inflation targetting policy in the early 2000's and appreciated domestic currency accounts for the limited impact of high of oil prices on industrial production during the consideration period. On the other hand, the observed positive and statistically significant relationship between the consumer price index (cpi) and industrial production in Model II indicates a noteworthy shift in the impact of the consumer price index on economic activity. This change in the pattern of the consumer price index's impact can be attributed to various factors including the implementation of expansionary monetary policies and the perceived credibility of the central bank in Turkey, particularly in light of the new unorthodox monetary policy adopted in 2021.

Finally, the primary aim of this study is not to directly measure the impact of oil prices but to determine whether disturbances in oil prices still affect macroeconomic production in Turkey, as one of the emerging countries. Therefore, future studies should focus on the effects of positive and negative price movements on total production using asymmetrical methods. Moreover, the study can be extended by incorporating additional variables such as interest rates, money supply, etc., over a longer sample size, and for other countries with similar income levels to Turkey, to compare the results across countries.

References

Algahtani, G. (2016). The Effect of Oil Prices Shocks on Economic Activity in Saudi Arabia: Econometric Approach. International Journal Business and Management. 11(2)

Alper E., C. & Torul, O., (2008). Oil prices, aggregate economic activity and global liquidity conditions: Evidence from Turkey, Economics Bulletin 17 (4). 1-8.

Altıntaş H., Benli M. , Kaplan, M. (November, 2016). Oil Prices and Economic Growth in Turkey: Evidence From NARLD. International Congress of Management Economy and Policy Proceedings, Vol.III, 26-27 November, Istanbul.

Alvarez, L, J., Hurtado, S., Sanchez, I., Thomas, C. (2011). The impact of oil price changes on Spanish and the euro

Barışık, S., & Yayar, R. (2012). Sanayi üretim endeksini etkileyen faktörlerin ekonometrik analizi. İktisat İşletme, Finans, 27, 53-70.

Barsky, R., & Kilian, L. (2001). Do we really know that oil caused the great stagflation? A monetary alternative. NBER Macroeconomics Annual 2001, Volume 16 (Vol. 16). https://doi.org/10.3386/w8389

Barsky R., Kilian L. (2004). Oil and Macroeconomy since the 1970s. Journal of Economic Perspectives,18(Fall), 115-134

Baumeister, C., Hamilton J., D., (2019). Structural Interpretation of Vector Autoregressions with Incomplete Identification: Revisiting the Role of Oil Supply and Demand Shocks. American Economic Review, 109 (5): 1873-1910.

Bernanke, B. S., Gertler, M., & Watson, M. (1997). Systematic Monetary Policy and the Effects of Oil Price Shocks. Brookings Papers on Economic Activity, 1997(1), 91–157. https://doi.org/10.2307/2534702.

Blanchard O. J., Gali J. (2007). The macroeconomic effects of oil shocks: Why are the 2000s so different from the 1970s? Gali, Jordi and Mark Gertler (eds.) International Dimensions of Monetary Policy. Chicago: University of Chicago Press, 2009.

Bohi, D. R. (1989). Energy price shocks and macroeconomic performance. Resources for the Future, Washington, DC.

Brown, S.,Yucel, M. (2002). Energy prices and aggregate economic activity: an interpretative survey. Quarterly Review of Economics and Finance 42, 193-208.

Bruno, M., Sach, J. (1982). Input Price Shocksand Slowdown in Economic Growth: Tha Case of UK Manufacturing. NBER Working Paper Series, No:851.

Cashin P., Mohaddes K., Raissi M., Raissi M. (2014). The differential effects of oil demand and oil supply shocks on global economy. Energy Economics (44), 113-134.

Chang, Y., Jha, K., Fernandez K.M., Jam'an , N. F. (2011). Oil price fluctuations and macroeconomic performances in Asian and Oceanic economies. Proceedings of 30th United States Association for Energy Economics/ International Association for Energy Economics North American conference, Washhington DC, October 9-12

Cologni, A., & Manera, M. (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. Energy Economics, 30(3), 856–888. https://doi.org/10.1016/j.eneco.2006.11.001

Conflitti, C. & Luciani, M. (2017). Oil price pass-through into core inflation. Finance and Economics Discussion Series 2017-085. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.085.

Cuñado, J., & Gracia, F. P. De. (2003). Do oil price shocks matter? Evidence for some European countries. Energy Economics, 25(2),137–154. https://doi.org/10.1016/S0140-9883(02)00099-3

Çatık A. Nazif, Özlem A. Önder (2013). "An asymnetric analysis of the relationship between oil prices and output: The case of Turkey", Economic Modelling, 33, pp.884-892.

Darby M. R. (1982). The price of oil and World inflation and recession. American Economic Review, 72(4), 738-751.

Dickey, D., A., Fuller, W. A.,(1981) Likelihood Ratio statistics for Autoregressive Time Series With a Unit Root. Econometrica, 49(4) 1057-1072.

Du, L., Yanan, H., & Wei, C. (2010). The relationship between oil price shocks and China's macro-economy: An empirical analysis. Energy Policy, 38(8), 4142–4151. https://doi.org/10.1016/j.enpol.2010.03.042

Elafif, M., Alsamara, M. K., Mrabet, Z.,..(2017). The asymmetric effects of oil price on economic growth in Turkey and Saudi Arabia: new evidence from nonlinear ARDL approach. International Journal of Development and Conflict, 7(2), 97-118.

Fratzscher, M., Schneider, D., Van, Robays I. (2014). Oil prices, exchange rates and asset prices. Working Paper Series No 1689, European Central Bank.

Ftiti Z., Guesmi K., Teulon F., Chouachi S. (2016). Relationship between crude oil prices and economic growth in selected OPEC countries. The Journal of Applied Business Research (32), 11-22.

Gisser M., Goodwin T. (1986). Crude oil and macroeconomy: Test of some popular nations. Journal of Money, Credit and Banking (32), 1-22.

Gokce, A. (2013). The Dynamics Impacts of Oil Price Shocks on Turkey's Economic Growth. Journal of Economics and Sustainable Development, 4(8), 181-192.

Gokmenoglu, K., Azin V., Taspınar, N. (2015). The Relationship between industrial producation, gdp, inflation, oil prices: The case for Turkey, Procedia Economia and Finace 25, 497-503

Gómez-Loscos, A., Gadea, M. D., & Montañés, A. (2012). Economic growth, inflation and oil shocks: Are the 1970s coming back? Applied Economics, 44(35), 4575–4589 https://doi.org/10.1080/00036846.2011.591741

R.F. Engle, C.W. Granger (1987). Co-integration and error correction: representation, estimation, and testing Econometrica journal of the Econometric Society, 251-276.

Hamilton, J.D. (1983). Oil and macroeconomy since World War II. Jounal of Political Economy 91,228-248.

Hamilton, J.D. (2003). What is an Oil Shock?, Journal of Econometrics 113: 363-398

Hamilton., J.D. (1996). This is what happened to oil price-macroeconomy relationship. Journal of Monetary Economics, 38, 215-220.

Hooker, M. A. (1996). What happened to the oil price macroeconomy relationship? Journal of Monetary Economics, 38(2), 195-213.,

Hooker, M. A. (2002). Are oil schock inflationary? Asymetric and non linear specifications versus changes in regime. Jourbal of Money, Credit, and Banking, 540-561.

Hoover, K.D., Perez, S.J. (1994). Post hoc ergo propter once more: an evaluation of does monetary policy matter? in the spirit of James Tobin. Journal of Monetary Economics 34, 47–73.

Iwayemi, A., & Fowowe, B. (2011). Impact of oil price shocks on selected macroeconomic variables in Nigeria. Energy Policy, 39(2), 603-612. doi:10.1016/j.enpol.2010.10.033

Ji, Q., Shahzad, S.J.H., Bouri, E. et al. (2020). Dynamic structural impacts of oil shocks on exchange rates: lessons to learn. Economic Structures 9, 20 (2020). https://doi.org/10.1186/s40008-020-00194-5

Jimanez-Rodriguez, R., Sanchez M. (May 2004). Oil Price Shocks and Real GDP Growth: Empirical Evidence for Some OECD Countries, Euopean Central Bank Working Paper Series, No: 362.

Johansen S. (1988). Statistical analysis of cointegration vectors. Journal of economic dynamics and control, 12, pp. 231-254

Kırca, M., Canbay, Ş., Pirali, K., (2020). Is relationship between oil-gas prices index and economic growth in Turkey permanent? Resources Policy, 69, pp.1-9.

Kibritcioglu A., "Türkiye'de Akaryakıt Ürünü Fiyat Gelişmelerive Enflasyon: Yeni Bulgular", Ankara Üniversitesi SBF Tartışma Metinleri, 1999

Kilian, L. (2009). 'Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market', American Economic Review, 99, 1053–69.

Kilian, L. (2008). 'A Comparison of the Effects of Exogenous Oil Supply Shocks on Output and Inflation in the G7 Countries', Journal of the European Economic Association, 6, 78-121.

Krugman, P. (1983). Oil shocks and exchange rate dynamics. In: Frenkel JA (ed) In exchange rate and international economics. University of Chicago Press, Chicago.

Lardic A., Mignon V. (2008). Oil prices and economic activity: An asymmetric cointegration approach. Energy Economics (30), 847-85

Lee. J., Strazicich M. C. (2003) Minimum Lagrange Multiplier Unit Root Test with Two Structural Breaks. The Review of Economics and Statistics 85(4):1082-1089.

Lee, K., Ni, S., Ratti, R. A. (1995). Oil shocks and the economy: the role of price variability. Energy Journal 16, 39-56.

Leung, G. C. K. (2010). China's oil use, 1990-2008. Energy Policy 38 (2): 932-944

Lilien, D. (1982), "Sectoral Shifts and Cyclical Unemployment", Journal of Political Economy 90: 777-793.

Mendoza O., Vera D. (2010). The Asymmetric Effects of Oil priceshocs on the oil exporting economy. Cuadernos de Economia (47), 3-13

Morana C. (2017). Macroeconomic and financial effects of oil price shocks: Evidence from Euro area. Economic Modelling (64). 82-96.

Mork K. A. (1989). Oil and macroeconomywhen prices go up and down:an extension of Hamilton's results. Journal of Political Economy 97, 740-744.

Mork K. A.(1994). Business cycles and oil market. Energy Journal, 15(S), 15-38.

Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. Applied Economics, 37(17), pp. 1979–1990. doi: 10.1080/00036840500278103.

Johansen, S., (1988). Statistical analysis of cointegrating vectors. Journal of Economic Dynamics and Control, 12, pp. 231–254.

Johansen, S. (1995). Likelihood-based Inference in Cointegrated Vector Autoregressive Models(Oxford:Oxford University Press).

Johansen, S. & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration withapplications to the demand for Money. Oxford Bulletin of Economics and Statistics,52, pp. 169–210.

Nkoro E., Uko A. K. (2016). Autoreggressive Distributed Lag (ARDL) cointegration technique. Journal of statistical and Econometric Methods, 5, 4, pp. 63-91.

Özlale, Ü. & Karakurt, A. (2012). Türkiye'de tasarruf açığının nedenleri ve kapatılması için politika önerileri, Bankacılar Dergisi TBB, 83, ss. 1-33

Pesaran, M.H., Pesaran B. (1997). Working with microfit 4.0: Interactive econometic analysis. Oxford: Oxford University Press.

Pesaran, M.H., & Shin, Y. (1999). An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. in S. Strom (eds), Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium, Cambridge University Press

Pesaran M. H., Shin Y, Smith J.R, (2001). Bound Testing approaches to the analysis of level relationships. Journal of Applied Econometrics,16, pp.289-326.

Philip P., C., B., Perron, P., P. (1988). Testing for unit root in time series regression. Biometrica, 75, 335-346.

Rasche R.H., Tatom J. A. (1981). Energy price shocks, aggregate supply, and monetary policy: theory and international evidence. In: Brunner, K., Meltzer, A.H. (Eds), Supply Shocks, Incentives and National Wealth, Carnegie-Roschester conference Series on Public Policy, 14, North Holland, Amsterdam.

Rogoff K. (2005). Oil and the global economy. International Energy Forum Meeting. Riyadh, November 19.

Romer, C.D., Romer, D.H. (1994). Monetary policy matters. Journal of Monetary Economics 34, 75–88.

Shimul, S. N., Grant, J. P., Abdullah, S. M., & Siddiqua, S. (2009). An Examination of Fdi and Growth Nexus in Bangladesh: Engle Granger and Bound Testing Cointegration Approach. BRAC University Journal, 1(1), 69–76.

OPEC (2018). Annual Statistical Bulletin, 53rd Edition. Retrieved from: https://www.opec.org/opec_web/static_files_project/media/downloads/publications/ASB%202018.pdf.

Sadeghi, A., (2017). Oil Price Shocks and Economic Growth in Oil-Exporting Countries: Does the Size of Government Matter?, IMF Working Papers 2017/287, International Monetary Fund.

Shahbaz, M., Solarin, S. A., Mahmood, H., & Arouri, M. (2013). Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis. Economic Modelling, 35, 145-152.

Sotoudeh, M. A. L. I., & Worthington, A. C. (2017). Nonlinear Effects of Oil Prices on Consumer Prices : A Comparative Study of Net Oil Consuming and Producing Countries, 9, 57–79.

Tausif, R., Haque M.,I. & Khan, M.R. (2023). Effect of oil price shocks on output and prices: evidence from Saudi Arabia. Environmental Science and Pollution Results, https://doi.org/10.1007/s11356-023-30041-6

Torul O., Alper E., C. (2010), Asymmetric Effects of Oil Prices on the Manufacturing Sector in Turkey. Review of Middle East Economics and Finance 6, 1-16

Van Dinh, D., (2022). Crude oil price fluctuation and economic growth : ARDL model approach. International Journal of Energy Economics and Policy 12 (4), S. 240 – 248.

Yildirim, N., Ozcelebi, O., & Ozkan, S. O. (2015). Revisiting the impacts of oil price increases on monetary policy implementation in the largest oil importer, Zbornik radova Ekonomskog fakulteta u Rijeci/Proceedings of Rijeka Faculty of Economics, University of Rijeka, Faculty of Economics and Business 33(1), 11–35.

Extended Summary

Oil price fluctuations have been a captivating subject of research for academicians over the past 50 years. One of the reasons for this keen interest is their dynamic and evolving impact on macroeconomic variables such as economic growth, inflation, and the real exchange rate. After the two oil price shocks in the 1970s and Hamilton's pioneering study in 1983, which identified oil price shocks as a primary cause of most US recessions, early research consistently found that oil prices had a negative impact on economic activity, both directly and indirectly. This early consensus was supported by numerous empirical studies, including Rasche and Tatum (1981), Bruno and Sach (1982), Hamilton (1983 and 2003), and Gisser and Goodwin (1986).

However, a shift occurred in the understanding of the relationship between oil prices and economic activity. Researchers such as Mork (1989), Lee et al. (Hamilton, 2003), and Jimenez-Rodriguez & Sanchez (2004) began to demonstrate an asymmetrical relationship between oil prices and economic activity. They found that while oil price increases could negatively affect production, the opposite was not true - price decreases could not stimulate economic growth as expected, indicating a nonlinear relationship. Subsequently, scholars like Bohi (1989), Hooker (1996), Bernanke and Gali (2004), and Bernanke et al. (1997) pointed to the implementation of monetary policy as the primary driver of recessions following oil price shocks.

Surprisingly, during the period of 2001-2007, the magnitude of oil price increases was similar to that of the 1970s, yet global economic growth remained robust until the global financial crisis of 2008. This led to a renewed inquiry: do oil prices still significantly impact economic activity? Many economists, including Hooker (2002), Bernanke and Gali (2004), Jimenez-Rodriguez and Sanchez (2004), Rogoff (2005), Blanchard and Gali (2007), Killian (2009), Cashin et al. (2014), Rasassi and Yılmaz (2016), Akinsolo and Odhiambo (2020), and Von Dinh (2022), have since affirmed that the effect of oil price fluctuations on economic growth has diminished compared to the 1970s-1980s.

Recent research has introduced a new dimension to this debate, emphasizing that the origin of oil price increases matters for their impact on economic growth. While demand-driven oil price rises do not lead to reduced economic activity in oil-importing countries, supply-driven increases can hinder economic growth, as argued by Killian (2008, 2009), Cashin et al. (2014), Sotoudeh and Worthington (2017), Baumeister and Hamilton (2019), and Tausif et al. (2023). This perspective sheds light on the global economic expansion during the early 2000s, marked by high oil prices, and provides a rationale for this phenomenon.

This study seeks to investigate the presence of a long-term and short-term relationship between oil prices and economic growth, represented by industrial production, the consumer price index, and the real exchange rates. We apply the ARDL cointegration analysis developed by Peseran and Shin (1999) and Pesaran et al. (2001). Our analysis is based on two distinct subsamples spanning from July 2001 to May 2023. The first model encompasses the period from July 2001 to August 2017, while the second model covers the period from September 2017 to May 2023. Our empirical results reveal that the industrial production index is cointegrated with the consumer price index, real exchange rate, and real oil prices in the long run in Model I and Model II. In Model I, the long-run coefficients of the real exchange rate and real oil prices are unexpectedly positive and statistically significant. The coefficient of the consumer price index is also positive but statistically insignificant. In the short-term model, our empirical findings demonstrate a positive relationship between all variables and industrial production at the level. Notably, only the one-period lagged value of real oil prices leads to a decrease in industrial production in the short run. The estimated error correction term, at -0.296, aligns with our negative expectation and indicates that approximately 29.6 percent of the deviation from the long-run equilibrium resulting from short-term shocks can be corrected in around three and a half periods, underscoring a rapid adjustment process.

Regarding the results obtained from Model II, the empirical results of Model II exhibit notable differences when compared to those of Model I. After 2017, the consumer price index (cpi) has a positive and statistically significant impact on industrial production in Turkey in the long run. A 10% rise in prices leads to a 0.38% increase in industrial production. Compared to Model I, we observe that both the direction and magnitude of the impact of the coefficient of the oil prices' impact on the economic performance have changed. This suggests that the Turkish economy has become more sensitive to oil prices after 2017 compared to the previous period. Regarding the short-run analysis, the results of Model II are similar to those of Model I. The coefficients of the consumer price index and real oil price in the current period in Model II have a positive relationship with industrial production. The consumer price index (cpi) has the most substantial impact on production in Turkey, with a coefficient of 0.424. Furthermore, the relative importance of real oil prices in Model II is slightly higher than in Model I in the short run.

Finally, the real effective exchange rate affects production negatively, but this effect is statistically insignificant. Additionally, in line with economic theory, the two-lagged value of the real effective exchange rate negatively impacts production.