Finans Ekonomi ve Sosyal Araştırmalar Dergisi, Cilt.8 Sayı.3, Eylül 2023
Research of Financial Economic and Social Studies, Vol.8 No.3, September 2023
ISSN : 2602 – 2486

PETROL FİYATI ŞOKU VE TÜRKİYE EKONOMİSİNİN MAKROEKONOMİK PERFORMANSI

OIL PRICE SHOCK AND MACROECONOMIC PERFORMANCE OF THE TURKISH ECONOMY[1]

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Araştırma Makalesi / *Geliş Tarihi: 01.06.2023*
Kabul Tarihi: 30.09.2023

Abstract

The variations in the price of oil can have influential effects on the macroeconomic performance of countries, as oil is a fundamental source in the production of many goods. This paper explores the influence of oil price shocks on macroeconomic indicators in Türkiye employing Structural Vector Autoregression (SVAR) model with a long-run relationship using data from 2009.Q1 to 2022.Q4. The findings from the investigation of the long-run association indicate that there is a non-significant negative association among the price of oil and GDP, employment and inflation. Furthermore, we find that as the period extends, the forecast error shock of oil explains less and less of itself, while other variables begin to explain more of the variation of oil price. Lastly, the results from the impulse decomposition validate that of the variance composition as a positive one standard deviation shock in inflation rate, GDP, and employment rate widens oil price.

Keywords: Oil Price Shock, Macroeconomic Performance, SVAR model.

JEL Classification: Q43, C32, F62.

Öz

Petrol, birçok malın üretiminde temel kaynak olarak kullanılmaktadır ve uluslararası piyasalardaki petrol fiyatlarındaki dalgalanmalar, ülkelerin makroekonomik performansı üzerinde etkili olabilmektedir. Bu çalışma, petrol fiyatı şoklarının Türkiye'deki makroekonomik değişkenler üzerindeki etkisini incelemektedir. Çalışmada, 2009.Q1'den 2022.Q4'e kadar olan üç aylık veriler kullanılarak uzun dönem ilişkileri içeren Yapısal Vektör Otoregresyon (SVAR) modeli uygulanmıştır. Uzun dönem ilişkilerden elde edilen sonuçlara göre, petrolün GSYİH, istihdam ve enflasyon arasında negatif bir ilişkiye sahip olduğunu göstermektedir. Ancak, bu ilişki istatistiksel olarak anlamlı değildir. Ayrıca, dönem uzadıkça, petrolün tahmin hatası şokunun kendisini giderek daha az açıklamaya başladığını, diğer değişkenlerin ise petrol fiyatındaki değişimi daha fazla açıklamaya başladığı sonucuna ulaşılmıştır. Son olarak, etki-tepki analizine göre, enflasyon oranındaki, GSYİH büyüme hızındaki ve istihdam oranındaki pozitif bir standart sapma şoku petrol fiyatlarının artmasına neden olmaktadır.

Anahtar Kelimeler: Petrol Fiyatı Şoku, Makroekonomik Performans, SVAR model.

JEL Sınıflaması: Q43, C32, F62.

[1] **Bibliyografik Bilgi (APA):** FESA Dergisi, 2023; 8(3) ,750 - 758 / DOI: 10.29106/fesa.1308519

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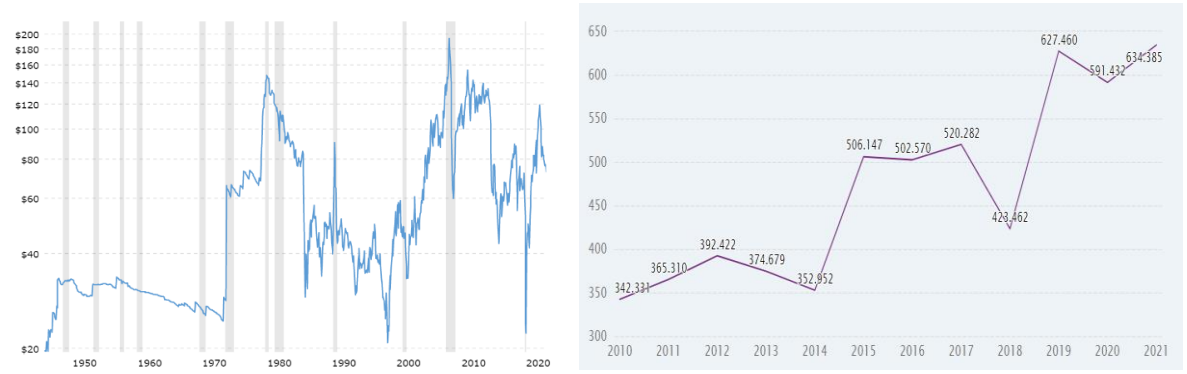
1. Introduction

The oil market has experienced significant price swings over the past three decades and energy-related topics have gained significant attention in the economic literature, particularly following the oil crises in 1973. The variations in oil prices can have a noteworthy impact on macroeconomic indicators, as oil is the fundamental source used in the productions of many goods. Specifically, the changes in oil prices may pass-through into production cost and affect the business profits. For instance, a rise in oil price will raise the cost of energy, potentially resulting in an escalation in the price level. Therefore, it will directly affect consumer and producer prices and increases inflation. If there is a high inflation rate, it will affect economic growth by affecting consumer spending. This may slow economic growth by affecting investment and employment. The imbalanced allocation of oil resources across the world leads to variations in oil availability and policies among countries. Hence, the effect of oil price changes on the economy can exhibit variations among countries, industries and over periods depending on the level of oil dependency and policy responses of each country. Consequently, it is noteworthy to search the potential costs of oil price changes on macroeconomic performance in country-specific.

Türkiye is a country dependent on energy imports so it is vulnerable to oil price changes and is influenced by variations in the international oil market. According to Figure 1, Türkiye's crude oil imports, which represents the average daily volume of crude oil imported by Türkiye during that month, were reported at 634.385 barrels per day in December 2021 as it demonstrates that Türkiye's oil dependency has significantly increased since 2010. In addition, this figure demonstrates that oil prices fluctuate significantly and a negative association can be observed among the price of oil and Türkiye's oil imports. This may affect the economic stability and macroeconomic performance of Türkiye as the volatility in oil prices will create unpredictable consequences. This work hence aims to delve into the effect of oil price shock on macroeconomic variables such as GDP, employment and inflation in Türkiye applying the Structural Vector Autoregression (SVAR) method with long run relationship using quarterly data during the period spanning from 2009.Q1 to 2022.Q4. Given Türkiye's high dependency on oil, the results from this study will shed light on the association among the variations in the price of oil and macroeconomic indicators in Türkiye and will provide valuable insights into the country's economic dynamics. This paper will also help policymakers to gain a deeper understanding of the potential risks and vulnerabilities regarding the fluctuations in oil prices and formulate appropriate policy responses to smooth the negative impacts of these fluctuations.

The changes in oil prices had historically affected the global economy. As can also be seen in Figure 1, the 1973 oil crisis is known as the "First Oil Shock" in global economic history. The first oil shock occurred due to the fact that OPEC implemented an oil restriction on countries assisting Israel during the Yom Kippur War. There was a substantial rise in energy costs from $3 to $12 per barrel for oil-importing countries. Since the sudden and significant increase in oil prices, there had been disruptions in supply chains and uncertainty in financial markets as well as economic growth was hindered in many oil-importing countries. There are some other key periods of oil price shocks such as the 1979 oil crisis that was the result of political turmoil in Iran, the 1990 Gulf War, 2008 global financial crisis which had both positive and negative effects on oil-dependent nations and oil-rich nations, respectively and 2014 oil price collapse which was caused by the imbalance between worldwide supply and demand of oil. These events had a noticeable influence on global economic activity.

Figure 1. Analysis of Global Oil Price Fluctuations and Türkiye's Oil Imports



Note: First figure is obtained from Macrotrends, WTI (https://www.macrotrends.net/1369/crude-oil-price-history-chart). The second figure is obtained from Ceicdata (https://www.ceicdata.com/en/indicator/turkey/crude-oil-imports).

The effect of oil price shocks and volatility can differ between net exporter and net importer of oil countries. Hence, the impact of shifts in oil prices can be different for each group of countries (Eagle, 2017). If there is any

increase in oil prices, it can be beneficial for net oil-exporting economies as it results in a rise in revenues. Therefore, economic growth will increase as well as government revenues and investment increases. However, any decline in oil prices will have adverse impacts on oil-exporting nations. For net oil importer nations, higher oil prices increases production costs, especially for industries heavily on oil. This can slow down economic growth as it leads to inflationary pressures and reduced consumer purchasing power. Conversely, if there is any decrease in oil prices, oil-importing countries will benefit as it decreases input costs and lowers inflationary pressures and supports economic growth.

Moreover, any shift in oil demand or supply will affect the crude oil price volatility (Hamilton, 2009b). In his paper, he provides a comprehensive analysis of the factors affecting crude oil prices and examines their implications for the global economy. On the demand side, he searches the role of global economic growth, oil consumption patterns and factors affecting the price sensitivity of oil demand. Regarding the supply side, he explores the impacts of geopolitical events, production disruptions, OPEC policies and technological progress in the oil sector. In addition, Hamilton (2009a) delves into the impact of oil price changes on the economy in 2007-2008. He aims to examine the resemblances and differences amongst oil prices in 2007-2008 and previous oil price crises by taking into account the factors that led to price increases and economic effects during these periods. He uncovered that high oil prices have played a substantial role in the recession during that period. Moreover, Yang et al. (2002) examine the factors influencing price instability within the crude oil market and focus on three aspects: the market organization of OPEC, the stability of demand composition and the responsiveness of demand. They use the error correction model to analyze the demand relationships and associated elasticity. Based on their results, they find that the expected outcome is an increase in oil prices when 4% reduction in OPEC production but the effect of this production cut on oil prices can be affected by the severity of the recession.

In this work, Section 2 reviews the existing literature. Section 3 exhibits the methodology of the study, Section 4 evaluates the primary findings and section 5 concludes the work.

2. Literature Review

The significance of oil as a primary energy source for the economies has drawn the interest of numerous scholars in the field of energy economics. Therefore, a substantial number of papers have assessed the influences of oil price fluctuations on macroeconomic indicators. These works mainly try to understand how changes in oil prices affect economic indicators such as GDP growth, inflation, employment, investment and consumer spending. However, it is important to mention that these studies employ a wide range of methods, techniques, time periods and variables to examine this research topic. By looking at this topic, scholars aim to provide a deep understanding of the ramifications of oil price variations on the overall economy. Some of these studies are hereby presented.

Dogrul et al. (2010) analyze the association among oil prices, interest rates and unemployment rates in Türkiye between 2005:01 and 2009:08 by using the efficiency wage model and utilizing the Toda-Yamamoto techniques to explore the causal relationship among these variables. They reveal that both oil prices and interest rates have an impact on the unemployment rate. Baek and Yoon (2022) focus on analyzing the influence of the price of oil volatility on growth, inflation and exchange rate in Indonesia applying monthly data spanning from 1998 to 2019. They employ a Structural VAR method to investigate the reactions of macroeconomic indicators to the demand and supply shocks that derive oil price volatilities. They highlight that the response of macroeconomic variables differs based on the type of shock examined. Furthermore, the study of Lorusso and Pieroni (2018) investigates the effects of oil price fluctuations on the performance of the UK economy. To achieve this aim, they employ an empirical strategy that enables them to decompose oil price variations into their primary sources of shocks. They explore that the effect of oil price volatility on the UK economy varies based on the type of oil price variations. More specifically, they find that demand driven fluctuations in oil prices does not have a negative effect on UK's economy in the short term but deficiencies in oil supply have an instant decrease in the growth of GDP. They also explore that total and specific demand of oil has an important effect on macroeconomic indicators such as GDP, inflation, nominal interest rate and unemployment.

Eagle (2017) investigates the link among the variations in oil price and macroeconomic indicators in Nigeria and Angola by applying the SVAR model, E(GARCH) model and Granger Causality test using quarterly data from 1994 to 2014. He finds that oil price volatility does not significantly influence the economic growth rate in both countries. Furthermore, the findings from impulse response functions and decomposition of variance display that when oil prices rise, there is an appreciation in the exchange rate. It means that the domestic currency strengthens relative to other currencies. However, when oil prices decrease, there is a depreciation. In this study, the Granger causality test findings show that there exists a bi-directional association among oil price volatility and macroeconomic indicators in Nigeria but this relation is unidirectional in Angola. Moreover, Köse (2021)

examines the influences of oil prices, the volatility of oil, labor cost and the exchange rate on inflation in Türkiye. To achieve this, they use the data (monthly) from 1988 to 2019 applying a SVAR model. Based on the results they obtained: 1) The influence of oil price and the volatility of oil price on inflation were initially limited but became more pronounced overtime same as the effect of the cost of labor on inflation. 2) The variations in inflation are predominantly driven by the exchange rate and its effect on inflation remains relatively stable.

Iwayemi and Fawowe (2010) utilize both linear and nonlinear frameworks for oil price shocks to explore the effect of shocks on macroeconomic indicators for Nigeria applying the quarterly data from 1985:Q1 to 2007:Q4. The outcomes of their analysis show that the fluctuations in oil prices do not have a substantial effect on most macroeconomic indicators in Nigeria. In addition, the outcomes of the Granger-causality test confirm that linear oil shock measures and positive oil shocks do not have a causal relationship with output, government spending, inflation and the real exchange rate. This work also confirms the presence of unequal impacts of oil price fluctuations. In addition, Yurtkur et al. (2016) investigate the effect of oil price changes on the macroeconomic performance of Türkiye and Russia using the monthly data from 1995:01 to 2014:12 and employing the VAR model. The findings of the paper present that oil price shocks result in inflationary pressures while it results in deflationary pressures on industrial production in both countries. Furthermore, Koşaroğlu et al. (2018) research the influence of the variations in oil prices on export in Türkiye using the ARDL method. They find that there is a positive link among the price of oil and the Türkiye's export. For OECD economies, Jimenez-Rodriguez and Sanchez (2005) empirically analyze the impacts of oil price shocks on the economy by employing a multivariate vector autoregression (VAR) analysis, considering both linear and non-linear models. For non-linear model, they adopt three approaches, namely asymmetric, scaled, and net specifications. They find that a surge in the price of oil has a more pronounced impact on GDP growth relative to a decrease in the price of oil, except for Japan. In addition, they explore that increases in oil price negatively influence the UK's GDP growth, but it contributes positively to Norway's GDP growth.

In the literature, various growth theories have been developed to determine the association between the volatility of oil price and the economy. Bergholt et al. (2019) built a medium scale Dynamic Stochastic General Equilibrium (DSGE) model and estimate this model by applying Norwegian and international data. Then, they explore the significance of oil price fluctuations for shaping the business cycle dynamics within the context of Norway. Also, Kose et al (2003) evaluate the influences of oil price variations in amongst countries that rely on oil imports by applying real business cycle theory (RBC). For oil exporting countries, Santos (2016) also uses a standard RBC model to determine the business cycles in an oil-exporting country, namely the Venezuelan economy. He explains that this country is influenced by large, frequent, volatile, and exogenous shocks: oil prices.

Quah and Gali (2007) examine the macroeconomic impacts of the variations in oil prices and explore why the influence of oil price variations in the 2000s differed from the 1970s by addressing how monetary policy can help mitigate the detrimental consequences of oil price fluctuations. In addition, Bernanke et al. (1997) investigate the influence of monetary policy on postwar U.S. business cycles by utilizing the VAR model framework. They explore that identified shocks specifically related to monetary policy constitute a relatively small portion of the fluctuations in output. In addition, Krichene (2006) focuses on analyzing the relationship between monetary policy and the price of oil applying a global oil demand and supply model. Specifically, he assesses how monetary policy influences variation in oil prices and stress the potential risks associated with high oil prices. Lastly, Abubakar et al. (2023) explore the link among oil price dynamics and the government balance in Nigeria applying both Linear and Nonlinear ARDL model to look the response of the government balance to the changes in the price of oil. Their results demonstrate that the government balance exhibits both symmetric and asymmetric patterns. More specifically, they find that in the long term, an upsurge in oil prices boosts the government's fiscal efforts. However, in the short term, if there is a positive oil shock, it temporarily worsens the government's fiscal efforts while a decrease in the price of oil has the opposite effect.

3. Methodology

Quarterly data from 2009 to 2022 is collected for Türkiye. There are four variables used in this paper. The data for employment rate (the population aged 15-64), consumer price index and oil price are collected from Federal Reserve Economic Data. The data on GDP is compiled from the OECD database.

To evaluate the influence of oil price fluctuations on macroeconomic indicators (GDP growth, employment rate and inflation), a structural vector autoregressive (SVAR) model is adopted. This model allows us to study how shocks in one variable propagate through the system and influences other time series variables over time (Hamilton, 1994). In this section, we present the SVAR procedure as follows:

$$\beta_0 x_t = k + \beta_1 x_{t-1} + \beta_2 x_{t-2} \ldots + \beta_p x_{t-p} + \mu_t$$

x_t represents the endogenous variables and the error terms are referred to as white noise. Hence, the structural disturbances are supposed to be uncorrelated serially. Shortly; $E|\mu_t \mu'_t|$=D. D is a diagonal matrix. If we multiply the equation by β_0^{-1} , we obtain the following equation:

$$x_t = \beta_0^{-1} (k + \beta_1 x_{t-1} + \beta_2 x_{t-2} \ldots + \beta_p x_{t-p} + \mu_t)$$

We can write this equation above as follows:

$$x_t = c + \emptyset_1 x_{t-1} + \emptyset_2 x_{t-2} \ldots + \emptyset_p x_{t-p} + \varepsilon_t$$

In this equation above , $\emptyset_s = \beta_0^{-1} \beta_2$, $C = \beta_0^{-1} k$, $\varepsilon_t = \beta_0^{-1} \mu_t$. Hence, the covariance matrix can be expressed as:

$$E|\varepsilon_t \varepsilon'_t| = \beta_0^{-1} E|\mu_t \mu'_t| (\beta_0^{-1})' = \beta_0^{-1} D(\beta_0^{-1}) = \Omega$$

In order to generate the structural shocks, in this study, we apply the Cholesky decomposition technique to the covariance matrix of the reduced VAR residuals and utilized by imposing the constraint proposed by the theoretical framework. The relationship among the error terms is depicted the matrix as well as the structural shocks as follows:

$$\varepsilon_t = \beta_0^{-1} \mu_t$$

$$\begin{pmatrix} \varepsilon_t^{oil} \\ \varepsilon_t^{gdp} \\ \varepsilon_t^{cpi} \\ \varepsilon_t^{emp} \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^{oil} \\ \mu_t^{gdp} \\ \mu_t^{cpi} \\ \mu_t^{emp} \end{pmatrix}$$

μ_t^{oil} is the oil price (supply) shock; μ_t^{gdp} is the output demand shock; μ_t^{cpi} is the inflationary shock and μ_t^{emp} is the employment shock. Based on the theoretical model, there are 16 parameters to be estimated in the matrix above so it satisfies the order requirement condition. Also, there is n(n-1)/2=6 restrictions in the model, where n=4 (number of variables). Under these circumstances, the identified disturbances have a contemporaneous impact on the corresponding variables, meaning that each shock affects its corresponding macroeconomic variables according to the specified ordering.

To test the existence of stationarity or non-stationarity of each variable, we use the Augmented Dickey Fuller (ADF) test. That is, it is necessary to check whether the data is stationary or not after the data is collected. In case we cannot reject the null hypothesis of non-stationarity variables, we need to take the difference of the variables until they become stationary. Then, we check if there exists a co-integration relationship among the time series variables. If there is a long-run equilibrium association between those indicators, it means that these variables are co-integrated. In this paper, we also use the Johansen co-integration method (Johansen, 1995). This methodology offers trace and maximum eigenvalue tests to assess the importance of the co-integration relationships and the reduced dimensions of the matrix.

4. Results

Before we conduct the SVAR model, we carry out the unit root tests on the macroeconomic indicators. Table 1 displays the outcomes of the ADF and PP tests. Both tests are performed on all variables (both in level and first differenced). The null hypothesis stands that the series exhibit non-stationarity at a significance level of 5%. Thus, the null hypothesis is rejected when the *t-stat* is higher than the *t-cal* but accepting the null hypothesis if it is not. In accordance with the results, it is observed that the variables exhibit stationarity after the first difference, except for GDP, which is stationary in its original level form.

Table 2 demonstrates the findings of the co-integration examination. In accordance with the null hypothesis, there is no long-run relation among the macroeconomic indicators. The trace test indicates the existence of one co-integrating equation while the maximum eigenvalue test uncovers the existence of no co-integrating association between the time series indicators based on a significance level of %5.

Table 1. ADF and PP Tests Results

Variables	ADF t-statistic	PP test	Order of integ.
GDP GROWTH	-4.831993	-4.840933	I (0)
EMP	-6.709849	-6.710179	I (1)
CPI	-3.959978	-3.825397	I (1)
OIL	-5.997952	-5.948429	I (1)

Table 2. Johansen Co-integration Test

Trace			
Hypothesized No. of CE(s)	**Eigenvalue**	**Statistics**	**Prob.****
None *	0.402714	48.46181	0.0438
At most 1	0.234640	21.14782	0.3485
At most 2	0.093884	6.975112	0.5805
At most 3	0.032478	1.749927	0.1859
Maximum Eigenvalue			
Hypothesized No. of CE(s)	**Eigenvalue**	**Statistics**	**Prob.****
None *	0.402714	27.31400	0.0541
At most 1	0.234640	14.17271	0.3510
At most 2	0.093884	5.225184	0.7132
At most 3	0.032478	1.749927	0.1859

Source: Author's computation.

The normalized co-integrating result is depicted in Table 3. Based on the reversed sign interpretation of the normalized co-integration method, the analysis reveals that when oil is treated as the dependent variable, oil exhibits a negative but statistically insignificant relationship with GDP, EMP and CPI.

Table 3. Normalized Cointegration Coefficients

OIL	GDP Growth	EMP	CPI
1.000000	92.90585 (19.2170)	45.08732 (45.0859)	5.797132 (15.9447)

Source: Author's computation. Standard errors are in parenthesis.

The variance decomposition results for the variable OIL (Oil prices) are shown in Table 4. During the initial period, the fluctuations in the forecast error shock of OIL explain 100% of the variation in oil price. In period two, the fluctuations in OIL explain about 99.36% of the forecast error shock of OIL while the fluctuations in the variables - GDP (GDP growth rate), EMP (Employment rate), and CPI (Inflation rate) explain about 0.10%, 0.42% and 0.10% respectively. Moreover, in period five, approximately 3.80% fluctuation in employment, 1.54% variation in CPI and 0.11% changes in GDP can be illustrated by the forecast error shock of oil.

In Table 4, we notice that as the period extends, the forecast error shock of OIL begins to explain less and less of itself while other variables begin to explain more of the fluctuations of oil price. For instance, in the tenth period, the forecast error shock of OIL explains approximately 78% of the variations in the price of oil while the forecast error shock of GDP, EMP and CPI explains about 0.49%, 8.19%, and 13.08% of the variation in oil price, respectively.

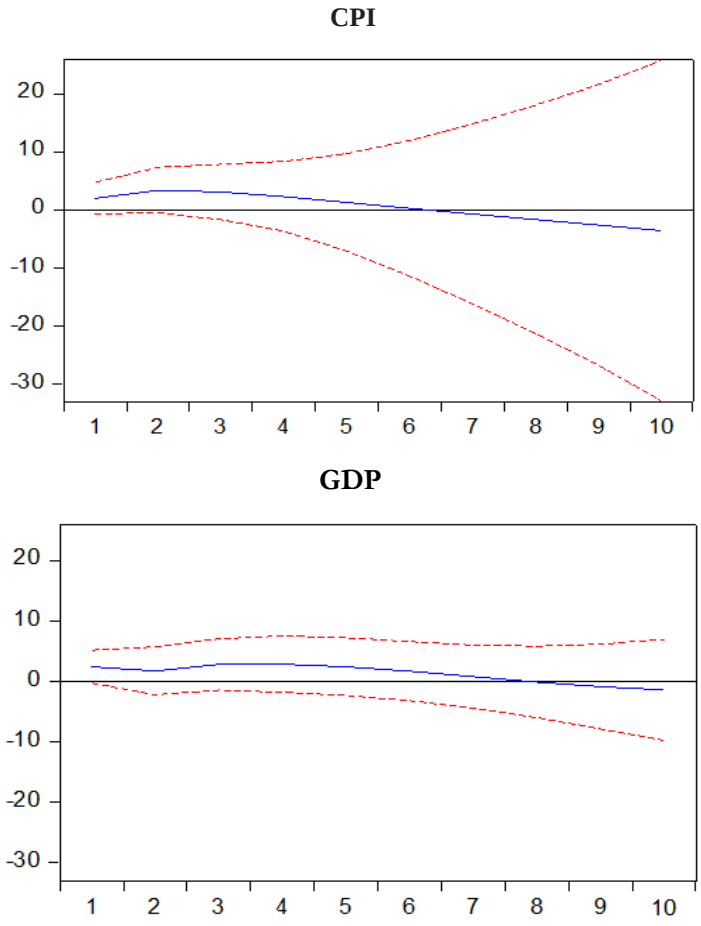
Table 4. Variance Decomposition Analysis of the Oil Price Movements

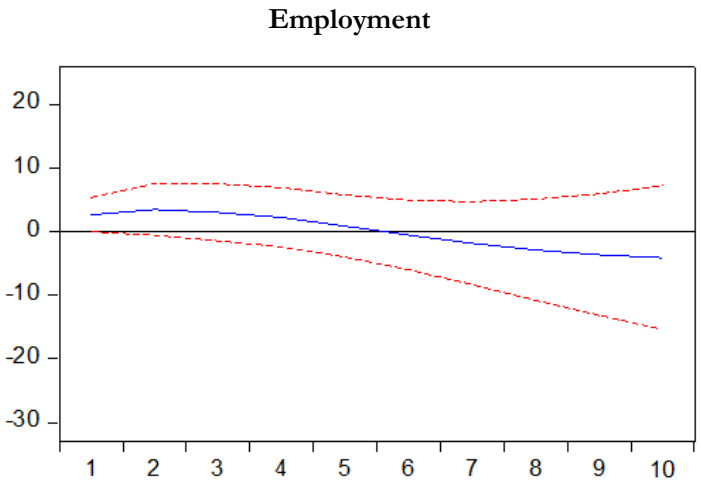
Time	OIL	GDP GROWTH	EMP	CPI
1	100.0000	0.000000	0.000000	0.000000
2	99.36626	0.107077	0.423817	0.102850
3	98.19912	0.134870	1.302058	0.363955
4	96.57823	0.113805	2.483146	0.824815
5	94.53766	0.113125	3.803517	1.545698
6	92.11137	0.164732	5.112826	2.611071
7	89.31593	0.259886	6.288072	4.136115
8	86.12612	0.367461	7.235853	6.270568
9	82.46596	0.452881	7.887656	9.193501
10	78.22377	0.491414	8.195167	13.08965

Source: Author's computation

The outcomes of the impulse response function are illustrated in Figure 2. The result from the impulse decomposition validates that of the variance composition as a positive one standard deviation shock in inflation rate (CPI), GDP growth rate (GDP), and EMP (Employment rate) widens OIL (Oil price). It can be deduced that with each increment in the period, the positive shock on the macroeconomic variables causes the oil price to widen further becoming negative in the 6th for the CPI, the 8th period for the GDP, and the 5th period for the EMP.

Figure 2. The Impulse Response of Oil to CPI, GDP and Employment





5. Conclusion

The variations in the price of oil have a notable effect on macroeconomic indicators. The fluctuations in oil prices usually cause a rise in the general price level as it increases the production costs, which may cause inflationary pressures. High inflation can negatively affect consumer spending and limit economic growth by affecting investment and employment of the country. This motivates many scholars to analyze the link among the price of oil and macroeconomic indicators and makes policy predictions for policy makers. It is also worth highlighting that the impact of oil price changes depends on individual characteristics and policy implemented of each country. Türkiye has a notable dependence on energy resources to fulfill its domestic energy demand. Therefore, it is essential to look at the possible impacts of oil price variations on macroeconomic variables in country basis.

In this research, we employ an SVAR model to demonstrate the impact of oil price variations on macroeconomic performance in Türkiye applying the data from 2009.Q1 to 2022.Q4, with a focused on employment, GDP and inflation. In this study, we first apply the ADF and PP analysis to explore the presence of unit roots indicating the non-stationary time series characteristics of the variables. The outcomes show that the time series variables we used are non-stationary data in level but they exhibited stationary behaviors after utilizing the first difference (except GDP growth). To assess the presence of co-integrating vectors, we apply the Johansen co-integration test. The results from the trace and maximum tests show that there is one co-integrating relationship and is no co-integration association between the macroeconomic indicators, respectively. The result from the long term association indicates that oil has a negative link between GDP, employment and inflation but this relationship is statistically insignificant. Moreover, we explore that the changes in oil price exhibit more variations across time for macroeconomic variables. In addition, the result from the impulse decomposition validates that of the variance composition as a positive one standard deviation shock in inflation rate, GDP growth rate, and employment rate widens oil price. This paper will assist policy makers in gaining a deeper understanding of the potential risks and vulnerabilities associated with fluctuations in oil prices.

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