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Global Crude Oil Prices: A Blessing, a Curse, or a Crisis-Driven Force? A New Analysis for Turkey

Ferhat Oztutus*

Department of Economics, Faculty of Economics and Administrative Sciences, Hakkari University, Turkiye.
*Email: ferhatoztutus@hakkari.edu.tr

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ABSTRACT

This paper examines the relationship between global crude oil price volatility (COP) and industrial production (IP) in Turkey, using monthly data from 1986:02 to 2023:12 and applying the time-varying Granger causality (TV-GC) analysis. The empirical results indicate that the causal relationship is highly dynamic, changing over time rather than remaining constant. Specifically, while the FE window results primarily detects causality at the beginning and end of the sample period, the RO and RE windows outcomes suggest a more sustained cause-and-effect relationship. The findings also highlight the importance of diversifying energy sources and adopting economic strategies to mitigate the impact of oil price volatility on industrial production. Turkish policymakers should focus on enhancing energy efficiency, promoting renewable energy investments, and strengthening industrial resilience to external shocks. A deeper understanding of these dynamics can help design new strategies to stabilize industrial output and support sustainable economic growth in Turkey.

Keywords: Crude Oil Prices, Industrial Production, Time-Varying Causality, Turkey
JEL Classifications: Q43, C32, Q41, Q48

1. INTRODUCTION

Crude oil is fundamental to modern economies, serving as both a primary energy source and a crucial input in industrial production. It influences economic activities through multiple channels. For instance, according to the Cost-Push Inflation Theory, rising oil prices increase energy and raw material costs, reducing profit margins and prompting firms to scale back production (Blanchard and Galí, 2007). As a result, volatility in energy prices contributes to variations in industrial output and broader economic performance. Research by Rasche and Tatom (1981), Hamilton (1982), Gisser and Goodwin (1986), and Santini (1994) identifies a persistent negative correlation between energy prices and aggregate output measures, demonstrating how energy costs shape economic activity. More recent analyses further illustrate that crude oil price volatility affects economic growth, inflation, financial stability, production expenses, transportation costs, supply networks, equity markets, and global energy industries (Apergis and Miller, 2009; Basher et al., 2012; Baffes et al., 2015; Dumitru and William, 2023; Lu et al., 2024; Ikevuje et al., 2024). These findings confirm that oil price movements drive fundamental shifts across multiple sectors, reinforcing their role in shaping economic conditions.

The volatility in crude oil prices, driven by shocks such as geopolitical tensions, supply-demand imbalances, and global economic shifts, creates uncertainty in industrial sectors that rely heavily on energy inputs. What is more, emerging economies that largely rely on imported fuel, such as Turkey, remain particularly vulnerable to these type of shocks, as increased crude oil prices directly or indirectly lead to high production costs, inflationary pressures, and overall economic instability. Therefore, the interconnected nature of global energy markets further complicates economic stability, making the relationship between oil price shifts and industrial production a topic of ongoing concern.

Global energy reports outline considerable fluctuations in crude oil prices over the past two decades, with periods of sharp increases and steep declines (Perry, 2018; FRED, 2024). According to data from the Federal Reserve Bank of St. Louis (FRED, 2024), west Texas intermediate (WTI) crude oil prices rose from $20 per barrel in 2001 to a brief peak of $140 in early 2008. Following this surge, prices dropped to $40 in 2009 before settling at an average of $110 in 2011 as economic activity rebounded. Although prices remained relatively stable for several years, a sharp downturn occurred between January 2015 and January 2016, when Brent crude declined from $112 to roughly $32 per barrel. In 2020, however, the COVID-19 pandemic caused an unprecedented collapse, leading to a moment when oil futures briefly turned negative. These shifts depict the unpredictable nature of oil prices, shaped by various global forces.

The official data from the Turkish Statistical Institute (TUIK) demonstrate that fluctuations in oil prices directly influence energy expenses (Turkish Statistical Institute, 2022). The depreciation of the Turkish lira, exacerbated by external market dynamics, further compounds the impact, making energy imports even more expensive (World Bank, 2018; Aydın, 2024). The crude oil price fluctuations have direct implications for industrial production, as they affect production input costs, investment decisions, and economic expectations (Tütüncü and Kahveci, 2020; Ren et al., 2023; Soliman et al., 2023).

As Turkey's economy has been dependent on external energy sources, any instability in oil prices may induce significant macroeconomic disruptions. Increased fuel costs inevitably lead to increased production expenditures, thereby affecting industrial efficiency and competitiveness. Moreover, the Typkish economy encounters additional challenges due to currency depreciation, exacerbating the cost of imported goods, including crude oil. While policymakers endeavour to mitigate these adverse effects through fiscal and monetary interventions, persistent fluctuations in energy prices create substantive challenges for long-term economic stability. Therefore, a comprehensive understanding of the dynamics of crude oil price volatility and its consequential influence on industrial production is essential for policymakers and economic stakeholders.

Further, a rigorous evaluation of the causal relationship between oil price fluctuations and industrial production is imperative for formulating effective regulatory frameworks aimed at mitigating economic instability and safeguarding the broader population's welfare. Extant literature has extensively examined the implications of oil price variabilities on macroeconomic aggregates such as inflation and GDP growth; however, there remains a salient need for further empirical inquiry into the intricacies of industrial production dynamics (Berument and Taşçı, 2002; Aktaş et al., 2010; Koçaslan and Yılancı, 2011; Gökçe, 2013; Gokmenoglu et al., 2015; Karadağ, 2021; Köse and Ünal, 2021; Akkoç et al., 2021; Khoj and Saeed, 2024). Notwithstanding these contributions, the empirical examination of the direct effects of crude oil price volatility on industrial production within Turkey remains relatively constrained.

Nevertheless, a limited body of research has employed diverse econometric methodologies to analyse the interdependence between crude oil price changes and industrial production in Turkey (Alper and Torul, 2009; Aktaş et al., 2010; Özdemir and Akgül, 2015; Gokmenoglu et al., 2015; Eyüboğlu and Eyüboğlu, 2016; Akkoç et al., 2021; Karadağ, 2021; Polat Çifçi and Yılmaz, 2024). The industrial sector, encompassing manufacturing, energy production, and transportation, is particularly susceptible to oil price volatility due to its increased dependence on energy-intensive processes (Sözen et al., 2014; Erdemir, 2022; Hale, 2022; Dumrul et al., 2024).

A variety of factors contribute to Turkey's industrial production, including electricity consumption, export, investment, capital intensity, high wages, and interest rates (Falcıoğlu, 2011; Öztürk and Agan, 2017; Pekçağlayan, 2021; Yildiz Töre and Elitaş, 2022). Existing literature suggests that crude oil price volatility can influence industrial production through multiple channels. Higher oil prices generally lead to increased production costs, reduced profit margins, and lower output in energy-intensive industries. Conversely, oil price declines can boost production by lowering operational expenses, though excessive volatility may also deter long-term investment due to uncertainty. However, the extent and direction of these effects vary across different economic environments and industrial structures.

Despite extensive discussions on the stability of industrial production in Turkey, the specific impact of crude oil volatility remains insufficiently addressed. This paper aims to fill this research gap. The key contributions of this paper are threefold. First, unlike previous research that primarily focuses on broad macroeconomic indicators, this paper provides a focused analysis on Turkey's industrial sector, contributing new insights to the literature. Second, unlike previous studies that primarily rely on co-integration tests, Vector Autoregression (VAR) models, and standard causality tests, this paper adopts an advanced econometric method, the time-varying Granger causality analysis, to better capture structural breaks and nonlinearities in the data. Third, it offers policy recommendations for mitigating the adverse effects of crude oil price shocks and enhancing industrial resilience.

The rest of this paper is organized as follows. Section 2 reviews the literature on the effects of oil price volatility on industrial production. Section 3 describes the data and methodological framework applied in the analysis. Section 4 reports the empirical findings. Lastly, Section 5 provides discussions, policy recommendations, and directions for future research.

2. LITERATURE REVIEW

A number of empirical studies have estimated the relationship between crude oil prices and industrial production in Turkey. Some of these studies are as follows:

Alper and Torul (2009) investigate the asymmetric relationship between oil price changes and the manufacturing sector output in Turkey using monthly data from 1991 to 2007. The paper employs a multivariate vector Autoregression (VAR) model incorporating global liquidity conditions, domestic financial conditions, and real exchange rate dynamics. To capture asymmetries in oil price shocks, the paper applies the methodologies adopted by Mork (1989), Lee et al. (1995), and Hamilton's (1996). The paper concludes that overall manufacturing output is not consistently hindered by oil price shocks; however, specific sub-sectors are affected, indicating that sector-specific energy policies are necessary.

Kocaslan and Yılancı (2010) examine the relationship between real GDP and oil consumption in Turkey, using annual data from 1970 to 2007. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are performed, followed by the Johansen co-integration test, which establishes a prolonged link between oil consumption and economic expansion. Additionally, the vector error correction model (VECM) is applied to assess short-term fluctuations. Over time, rising oil consumption hampers economic progress, while no substantial short-term link is detected. Their findings suggest that Turkey's dependence on imported oil weakens economic stability, contributing to trade deficits and fiscal pressures.

Aktaş et al. (2010) investigate the impact of oil price fluctuations on Turkey's macroeconomic indicators using quarterly data from 1991:Q1 to 2008:Q2. The paper employs the Augmented Dickey-Fuller (ADF) unit root test to confirm the integration orders of the variables, the Vector Autoregression (VAR) model to examine the relationships between gross national product (GDP), inflation, unemployment, the ratio of exports to imports, and crude oil prices. The impulse response analysis reveals that oil price shocks have a statistically significant positive impact on inflation but a negative effect on the ratio of exports to imports and unemployment, implying that higher oil prices increase production costs, worsen trade balance, and reduce job availability. However, the results indicate that oil price fluctuations do not significantly impact Turkey's GDP, suggesting that energy price shocks are partially absorbed by market mechanisms and economic policies. The variance decomposition analysis further supports these findings, showing that oil price volatility explains a modest share of the variation in macroeconomic variables, stabilizing after four to five quarters. It is concluded that Turkey's dependence on oil imports primarily affects inflation and trade balance rather than overall economic growth.

Gökçe (2013) investigates the dynamic effects of oil price volatility on Turkey's economic growth using quarterly data from 1987:Q1 to 2011:Q4. The paper employs the exponential GARCH (EGARCH) model to estimate oil price volatility and the structural vector autoregression (SVAR) model to analyse its impact on economic growth. The empirical results reveal that a structural shock in crude oil price volatility reduces quarterly economic growth by 0.0164 percentage points, a statistically significant finding. The impulse response analysis confirms that oil price volatility shocks have a persistent negative effect on real GDP growth, with the impact dissipating after two quarters. The variance decomposition analysis further shows that oil price volatility explains approximately 39.37% of the variation in Turkey's GDP growth, underscoring its importance as a macroeconomic determinant. As a result, it suggests that Turkey's high dependency on oil imports makes its economy vulnerable to volatility-induced slowdowns, highlighting the need for hedging strategies and energy diversification policies.

Gokmenoglu et al. (2015) examine how oil prices, industrial production, GDP, and inflation interact in Turkey from 1961 to 2012 using annual data. The paper applies the Phillips-Perron (PP) unit root test, followed by the Johansen co-integration test and the Granger causality test. The findings of the authors confirm a sustained long-term association among oil prices, GDP, inflation, and industrial production, implying that fluctuations in oil prices leave a lasting effect on Turkey's macroeconomic conditions. The Granger causality test results demonstrate a one-way causal link from oil prices to industrial production, suggesting that changes in oil prices substantially shape Turkey's industrial output. Moreover, the analysis concludes that as a net oil-importing country, Turkey remains highly susceptible to oil price shifts, requiring risk mitigation strategies and energy diversification policies to maintain industrial stability.

Özdemir and Akgül (2015) analyse how fluctuations in crude oil and gasoline prices shape industrial production in Turkey, using monthly data from October 2005 to February 2014. The research applies the Markov-Switching Vector Autoregressive (MS-VAR) model. The Likelihood ratio (LR) test identifies two distinct regimes, suggesting that the impact of oil and gasoline price changes on industrial production varies based on economic conditions. The research concludes that while oil and gasoline price fluctuations do not consistently hinder industrial production, their inflationary effects may create challenges for monetary policy within an inflation-targeting framework.

Eyüboğlu and Eyüboğlu (2016) explore the association between natural gas and oil prices and BIST industrial sector indexes in Turkey by analysing monthly data from October 2005 to September 2015. To assess long-term dependencies, the Johansen co-integration test is employed, while the vector error correction model (VECM) is applied to examine short-term fluctuations. Findings confirm that natural gas and oil prices maintain a persistent linkage with industrial sector indexes, suggesting that shifts in energy prices considerably affect Turkey's industrial sector. Additionally, the VECM framework identifies those short-term causal dependencies exist between oil prices, and the BIST Industrial Index and other related indexes. However, no short-term relationship is observed between natural gas prices and the sector indexes. The Granger causality test further validates the unidirectional impact of oil prices on industrial indexes, implying that oil price movements influence stock market performance in Turkey's industrial sector.

Akkoç et al. (2021) analyse how oil price shocks influence the Turkish economy between 2005:01 and 2018:04 through the factor-augmented vector autoregression (FAVAR) approach. This research incorporates an extensive dataset consisting of 134 macroeconomic variables. The impulse response analysis presents three primary insights: (1) fluctuations in oil prices have minimal impact on industrial production growth or its subsectors, (2) positive oil price shocks contribute to statistically measurable and sustained increases in various price indices, with the most pronounced effects detected in the transportation and food and beverage sectors, and (3) monetary policy remains largely unresponsive to oil price shocks, suggesting that interest rates are not actively adjusted, allowing price levels to stabilize through market mechanisms. The empirical findings suggest that Turkey's heavy reliance on oil imports intensifies inflationary pressures, while the industrial sector demonstrates resilience to variations in oil prices.

Karadağ (2021) examines the influence of fluctuations in Brent crude oil prices on the industrial production index and the consumer price index (CPI) in Turkey, using quarterly data from 2010Q1 to 2020Q4. The research applies the Phillips-Ouliaris cointegration test to analyse long-term relationships, while the Granger causality test and the Hatemi (2012) bootstrap causality test assess the directional effects among these variables. According to the Phillips-Ouliaris test, higher oil prices lead to an increase in CPI, primarily through rising industrial production costs. The Granger causality test shows a one-way relationship from oil prices to both CPI and industrial production, suggesting that shifts in oil prices drive inflation and production costs. These findings are further supported by the Hatemi (2012) bootstrap causality test, which confirms that rising oil prices disrupt price stability and heighten production expenses in Turkey.

Polat Çifçi and Yılmaz (2024) researched about how fluctuations in the exchange rate and oil prices shape the BIST Industrial Index in Turkey, using monthly data from January 2003 to June 2023. The research first applies unit root tests (ADF, PP, and KPSS) to examine data properties before employing the autoregressive distributed lag (ARDL) bounds test to explore both short- and long-term effects. The findings suggest that a 1% rise in the exchange rate contributes to a 1.52% increase in the BIST Industrial Index, while a 1% rise in oil prices leads to a 0.54% gain, both statistically valid at the 1% level. It is concluded that currency depreciation and rising oil prices strengthen industrial sector stock valuations in Turkey.

3. DATA AND METHODOLOGY

The empirical analysis examines economic data from Turkey spanning February 1986 to December 2023, focusing on industrial production and crude oil price volatility, as shown in Table 1. The IP variable represents the industrial production index, capturing changes in economic output, while the COP variable measures crude oil price volatility. To quantify this volatility, the EGARCH-M (Exponential Generalized Autoregressive Conditional Heteroskedasticity-in-Mean) model is applied, which accounts for asymmetric fluctuations and incorporates conditional variance into mean return dynamics. Both datasets consist of monthly observations, ensuring a high-frequency perspective on economic variability over the sample period.

In the literature, the correlation between industrial production and global crude oil price have been examined by co-integration tests, Vector Autoregression (VAR) models, and traditional causality tests. However, in this paper, time-varying causality test has been applied, unlike traditional tests.

Traditional unit root tests such as ADF (augmented dickey-fuller) and PP (Phillips-Perron) tests are used to determine whether the variables exhibit stationarity. Economic downturns, natural catastrophes, or transformative policy measures can disrupt the stability of a time series, altering its average level, trajectory, or both (Perron, 1989). To address structural breaks, the methodology incorporates unit root tests proposed by Zivot and Andrews (1992), which accommodate structural shifts (ZA). Accordingly, the process begins with a statistical summary of the data, followed by the application of ADF, PP, and ZA unit root tests. After assessing stationarity, a time-dependent causality framework is implemented to capture evolving relationship.

Given the challenge and necessity of accounting for structural shifts in the accuracy of econometric estimations (Granger, 1996), few methodologies have been devised to generate Wald test statistics for individual observations.

The recognition that causal associations among variables may change over time has prompted a methodological transition from static to dynamic analyses. Within this framework, various Granger causality techniques have been applied to examine temporal variations in causality. Notably, the Forward Expanding Window (FE) test, first introduced by Thoma (1994), relies on proportionally structured forward-growing sub-samples while maintaining a fixed starting point. Meanwhile, the Rolling Window (RO) test, initially formulated by Swanson (1998) and later refined by Balcılar et al. (2010), considers structural modifications that may emerge over time. This approach constructs a sequence of Wald test statistics by systematically advancing a fixed window length across observations. Arora and Shi (2016) further applied the RO technique to examine time-dependent Granger causality. Expanding upon these methodologies, Shi et al. (2018) proposed the Recursive Rolling Window (RE) method, which integrates forward-expanding and sliding window techniques. Within this structure, test regressions are performed on progressively extended backward sub-samples, with the most recent data point determining the computed test statistic. Wald test statistics are estimated across almost the entire dataset, except for the smallest window-sized sub-samples, facilitating an extensive assessment of shifting causal relationships. This approach allows the initial observation to include the maximum number of windows, ensuring full dataset coverage while generating a structured sequence of Wald test statistics. Building upon this structure, Shi et al. (2020) applied the RE method, originally conceptualized by Phillips et al. (2015a; 2015b), to detect financial bubbles by examining monetary expansion and income fluctuations within a lag-adjusted VAR model. Scholars have found that both RO and RE methods provide reliable assessments of time-dependent Granger causality, whereas the FE test is considered comparatively less effective.

For an extensive discussion on time-sensitive causality tests, particularly the time-dependent Granger causality (TV-GC) framework, readers may consult the research of Shi et al. (2018), along with Baum et al. (2022).

4. EMPIRICAL RESULTS

4.1. Descriptive Statistics

The descriptive statistics in Table 2 disclose that IP series maintains a relatively steady distribution, whereas COP fluctuates considerably, demonstrating pronounced asymmetry and extreme sharpness in its probability density. Such characteristics of COP series imply that external shocks may introduce considerable uncertainty to oil price fluctuations.

4.2. Unit Root Test Results

Determining the integration order of a series is fundamental in econometric analysis, as it influences the appropriate modelling approach. Accordingly, the results of the ADF, PP, and ZA tests are summarized in Table 3. The findings indicate that the IP variable achieves stationarity after first differencing, whereas COP remains stationary at level in both the intercept model and the intercept with time trend specifications at the 5% significance level. Since the VAR model under consideration includes an I(1) variable, time-dependent causality is derived from an LA-VAR model where d = 1.

4.3. Time-Varying Granger Causality Test Results

To assess the direction, magnitude, and duration of causality between COP and IP, the next stage of estimation applies Wald test statistics. A bivariate VAR model with an optimal lag length of 2 is adopted to examine this causal link. The Granger causality results derived from FE, RO, and RE align with the full sample findings (Table 4), reinforcing the validity of the causality analysis. In all cases, the computed statistic surpasses the 95th and 99th percentiles of the empirical distribution of the bootstrap test statistics, leading to a strong rejection of the null hypothesis at the 5% and 1% significance levels. These findings substantiate the existence of Granger causality from COP to IP, confirming that fluctuations in COP shape IP over time.

In the second-stage, TVC test results are displayed in Figure 1, where the solid line depicts the maximum Wald test statistics, demonstrating how causal effects vary over time. Meanwhile, the dotted and dashed lines correspond to the resistant critical values, obtained via the bootstrap method, at the 5% and 10% significance levels, respectively. For a causal relationship to hold statistical significance, the solid line must surpass the dotted line (5% level) or the dashed line (10% level). If it remains beneath both thresholds, then causality is absent at these levels for the examined period. Beyond determining whether causality exists, the findings also pinpoint the beginning and ending points of this relationship. Additionally, the results display how the intensity of causality fluctuates over different time-intervals, offering insight into its causal progression across time.

According to Figure 1, the causal relationship between IP and COP displays considerable variation over time. In general, all the plots suggest that Granger-causal relationships between the variables are highly time-varying and dynamic. Additionally, the outcomes depend on the specific recursive algorithm applied to compute the test statistics. While the RO and RE algorithms effectively detect the causal mechanism, the FE window partially identifies it, particularly at the beginning and end of the sample. Furthermore, the causality from COP to IP generally aligns with periods of major global and regional economic and political crises. Lastly, the plots suggest that industrial production becomes more sensitive to fluctuations in crude oil prices when economic and geopolitical uncertainty intensifies.

The FE estimate demonstrates variations in the causal impact, indicating that crude oil price volatility did not consistently influence industrial production. The periods of stronger causality align with major economic crises, such as the 1990-1991 Gulf War, The COVID-19 pandemic from 2019 to 2022, and the Oil Price War (2020-2022). These crises were marked by heightened

Table 1: Data

Variables	Abbreviations	Source
Industrial production index	IP	TUIK
Crude oil prices: West texas intermediate (WTI)	COP	FRED

Table 2: Descriptive statistics

Statistic	IP	COP
Mean	48.944	86.065
Median	41.906	60.750
Maximum	109.218	1595.747
Minimum	16.480	31.265
Std. Dev.	26.134	109.834
Skewness	0.742	8.901
Kurtosis	2.339	105.404
Jarque-Bera	50.067	20481
Probability	0.000	0.00
Sum	22269.790	39160.00
Sum Sq. Dev.	310097.70	547684.00
Observations	455	455

SD: Standard deviation

Table 3: Unit root tests results

Variables	ADF		PP		ZA		Decision
	Intercept	Intercept and time trend	Intercept	Intercept and time trend	Intercept	Intercept and time trend	
IP	1.062 (0.997)	−1.534 (0.816)	1.908 (0.999)	−1.912 (0.646)	−2.275 (1994M02)	−3.705 (2000M12)	I (1)
ΔIP	−15.960* (0.000)	−16.068* (0.000)	−28.796* (0.000)	−34.466* (0.000)	−12.986* (2009M05)	−12.973* (2009M05)	
COP	−11.371* (0.000)	−11.503* (0.000)	−8.937* (0.000)	−8.841* (0.000)	−11.622* (2014M11)	−11.682* (2018M04)	I (0)
ΔCOP	−15.028* (0.000)	−15.014* (0.000)	−35.548* (0.000)	−36.127* (0.000)	−10.803* (2009M02)	−10.779* (2009M02)	

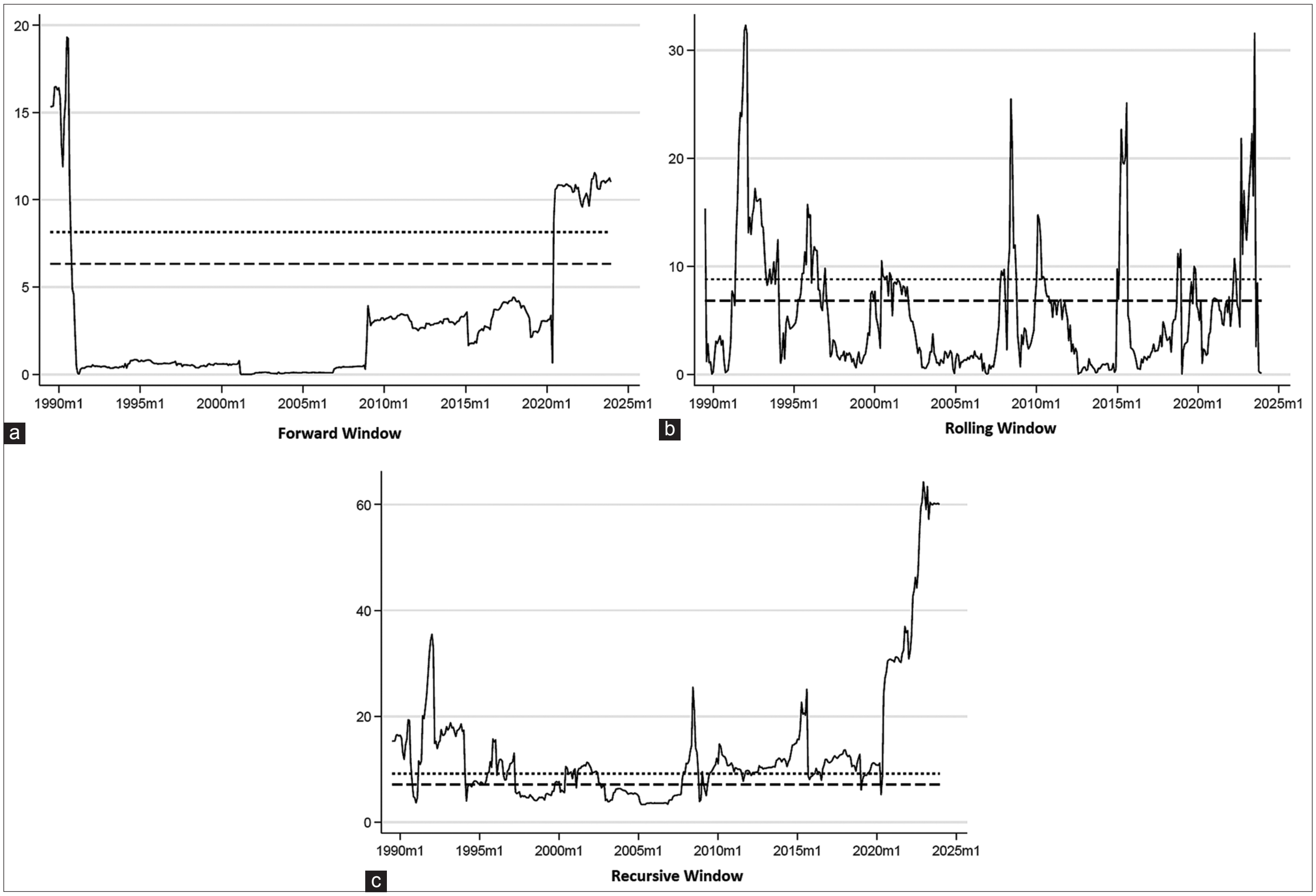
*, **, *** denote significance levels at the 1%, 5%, 10% levels, respectively. The values in the brackets are probability values. Lag Length based on AIC

Table 4: Wald tests for time-varying granger causality

Country	Null-hypothesis	Lags	TVGC test statistics		Bootstrap critical values			Result
					0.90	0.95	0.99	
Turkey	COP↛IP	2	Max Wald FE:	19.321*	6.329	8.143	13.737	Granger Causality
			Max Wald RO:	32.307*	6.809	8.809	14.036	
			Max Wald RE:	64.273*	7.117	9.191	14.861	

The underlying model is a bi-variate VAR (2) model estimated with a trend. The minimum window size is set at 42 observations, calculated using the formula developed by Caspi (2017). The 90th, 95th, and 99th percentiles show the empirical distribution of the bootstrap test statistics, respectively. The Wald test statistics are based on 1,000 replications, and robust to heteroskedasticity. The symbol (*) denotes significance at the 1% level

Figure 1: (a) time-varying Granger causality (TV-GC) tests between IP and crude oil price (COP) (Forward Expanded Window ≈ FE). (b) TV-GC tests between IP and COP (Rolling Window ≈ RO). (c) TV-GC tests between IP and COP (Recursive Window ≈ RE)



The underlying bi-variate VAR(2) model is estimated with a trend. The 10% and 5% bootstrapped critical values, represented by horizontal dashed and dotted lines respectively, are derived from 1,000 replications and are adjusted to account for heteroskedasticity

uncertainty, during which fluctuations in oil prices likely aggravated industrial production in Turkey by raising production costs and disrupting input availability (Figure 1a).

The RO estimate reveals that the causal link between COP and IP is not static but changes over time, indicating the periods of significant causality interspersed with phases of negligible or no causality. The result also suggests that causality is influenced by increasing national or global political instabilities and economic crises, such as during or in the aftermath of the Gulf War (1990-1991), the Turkish economic crisis (1994-1995), the Asian and Russian financial crises (1997-1998), the Turkish financial and banking crisis (2000-2001), the 9/11 event and the Iraq War (2001), the global financial crisis (2007-2008), the Arab uprising (2010-2011), the global oil price shock (2014-2016), the Russia-Crimea conflict (2014), the USA-China trade disputes (2018), the Turkish currency crisis (2018-2019), the COVID-19 pandemic, and the oil price war (2020-2022), among others. It can be inferred from the plot that external shocks play a crucial role in shaping the dynamic interaction between oil prices and industrial production in Turkey (Figure 1b).

The RE estimate signals a persistent and, at certain junctures, intensifying causality, particularly in the wake of economic disruptions. The pronounced spikes in causality observed in the late 1990s and after 2008-2009 indicate that industrial production became increasingly sensitive to oil price movements during periods of economic and geopolitical turbulence. There is strong evidence of TVC from COP to IP, emerging in early 2020 and persisting thereafter. This could be attributed to Turkey's evolving economic structure, including a shift towards more energy-intensive manufacturing and a rising dependence on imported raw materials (Figure 1c).

5. CONCLUSION AND POLICY IMPLICATIONS

The empirical results obtained via the TV-GC analysis show that the relationship between crude oil price volatility (COP) and industrial production (IP) in Turkey is dynamic and fluctuates over time, strongly influenced by external economic and geopolitical shocks. Different time-varying estimation results of the methods (FE, RO, and RE windows) suggest that causality is not constant, with a pronounced effect during periods of global and regional crises, such as the Gulf War (1990-1991), the 2008 financial downturn, the COVID-19 pandemic, and the oil price conflict (2020-2022). The FE window results identifies stronger causality at both the beginning and the end of the sample period. However, the outcomes for RO and RE windows outcomes show a more consistent relationship, implying that industrial production responds notably to oil price fluctuations during economic disturbances. This outcome is consistent with previous findings that oil-importing economies are particularly vulnerable to energy price volatility, especially when uncertainty increases. The persistence of causality observed in the RE window finding suggests a structural shift in Turkey's industrial sector, potentially driven by increasing energy reliance and evolving production trends.

While these results align with much of the existing literature on the impact of oil price volatility on economic performance, some unusual trends are evident. Unlike other studies that suggest a persistent relationship between COP and IP, this analysis uncovers periods with weak or even no causality, suggesting that factors such as domestic policies, technological advancements, and alternative energy sources may have lessened the impact of oil price fluctuations during specific times. Furthermore, the intensification of causality after some specific years points to Turkey's growing dependence on imported energy and a more energy-intensive industrial sector. These insights indicate the necessity of considering the specific economic structure of each country when evaluating the effects of oil price volatility. A strength of the analysis lies in its use of various time-varying causality detection methods, providing a more thorough understanding of the changing relationship between COP and IP. A limitation, however, is the potential sensitivity of recursive estimation techniques to outliers or structural breaks, which may affect the reliability of the results.

From a policy perspective, these findings stress the importance of diversifying Turkey's energy sources to reduce reliance on unstable oil markets. Any measures to promote renewable energy adoption, improve energy efficiency in industrial sectors, and build strategic oil reserves could cushion the negative effects of oil price volatility. Additionally, stabilizing macroeconomic conditions and applying counter-cyclical fiscal policies during periods of crisis could protect the economy from external disruptions. Future research could explore the effects of alternative energy sources on industrial output, sector-specific responses to globa oil price volatility, and the influence of fiscal and monetary policies on mitigating these impacts. In conclusion, this paper demonstrates that highly volatile global crude oil prices function more as a crisis-driven factor in Turkey. In other words, industrial production in Turkey is more sensitive to the fluctuations in global crude oil prices during times of economic crisis and geopolitical instability, underscoring the need for resilient energy and economic policies.

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