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A Study on Macroeconomic Shocks and the Crude-Oil Price Dynamics

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Abstract

In the pretext of international business, trade and economic analysis, certain commodities hold a position of exceptional prominence due to their value, utility and global demand. Among these, crude- oil is very important because of its economic significance. Crude- oil is known as Black gold. This particular commodity occupies a central place in international economic discussion and financial systems. Shaping national policies, investors psychology and market sentiment across the world. Its importance is reflected in the vast volume of research, media attention and policy debates surrounding it. This research focuses on crude-oil because of its continued relevance in shaping both macro-economic and micro-economic conditions. The study also highlights the distinctive role of crude-oil in international financial markets. The methodology adopted in this research emphasises simplicity and clarity, focusing on observable patterns and statistical analysis without overcomplicating the interpretive framework. This ensures that the results are accessible and interpretable by a wide range of audiences, including economists, finance professionals and students.

***Keywords**: Geopolitical, Crude Oil, Investment, Commodities, Macroeconomic Factors, Global Events.*

Introduction

Commodity Crude oil is a fundamental driver of the international economy, which has a high impact on international production, logistics and transportation and energy security. It is more than merely an industrial input; it is a key indicator of macroeconomic health and geopolitical health and stability. High oil prices often correlate with periods of strong industrial activity, whereas sharp declines can indicate oversupply or weakening economic growth. The demand for crude-oil at the global level oil is influenced by factors like industrial development, urbanisation and increase in population, which makes it an essential commodity for investors and policymakers and influencers. The supply factors are important indicators in the pricing of crude-oil. On the demand factors, crude oil consumption reflects the broader global economic scenario. Industrial output, transportation needs and seasonal energy requirements drive short-term consumption, which reflects broader economic conditions. Industrial output, transportation needs and seasonal energy requirements drive short-term consumption trends. Economic slowdown or policy induced energy transitions can reduce demand, putting downward pressure on prices. Emerging trends such as the global push towards sustainable and renewable energy, demand for EVs, and energy conservation measures are gradually reshaping demand structures.

The growing participation of investors/finance influencers has intertwined crude oil market and the international equity, currency and bond markets, reflecting how financial speculation and physical supply-demand dynamics jointly determine pricing. The Russia- Ukraine conflict highlighted the sensitivity of crude oil to geographical events. Sanctions on Russian oil exports constrained supply, causing significant price spikes and increased global volatility.

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India's domestic crude oil market is heavily dependent on global price trends due to high import dependency. Volatility in international crude-oil price, directly affects domestic fuel pricing, trade balance and global inflation. The Indian government and the refiners respond through pricing mechanisms, subsidies and strategic reserves management to mitigate economic shocks. Current trends show India diversifying its crude sourcing to reduce dependence on any single region and investing in refining capacities to manage supply efficiency.

Influence of Global Events on Crude Oil Prices

Global events like geopolitical conflicts have historically exerted an immense effect on commodity markets. Commodities such as crude oil respond od not only to supply-demand fundamentals but also to investor sentiment, global economic conditions and macroeconomic policy decisions. Among the most impactful events in recent history is the Russia-Ukraine War.

- **Impact of the Russia and Ukraine War on Crude Oil Prices**

Crude oil, often termed black gold, is primarily an industrial commodity whose price depends majorly on the supply-demand dynamics and geopolitical risk. The Russia-Ukraine war, which escalated in early 2022, serves as a testimony of how the geopolitical tensions can drastically affect crude oil markets. Russia is one of the largest oil producers globally, and any disturbance or hindrance to its supply chains will have immediate effect over the global energy prices.

The start of the conflict the global sanctions on Russian exports created significant supply limitations in the fuel supply markets. Crude oil prices surged above $120 per barrel in mid 2022, reflecting both physical supply shortages and heightened risk premiums. The conflict introduced elevated volatility to energy markets, affecting not only spot prices but also futures and derivative markets worldwide. Crude oil prices respond rapidly to the tangible disruptions and innovations in the field of production, international means of transportat and geopolitical risk perception.

The Russia-Ukraine conflict underscored the relationship, between energy supply market, and the macro-economic stability. Rising crude oil prices increased input costs for industries, elevated transportation expenses, and contributed to international inflationary pressures.

Impact of Macroeconomic Variables on Crude Oil Price

The behaviour of crude oil price is not solely determined by demand and supply fundamentals or immediate global shocks; it is also significantly influenced by key macroeconomic variables. Among the most critical factors is the Federal Reserve's interest rate decisions. This factor plays a unique part in influencing investor expectations, pricing mechanisms and the dynamics of the international commodity market.

Federal reserve rate is one among the macro-economic factors that regulates the liquidity and controls inflation, in the US economy. Changes in this rate has a direct and immediate impact on the international commodity prices in general. Federal Reserve rate also has an impact on the price of crude-oil. The change in the interest rate also affect economic growth. It has an impact, on the spending habit and other industrial activities that will determine the requirement of energy. When the price increases the cost of borrowing also increases, consumption decreases, and industrial output may decrease, thus decreasing the demand for oil and potentially leading to price declines. If the interest rate is low it will stimulate the economic activities, increase energy consumption, and will create a price-increasing trend on oil prices. In this way, the Federal Reserve policy plays a major role a macroeconomic factor of crude oil movements.

Literature Review

- Huseynli, N. (2023) in *"Analysing the Relationship between Oil Prices and Gold Prices before and after COVID-19"* examined the, cause and effect correlation between oil and gold price using daily-data of the period January- 2011 to June-2022. Applying A D F unit- root tests, Johansens co-integration, and Granger causality, the study found, that most variables were stationary at first difference. The results disclosed a one-way causal relationship from gold prices to oil prices, in the pre-pandemic period, while no significant long-term relationship was observed post-pandemic.
- Dhanabhakyam, M. (2018) in their research titled *"A Study on Impact of Crude Oil Price in the Price of Gold"* studied the relation, between prices of crude-oil and gold by using monthly-data from 2013- 2017. Regression analysis was applied to find out the effect of oil-price fluctuations, on gold prices. The study investigated that the changes in crude-oil prices majorly influence gold price movements, reflecting the, close link between, energy and precious metal markets.

- Rastogi, S.,et.al. (2023) in *"Volatility Integration of Crude Oil, Gold, and Interest Rates on the Exchange Rate: DCC-GARCH and BEKK-GARCH Applications"* analysed the volatility linkages of gold price, crude oil price and interest rates with the USD/INR exchange-rate using**,** daily-data from 2000 to 2022. Applying BEKK-GARCH and DCC-GARCH models, the study found significant conditional volatility associations, confirming market connectivity. While price co-movements were limited, volatility integration showed stronger and long-term effects. The findings suggest that these markets, though interconnected through volatility spillovers, can be treated separately for exchange rate risk management.
- Alquist, R., et.al.(2011) in "*The Role of Financial Speculation in Driving the Price of Crude Oil The Role of Financial Speculation in Driving the Price of Crude Oil*." have written that since 10 years, few firms in the financial sector have increased their procession in the oil-futures market. At the same time, oil price also has increased tremendously. But there are its own doubts to accept the fact. Even though the stock of open futures contracts is much larger than the oil consumption in the US, it is not logical to compare the statistics of these two data sets. The primary data analysed showed that changes in financial firms' positions do not predict the oil-price changes, but on the other hand the oil-price changes predict the changes in position. Finally there are evidences to show that the position of the financial firms did not cause the market to expect persistent price increases during 2007/08. Other explanations for the increase in oil prices include macroeconomic fundamentals, such as interest rates and increased demand from emerging Asia.
- Khan, K., et.al. (2021) in their article "*Do crude oil price bubbles occur",* opined that, the Generalised Supremum Augmented Dickey-Fuller test (GSADF), is used to test the reaction of crude oil price, that is if it will have multiple bubbles or if the oil price is extremely significant because of its strategic position, and several other factors. The results show that there are bubbles which means that the oil price, deviates three times. This indicates that the starting and ending of few bubbles are due to some event or crisis. The broadening of the world economy, the demand and supply imbalance, depreciation of the dollar, oversupply by the OPEC, shale-oil production of the U.S., and decrease in demand for oil by the developing countries are the reasons for the OP bubbles.
- Jang, P. Y., et.al. (2020). have investigated in "*Time-Varying Influences of Oil-Producing Countries on Global Oil Price*" that there are major time-varying influencers on major crude rigging countries on Brent oil prices. They have studied the the seven-panel data from 1998 to 2018. This study is informative and useful for understanding better the impact of oil price among various oil-producing countries. The study provides evidence for the argument that production by OPEC is a negative influencer on the crude oil price during the periods (2001–2003) and (2016–2018) only, but the the OPECs dominating role was taken over the Dollar Index of the US during other periods. This happened later in Iran, US and China.
- Bâra, A., et al. (2024). In their paper titled "*Exploring the Dynamics of Brent Crude Oil, S&P500 and Bitcoin Prices Amid Economic Instability*,". The authors have observed three variables which relevant influencer of price volatility of Brent crude oil, S&P500 index and the price of Bitcoin. The fluctuation of the price of all the three variables hs an impact on environmental factors, transportational and mobility factors and socio economic factors. This research has reviewed the GARCH model and its ability to forecast and then identified the suitable model for estimating the Value at Risk (VaR) for the price of Brent crude oil. Additionally, understanding the risks connected with oil prices supports effective long-term strategic planning.
- Berument, H.,et. Al. (2002) in the paper titled "*Inflationary effect of crude oil prices in Turkey*.", have agreed upon the fact that the changes in oil-prices affect economic-welfare of a nation. But this effect is not completely reflected in the price or transactions of the oil-market. The authors, in the research-paper have used the inflationary-effect of the prices of the crude-oil by using the data set of 1900. The effect of factors like fixed-wages, profits and interests on inflation is very marginal. The effect of inflation on price of crude oil becomes significant when factors like wages and income are adjusted to the general price level. Therefore, the authors conclude that the indexing effort may cause severe implication of changes in oil price on the economy. This has a fear of causing hyper inflation also.

- Santis, D., et al. (2000). In their paper titled "*Crude Oil Price Fluctuations and Saudi Arabian Behaviour*", they aim to research the important causes for the changes in crude oil prices. They argue that the main factor causing these fluctuations is the quota system, which is part of OPEC agreements. Since Saudi Arabia's oil supply is not easily adjustable in the short run, any sudden change in the crude oil market leads to an immediate correction in prices. However, in the long term, when a dominant firm like Saudi Arabia behaves, it responds by changing its output, which results in a minor change in price. This helps explains the reason for oil price changes or increases above their normal levels. The findings that support this is found in a general-equilibrium model applied to Saudi Arabia. The study even reveals that Saudi-Arabia doesn't have a strong reason to alter the balance of the crude-oil market in response to either negative/ positive supply shock. Additionally, its actions are not the same when faced with changes in global demand. If there is a negative demand shock, Saudi Arabia has an incentive to step in, but if there is a positive shock, it may be less motivated to act. A tax cut could make the situation worse, while policies that help increase the response to demand on price changes are likely to be more effective.

Methodology

The study investigates- how key macro-economic, variables, influence their fluctuations. It analyses both short term and long term dynamics, including market interdependence, spillover effects and volatility transmission. The research also examines the, response these markets show to global-events, providing more valuable information to the investors, policymakers in our bureaucratic system and academic and non academic researchers on price behaviour and market interactions. The analysis is conducted using monthly-data, from January 2016-December 2025.

- **Data**

All the secondary-data, were extracted from reliable online sources, including financial websites and official economic databases. The variables considered include crude oil prices (WTI, quoted in US dollars per barrel), exchange rates (quoted as USD/ INR) and the Federal Funds rate (reported in percentage) covering the period starting from, January 2016 upto -December 2025.

The data for this study is collected from the following websites, which provide reliable and authentic information on commodity prices and global market trends:

- Investing.com
- World Bank (commodity markets and pink sheet data)
- Federal Reserve Economic Data(FRIED)

In addition to collecting raw price data from these sources, the Rate of Change (ROC) was calculated in percentage (%) terms in order to capture the monthly fluctuations in crude-oil and other selected macroeconomic variables. By standardising the measurement in percentages, the study ensures consistency and clarity in interpreting both short term movement s and long-term dynamics.

- **Tools Used**
  - Descriptive statistics, Unit test root, Regression Analysis and paired sample t-test is used
- **Hypothesis to be Tested**

Hypothesis 1: Unit-root test for Stationarity of WTI Crude Oil ROC

Ho: WTI CRUDE ROC has unit root (It is non- stationary)

H1: WTI CRUDE OIL ROC doesn't have unit root (It is stationary)

Hypothesis 2: Impact of Global Events on Crude Oil Prices

Ho: There isn't any significant-difference in price of WTI Crude oil before, and after, the commencement of Ukraine and Russia war

H1: There, is some significant-difference in price of WTI Crude-oil before, and after the commencement of the Ukraine and Russia war

Hypothesis 3: Impact of Macroeconomic- Variables, **on WTI Crude-Oil Price**

Ho: Federal Funds Rate ROC doesn't have a significant impact on the ROC of WTI-Crude Oil.

H1: Federal Funds Rate ROC has a significant impact on the ROC of WTI Crude-Oil

Empirical Analysis and Discussions

- **Descriptive Statistics**

The descriptive statistics shown in Table 4.1 shows that WTI-crude oil price from January 2016 to December 2025 have a monthly average of $62.0 and a median of $59.5, indicating a fairly symmetric distribution. The standard deviation of 18.1 and the range of 98.1 reflect high variability in prices, ranging from $16.5 to $115. A slight positive skewness(0.413) suggests a few higher price months. Kurtosis (0.192) indicates a distribution close to normal. The Sapiro-Wilk test p-value (0.105) is above 0.05, implying that there is no significant difference or deviation from the normality. Figure 4.1 shows the distribution of the monthly prices.

Hypothesis 1: Unit-root test for Stationarity of WTI Crude Oil ROC

Ho: WTI CRUDE ROC has unit root (It is non- stationary)

H1: WTI CRUDE OIL ROC doesn't have unit root (It is stationary)

Interpretation

The Figure 4.2 figure above shows the ROC of WTI-crude oil price, where X-axis depicts years and the Y-axis depicts ROC(%). In Table 4.2 the Augmented-Dickey -Fuller Test (ADF test) and Phillips - Perron test (PPtest) were used to check if the crude oil rate of change is stationary over the period of the study. These tests have showed p values are lesser than 0.05. Therefore, the null hypothesis is not accepted. Such stationarity is essential for ensuring that relationships identified in time series models are reliable, making the crude oil rate of change suitable for further econometric analysis.

Hypothesis 2: Impact of Global Events on Crude Oil Prices

Ho: There isn't any significant-difference in price of WTI Crude oil before, and after, the commencement of Ukraine and Russia war

H1: There, is some significant-difference in price of WTI Crude-oil before, and after the commencement of the Ukraine and Russia war

Interpretation

In Table 4.3 the result of paired sample t-test implies a significant difference in WTI-crude oil prices before and after commencement of Ukraine -Russia war $t(119)=38.1$, $p<0.001$. Since the p-value is well below 0.05, the null-hypothesis is not accepted, indicating that the war had large significant impact on the, price of crude-oil.

In Figure 4.3 the sharp increase in prices, can be attributed to supply disruptions, geopolitical uncertainty, and concerns over global energy security. This result demonstrates that oil markets are sensitive to oil markets to geopolitical events and underscores the relevance of monitoring such shocks for investors, policymakers, and other market participants.

Hypothesis 3: Impact of Macroeconomic- Variables, **on WTI Crude-Oil Price**

Ho: Federal Funds Rate ROC doesn't have a significant impact on the ROC of WTI-Crude Oil.

H1: Federal Funds Rate ROC has a significant impact on the ROC of WTI Crude-Oil

Interpretation

The Figure 4.4 illustrates the relationship between, Federal Funds Rate-ROC and Crude- Oil ROC. The x-axis represents year, while the y-axis represents the rate of change (ROC%).

The regression results in Table 4.4 indicates a positive coefficient (0.111825) for Federal Funds Rate ROC, suggesting that an increase in Federal Funds Rate ROC is associated with a slight increase in Crude Oil ROC. This relationship, is statistically-significant, ($p = 0.0086$). The model's explanatory power is low ($R^2 = 0.0575$), meaning that Federal Funds Rate ROC accounts for approximately 5.75% of the variation in the Crude-Oil ROC. Based on the data, of January 2016-December 2025, the, regression result shows that Federal-Funds Rate ROC has statistically significant- positive-effect on WTI Crude Oil ROC; therefore, there the null-hypothesis (H_0) is not accepted.

Conclusion

It is observed from the study that global- events like crude-oil prices surged after the Ukraine - Russia war, exchange-rate, fluctuations negatively influence crude oil returns and federal funds has a small positive impact, on crude-oil returns. Overall, crude oil remains primarily self-driven in the short

term with minimal cross-market effects, but global events and macroeconomic conditions can influence its longer-term dynamics. The authors have few recommendations like crude oil traders should monitor macroeconomic indicators closely for short term forecasting, portfolio diversification across commodities like crude oil can reduce investment risk and other policy-makers can make use of these insights to anticipate market response to economic events.

Tables and Figures

Table 4.1: Descriptive-Statistics of Monthly WTI-Crude-Oil, Prices ($/BBL)

Crude Oil WTI ($/troy oz)			
N	120	Skewness	0.413
Mean	62.0	Std. error skewness	0.221
Median	59.5	Kurtosis	0.192
Standard deviation	18.1	Std. error kurtosis	0.438
Variance	326	Shapiro-Wilk W	0.982
Range	98.1	Shapiro-Wilk p	0.105
Minimum	16.5		
Maximum	115		

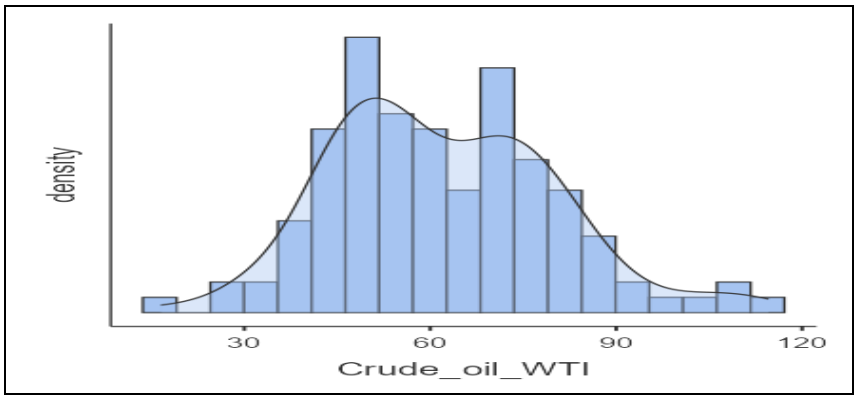


Figure 4.1: Distribution of Monthly WTI- Crude- Oil Prices ($/BBL)

Table 4.2: Showing the Unit- Root Test Result for WTI-Crude Oil ROC

Test	Test Statistic	(1% Critical Value)	(5% Critical Value)	(10% Critical Value)	P-Value	Stationary
Augmented Dickey-Fuller (ADF)	-8.8222	-3.4870	-2.8863	-2.5800	0.0000	Yes
Phillips-Perron (PP)	-10.166	-3.4866	-2.8861	-2.5799	0.0000	Yes

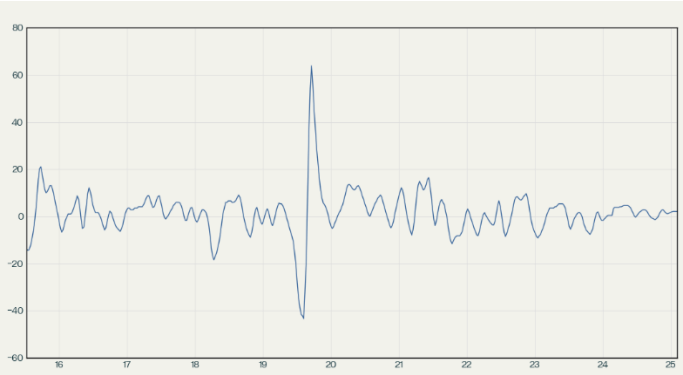


Figure 4.2: Showing the Line Plot of WTI Crude-Oil ROC

Table 4.3: Paired Samples T-Test for the Price of WTI-Crude Oil before/after Commencement of Ukraine–Russia War

Paired Samples T-Test					
			statistic	df	p
WTI Crude oil	Ukraine-Russia War	Student's t	38.1	119	<.001

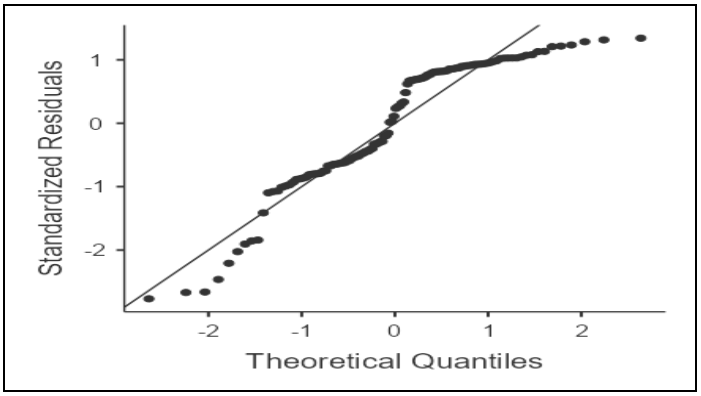


Figure 4.3: Showing the Comparison of Price WTI-Crude Oil-Prices before/after Commence of the Ukraine–Russia War

Table 4.4: Regression of Federal Funds Rate ROC on WTI Crude-Oil ROC

Regression Statistics

Statistic	Value
R Square	0.0575
Adjusted R Square	0.0494
Observations	120
F-statistic	7.1379
Prob (F-statistic)	0.0086
S.E. of regression	11.9088
Durbin-Watson stat	1.5693

Variables	Co-efficients	Standard-Error	tstatistics	P-value
Intercept (C)	0.306383	1.127273	0.271791	0.7863
FEDERAL FUNDS ROC	0.111825	0.041856	2.671689	0.0086

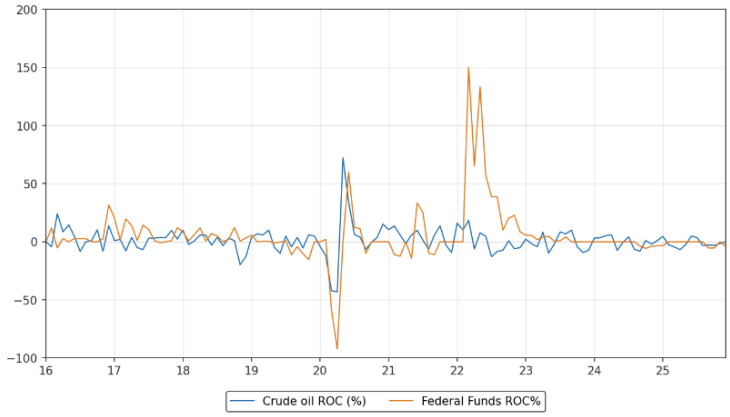


Figure 4.4: Movement of Federal Funds Rate ROC and WTI-Crude Oil ROC

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