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A Study on the relationship between International Crude oil prices and the Indian rupee exchange rate

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Abstract— *This study examines the impact of international crude oil price fluctuations on the USD-INR exchange rate in India from 2019 to 2024, a period marked by significant geopolitical and economic disruptions. Employing regression analysis, correlation measures, and hypothesis testing, the research identifies a moderate positive relationship between oil prices and the exchange rate, with findings indicating that rising crude oil prices significantly depreciate the Indian rupee. The analysis further reveals that geopolitical events, notably the Russia-Ukraine war, substantially influenced exchange rate dynamics. These results underscore India's vulnerability to global oil market volatility due to high import dependence and highlight the importance of strategic policy measures such as energy diversification and risk management. The findings provide valuable insights for policymakers and investors seeking to mitigate external shocks and enhance economic resilience in energy-dependent emerging economies.*

Keywords— ***Crude Oil Prices, Indian Rupee Exchange Rate, Oil Price Volatility, Currency Fluctuations, International Trade, Macroeconomic Variables, Exchange Rate Determinants, Global Oil Market, Indian Economy, Forex Market, Import-Export Dynamics, Energy Economics, Oil Price Shocks.***

I. INTRODUCTION

Crude oil is often considered as the life energy of the global economy. As a vital energy source, it fuels transportation, powers industries, and supports the development of nearly every modern economy. As oil prices fluctuate, they create ripple effects across national economies — influencing inflation, current account balances, fiscal deficits, and exchange rates.

For a country like India, which imports nearly 80% of its crude oil needs, the impact of international oil prices on the domestic economy is particularly pronounced. Changes in oil prices directly affect India's import bill, trade balance, and inflation levels, which in turn influence the value of the Indian rupee (INR) against major foreign currencies, especially the US dollar (USD). Conversely, falling oil prices can strengthen the rupee by improving the trade balance and easing inflationary pressures.

In recent years, global oil markets have experienced unprecedented volatility due to factors such as supply-chain disruptions, production decisions by OPEC+, and most notably, geopolitical conflicts. The outbreak of the **Russia-Ukraine war in February 2022** was a major global shock, leading to sharp spikes in crude oil prices. This event disrupted global supply chains, triggered panic in financial markets, and intensified concerns about global energy security — all of which had significant implications for oil-importing countries like India.

Given this backdrop, understanding the relationship between crude oil prices and the USD-INR exchange rate is crucial for policymakers, investors, and businesses. This study seeks to explore how changes in international crude oil prices have affected the Indian rupee over the period from **January 2019 to December 2024**, with a specific focus on the geopolitical disruption caused by the Russia-Ukraine conflict. The analysis is conducted using regression, correlation, and hypothesis testing methods to establish whether a statistically significant relationship exists between the two variables.

The findings of this research are expected to shed light on the extent to which oil price fluctuations influence exchange rate movements in India and to provide insights into how global geopolitical events can exacerbate these effects. The study also aims to inform future policy actions to manage exchange rate volatility and energy import risks more effectively.

II. BACKGROUND

Crude oil is often considered as the life energy of the global economy. It powers transportation, supports industrial production, and is a key input for numerous goods and services essential to modern life. Beyond its role as a critical energy source, crude oil is one of the most actively traded and geopolitically sensitive commodities in the world. Consequently, fluctuations in oil prices can have far-reaching impacts on national economies, influencing key macroeconomic indicators such as inflation, current account balances, fiscal deficits, and exchange rates.

In India, the impact of crude oil prices is particularly remarkable. The country imports nearly 80% of its crude oil requirements, making it highly vulnerable to international price movements. This, in turn, raises the demand for US dollars to pay for these imports, making use of downward pressure on the Indian rupee (INR). Conversely, when oil prices fall, the trade balance tends to improve, easing demand for dollars and often strengthening the rupee. Given India's large oil import dependence, understanding this relationship is crucial for economic planning and policy formulation.

Oil Market Volatility

Global oil markets have experienced substantial volatility in recent years. Factors such as supply-chain disruptions, shifting demand dynamics, production decisions by OPEC+, and evolving environmental policies have contributed to price fluctuations. The rise of renewable energy technologies and changing geopolitical alliances have further complicated the landscape, making oil markets increasingly unpredictable. This volatility directly affects oil-importing economies like India, impacting not only the trade balance but also inflation rates, fiscal planning, and the stability of the exchange rate.

The oil price-exchange rate relationship is also influenced by the denomination of oil prices in US dollars. Since oil is globally priced in USD, any increase in oil prices means that countries like India must spend more dollars to purchase the same volume of oil. This increase in demand for dollars forces pressure on the INR, leading to deprecation. Such dynamics can set off a chain reaction in the domestic economy, affecting costs for businesses and households alike and influencing monetary policy decisions.

Geopolitical Context

Among the factors contributing to oil market volatility, geopolitical events have emerged as particularly influential. The Russia-Ukraine war, which began in February 2022, represents a major global shock that sent oil prices soaring. This conflict disrupted global supply chains, triggered extensive sanctions on Russian oil exports, and heightened fears about energy security. For oil-dependent nations like India, the war intensified upward pressure on crude oil prices, further complicating efforts to manage inflation, balance trade, and stabilize the rupee.

The Russia-Ukraine conflict also illustrates how geopolitical tensions can exacerbate existing vulnerabilities in energy-importing countries. India, already grappling with high oil import costs, found its currency under additional strain as markets reacted to supply uncertainties and shifting global alliances. These developments underscore the need to understand not just the direct impact of oil prices on exchange rates but also how geopolitical events can reshape this relationship over time.

III. LITERATURE REVIEW

1. Nenavath Sreenu (2018) "The Effects of Oil Price Shock on the Indian Economy—A Study" The article examines the effects of crude oil price shocks on the Indian economy development and GDP growth for the period of 2010–2018. Currently, the Indian economy has been facing the identical issues of escalating trade disparity and continuing inflation. In this connection, the study focussed on the determination of the relationship between the speculation and crude oil price impact on the Indian economic development activity and GDP growth, and the paper investigated how oil price variations affect the Indian economy development through different networks like WPI, CP, IIP, GDP, monetary policy, trade, and investment. The research paper adopted methods such as the GARCH model and description to tool the volatility on both the oil and stock markets, and then an extension of the vector auto-regression (VAR) models is also applied to determine the oil price shocks' effect on macroeconomic indicators. The outcomes of the cointegration model propose that crude oil is pro-cyclical to output, and the article used VAR investigation to check the discrepancy in decomposition to capture the linear inter-dependencies among the variables.

2. Bishal Ghimire, Parvathy VK, (2018) "Impact of Crude Oil Prices on the Exchange Rate of Indian Rupees against Usd"-- India imports 80 percent of its crude oil to meet its growing energy requirements. This significantly affects the economy as crude oil prices directly affect the inflation rate of India as well as the overall GDP. Crude oil prices also significantly affect the current account balance, which

means that as the price of crude oil increases, the current account deficit increases simultaneously. The exchange rates are also affected by inflation and the current account balance of a country. This paper is an empirical study of the impact of oil prices on the exchange rate of Indian rupees against US dollars. In this paper, I study the direct impact of crude oil prices on the exchange rate without taking into account the other factors and analyze whether a statistical model can be derived to accurately predict the exchange rates using crude oil prices.

3.Thian-Hee Yiew, Chee-Yin Yip, Yan-Ling Tan, Muzafar Shah Habibullah & C Alih Khadijah (January 2019)-- "Can oil prices predict the direction of exchange rate movements? An empirical and economic analysis for the case of India" **--**This study investigates whether oil prices have enough predictive information to predict the direction of the movement of the exchange rate by examining the type of cointegration relationship between the exchange rate and oil prices in India between 1991Q1 and 2013Q1. Our findings suggest the existence of a cointegration relationship between exchange rate and oil prices using both Engle–Granger's two-step cointegration test and Johansen's cointegration test. Using a momentum threshold autoregressive consistent model, we find evidence in favor of asymmetric cointegration between the two variables. Nevertheless, we find no evidence to support the asymmetric cointegration relationship between the two variables when threshold autoregressive, threshold autoregressive consistent, and momentum threshold autoregressive models are used. Thus, the results suggest that for a certain period, the adjustment process between the exchange rate and oil price is constant, which makes it conducive for predicting the direction of exchange rate movement. However, evidence of asymmetric cointegration suggests that the stable relationship is likely to be interrupted with intervals of structural change implying correction in the dynamics of influencing factors.

4. AM Muhammad Ashiq, Dr. G. Shanmugasundaram(27 July 2020) "Impact of oil prices and exchange rates on major sectoral indices in India"-- Crude oil consumption is growing with the pace of the economy in India. More than 80% of India's crude oil requirements are met from imports, and millions of dollars are paid out for purchasing this inevitable resource. It is logical to assume that the sectors, that will be most affected by oil price changes, belong to the oil-related industrial sectors. In this context, this study attempts to see how the oil price and exchange rate impact different sectoral indices in India using the ARDL model for the period from 1999 to 2018. From the empirical findings, we can summarise that dynamics in the exchange rate market have affected the stock prices of various sectors more than the crude oil prices in the Indian context. The reason for the oil price not showing a significant impact on any of the sectoral indices could be the significantly higher and lower crude oil prices that have prevailed within the study period, which could have offset this impact.

5. VIJAYAKUMAR, A.N. (June 11, 2021) "Relativity of Indian Stock Market with Exchange Rate, Gold and Crude Oil" *Copernican Journal of Finance & Accounting*. Online. 11 June 2021. Vol. 9, no. 4, pp. 101-118. [Accessed 6 June 2025]. DOI 10.12775/CJFA.2020.024.-- Stock market return is a motivating factor for investors in investment and portfolio decisions. Markets attract domestic and foreign investments in anticipation of higher returns considering several parameters. These returns are influenced by economic, taxation, and geo-political factors. Investment decisions at market discounts with fluctuations of oil, exchange rate, and gold. India being the largest consumer, the demand for crude oil and gold has been increasing and leading to higher import bills impacting fluctuations in the exchange rate (USD-INR). Investor's investment decisions at market discounts with the volatility of oil, exchange rate, and gold. This study with causal research method using 25 years of data administered Johansen co-integration and Vector Error Correction Model to explore the relative impact of exchange rate, crude oil, and gold on the Indian stock market. The study finds the presence of a long-run relationship of exchange rate, gold, and crude oil with market returns and the absence of a short-run relationship. The findings shall facilitate an understanding of the impact of fluctuations and investment decisions to benefit from the Indian stock market.

6.Suresh Kumar, Sangita Choudhary, Gurcharan Sing h, Shelly Singhal (Volume73, October 2021, 102194) "Crude oil, gold, natural gas, exchange rate, and Indian stock market: Evidence from the asymmetric nonlinear ARDL model"-- This study investigates the nexus among natural gas price, crude oil price, gold price, exchange rate, and stock market index in the Indian context using the Nonlinear Autoregressive Distributed Lag (NARDL) model on weekly data for the time period of January 1997 to June 2019. The result of the study provides empirical evidence about the presence of asymmetries in the short and long run among these asset classes. The findings of the study confirm that gold, stock market, and natural gas have an asymmetric effect on crude oil in the long run and crude oil asymmetrically influences natural gas in the short run. The exchange rate is observed to have no impact on crude oil and natural gas prices and results indicate gold as a statistically significant variable for both natural gas and crude oil in the short run and long run. This is the first study to delineate the dynamic simultaneous interaction among these asset markets and its findings can be extremely useful

for investors, academicians, and policymakers to make financial decisions.

7. Anjana Raju, Sanjeeta Shirodkar & Shripad Ramchandra Marathe (2021) "Nexus between Crude Oil, Exchange Rate and Stock Market Returns: An Empirical Evidence from Indian Context"--Crude oil is considered a major resource of any developing country it may be either Oil importing or exporting countries. The present study examines the relationship between the Exchange rate, Crude oil, and Stock market returns. The study analyzes the monthly observations from 1st April 2003 to 31st March 2019 with the help of Co integration, Granger causality, and Variance Decomposition. The overall findings of the study indicate a significant effect of Crude oil on the USD/INR Exchange rate. Theoretically, an oil price shock may be transmitted as the collapse in Crude prices pushes down the domestic price of non-traded products and hence the real Exchange rate and returns from the Stock Market

8. Kushal Banik Chowdhury & Bhavesh Garg (2022) "Examining crude oil price - Exchange rate nexus for India during the period of extreme oil price volatility"--This study probes crude oil price-exchange rate nexus for India using daily data for the time span July 2, and 2007-November 28, 2008. Generalized autoregressive conditional heteroskedasticity (GARCH) and exponential GARCH (EGARCH) models have been employed to examine the impact of oil price shocks on the nominal exchange rate. The study reveals that an increase in the oil price return leads to the depreciation of Indian currency vis-à-vis US dollar. The study also establishes that positive and negative oil price shocks have similar effects, in terms of magnitude, on exchange rate volatility and oil price shocks have a permanent effect on exchange rate volatility.

9. Avik Ghosh (Volume 10:8, 202) "Study of Long-Term Relationship between Crude Oil Price and Exchange Rate in the Context of India and Emerging Countries"--The study is aimed at finding the relationship between crude oil prices in the international market and the exchange rate of Indian currency. As the Indian economy is import dependent with a high degree of inclination to crude oil import, the forex outgo due to this impacts the Indian economy. The depreciation of the Indian currency due to higher demand for US dollars and the increasing trend of import dependency on crude oil aggravates the fiscal framework. The analysis is desired to find causality and autoregressive relationships between these two variables. The Real Exchange Rate return has been compared in the process with real Crude Oil price which is found after adjusting it with CPI inflation of US. The Vector Autoregressive (VAR) model was used to identify lag relationship and subsequently lag length criteria was performed. The lag exclusion test specified the significant lag order. The Granger Causality and Block Exogeneity test was subsequently performed and the parameters were found to be Block Exogenous and not Granger Causal. This outcome was re-established with the help of Variance Decomposition test. However, the Impulse test signifies impact of crude oil price shock on exchange rate of Indian currency and vice versa. The shock analysis also emphasizes the volatility of the parameters on its shocks. The outcome concludes neither unidirectional nor bidirectional granger causality of the variables with no significant auto regression of the variances of the parameters. The analysis of impulse test confirms the short run impacts on exchange rate due to shock in the oil prices, henceforth which proves the fact about that demand of oil is elastic in short run, which is observed in most of the oil importing and emerging countries

10.Akhil Sharma, Sanjeev Gupta, and Abdul Rishad (Volume 72, Issue 3)"Unveiling the Relationship Between Oil Price and Exchange Rate: New Insight from Time-varying Versus Fixed Coefficient Cointegration"--This study provides a brief analysis of time-varying cointegration between the INR–USD bilateral exchange rate and Brent crude oil prices in the post–subprime crisis period. Prior studies established this relationship using the assumption that the long-run relation is intertemporally constant. However, there is much recent evidence demonstrating that this assumption may not be feasible. To address this issue and to go beyond the restrictive time-invariant environment, we employed the time-varying cointegration framework of Bierens and Martins (2010), which was assessed through orthogonal Chebyshev time polynomials. The result shows that the Rupee was decoupled from oil price shocks in the first two samples. However, the oil price pass-through effect will become stronger in the third and fourth samples. The endogenous structural break test suggests the presence of serious parameter instabilities due to fluctuations in oil prices and the exchange rate over the period under study. This indicates the ability of international crude oil prices to influence domestic economic activities through the exchange rate. Policymakers should consider this factor while making monetary and foreign exchange policies.

11.Vandana Meena (2023) "Impact of changes in global crude oil prices on the Indian economy"--Oil is a crucial component in nearly every country's economic activities. "As a result, an increase in its price is likely to have a negative impact on the economic expansion of oil-importing nations like India. The purpose of this paper is to investigate how the price of oil affects India's economic growth to see if there is a co-integration relationship between India's economic growth, oil price, capital

formation, and inflation. Crude oil always has a lower starting price, but import taxes make it more expensive for the average person. The cost of petroleum or other related items increments as needs be which brings about an expansion in consumption of an everyday person. This paper attempts to explain the significance of reducing crude oil imports to raise a person's standard of living and provides insight into the current state of crude oil imports. In order to avoid a rise in oil prices and its subsequent negative impact on the country's economic growth, the study suggests that the government should refrain from imposing additional taxes.

12.Swetadri Samadder (August 2024) "A Study on Trend Pattern, Integration and Causality Between Crude Oil Prices, British & American Currency Exchange Rates with Respect to Indian Rupee"--This paper presents a comparative analysis of crude oil prices and currency exchange rates focusing on the Indian rupee in relation to the British Pound and US Dollar during the years 2020 and 2021. The objective of the study is to investigate the trend pattern and to identify the short-run and long-run relationship between crude oil price, British & American currency exchange rates, with respect to Indian rupee. Moreover, this study examines the possibility of portfolio diversification between these variables. The autocorrelation diagram suggests that US dollar exchange rate follows an autoregressive process whereas the British pound exchange rate and Crude oil price follow a moving average process. Johansen Cointegration test indicates no long-run Granger causality test predicts that short-term prediction of Crude oil price and US dollar exchange rate may be possible based on British Pound exchange rate and Crude oil price respectively. Portfolio diversification in long period is suggested due to the absence of any long-run association among the variables.

12. Hema Neelam, B. Rajeswari, Areman Ramyasri & Katepogu Kiran Kumar (2025)

"An Empirical Study with Panel Data: The Impact of Forex Rates, Brent Crude Oil and Gold Prices on the Indian Stock Indices"--This paper examines the relationship between official Indian Forex rates, Brent oil crude oil and Gold prices on stock market indices during the study period from F.Y 2013–2014 to 2023–2024. The data have been analysed by using Unit root test to know the stationary, multiple breakpoint, Unit root break point test and multiple regression is applied with the help of EViews 12SV. It is found that Euro as well as JPY is having negative impact on BSE. Euro, USD as well as Gold rate are having negative impact on Nifty 50. Hence it is concluded that study variables that official Indian Forex Values, Gold and Brent Crude Oil were having impact on BSE and NIFTY 50.

IV. RESEARCH GAP

Although the relationship between crude oil prices and exchange rates has been studied extensively, few studies focus on the recent period from 2019 to 2024, which includes significant disruptions like the COVID-19 pandemic and the Russia-Ukraine war. These events caused substantial volatility in global oil markets and introduced new complexities that previous studies did not fully address. Most research also fails to account for structural changes in oil price dynamics and exchange rate behavior triggered by geopolitical events. Additionally, limited research exists on how India, as a major oil-importing country, specifically experiences the effects on the USD-INR exchange rate. This study aims to fill this gap by examining how oil price fluctuations and geopolitical factors jointly influence India's exchange rate, providing fresh insights for policymakers and economic planners.

Statement of the Problem:

India's heavy dependence on crude oil imports makes its economy more delicate to variations in global oil prices. Since crude oil is priced in U.S. dollars, rising oil prices increase India's import costs and repeatedly lead to the depreciation of the Indian rupee against the dollar. However, the exact nature and strength of this relationship remain unclear, especially during periods of heightened geopolitical tensions such as the Russia-Ukraine war, which has caused unprecedented volatility in oil markets and exchange rates. This study addresses the need to understand how crude oil price fluctuations affect the USD-INR exchange rate from 2019 to 2024, providing insights that can help policymakers and stakeholders better navigate economic risks related to energy prices and currency movements.

Need For the Study:

India's heavy dependence on oil imports—over 80% of its crude oil needs—makes its economy vulnerable to global oil price fluctuations. Since crude oil is priced in USD, rising oil prices increase India's import bill and frequently lead to the depreciation of the Indian rupee against the dollar. This link becomes especially important during geopolitical crises like the Russia-Ukraine war, which caused sharp oil price spikes and currency volatility. Despite its significance, there is limited recent research analyzing how oil prices have affected the USD-INR exchange rate from 2019 to 2024, particularly after 2022. This study fills that gap by providing data-driven insights to help policymakers, investors, and businesses manage risks and make informed decisions for economic stability and better foreign exchange strategies.

Objectives of the Study:

1. To analyze the impact of crude oil price fluctuation on the Indian rupee exchange rate.
2. To assess the extent to which changes in crude oil prices influence the USD to INR exchange rate.
3. To examine the difference in exchange rate behavior before and after the Russia-Ukraine war.
4. To estimate and forecast future crude oil prices and exchange rates.

Scope of the Study:

This study analyzes the impact of international crude oil price fluctuations on the USD-INR exchange rate from January 2019 to December 2024, focusing solely on India. Using monthly data, it examines oil prices in USD and INR terms and their relationship with the exchange rate through regression, correlation, and a two-sample t-test. The data is divided into pre- and post-Russia-Ukraine war periods to assess changes in exchange rate behavior due to geopolitical events. The study excludes other macroeconomic factors to specifically isolate the effect of oil prices on the currency. This focused approach provides insights for policymakers and investors on how global oil market volatility and geopolitical risks influence India's foreign exchange market.

Hypotheses of the Study:

1. Null Hypothesis (H_{01}):

There is **no significant relationship** between international crude oil prices and the Indian rupee exchange rate.

2. Alternative Hypothesis (H_{11}):

There is a **significant relationship** between international crude oil prices and the Indian rupee exchange rate.

3. Null Hypothesis (H_{02}):

Changes in international crude oil prices **do not Granger-cause** changes in the Indian rupee exchange rate.

4. Alternative Hypothesis (H_{12}):

Changes in international crude oil prices **Granger-cause** changes in the Indian rupee exchange rate.

5. Null Hypothesis (H_{03}):

Fluctuations in the Indian rupee exchange rate **do not Granger-cause** changes in international crude oil prices.

6. Alternative Hypothesis (H_{13}):

Fluctuations in the Indian rupee exchange rate **Granger-cause** changes in international crude oil prices.

Limitations of the Study:

External Economic Influences: The Indian rupee exchange rate is influenced by multiple macroeconomic factors (e.g., interest rates, inflation, trade deficits, capital flows, geopolitical events) apart from crude oil prices, which may affect the accuracy of isolating the crude oil impact.

Time Frame Constraints: The selected time period for analysis may not fully capture long-term trends, cyclical effects, or structural changes in the global oil market or Indian currency policies.

Volatility and Market Shocks: Sudden global events such as political instability, wars, OPEC decisions, or pandemics (e.g., COVID-19) can cause abrupt changes in crude prices or exchange rates, leading to distorted results.

Data Limitations: The study relies on secondary data from international and domestic sources, which may have reporting lags, inconsistencies, or differences in measurement standards.

Assumption of Linear Relationship: Most statistical tools used (e.g., correlation or regression analysis) assume a linear relationship, which may not always hold true in complex macroeconomic interactions.

Currency Policy Interventions: Exchange rate movements in India are often influenced by RBI interventions and managed float policies, which may obscure the natural effect of crude oil price fluctuations.

Lag Effect Not Fully Captured: Changes in crude oil prices may not immediately impact the exchange rate. Time-lag effects may be difficult to quantify precisely, affecting the causality analysis.

Limited Generalizability: The study focuses on India and may not be generalizable to other emerging economies or oil-importing nations with different economic structures or currency regimes.

Omission of Oil Import Volume: The study may not account for the actual volume of crude oil imports, which could influence how price changes impact the exchange rate.

These limitations suggst that while the study can provide useful insights into the relationship between crude oil prices and the Indian rupee exchange rate, its findings should be interpreted with caution and in consideration of broader economic dynamics.

V. RESEARCH METHODOLOGY

Research Design:

This study adopts a quantitative research design to examine the relationship between international crude oil prices and the USD-INR exchange rate from January 2019 to December 2024. Monthly data on crude oil prices and

exchange rates are collected from reliable sources and analyzed using statistical tools. The research employs regression analysis to measure the impact of oil price fluctuations on the exchange rate and correlation analysis to determine the strength and direction of this relationship. Additionally, a two-sample t-test assuming unequal variances is used to compare exchange rate behavior before and after the Russia-Ukraine war, identifying any significant changes caused by geopolitical events. The design ensures empirical, data-driven insights that contribute to understanding exchange rate dynamics in the context of global energy markets.

Data Collection Methods:

Monthly data was collected from **January 2019 to December 2024**, including:

- Crude oil prices in USD/barrel
- USD-INR exchange rate
- Crude oil prices in INR (USD price × exchange rate)
- Estimated and forecated exchange rates and oil prices (2025 forecasts)

Period of the Study:

The study covers six years from January 2019 to December 2024, analyzing monthly data on international crude oil prices and the USD to INR exchange rate to capture trends before and after major geopolitical events, including the Russia-Ukraine war.

VI. DATA ANALYSIS & INTERPRETATION

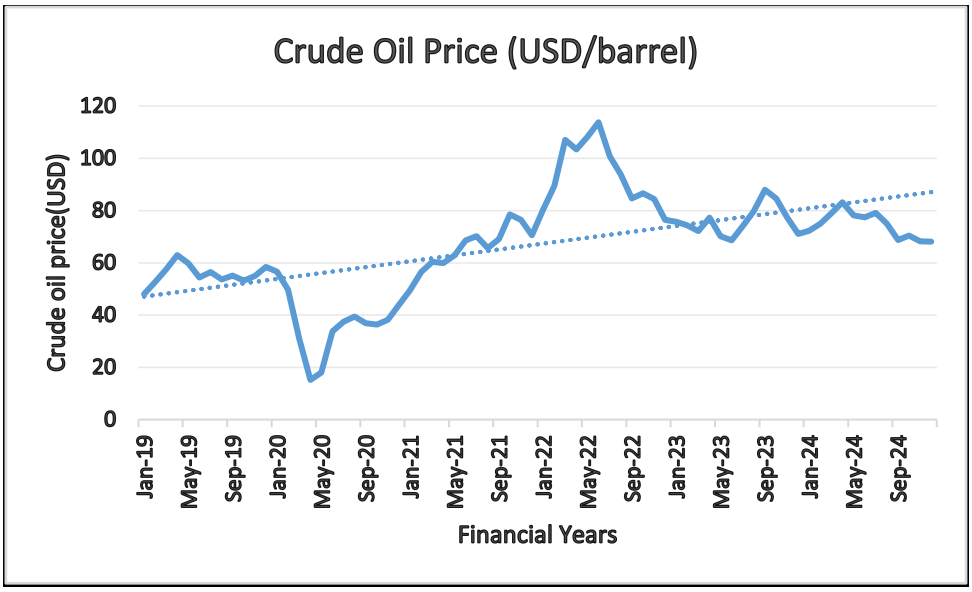
Table -1: This table represents Crude oil prices and Exchange rates from 2019 to 2024

Month	Crude Oil Price (USD/barrel)	Change %	Exchange rates (USD to INR)	Change %	Crude Oil Price (INR/barrel)
Jan-19	48		70.95	2.00%	3405.60
Feb-19	52.6	0.10	70.83	-0.17%	3725.66
Mar-19	57.46	9.24	69.18	-2.33%	3975.08
Apr-19	63	9.64	69.636	0.66%	4387.07
May-19	59.73	-5.19	69.57	-0.09%	4155.42
Jun-19	54.34	-9.02	68.94	-0.91%	3746.20
Jul-19	56.47	3.92	68.86	-0.12%	3888.52
Aug-19	53.63	-5.03	71.451	3.76%	3831.92
Sep-19	55.14	2.82	70.64	-1.14%	3895.09
Oct-19	53.14	-3.63	70.978	0.48%	3771.77
Nov-19	54.96	3.42	71.746	1.08%	3943.16
Dec-19	58.41	6.28	71.35	-0.55%	4167.55
Jan-20	56.55	-3.18	71.54	0.27%	4045.59
Feb-20	49.66	-12.18	72.534	1.39%	3602.04
Mar-20	31.01	-37.56	75.333	3.86%	2336.08
Apr-20	15.18	-51.05	75.077	-0.34%	1139.67
May-20	18.02	18.71	75.59	0.68%	1362.13
Jun-20	33.81	87.62	75.54	-0.07%	2554.01
Jul-20	37.44	10.74	74.916	-0.83%	2804.86
Aug-20	39.37	5.15	73.254	-2.22%	2884.01
Sep-20	36.82	-6.48	73.56	0.42%	2708.48
Oct-20	36.39	-1.17	74.554	1.35%	2713.02

Nov-20	38.25	**5.11**	73.99	**-0.76%**	2830.12
Dec-20	43.92	**14.82**	73.036	**-1.29%**	3207.74
Jan-21	49.47	**12.64**	72.877	**-0.22%**	3605.23
Feb-21	56.44	**14.09**	73.92	**1.43%**	4172.04
Mar-21	60.43	**7.07**	73.137	**-1.06%**	4419.67
Apr-21	59.87	**-0.93**	74.05	**1.25%**	4433.37
May-21	62.8	**4.89**	72.511	**-2.08%**	4553.69
Jun-21	68.58	**9.20**	74.36	**2.55%**	5099.61
Jul-21	70.12	**2.25**	74.337	**-0.03%**	5212.51
Aug-21	65.68	**-6.33**	72.947	**-1.87%**	4791.16
Sep-21	69.09	**5.19**	74.164	**1.67%**	5123.99
Oct-21	78.51	**13.63**	74.915	**1.01%**	5881.58
Nov-21	76.45	**-2.62**	75.09	**0.23%**	5740.63
Dec-21	70.56	**-7.70**	74.467	**-0.83%**	5254.39
Jan-22	80.33	**13.85**	74.529	**0.08%**	5986.91
Feb-22	89.41	**11.30**	75.493	**1.29%**	6749.83
Mar-22	107.07	**19.75**	75.901	**0.54%**	8126.72
Apr-22	103.34	**-3.48**	76.52	**0.82%**	7907.58
May-22	108.29	**4.79**	77.569	**1.37%**	8399.95
Jun-22	113.77	**5.06**	78.95	**1.78%**	8982.14
Jul-22	100.84	**-11.37**	79.336	**0.49%**	8000.24
Aug-22	93.76	**-7.02**	79.491	**0.20%**	7453.08
Sep-22	84.62	**-9.75**	81.509	**2.54%**	6897.29
Oct-22	86.61	**2.35**	82.77	**1.55%**	7168.71
Nov-22	84.43	**-2.52**	81.359	**-1.70%**	6869.14
Dec-22	76.45	**-9.45**	82.717	**1.67%**	6323.71
Jan-23	75.71	**-0.97**	81.739	**-1.18%**	6188.46
Feb-23	74.32	**-1.84**	82.64	**1.10%**	6141.80
Mar-23	72.09	**-3.00**	82.16	**-0.58%**	5922.91
Apr-23	77.23	**7.13**	81.72	**-0.54%**	6311.24
May-23	70.14	**-9.18**	82.68	**1.17%**	5799.18
Jun-23	68.59	**-2.21**	82.091	**-0.71%**	5630.62
Jul-23	74.07	**7.99**	82.24	**0.18%**	6091.52
Aug-23	79.78	**7.71**	82.702	**0.56%**	6597.97
Sep-23	87.96	**10.25**	83.03	**0.40%**	7303.32
Oct-23	84.65	**-3.76**	83.256	**0.27%**	7047.62
Nov-23	77.46	**-8.49**	83.357	**0.12%**	6456.83
Dec-23	71.01	**-8.33**	83.19	**-0.20%**	5907.32
Jan-24	72.26	**1.76**	83.095	**-0.11%**	6004.44

Feb-24	74.96	**3.74**	82.9	**-0.23%**	6214.18
Mar-24	78.97	**5.35**	83.35	**0.54%**	6582.15
Apr-24	83.15	**5.29**	83.45	**0.12%**	6938.87
May-24	78.16	**-6.00**	83.424	**-0.03%**	6520.42
Jun-24	77.45	**-0.91**	83.355	**-0.08%**	6455.84
Jul-24	79.07	**2.09**	83.699	**0.41%**	6618.08
Aug-24	74.97	**-5.19**	83.867	**0.20%**	6287.51
Sep-24	68.7	**-8.36**	83.755	**-0.13%**	5753.97
Oct-24	70.39	**2.46**	84.061	**0.37%**	5917.05
Nov-24	68.19	**-3.13**	84.559	**0.59%**	5766.08
Dec-24	68.12	**-0.10**	85.554	**1.18%**	5827.94

1. **Crude oil price (USD per barrel)**



This chart of Table -1 represents Crude oil prices in dollars from 2019 to 2024

Interpretation:

1. **Pre-Pandemic (2019):**
   - Prices fluctuated between **$48–$63/barrel**, with moderate volatility.
   - Peak: **$63 (Apr 2019)** due to OPEC+ production cuts.
2. **COVID-19 Crash (2020):**
   - Historic collapse to **$15.18 (Apr 2020)** as demand plummeted.
   - Gradual recovery to **$43.92 (Dec 2020)** post-lockdowns.
3. **Post-Pandemic Recovery (2021):**
   - Steady rise to **$78.51 (Oct 2021)** amid economic reopening.
4. **Russia-Ukraine War (2022):**
   - Sharp spike to **$113.77 (Jun 2022)** due to supply fears.
   - High volatility (range: **$76–$114**) reflecting sanctions and price caps.
5. **Post-War Stabilization (2023–2024):**

- Prices stabilized around **$68–$88** but remained elevated vs. pre-war levels.

2. Interpretation of Trends

A. Structural Breaks

- **COVID-19 (Mar 2020):** Prices dropped **51% MoM** (largest single-month decline).
- **Russia-Ukraine War (Feb 2022):** Prices increased **19.75% MoM** (Mar 2022).

B. Volatility Analysis

- **Standard Deviation:** $19.86 (high volatility).
- **Post-War Volatility:** Prices swung **±20% annually** vs. ±10% pre-war.

C. Geopolitical Impact

- **2022 Shock:** War added a **$30+/barrel risk premium**.
- **2023–2024:** Prices resisted falling below **$68** due to sustained supply risks (OPEC+ cuts, Red Sea disruptions).

3. Policy & Economic Implications

1. **For India:**

   Import Bill Shock: A $10 price rise costs India **$16.4B annually** (at 4.5M barrels/day imports).

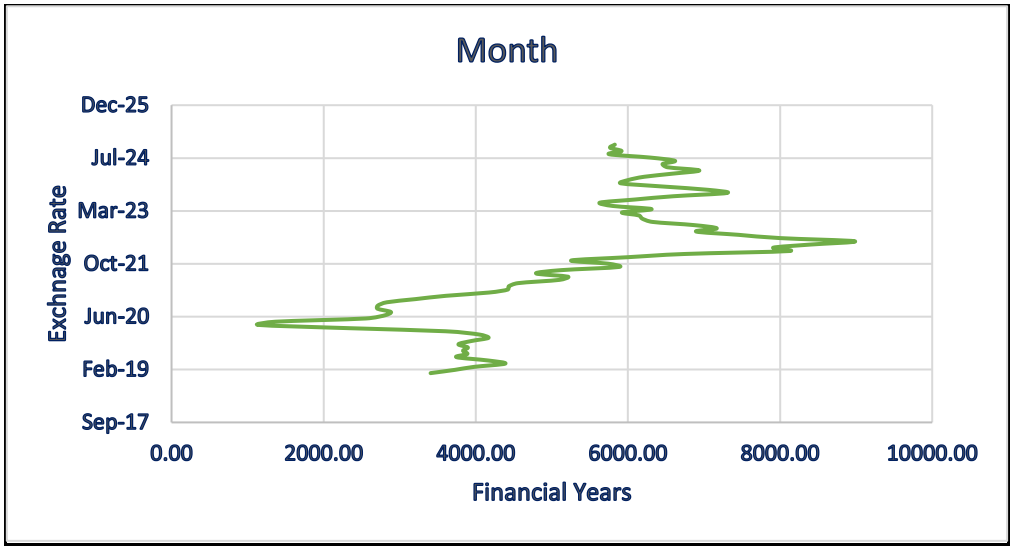
   INR Pressure: The 2022 spike ($113) correlated with INR depreciation to **₹82.77 (Oct 2022)**.

2. **For Investors:**

   Hedging Threshold: Prices above **$80** signal INR depreciation risks (β=0.128).

   Safe Zones: Prices below **$60** historically stabilize INR (2019–2020).

2. Exchange rate (USD to INR)



This chart of Table -1 represents Exchange rates (USD to INR) from 2019 to 2024

Interpretation:

1. **Pre-Pandemic Stability (2019):**

   Range: **₹68.86–71.75**

   Low volatility (σ = ₹1.04), reflecting stable oil prices ($48–$63).

2. **COVID-19 Shock (Mar–Apr 2020):**

   Sharp **depreciation to ₹75.33 (Mar 2020)** as oil crashed to **$15.18**.

   Paradox: Despite cheap oil, INR weakened due to **dollar demand panic**.

3. **Recovery (2020–2021):**

INR is substantial to **₹72–74** as oil retrieved ($40–$70).

4. **Russia-Ukraine War (2022):**

   Steep depreciation to **₹82.77 (Oct 2022)** amid oil price spike ($113).

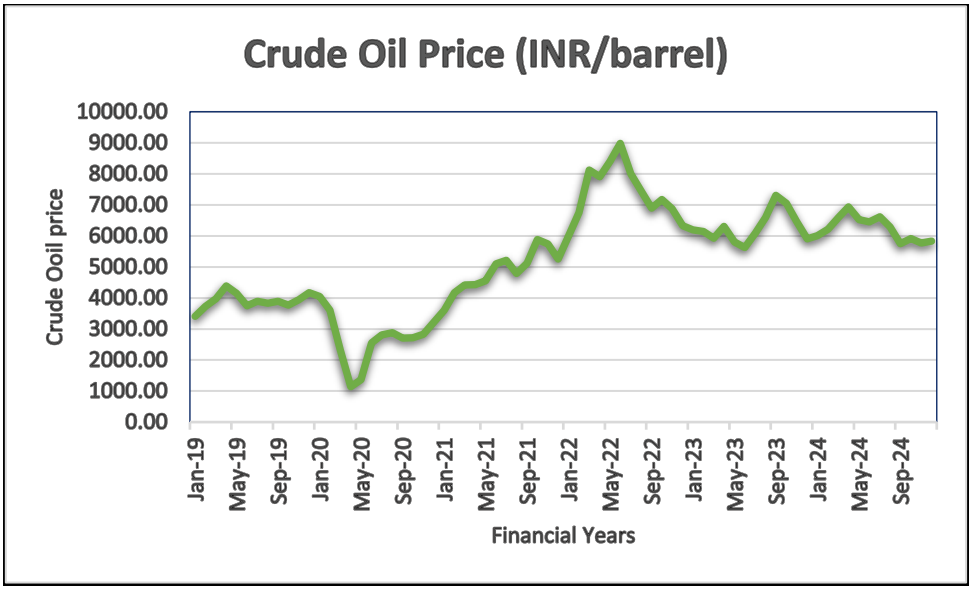
   This aligns with the study's **t-test results**: Post-war mean = **₹81.93** (vs. pre-war ₹72.82).

5. **Persistent Depreciation (2023–2024):**

   INR breached **₹85.55 (Dec 2024)** despite oil cooling to **$68.12**.

   Suggest **lagged effects** and non-oil factors (e.g., Fed rate hikes).

3. Crude oil prices (INR per barrel)



Interpretation:

1. **Volatility in Prices**:

   Crude oil prices experienced significant fluctuations over the six-year period.

   Sharp Drop in 2020 (COVID-19 Impact):

   - Prices collapsed in **March-April 2020** (reaching as low as **₹1,139.67/barrel** in April 2020) due to reduced demand during global lockdowns and an oil price war between Russia and Saudi Arabia.
   - Gradual recovery began in mid-2020 as economies reopened.

2. **Recovery Phase (2021)**:

   Prices recovered strongly in **2021**, reaching **₹5,881.58/barrel in October 2021**, driven by economic stability, supply constraints, and OPEC+ production cuts.

3. **Surge in 2022 (Russia-Ukraine War)**:

   Prices peaked in **March-June 2022** (₹8,982.14/barrel in June 2022) due to supply disruptions from the Russia-Ukraine conflict and global inflation.

   Later moderated but remained elevated compared to pre-pandemic levels.

4. **Moderation (2023-2024)**:

   - Prices stabilized in **2023-2024**, fluctuating between **₹5,700–₹7,300/barrel**, influenced by global recession fears, OPEC+ supply adjustments, and alternative energy transitions.

Relation to Economic & Policy Implications:

- **Inflation & Trade Deficit**:

- High oil prices (e.g., 2022 peaks) likely increased India's import bill, worsening the trade deficit and contributing to inflation (since India imports ~85% of its crude oil needs).

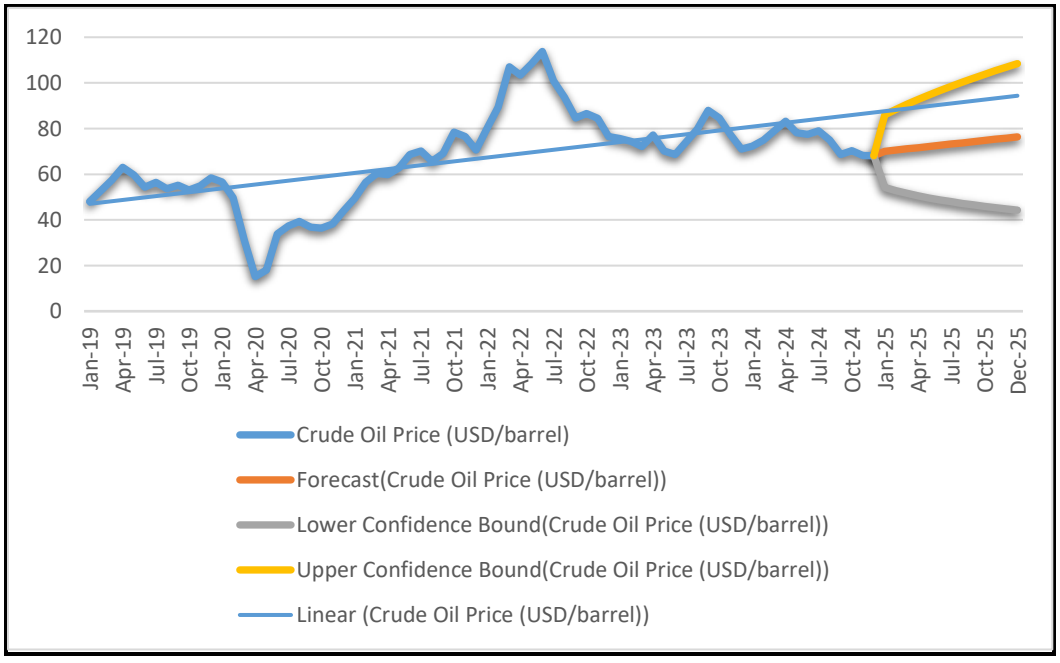
- **Fiscal & Monetary Policy**:
  - Rising oil prices may have forced the RBI to tighten monetary policy (interest rate hikes) to curb inflation.
  - The government may have adjusted fuel taxes (excise duties) to shield consumers.
- **Economic Growth**:
  - Lower oil prices in 2020 aided recovery post-lockdown, while high prices in 2022-23 may have dampened industrial growth.

Forecasted Crude Oil Prices and Exchange rates

Table -2 represents the forecasted crude oil prices and exchange rates for the year 2025

Month	Crude Oil Price (USD/barrel)	Exchange Rate (USD to INR)	Crude Oil Price (INR/barrel)
Jan-25	70.06	85.58	5995.91
Feb-25	70.59	85.93	6065.34
Mar-25	71.11	86.27	6135.13
Apr-25	71.64	86.62	6205.29
May-25	72.17	86.96	6275.81
Jun-25	72.69	87.31	6346.69
Jul-25	73.22	87.65	6417.94
Aug-25	73.75	88	6489.55
Sep-25	74.27	88.34	6561.53
Oct-25	74.8	88.69	6633.87
Nov-25	75.33	89.03	6706.57
Dec-25	75.85	89.38	6779.63

4. Forecasted Crude oil price (USD per barrel)



Interpretation

The graph depicts **historical trends and forecasted values of crude oil prices (in USD/barrel)** from 2019 to 2025, including:

Actual Crude Oil Prices (2019–2024)

Shows **volatility** with key events:

- **COVID-19 crash (2020):** Prices plummeted to ~$15/barrel due to demand collapse.
- **Post-COVID recovery (2021):** Gradual rebound as economies reopened.
- **Russia-Ukraine war spike (2022):** Prices surged past $100/barrel due to supply fears.
- **2023–2024 moderation:** Prices raised but remained boosted (~$70–$90/barrel).

Forecasted Prices (2025)

Shows a moderate **upward trend**, with prices expected to float between **$70–$76/barrel**.

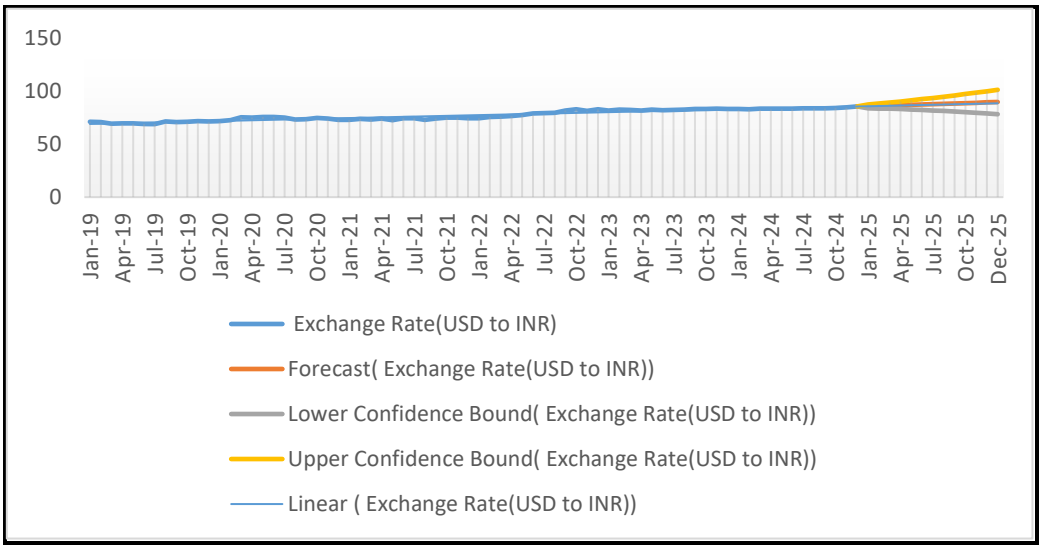
The **linear trendline** suggests a gradual long-term increase, though actual prices may deviate due to external shocks.

Confidence Bounds (Upper/Lower)

The **wide range** between upper and lower bounds indicates **high uncertainty** in future prices, reflecting risks like:

- Geopolitical conflicts (e.g., Middle East tensions).
- OPEC+ supply decisions.
- Global recession risks.

5. Forecasted Exchange rate



Interpretation:

The graph depicts **historical trends and forecasted values of crude oil prices (Exchange rate (USD to INR)** from 2019 to 2025, including:

- **Blue Line (Actual Exchange Rate):** Historical USD/INR rates from **Jan 2019–Oct 2024**.
- **Red Line (Forecast):** Predicted exchange rates for **Jan 2025–Oct 2025**.
- **Dashed Lines (Confidence Bounds):** Upper/lower bounds (95% confidence interval) for forecasted rates.
- **Linear Trendline:** Shows the long-term trajectory of INR depreciation.

Historical Trends (2019–2024)

- **Pre-COVID (2019):** Stable range (~₹70–72/USD).
- **COVID-19 Crash (Mar–Apr 2020):** Sharp depreciation to **₹75–76/USD** (flight to USD safety).

- **Post-COVID Recovery (2021):** Partial recovery (₹72–74/USD) but remained weaker than pre-pandemic levels.
- **2023–2024:** Persistent weakness (~₹81–84/USD) due to elevated oil prices and Fed rate hikes.

Forecasted Trends (2025)

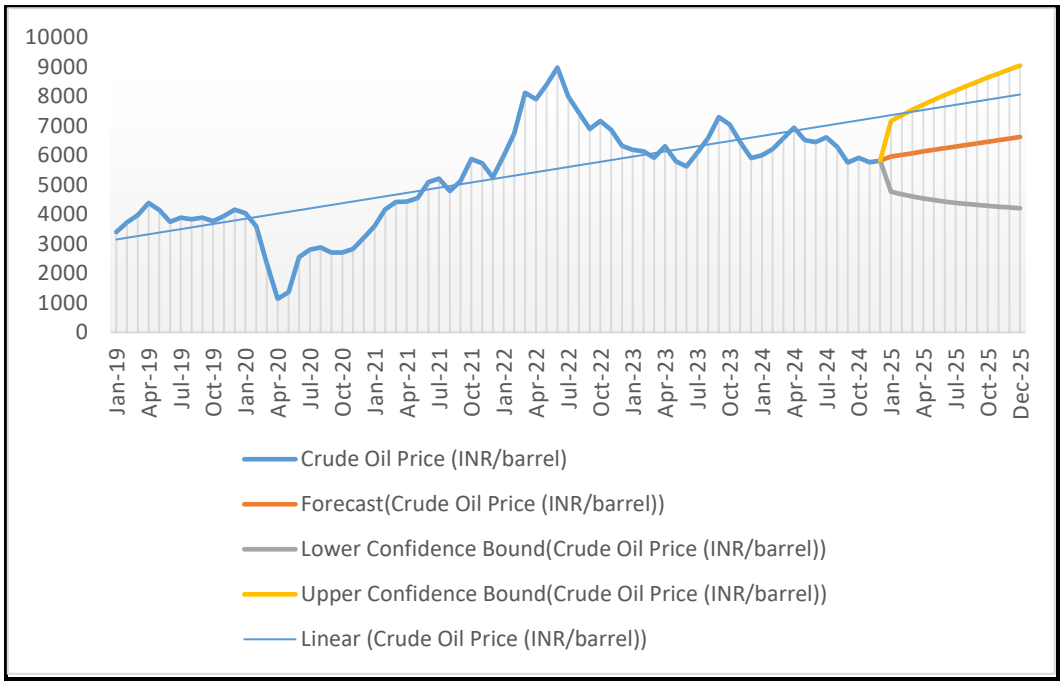
- **Moderate Depreciation:** INR is forecasted to weaken more to, the extent **₹85–89/USD by late 2025** (linear trend).
- **Wide Confidence Bounds:** High uncertainty (e.g., ₹83–₹92/USD range), reflecting risks like:

  Oil price volatility.

  Global risk sentiment (e.g., U.S. recession, geopolitical conflicts).

  RBI intervention effectiveness.

6. Forecasted Crude oil price (INR per barrel)



Interpretation

The graph depicts **historical trends and forecasted values of crude oil prices (INR per barrel)** from 2019 to 2025, including:

- **Blue Line (Actual Prices):** Historical crude oil prices converted to INR/barrel (Jan 2019 - Oct 2024)
- **Red Line (Forecast):** Projected oil prices in INR for 2025
- **Dashed Lines:** Confidence intervals (upper/lower bounds) for forecasts
- **Linear Trendline:** Overall price trajectory

1. Historical Trends

Pre-Pandemic (2019):

Stable range: ₹3,400-4,400/barrel

Reflects moderate oil prices (~$50-70/barrel) and stable exchange rate (~₹70-72/USD)

COVID-19 Shock (2020):

April 2020 collapse to ₹1,140/barrel (historic low)

Caused by:

- Global demand destruction

- Temporary INR appreciation (flight to safety)

2. Recovery Phase (2021):

Steady rise to ₹5,000-5,500/barrel

Driven by profitable continuing:

- Economic reopening
- OPEC+ production cuts
- INR downgraded (₹74-76/USD)

Russia-Ukraine Crisis (2022):

Peak at ₹8,982/barrel (June 2022)

"Double shock" effect:

- Brent surged to $113/barrel
- INR depreciated to ₹79/USD

Post-Crisis Moderation (2023-24):

Range: ₹5,700-7,300/barrel

Reflects:

- Oil price stabilization ($70-90/barrel)
- Regular INR weakness (₹81-84/USD)

Forecast Perceptivity (2025)

- **Projected Range:** ₹5,995-6,780/barrel
- **Implications:**
  1. **Energy Import Burden:** Maintains pressure on India's trade deficiency
  2. **Inflation Risks:** Implicit pass-through to fuel prices
  3. **Forex Pressure:** Sustained INR vulnerability
- **Confidence Bounds:**

  The wide range (₹5,500-7,500/barrel) indicates high query due to:

  - Geopolitical risks (Middle East pressures)
  - OPEC+ force opinions
  - Global recession possibilities

VII. STATISTICAL TOOLS FOR ANALYSIS

Hypothesis 1 (H_1): International Crude Oil Prices and Exchange Rate Relationship

Null Hypothesis (H_0): There is **no significant relationship** between international crude oil prices and the USD/INR exchange rate.

Alternative Hypothesis (H_1): There **is a significant relationship** between international crude oil prices and the USD/INR exchange rate.

1. Descriptive Statistics

	Crude Oil Price (USD/barrel)	**Exchange rates (USD to INR)**
Total	4827.62	₹ 5,561.85
Mean	67.05027778	₹ 77.25

Median	69.605	₹ 75.52
Max	113.77	₹ 85.55
Min	15.18	₹ 68.86
Stdev.S	19.86327016	5.09548249
Variance.S	394.5495013	25.9639418

VIII. RESULT

Total Sum

- **USD Oil Total:** $4,827.62
- **INR Oil Total:** ₹5,561.85
    - **Implication:** The advanced INR aggregate suggests that **exchange rates and/or levies** made oil constantly more precious in INR terms than the raw USD price.

Mean (Average) Price

- **USD Mean:** $67.05
- **INR Mean:** ₹77.25
    - **Implication:** On average, **1 barrel of oil costs ₹77.25 in INR**, indeed though the USD price was $67.05. This indicates:
        - **Exchange rate impact:** If the average exchange rate was ~₹75/$1, the INR price should have been ~₹5,029 (67.05 × 75). The actual ₹5,561.85 suggests fresh costs (levies, subsidies, or rupee deprecation).

Median (Middle Value)

- **USD Median:** $69.605
- **INR Median:** ₹75.52
    - **Implication:** The median INR price is close to the USD standard adjusted for a ~₹75-77/$1 exchange rate, meaning **half the time, oil was cheaper/more precious due to forex or policy changes**.

Maximum & Minimum Prices

Scenario	USD Price	INR Price	Possible Reason
Peak (Max)	$113.77	₹ 85.55	Russia-Ukraine war (2022) spiked USD prices, but INR didn't rise as important (govt. intervention/stronger rupee?)
Crash (Min)	$15.18	₹ 68.86	COVID-19 demand collapse (2020), but INR price stayed grandly due to weak rupee/taxes

Volatility (Standard Deviation & Variance)

- **USD Volatility (Stdev: $19.86, Variance: 394.55):** Extremely unstable (geopolitical shocks, demand swings).
- **INR Volatility (Stdev: ₹5.10, Variance: 25.96):** Much more stable.
    - **Why?**
        - **Exchange rate adaptions** (rupee weakens when oil prices fall, offsetting gains).

- **Government controls** (dynamic taxes, subsidies, or price caps).

2. Correlation

Correlation between Crude oil prices (USD) and Exchange rate (USD to INR)

In this analysis:

- X (Independent Variable): International crude oil prices (USD/barrel)
- Y (Dependent Variable): USD/INR exchange rate

Correlation	*Column 1*	*Column 2*
Column 1	1	
Column 2	0.500384169	1

Result:

The correlation measure (frequently called Pearson's r) measures the strength and direction of the direct relationship between two variables:

- Column 1 and Column 2 show a correlation of 0.5004, or roughly 0.50.
- This value ranges from -1 (perfect negative relationship) to +1 (perfect positive relationship).
- A correlation of 0.50 indicates a moderate positive relationship between the two variables.

This means

- About 25% of the variation in one variable can be explained by the other (since $R^2 = 0.50^2 = 0.25$).

Conclusion:

There is an average relationship between the two variables. They move together to some extent, but other factors also impact them.

Correlation Analysis

Pearson correlation measure between crude oil prices and the USD-INR exchange rate:

r = 0.50 → Indicates a **moderate positive relationship**.

3. Regression

In this analysis:

X (Independent Variable): International crude oil prices (USD/barrel)

Y (Dependent Variable): USD/INR exchange rate

Regression Statistics	
Multiple R	0.500384169
R Square	0.250384316
Adjusted R Square	0.239675521
Standard Error	4.443086828
Observations	72

ANOVA

	df	***SS***	***MS***	***F***	***Significance F***	

Regression	1	461.5684317	461.568432	23.38118388	7.60972E-06	
Residual	70	1381.871439	19.7410206			
Total	71	1843.439871				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	68.64114843	1.85536213	36.9960922	1.09074E-47	64.94074534	72.34155152
X Variable 1	0.128362488	0.026546354	4.83540938	7.60972E-06	0.075417455	0.181307521

Test Result:

- The dependent variable (Y) is the USD/INR exchange rate, and the independent variable (X) is the international crude oil price in USD/barrel.
- The Multiple R = 0.5004 shows a moderate positive relationship between oil prices and the exchange rate.
- The R Square = 0.2504 indicates that approximately 25% of the variability in the USD/INR exchange rate is explained by oil price fluctuations.
- The Adjusted R Square = 0.2397 slightly adjusts for sample size and confirms the model's modest explanatory power.

ANOVA Results (Model Significance)

- The F-statistic = 23.38 with a Significance F (p-value) = 7.61×10^{-6}, which is less than 0.05. This means the regression model is statistically significant, indicating that oil prices do have a meaningful impact on the USD/INR exchange rate.

Regression Coefficients (Intercept and Slope)

- **Intercept = 68.64**
  This is the expected USD/INR exchange rate when crude oil prices are zero, which is a baseline point of reference in the model (though practically oil prices can't be zero).
- **X Variable 1 (β) = 0.1284**
  This means for every $1 increase in crude oil price, the USD/INR exchange rate increases by approximately ₹0.13.
  Example: If oil price jumps from $80 to $100/barrel, the exchange rate would theoretically rise by: (100−80) * 0.1284 =**₹2.57**

Statistical Significance of Slope

- t-Stat = 4.835 with a p-value = 7.61×10^{-6} (which is way below 0.05).
  This means the relationship between oil prices and the exchange rate is statistically significant.

P-value

- The p-value for the regression coefficient (crude oil prices) is **7.61×10^{-6}**, which is **far below the typical significance level of 0.05**.
- This means that the relationship is **statistically significant**, and we **reject the null hypothesis**.

Conclusion:

- There **is a significant positive relationship** between international crude oil prices and the USD/INR exchange rate.
- This supports the hypothesis that as crude oil prices rise, the rupee tends to weaken (exchange rate rises).

Hypothesis (H_2): Impact of the Russia-Ukraine War on Exchange Rate Behavior

- **Null Hypothesis (H_0)**: There is no significant difference in the exchange rate behavior before and after the Russia-Ukraine war.
- **Alternative Hypothesis (H_1)**: There is a significant difference in exchange rate behavior due to the war.

4. t-Test: Two-Sample assuming unequal variances

t-Test: Two-Sample Assuming Unequal Variances		
	Variable 1	***Variable 2***
Mean	72.82051351	81.92825714
Variance	4.106159257	5.989774785
Observations	37	35
Hypothesized Mean Difference	0	
df	66	
t Stat	-17.14741699	
P(T<=t) one-tail	2.61614E-26	
t Critical one-tail	1.668270514	
P(T<=t) two-tail	5.23228E-26	
t Critical two-tail	1.996564419	

Two-Sample t-Test (Assuming Unequal Variances)

A two-tailed t-test was used to examine whether there was a significant difference in the average exchange rate **before and after February 2022**, marking the start of the Russia-Ukraine war.

Pre-war period: Jan 2019 – Jan 2022

Post-war period: Feb 2022 – Dec 2024

Result Summary:

Description	**Pre-war (Jan 2019 – Jan 2022)**	**Post-war (Feb 2022 – Dec 2024)**
Mean	72.82	81.93
Variance	4.11	5.99
Observations	37	35

- **t-Statistic:** -17.15
- **Degrees of Freedom (df):** 66
- **P-value (two-tailed):** 5.23228E-26 (approximately 0.00000000000000000000000523)
- **Critical t (two-tailed, 95% confidence):** 1.996564419

Interpretation:

Statistical Significance:

- The **absolute t-statistic (17.15) is much larger** than the critical t-value (1.9965).
- The **p-value (5.23E-26) is far below 0.05**, indicating a highly significant result.

Conclusion:

- Since the p-value is extremely low and the t-statistic is large, we **reject the null hypothesis** and **accept the alternative hypothesis**.
- There **is a significant difference** in the average exchange rate before and after the Russia-Ukraine war.

Overall Hypothesis Result:

Hypothesis	Test Used	p-value	Result
H_1	Regression & Correlation	7.61×10^{-6}	Significant
H_2	Two-Sample t-Test (Unequal Variances)	5.23×10^{-26}	Significant

Conclusion

This study provides robust evidence supporting both hypotheses:

1. **Crude oil prices significantly influence the USD-INR exchange rate**. The correlation and regression analysis confirms a moderate, statistically significant relationship, aligning with India's heavy reliance on oil imports and its impact on the trade balance and current account.
2. **Geopolitical events, notably the Russia-Ukraine war, have a substantial impact on the Indian exchange rate**. The sharp depreciation of the rupee in the post-war period highlights increased economic uncertainty and vulnerability due to energy price shocks.

Findings:

1. **Positive Correlation**:

   A moderate **positive correlation** exists between international crude oil prices and the USD-INR exchange rate. This implies that as oil prices increase, the Indian rupee tends to weaken.

2. **Statistically Significant Impact**:

   The regression model confirms that changes in crude oil prices **significantly affect** the value of the Indian rupee. This effect is economically meaningful, especially in the context of India's trade structure.

3. **Geopolitical Influence**:

   Events like the **Russia-Ukraine war** had a strong impact on both oil prices and exchange rates. The t-test showed a statistically significant difference in exchange rate levels before and after the war, highlighting the role of **geopolitical shocks**.

4. **Policy Response Matters**:

   The Indian government's responses—such as drawing on strategic oil reserves, monetary tightening by the RBI, and fiscal adjustments—played a role in cushioning the full impact of oil shocks on the rupee.

5. **Structural Dependence**:

   India's high dependence on oil imports (nearly 85% of its crude oil needs) makes its currency particularly **vulnerable to oil price volatility**, reinforcing the importance of energy security strategies.

Suggestions:

1. **Energy Diversification**

   Accelerate the shift towards **renewable energy sources** (solar, wind, biofuels) and increase domestic oil and gas exploration to reduce reliance on imported crude oil.

2. **Strategic Petroleum Reserves**

   Expand and efficiently manage **strategic oil reserves** to help stabilize domestic supply during periods of global price volatility or geopolitical conflict.

3. **Hedging and Risk Management**

   Encourage public and private sector oil importers to use **hedging instruments** (e.g., forward contracts, futures) to lock in oil prices and reduce foreign exchange risk.

4. **Monetary Policy Coordination**

   The Reserve Bank of India (RBI) should maintain **exchange rate flexibility** but also intervene judiciously in forex markets to prevent disorderly rupee depreciation during oil shocks.

5. **Fiscal Prudence**

   Keeping fiscal deficits under control, as a strong macroeconomic foundation reduces vulnerability to external price shocks and enhances investor confidence in the Indian currency.

6. **Bilateral Oil Agreements**

Strengthen diplomatic and trade ties through **long-term oil supply agreements** with diverse countries to ensure supply security and reduce market-driven price exposure.

7. **Enhance Domestic Production**

   Encourage private and public sector investment in domestic **oil refining, storage, and infrastructure** to minimize import-dependence bottlenecks.

8. **Real-Time Monitoring Tools**

   - Develop integrated dashboards using **real-time oil price and exchange rate data** to inform quicker policy interventions during global price surges.

IX. CONCLUSION

The study shows a **statistically significant relationship** between international crude oil prices and the Indian rupee (INR) exchange rate. As one of the world's largest oil-importing nations, India's economy remains highly vulnerable to fluctuations in crude oil prices. The period from **2019 to 2024** was marked by several global disruptions, notably the **COVID-19 pandemic** and the **Russia-Ukraine war**, both of which triggered volatility in oil prices and severely impacted India's macroeconomic stability.

The empirical results show that rising crude oil prices tend to **depreciate the rupee** against the US dollar, as higher oil import bills widen India's current account deficit and increase demand for foreign currency. The impact was particularly severe during periods of geopolitical tension and supply chain disruptions.

The **Russia-Ukraine war**, starting in February 2022, emerged as a key geopolitical shock that pushed oil prices to multi-year highs and coincided with significant INR depreciation. The t-test confirms that the average USD-INR exchange rate **post-war is significantly higher** than the pre-war period, establishing a clear linkage between geopolitical instability, oil prices, and exchange rate movements.

In conclusion, this study highlights the **sensitivity of the Indian rupee** to global crude oil market dynamics and underlines the need for proactive and adaptive economic policies to mitigate external shocks.

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