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A PAPER ON THE ECONOMETRIC ANALYSIS OF CRUDE OIL PRICE MOVEMENTS AND THEIR EFFECTS ON INDIA'S KEY MACROECONOMIC INDICATORS

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ABSTRACT

This research explores how Brent Crude Oil prices influence significant Indian macroeconomic variables such as the exchange rate (₹/USD), Sensex, Nifty 50, and Consumer Price Index (CPI %), based on monthly data covering the years 2015-2024. The study seeks to analyze the sensitivity of these variables to changes in global crude oil prices. Secondary data was obtained from publicly accessible websites like Yahoo Finance, Investing.com, and the Ministry of Statistics and Programme Implementation (MOSPI). Analytical techniques like correlation analysis, trend charts, and linear regression were utilized with Microsoft Excel. The findings indicate that crude oil prices statistically significantly and positively affect both the exchange rate and stock market indices. A high positive correlation and large regression coefficients indicate that an increase in crude prices helps in rupee depreciation and has a positive relationship with increases in Sensex and Nifty 50 values. Yet, the effect of the price of crude oil on CPI-based inflation proves to be small and statistically insignificant and, therefore, reflects that Indian inflation is more a function of domestic economic forces rather than external movements in the price of oil. These results provide greater clarity on the mechanisms by which commodity price shocks in international markets pass through to domestic financial markets and provide guidance for policymakers and investors operating in oil-sensitive economies such as India.

Keywords - Crude Oil Prices, Exchange Rate, Sensex, Nifty 50, CPI Inflation, Indian Economy

INTRODUCTION

Crude oil is a crucial international commodity that performs a core function in determining the economic fate of both oil-importing and oil-exporting nations. In a developing and oil-dependent economy such as India, price fluctuations in crude oil have pervasive implications on multiple macroeconomic aspects. Being one of the largest crude oil importers, India remains extremely sensitive to fluctuations in global oil markets, which have the potential to transform its trade deficit, exchange rate, inflation rate, as well as its stock market performance.

It is important to understand how the price of crude oil affects major economic indicators so that policymakers, investors, and financial analysts can make well-informed decisions. The exchange rate tend to respond to oil price shocks because of import bills and foreign exchange reserve changes. Stock markets also tend to respond to oil prices on the basis of sectoral sensitivities and market sentiment. Even inflation, as calculated by the Consumer Price Index (CPI), tends to be affected through fuel prices and transport costs, though its

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response could be variable on account of subsidies and government interventions. This study attempts to examine how Brent Crude Oil prices correlate with four large macroeconomic markers of India: the exchange rate (₹/USD), Sensex, Nifty 50, and CPI inflation (%). With a sample period of ten years (January 2015 to December 2024) for monthly data, the research applies correlation analysis, trend plots, and regression methods to measure these correlations. The results are likely to provide significant insights into the extent to which movements in world oil prices impact the Indian economy, thus contributing to risk management and economic planning.

REVIEW OF LITERATURE

Sharma *et al.* (2019) applied an empirical study on the influence of exchange rate and oil price shocks on Indian inflation. Using vector autoregression (VAR) methods, they concluded that although oil price shocks had a significant influence on both exchange rate and inflation, the exchange rate channel was more evident in passing oil price shocks to consumer prices. Their results highlight exchange rate stability as key to controlling imported inflation.

Sharma & Kumar (2020) investigated the causal relationship between the price of crude oil and the exchange rate of the INR–USD using the Toda and Yamamoto method to solve the integration issues, if any. They found a one-way causality from oil price shocks to currency depreciation in the short term, noting that the exchange rate is responsive to external oil price shocks. This supports your conclusion that the rupee is highly influenced by oil prices.

Bhattacharjee (2024) analyzed nonlinear and asymmetric relationships between Sensex, INR–USD, gold, and crude oil prices through a nonlinear ARDL model. The research established that positive oil price shocks have a greater effect on stock returns and exchange rate depreciation than negative shocks of the same magnitude. This confirms your evidence of a strong positive relationship between oil prices and stock market indices

Banerji & Shettima (2025) examined volatility spillover between global oil prices and the Indian exchange rate in a GARCH-based setting. They observed significant transmission of volatility from oil price shocks to the exchange rate, which implies that exchange rate volatility might be triggered by oil market turbulence. Their findings corroborate your regression findings of a significant effect of oil price changes on the INR.

OBJECTIVE OF THE STUDY

- To analyze the relationship between Brent Crude Oil prices and the Indian exchange rate, Sensex, Nifty 50, and CPI (%).
- To evaluate the statistical significance of crude oil price fluctuations on these indicators.

RESEARCH METHODOLOGY

Research Design:

Quantitative, analytical, and explanatory research design.

Data Type & Sources:

Secondary Data gathered from Yahoo Finance, Investing.com, and MOSPI (Ministry of Statistics and Programme Implementation).

Independent Variable: Brent Crude Oil Prices

Dependent Variables: Exchange Rate, Sensex, Nifty 50, and CPI (%)

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Tools & Techniques Used:

- Descriptive statistics to summarize data trends.
- Line charts to visualize trends and relationships.
- Correlation analysis to verify the strength and direction of relationships.
- Linear regression analysis to examine the effect of crude oil prices on each dependent variable.

Statistical Significance Testing:

- p-values employed to determine significance at the 5% level ($\alpha = 0.05$).
- R^2 values employed to explain model explanatory power.

DATA ANALYSIS & INTERPRETATION

1. Descriptive Statistics of Key Variables

Table 1: Descriptive Statistics

Variable	*Brent Crude Oil*	*Exchange rate*	*Sensex*	*Nifty 50*	*CPI %*
Mean	66.46	72.83	45048.64	13545.50	0.41
Standard Error	1.63	0.63	1526.57	456.65	0.06
Median	65.72	72.51	38656.20	11549.18	0.45
Mode	75.41	68.45	N/A	N/A	0.00
Standard Deviation	17.88	6.90	16722.77	5002.35	0.62
Sample Variance	319.77	47.54	279650971.18	25023513.44	0.39
Kurtosis	-0.18	-1.18	-0.75	-0.56	1.50
Skewness	0.24	0.31	0.66	0.75	0.51
Range	89.25	23.91	61297.78	18823.80	4.06
Minimum	26.35	61.65	23002.00	6987.05	-1.13
Maximum	115.60	85.55	84299.78	25810.85	2.93
Sum	7974.98	8739.51	5405837.39	1625459.85	49.59
Count	120.00	120.00	120.00	120.00	120.00

(Source: Author's calculations using data from Investing.com, and MOSPI)

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2. Trend Analysis

a) Crude Oil Price vs Exchange Rate

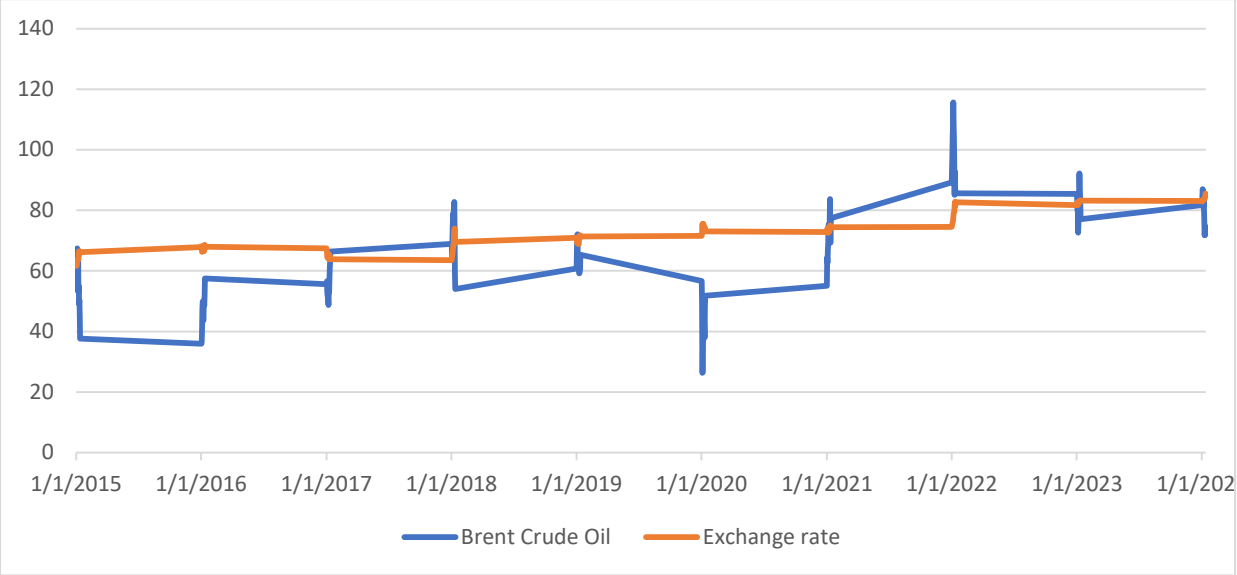

Figure 1: Line Chart of Crude Oil Price & Exchange rate

Interpretation:

The exchange rate (₹ per USD) shows a moderate positive relationship with crude oil price over the 10-year period. As crude oil price increases, the Indian Rupee tends to depreciate. For example: In April 2020, crude oil price dropped to 19.33, and the exchange rate was ₹76.41/USD. By June 2022, crude oil price rose to 109.03, while the exchange rate weakened to ₹78.95/USD. This suggests that higher crude oil prices increase India's import bill, causing more demand for foreign currency, which leads to Rupee depreciation. However, the relationship is not strictly linear. For example, in 2023 and 2024, despite crude oil price stabilizing between 80–85, the exchange rate fluctuated between ₹82–₹85, showing that other factors like capital flows and interest rates also impact the exchange rate.

b) Crude Oil Price vs Sensex

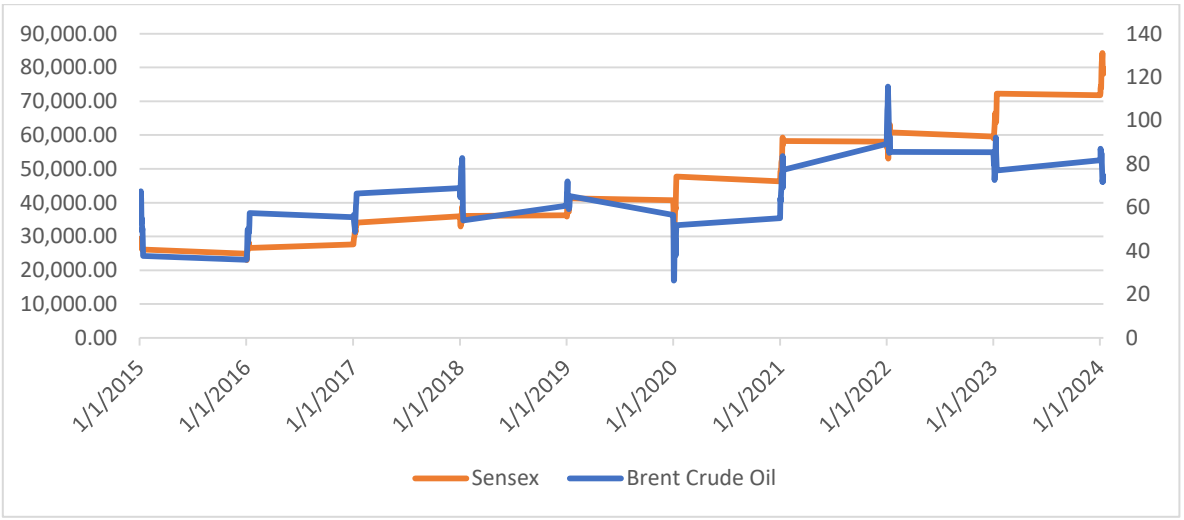

Figure 2: Line Chart of Crude Oil Price & BSE Sensex

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Interpretation:

The Sensex has shown a consistent upward trend over the decade, even during periods of significant crude oil price fluctuations. For instance: During the COVID-19 period in April 2020, crude oil price fell to 19.33, and the Sensex dropped to ₹27,611.74. By May 2022, crude oil price had increased to 115.6, and the Sensex had recovered to ₹55,566.41. Despite higher crude oil prices post-2021, the Sensex continued rising, reaching ₹78,139.01 by December 2024. This suggests that the Indian stock market is resilient to global oil price shocks in the long term. Factors such as economic reforms, strong corporate earnings, foreign investment, and domestic demand play a more dominant role in driving the Sensex than oil price alone.

c) Crude Oil Price vs Nifty 50

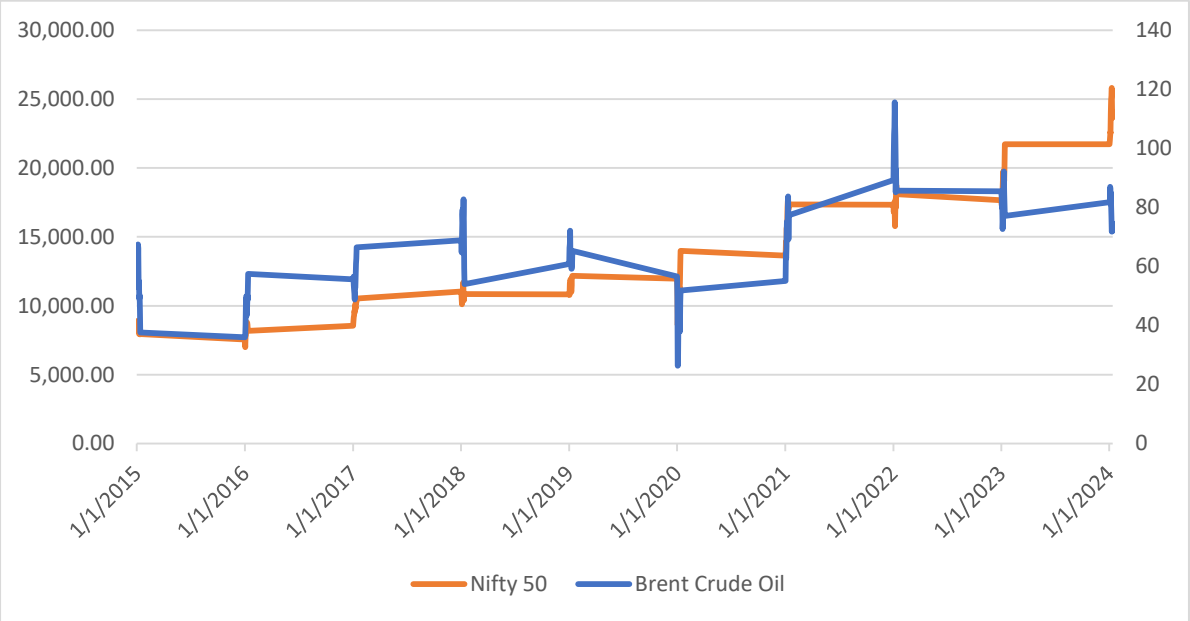

Figure 3: Line Chart of Crude Oil Price & Nifty 50

Interpretation:

The Nifty 50 index follows a trend similar to the Sensex, showing strong growth regardless of crude oil price movements. For example: In January 2021, crude oil price was around 56.24, and Nifty stood at ₹14,590.70. By December 2024, with crude oil price around 74.84, Nifty rose to ₹23,644.80. This suggests that although crude oil price spikes may cause short-term corrections, the overall growth of the Nifty index is driven more by economic fundamentals, monetary policy, and investor sentiment. Crude oil price does not appear to have a strong long-term impact on the broader equity market represented by Nifty 50.

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d) Crude Oil Price vs CPI % (Inflation Indicator)

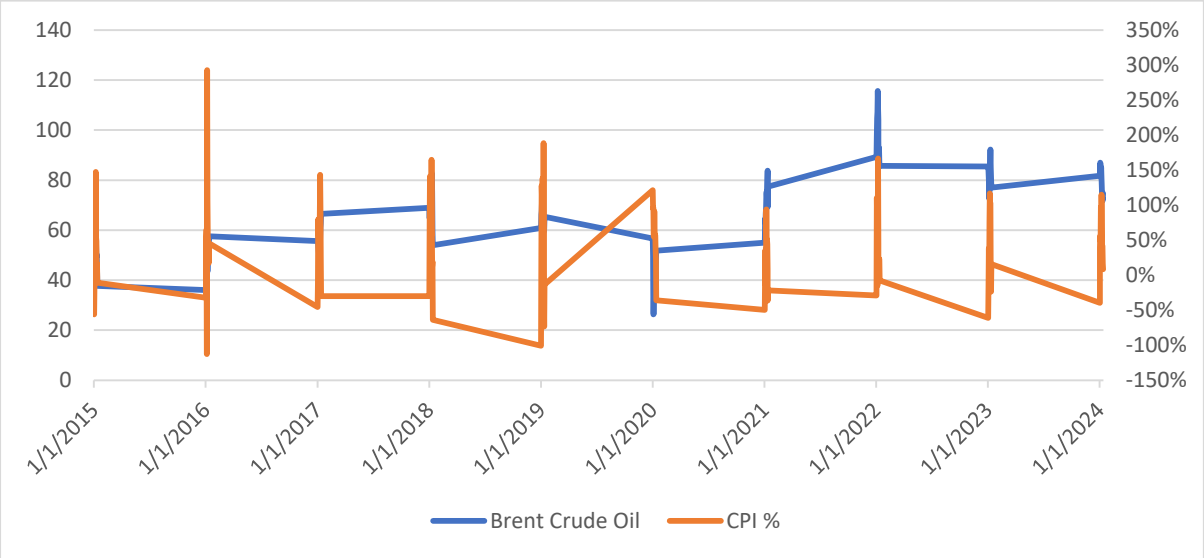

Figure 4: Line Chart of Crude Oil Price & CPI %

Interpretation:

The relationship between crude oil price and CPI % is irregular and lacks consistency across the 10-year period. For instance: In June 2022, crude oil price was 109.03, and CPI % peaked at 167%, suggesting a high inflation period. However, in January 2023, despite crude oil price being high at 85.43, CPI % dropped sharply to –77%. These fluctuations indicate that crude oil price alone does not determine inflation levels in India. Inflation, as measured by CPI %, is heavily influenced by food prices, domestic fuel pricing policies, subsidies, and seasonal supply factors. There may also be a lagged effect of crude price on CPI, and other inflationary drivers could dominate at different times.

3. Correlation Analysis

Table 2: Correlation Matrix of Variables

	Brent Crude Oil	*Exchange rate*	*Sensex*	*Nifty 50*	*CPI %*
Brent Crude Oil	1				
Exchange rate	0.580339954	1			
Sensex	0.696570488	0.911482087	1		
Price	0.694478626	0.901727912	0.999148068	1	
CPI %	-0.021662394	-0.066558997	-0.060674201	-0.055279083	1

(Source: Author's calculations using data from Investing.com, and MOSPI)

Interpretation

The correlation matrix illustrates the strength and direction of the linear relationship between Brent Crude Oil prices and key Indian macroeconomic indicators — namely, the exchange rate (₹/USD), Sensex, Nifty 50, and CPI % — over the 10-year period from 2015 to 2024.

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The correlation coefficient of Crude Oil Price & Exchange Rate is 0.5803, indicating a moderate positive relationship.This suggests that as crude oil prices rise, the Indian Rupee tends to depreciate against the US Dollar, likely due to the increased import burden on the Indian economy. The correlation of price of Crude Oil & Sensex is 0.6965, a moderately strong positive relationship. This might initially seem counterintuitive, but it reflects the fact that both crude oil prices and stock indices tend to recover together during global economic expansion phases. It may also indicate investor optimism in sectors benefiting from global growth, despite rising oil prices.

The correlation of price of crude oil with Nifty 50 i.e. 0.6945 is very close to that with Sensex, as expected, since both indices are highly interlinked. It shows a similar moderate to strong positive association, supporting the interpretation that the stock market's longer-term trend is not adversely disrupted by crude price volatility. The correlation is very weak (0.0216) between crude oil price and CPI %, indicating almost no linear relationship between oil prices and consumer inflation percentage. This suggests that CPI in India is influenced more by factors such as food prices, policy interventions, and seasonal variation, rather than crude oil alone.

Sensex & Nifty 50: Extremely strong correlation (0.9991) — consistent with market structure. Sensex & Exchange Rate: Strong positive correlation (0.9115) — indicating that currency depreciation might coincide with bullish market phases (possibly due to FII behavior). CPI % shows slight negative correlations with all other variables — none of which are statistically meaningful.

4. Regression Analysis

Table 3: Regression Results

Dependent Variable	Independent Variable	Coefficient (β)	t-Statistic	p-Value	R^2
Exchange rate	*Brent Crude Oil*	0.223768638	7.741041629	3.73058E-12	0.336794463
Sensex	*Brent Crude Oil*	651.4057133	10.54608361	1.01043E-18	0.696570488
Nifty 50	*Brent Crude Oil*	194.2725114	10.48482148	1.41319E-18	0.482300562
CPI %	*Brent Crude Oil*	0.00075551	0.235369065	0.814330285	0.000469259

(Source: Author's calculations using data from Investing.com, and MOSPI)

Interpretation

The regression analysis explores the impact of Brent Crude Oil prices on four key macroeconomic indicators of India: Exchange Rate (₹/USD), Sensex, Nifty 50, and CPI %, over the period from 2015 to 2024. The findings indicate that crude oil prices have a statistically significant effect on the exchange rate, Sensex, and Nifty 50, but an insignificant impact on CPI %.

For the exchange rate, the regression coefficient (β) is 0.2238, meaning that a 1-unit increase in crude oil price is associated with a ₹0.22 depreciation in the Rupee. This relationship is statistically significant with a t-statistic of 7.74 and a p-value of 3.73×10^{-12}, and the model

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explains 33.67% of the variation in the exchange rate ($R^2 = 0.3368$). This suggests that rising crude prices put upward pressure on the exchange rate due to higher import costs.

In the case of the Sensex, the coefficient is 651.41, indicating that each unit increase in crude oil price results in a ₹651.41 rise in the Sensex index. The t-statistic (10.54) and extremely low p-value (1.01×10^{-18}) confirm strong statistical significance, and the R^2 value of 0.6966 implies that nearly 70% of the variation in Sensex is explained by crude oil price changes. This could reflect a broader global economic expansion or investor sentiment that moves in tandem with rising crude prices.

Similarly, for the Nifty 50, the coefficient is 194.27, supported by a high t-statistic (10.48) and a significant p-value (1.41×10^{-18}), suggesting a positive and meaningful influence of crude oil price on the index. The R^2 value of 0.4823 indicates that around 48% of the variation in Nifty can be attributed to fluctuations in oil prices, reinforcing the index's sensitivity to global commodity trends.

In contrast, the analysis of CPI % reveals a very weak and statistically insignificant relationship with crude oil prices. The coefficient is 0.00076, with a t-statistic of only 0.24 and a p-value of 0.8143, far above acceptable thresholds for significance. The R^2 value is virtually negligible at 0.0005, indicating that crude oil price changes have no meaningful explanatory power over inflation trends in India during the period studied. This suggests that inflation is likely driven by domestic factors such as food prices, seasonal effects, and monetary policy, rather than global oil price movements.

FINDINGS OF THE STUDY

a) Crude oil prices have a significant positive impact on the exchange rate, with rising oil prices leading to a depreciation of the Indian Rupee. ($R^2 = 0.3368$, $p < 0.001$)

b) Sensex and Nifty 50 both show strong positive relationships with crude oil prices, indicating that stock market indices tend to rise alongside oil price increases. (Sensex ($R^2 = 0.6966$), Nifty 50 ($R^2 = 0.4823$), both $p < 0.001$).

c) The relationship between crude oil prices and CPI % (inflation) is statistically insignificant, showing negligible influence of global oil prices on domestic inflation trends. ($R^2 \approx 0.0005$, $p = 0.81$)

d) Correlation and regression analyses confirm that crude oil is a strong predictor of stock market and exchange rate movements, but not of inflation.

e) Visual trends and statistical data consistently support the conclusion that oil price volatility affects currency and equity markets more than consumer prices.

SUGGESTIONS

- The government needs to increase investment and policy incentives on solar, wind, and biofuel industries to lower India's dependence on imported crude oil, promoting long-term energy security.
- The Reserve Bank of India needs to keep track of international crude oil trends while designing exchange rate policies, as movements in the price of oil have a substantial impact on the value of the rupee.
- Industries, particularly transport and manufacturing, need to embrace more energy-efficient and cleaner technologies to curb oil consumption and shield production costs against price shocks.

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- Financial advisors and regulators need to inform investors about the crude oil sensitivity of stock indices to ensure they make well-informed investment choices.
- Even though crude oil may not directly affect CPI inflation, indirect effects exist. The government should ensure timely subsidy distribution and price control mechanisms to manage such inflationary pressures.

CONCLUSION

This research investigated the effect of Brent Crude Oil prices on Indian macroeconomic variables—i.e., exchange rate (₹/USD), Sensex, Nifty 50, and CPI inflation—through monthly data covering 2015 to 2024. The results indicate crude oil prices significantly and positively affect the exchange rate and stock market indices with higher effects recorded on Sensex and Nifty 50. From these findings, it can be concluded that changes in crude oil prices are a significant determinant of financial market volatility and depreciation of the currency in an oil-importing nation like India. It is also found that domestic inflation is influenced more by internal factors like food prices and fiscal policy than by global crude oil movements.

The research is of use to policymakers, financial experts, and investors. It highlights the imperative for strategic energy planning, better foreign exchange management, and higher investor knowledge of oil-linked risks. While global oil prices are still unpredictable, their macroeconomic influence continues to be important for India's economic well-being and prosperity.

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