

Crude Oil Price Volatility and Its Impact on Indian Financial Markets: An Econometric Analysis

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Abstract

Crude oil is a vital commodity in both international and domestic economies, being the most traded commodity globally. Price movements of crude oil have profound effects on financial markets, industry performance, and exchange rate regimes. This research explores the complex relationship between crude oil prices and major financial indicators in India, such as the Nifty 50 Index, the Nifty Auto sector, the Nifty Energy sector, and the USD/INR exchange rate. Utilizing sophisticated econometric methods like correlation analysis, Ordinary Least Squares (OLS) regression, Granger causality, and the ARCH-GARCH model, this study examines a ten-year data set to evaluate the influence of crude oil price fluctuations. The results reveal strong positive correlation between crude oil prices and the Nifty 50, Nifty Auto, and Nifty Energy indices, which indicate that increases in crude oil prices stimulate growth in these market segments. On the other hand, a high negative correlation is found between crude oil prices and the USD/INR exchange rate, reflecting that oil price hikes are responsible for currency devaluation. The research also finds a one-way impact of the Nifty Auto sector and the USD/INR exchange rate on crude oil prices, which highlights possible predictive relationships. These findings have significant implications for policymakers, investors, and financial analysts as they offer greater insight into how crude oil price volatility affects market stability and exchange rate volatility. The research emphasizes the importance of risk management mechanisms in financial markets to counter the negative impacts of crude oil price shocks.

Keywords: Crude Oil Prices, Financial Markets, Exchange Rate Volatility, Econometric Analysis, Stock Market Indices.

JEL Codes: G12, G15, Q43, C58, F31.

INTRODUCTION

Crude Oil is also well known as Black Gold. India is one of the world's fastest rising economies, with a GDP growth rate of 8.7% in FY 2022 (Ministry of Statistics). There are many factors that influence our country's economic progress. Examples include human resources, physical capital, natural resources, and technology. The first Oil resources in India were discovered in 1889, near the town of Digboi in the state of Assam. India's natural gas sector began in the 1960s, with the discovery of gas resources in Assam and Gujarat. Natural gas gained further significance after ONGC discovered large supplies in the South Basin areas in the 1970s. The Oil is removed from the Krishna Godavari, which is 30 kilometres away from the coast of Kakinada. The stock market, often known as the financial market, has contributed significantly to the country's development. Crude Oil is essential to a country's development since it serves as a foundation for industrial advancement. Crude Oil accounts for 90% of all transportation Energy. The Crude Oil market has increased significantly in recent years. It will increase from \$2,829.69 billion in 2023 to \$2,998.39 billion in 2024, with a compound annual growth rate (CAGR) of 6.0%. (Upadhyay, 2019) The association between Oil prices and the Indian stock market, which is frequently analysed using the NIFTY 50 Index, Nifty Auto Indices, Nifty Energy indices and USD/INR exchange rate, sheds light on market dynamics. The NIFTY 50 Index, which was introduced in 1996, is made up of 50 important firms listed on the National Stock Exchange and serves to guide investment decisions while also reflecting general market performance. The study of Crude Oil prices in dollars, as well as the analysis of the dollar-rupee exchange rate, would be more useful in understanding the influence of Oil prices on stock markets. (Mondal, Debasish, 2015) Exchange rates and the price of Crude Oil are also, at least in theory, related. With the exception of OPEC nations, rising Oil prices have the potential to widen the current account deficit,

which raises the currency rate. This calls for fiscal adjustment, which could have an effect on the exchange rate. A rise in Oil prices will decrease spending on Oil and thus the demand for dollars, which will raise the exchange rate if price elasticity of Oil in Oil importing countries is greater than one. The purpose of the study is to find out the causal relationship between the price of Crude Oil and the movements of the selected NSE Indices like Nifty 50 Index, Nifty Auto, Nifty Energy Sectors and the USD/INR exchange rate. One commodity that is crucial to a nation's development is Crude Oil, and in the past few years, there has been a lot of volatility in the price of Crude Oil. Many businesses are impacted by changes in the price of Crude Oil, including cement, oil marketing companies, paints, tires, aircraft, and oil exploration.

LITERATURE REVIEW

(Chowdhury, 2024) Used impulse response analysis and ARIMA modeling to assess the empirical significance of asymmetry in responses to Oil price shocks in Oil-exporting emerging nations. It acknowledged prior research's methodological limitations, but found significant evidence of inequalities in output and government expenditure responses. The findings provided valuable insights into the spread of Energy price shocks and emphasized the necessity of fiscal restraint, countercyclical fiscal policy, an independent monetary authority, and institutional quality improvement to improve resilience to Oil shocks in these economies.

(Sadeesh, 2023) Examined the study on growth, performance and relationship of Nifty 50, Auto Index, Pharma Index, bank Index and fmcg Index in the Indian stock market using descriptive statistics and correlation analysis. It relied on secondary data from the NSE website, observing that accuracy and dependability may be limited. While focused on the period from January 2018 to December 2023, which may not include the most recent market changes, the study shed light on market efficiency and interrelationships between Indexes. By analyzing trends and correlations, it helped to better understand sectoral efficiency and Index linkage dynamics in the Indian stock market, emphasizing market volatility and the significance of monitoring new data for informed investing decisions.

(Basha, 2023) Aimed to understand the study on price behavior of Crude Oil, Gold, Nifty, and India VIX through multivariate analysis, utilizing regression statistics and ANOVA. The study has short observation period from January 2014 to December 2018 and a lack of detailed methodology exposition, significant findings were revealed. The study found a positive correlation between Gold and Crude Oil prices in most instances, with occasional instances of negative correlation. Recommendations included simultaneous buying and selling of Gold and Crude Oil to mitigate risk, with exceptions noted for specific market conditions. Additionally, the findings showed a negative correlation between India VIX and Gold, Crude Oil, and the Nifty Index, implying potential implications for stock market volatility

(Thomas, 2023) Emphasized the study on identifying Oil supply news shocks and their influence on the global Oil market, with a particular emphasis on the role of expectations in spreading these shocks and their effects on macroeconomic indicators. Using a non-causal VAR (1,2) model, it solved the no fundamentality issue with regard to Oil price swings and recovered structural shocks. Environmental restrictions and Energy-transition regulations presented challenges that influenced Oil production capacity investment decisions and future supply predictions. A non-causal VAR model was used to analyse the propagation of Oil market shocks, taking into account Heteroskedasticity.

(MARATHE, 2022) Investigated the study on relationship between Crude Oil prices and the economies of the BRICS nations. The study aimed by using a comprehensive technique that includes correlation, regression analysis, unit root test (ADF), Johansen cointegration test, Granger causality test, VECM, impulse response function (IRF), and ARCH-GARCH model. It analyzes 13 macroeconomic variables that influence Crude Oil prices, demonstrating a lengthy and steady link among the BRICS countries. In Brazil and Russia, the Granger causality test reveals significant directional correlations. The study also investigates the transmission of volatility between Crude Oil prices and BRICS stock market results. It examines the impact of structural events on Crude Oil and stock market indices, emphasizing the post-crisis period's increased sensitivity to shocks.

(Vats, 2022) Conducted a study on relationship between macroeconomic variables and its impact on Nifty sectorial indices. The study aimed to investigate the relationship between macroeconomic variables (LIPI, LGDPI, LER, LINFR, and MSM2) and NSE sectoral indices, utilizing descriptive statistics, ADF tests, OLS regression, VECM

modeling, and Granger causality tests. The study period is from 2011 to 2021, hence the study is of cross-sectional data. Despite acknowledging limitations such as the exclusion of certain macroeconomic indicators and the impact of the COVID-19 pandemic without pre and post analysis, the study contributed to understanding the interactions in India's stock market. The finding indicates that the stationarity of variables is at level and linear correlations from LIPI to AUTO, BANK and PHRAMA sectors, showing sector-specific influences. The study emphasized the importance of macroeconomic variables in producing NSE sectoral Indexes, providing information for policymakers and investors to make informed decision

(Bhat, 2022) Conducted a study on volatility of Crude Oil prices for Oil price prediction-Indian scenario. The study aims to examine Crude Oil price volatility in India using OLS, cointegration tests, and VAR models. Monthly data were used, however daily data may have improved prediction accuracy. While macroeconomic statistics were primarily relied on, microeconomic components have been left out, potentially restricting understanding. They emphasized the need for government intervention to avoid Crude Oil usage, a potential rewrite of the Petroleum Act, and a decrease in excessive gasoline taxes. The suggestions included socially conscious government initiatives, Oil companies following the law, and retail operations being directed to enhance the quality and cost of Crude Oil products while avoiding theft.

(S, 2022) Conducted a study on cointegration analysis of Crude Oil prices in India and the Nifty Auto Index returns. The study objective was to examine the relationship between Crude Oil prices in India and NIFTY AUTO Index returns using a linear regression model, ADF, and the Granger causality test. While the analysis focuses solely on the long-term influence of the Nifty Auto Index, it ignores other stock market sectors. The study Emphasize that its dependence on a 10 years secondary data collection can affect data accuracy and dependability. Considering the use of econometric methodologies such as co-integration analysis, the study fails to take into account larger impact factors on Nifty Auto Index results. However, the study finds a significant long-term relationship between Crude Oil prices and Nifty Auto Index returns, underscoring the importance of Oil price variations on the success of the automotive sector in the stock market.

(Akbulayev, 2022) The study investigated the impact of Energy prices, particularly those of Crude and Brent Oil, on stock indices in Brazil, India, Russia, and Turkey over the COVID-19 period spanning from February 2020 to December 2021. A substantial association between Oil prices and stock Indexes was discovered by researchers using techniques such as the Granger causality test and the Vector Autoregressive (VAR) model. Natural gas prices, didn't see any significant change. The study discovered that changes in Brent Oil prices influenced Brazilian and Indian stock Indexes, whereas Crude Oil prices affected all indices studied. They also verified that WTI Crude Oil prices impacted the Indian stock market.

(Le Thanh Ha, 2022) The study focused on the impact of the Russia-Ukraine war on the stock market, gold, and Oil volatility between January 2018 and April 2022. Researchers investigated the relationships between these markets throughout the conflict period beginning on February 24, 2022, using a TVP-VAR model. They discovered that the interplay between these marketplaces was greatly affected by the shock of the war. The primary transmitters of shocks were found to be the Oil and gold markets, with Oil having a significant influence on the transmission of negative impacts to other markets. The goal of the study was to provide policymakers with information about these impacts so they could create plans to control market volatility.

(Sreenu, 2022) The study examined the impact of Crude Oil price volatility on stock market returns in India between March 2008 and March 2020. It examined if the impacts varied depending on the state of the market and concentrated on measuring this uncertainty using the Oil price volatility Index (OPVI). The study found that OPVI modifications significantly impacted Indian stock returns negatively, particularly during price decreases. It's interesting to note that positive OPVI shocks were discovered to have a bigger impact than negative ones. The study also demonstrated how a 2012 legislation intended to decrease India's control over domestic Crude Oil pricing helped mitigate the positive effects of OPVI shocks on stock returns.

(Malik, 2022) This study used a variety of statistical tests to investigate the relationship between Crude Oil prices, USDINR exchange rates, and stock market performance in India from 2011 to 2021. It did this by concentrating on weekly data and certain NSE sectoral indicators in order to comprehend both short- and long-term trends. The results

showed that USD/INR had a short-term negative effect on the Energy, pharmaceutical, and banking sectors, suggesting chances for investors to diversify their portfolios. It's interesting to note that while COVID-19 had a mixed effect on several industries, including Energy and IT, metals, and Pharma, it had a positive impact on the pharmaceutical industry.

(Rahman, 2022) The study examined the relationship between the price of Crude Oil and the stock markets in Norway and Sweden between 2000 and 2019. Notwithstanding certain constraints, such as the absence of previous investigations on the Swedish stock market and the study's exclusive concentration on two Nordic nations, significant findings appeared. In contrast to several former studies, the Swedish stock market exhibited a weaker positive association with Crude Oil prices, whereas the Norwegian stock market showed a positive link with Crude Oil prices, supporting prior findings. According to the study, while these associations might not hold true everywhere, they might be significant for Nordic economies that are comparable to one another. It also emphasized Norway's short-term economic gains from rising Oil prices.

(Muhammad , 2022) The study aimed to fill in knowledge gaps and make recommendations for improvements by reviewing previous research on the connection between stock market results and Oil price volatility. It concluded that there is a need for greater integration of institutional-level research in the current literature, which lacks a solid theoretical framework. It also highlights the significance of researching how variations in Oil prices impact other markets and industries independently. The study suggests using meta-analysis as a useful technique for properly summarizing research findings. Additionally, it points out that terms like "volatility" and "Oil price shocks" are commonly utilized, demonstrating the significance of these terms in study. Lastly, it lists the USA, China, the UK, France, and Tunisia as significant contributions to this field of study.

RESEARCH METHODOLOGY SCOPE OF THE STUDY

The scope of our study is limited to Dependent variables are Nifty 50 Index, Nifty Auto sector and the Nifty Energy sector & USD/INR Exchange rate and independent variable is Crude Oil Prices. However, there are many other factors that do have an impact of Crude Oil prices.

RESEARCH QUESTIONS, OBJECTIVES, PERIOD, TOOLS & TECHNIQUES, VARIABLES AND HYPOTHESIS OF THE STUDY

Research Question 1: Is there any relationship among Daily Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate

Research Objective 1: To study the significant relationship between Daily Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate

Period of the study: 6th Jan 2014 to 9th Jan 2024 (10 Years)

Tools and Techniques Used: Correlation Test

Variables: Dependent Variables - Nifty 50 Returns, Nifty Auto Returns, Nifty Energy Returns & USD/INR Exchange Rate Returns

Independent Variable - Crude Oil Returns

Hypothesis:

H0: There is no significant relationship between daily Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

H1: There is a significant relationship between daily Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Research Question 2: Do daily prices of Crude Oil have any significant impact on Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Research Objective 2: To study the significant impact of daily prices of Crude Oil on Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Period of the study: 6th Jan 2014 to 9th Jan 2024 (10 Years)

Tools and Techniques Used: Regression (Ordinary Least Square Model – OLS Model)

Variables: Dependent Variables - Nifty 50 Returns, Nifty Auto Returns, Nifty Energy Returns & USD/INR Exchange Rate Returns

Independent Variable - Crude Oil Returns

Hypothesis:

H0: There is no significant impact of Daily Crude Oil prices on Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

H1: There is a significant impact of Daily Crude Oil prices on Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Research Question 3: Is there any causal relationship between Crude Oil price and Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate?

Research Objective 3: To investigate the presence of short run causal relationship between daily Crude Oil prices and Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Period of the study: 6th Jan 2014 to 9th Jan 2024 (10 Years) Tools and Techniques Used: Granger Causality Test

Variables: Dependent Variables - Nifty 50 Returns, Nifty Auto Returns, Nifty Energy Returns & USD/INR Exchange Rate Returns

Independent Variable - Crude Oil Returns

Hypothesis:

H0: There is no Causal relationship between Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

H1: There is Causal relationship between Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

DATA ANALYSIS AND INTERPRETATION

DESCRIPTIVE STATISTICS

Descriptive statistics have been used in order to describe the features of the series data that has been considered for the study.

	Crude Returns	Oil Returns	Nifty Returns	50 Nifty Returns	Auto Returns	Nifty Returns	Energy Returns	USD/INR Returns
Mean	0.084882	0.050871	0.051990	0.061069	0.012010			
Median	0.023961	0.081628	0.095624	0.094632	0.000607			
Maximum	346.5504	8.400295	9.899664	8.281801	2.837345			
Minimum	-34.57270	-13.90376	-14.90552	-10.21667	-2.311532			
Std. Dev.	7.555527	1.052068	1.382587	1.313619	0.405631			
Skewness	39.39528	-1.377221	-0.570855	-0.666022	0.269346			
Kurtosis	1810.560	23.25759	13.67786	9.524312	7.010866			
Jarque-Bera	3.33E+08	42579.37	11748.25	4517.238	1668.430			
Probability	0.000000	0.000000	0.000000	0.000000	0.000000			
Observations	2445	2445	2445	2445	2445			
<i>Source: Author's Compilation</i>								

Table Descriptive Statistics

No. 1:

From the above table, it can be inferred that the mean value of Crude Oil returns is 0.084882 during the study period, i.e., from January 6, 2014, to January 9, 2024. Whereas the Nifty 50 returns are 0.050871, the Nifty Auto returns are 0.051990, the Nifty Energy returns are 0.061069, and the USD/INR exchange rate returns are 0.012010. Which means the sum of all the observations divided by the total number of observations.

The median value of Crude Oil returns during the study period is 0.023961. Whereas the median values of Nifty 50 returns, Nifty Auto returns, Nifty Energy returns, and USD/INR exchange rate returns during the period of the study are 0.081628, 0.095624, 0.094632, and 0.000607, respectively. When we look at the median values, we can say that all the median values of the variables are somewhere close to the mean values.

The maximum and minimum return values can also be obtained from the above table.

The maximum return values are Crude Oil returns of 346.5504, Nifty 50 returns of 8.400295, Nifty Auto returns of 9.899664, Nifty Energy returns of 8.281801, and USD/INR The exchange rate return of 2.837345 refers to the highest return value during the study period.

minimum return values are Crude Oil returns of -34.57270, Nifty 50 returns of -13.90376, Nifty Auto returns of

-14.90552, Nifty Energy returns of -10.21667, and USD/INR exchange rate returns of -2.311532, which refers to the lowest return value recorded during the study period.

Standard deviation measures the dispersion or variability of returns around the mean. The standard deviation of Crude Oil returns is 7.555527, which shows more variation in data, and the standard deviation of Nifty 50 returns is 1.052068. Whereas the Nifty Auto returns are 1.382587, which indicates more variation in data, the Nifty Energy returns are 1.313619, which indicates more variation in data, and the USD/INR exchange rate return is 0.405631, which tells us less variation in data. Whereas the average standard deviation should be between 0 and 1.

Skewness is used in order to describe asymmetry from the normal distribution of a set of data. From the above table of descriptive statistics, it is found that Crude Oil returns are 39.39528 and USD/INR returns are 0.269346, which says that both the return series are positively skewed. And Nifty 50 returns are -1.377221, Nifty Auto returns are 0.570855, and Nifty Energy returns are -0.666022, respectively, which says that all three variables are negatively skewed. Which signifies the data is not normally distributed. Whenever Skewness is zero, it is said that data is normally distributed.

Kurtosis is a measure that tells whether the data are more peaked or flatter relative to a normal distribution. The Kurtosis coefficient of the normal distribution is 3. If the value of Kurtosis is above 3, it is leptokurtic; if the value of Kurtosis is below 3, it is Platykurtic; and if the value of Kurtosis is equal to 3, it is Mesokurtic. In the above descriptive statistics table, the kurtosis value of Crude Oil returns is 1810.560, Nifty 50 returns are 23.25759, Nifty Auto returns are 13.67786, Nifty Energy returns are 9.524312, and USD/INR exchange rate returns are 7.010866, respectively, which state that $k > 3$, and if the k value is more than 3, it is called a leptokurtic. Here, all the return series kurtosis values are greater than 3. Which indicates the curve is more peaked.

From the Jarque-Bera test, we can tell whether the residuals are normally distributed or not. We look for the Jarque-Bera test only if we have a large number of observations. Since in our study we have a large number of observations, we look for the Jarque-Bera test in order to check for normality. The null hypothesis for the normality test is that there is a normal distribution, and the alternate hypothesis is that there is no normal distribution. If the p-values are less than 0.05, we reject the null hypothesis. In the above table, we can see that all the p-values of the variables are less than the 0.05 critical value; hence, we reject the null hypothesis, which means that the residuals are not normally distributed and do not comply with the Classical Linear Regression Model (CLRM).

AUGMENTED DICKEY FULLER TEST (ADF)

Table No. 2 Unit Root Test

Variables	ADF Value	Probability Value	Decision
Crude Oil returns	-49.12126	0.0001	Reject the Null Hypothesis
Nifty 50 returns	-17.52431	0.0000	Reject the Null Hypothesis
Nifty Auto returns	-47.92875	0.0001	Reject the Null Hypothesis
Nifty Energy returns	-48.74465	0.0001	Reject the Null Hypothesis
USD/INR Exchange rate	-40.39685	0.0000	Reject the Null Hypothesis
Source: Author's Compilation			

Table 2 above exhibits the result of the ADF test. The ADF test is carried out with the null hypothesis of non-stationary (unit root). It can be seen that all the variables, such as Crude Oil returns, Nifty 50 returns, Nifty Auto returns, Nifty Energy returns, and USD/INR exchange rate returns, are stationary at the 1% level of significance, which means we can reject the null hypothesis and conclude that the return series are stationary.

CORRELATION TEST

Objective 1: To study the significant relationship between daily Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate

Correlation means relationship between two variables. When the variables increase or decrease in same direction it means that there is positive correlation and vice versa. Correlation coefficient ranges between -1 to +1 which indicates that there is perfectly negatively and positive correlation respectively and if it is zero it indicates that the variables are random and there is no relationship between them.

Variables	Crude Oil returns	Correlation
Crude Oil returns	1	
Nifty 50 returns	0.058833***	Positive Correlation
Nifty Auto returns	0.034948*	Positive Correlation
Nifty Energy returns	0.034250*	Positive Correlation
USD/INR returns	-0.039447*	Negative Correlation
Source: Author's Compilation		
Note: *, **, and *** indicates significance at 10%, 5% and 1% respectively.		

Hypothesis:

H0: There is no significant relationship between daily Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate

H1: There is a significant relationship between daily Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate

Table No. 3: Correlation Test

The above table 3 of the correlation test displays the result of the correlation analysis for Crude Oil returns and Nifty 50 returns, Nifty Auto Returns, Nifty Energy Returns & USD/INR Exchange rate Returns.

Since in the above table the strength of the relationship is 0.0588329, i.e., 5%, indicating a positive correlation between Crude Oil returns and Nifty 50 returns. This means that when Crude Oil returns increase, Nifty 50 returns also increase, and when Crude Oil returns decrease, Nifty 50 returns also decrease.

The strength of the relationship between Crude Oil returns and Nifty Auto returns is 0.0349483, i.e., 5%, indicating a positive correlation between Crude Oil returns and Nifty Auto returns. This means that when Crude Oil returns

increase, Nifty Auto returns also increase, and when Crude Oil returns decrease, Nifty Auto returns also decrease.

The strength of the relationship between Crude Oil returns and Nifty Energy returns is 0.0342504, i.e., 5%, indicating a positive correlation between Crude Oil returns and Nifty Energy returns. This means that when Crude Oil returns increase, Nifty Energy returns also increase, and when Crude Oil returns decrease, Nifty Energy returns also decrease.

The strength of the relationship between Crude Oil returns and USD/INR returns is -0.039446, i.e., 5%, indicating a negative correlation between Crude Oil returns and USD/INR returns. This means that when Crude Oil returns increase, USD/INR returns also increase, and when Crude Oil returns decrease, USD/INR returns also decrease.

REGRESSION ANALYSIS (ORDINARY LEAST SQUARE MODEL)

Objective 2: To study the significant impact of daily prices of Crude on Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Ordinary least square (OLS) regression or linear least square is a statistical method of analysis which estimates the impact of Crude Oil returns (Independent variable) on Nifty 50 returns, Nifty Auto returns, Nifty Energy returns & USD/INR Exchange rate returns. (Dependent variable).

Hypothesis:

H0: There is no significant impact of Daily Crude Oil prices on Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

H1: There is a significant impact of Daily Crude Oil prices on Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Table No. 4: Regression Analysis (Ordinary Least Square Model – OLS Model)

Variable	Coefficient	Std. Error	t-Statistic	Adjusted R ²	Prob.	D W Stat.
Nifty 50 returns						
Crude Oil returns	0.008192	0.002812	2.912964	0.003053	0.0036	2.014572
Nifty Auto returns						
Crude Oil returns	0.006395	0.003700	1.728437	0.000813	0.0840	1.940136
Nifty Energy returns						
Crude Oil returns	0.005955	0.003516	1.693880	0.000764	0.0904	1.975332
USD/INR returns						
Crude Oil returns	-0.002118	0.001085	-1.951231	0.067494	0.0511	2.009788

Note: Dependent variable: Nifty 50 returns, Nifty Auto returns, Nifty Energy returns & USD/INR exchange rate returns. & **Independent variable:** Crude Oil returns.

Source: Author's Compilation

The above table 4 shows the impact of daily Crude Oil prices on Nifty 50 returns, Nifty Auto returns, Nifty Energy returns, and USD/INR returns. Here the dependent variables are Nifty 50 returns, Nifty Auto returns, Nifty Energy returns, and USD/INR returns, and the independent variable is Crude Oil returns.

It is found that Crude Oil returns are having a significant impact on Nifty 50 returns at 1% level of significance (at a 99% confidence limit). When the p-value is less than the critical value of 0.05, we say it is significant. In the above table, we can see that the p-value is 0.0036, which is less than 0.05; hence, we say that Crude Oil returns are having a significant impact on Nifty 50 returns.

The Crude Oil returns are having a significant impact on Nifty Auto returns at 10% level of significance (at the 90% confidence limit). When the p-value is less than the critical value of 0.05, we say it is significant. In the above table, we can see that the p-value is 0.0840, which is more than 0.05; hence, we say that Crude Oil returns are having a significant impact on Nifty Auto returns.

The Crude Oil returns are having a significant impact on Nifty Energy returns at 10% level of significance (at the 90% confidence limit). When the p-value is less than the critical value of 0.05, we say it is significant. In the above table, we can see that the p-value is 0.0904, which is more than 0.05; hence, we say that Crude Oil returns are having a significant impact on Nifty 50 returns.

The Crude Oil returns are having a significant negative impact on USD/INR returns at 5% level of significance (at the 95% confidence limit). When the p-value is less than the critical value of 0.05, we say it is significant. In the above table, we can see that the p-value is 0.0511, which is more than 0.05; hence, we say that Crude Oil returns are having a significant impact on USD/INR returns.

The adjusted R-squared is 0.003053, which indicates that only 0.30% variation in Nifty 50 returns can be explained by Crude Oil returns. The adjusted R-squared is 0.000813, which indicates that only 0.08% variation in Nifty Auto returns can be explained by Crude Oil returns. The adjusted R-squared is 0.000764, which indicates that only 0.07% of the of the variation in Nifty Energy returns can be explained by Crude Oil returns and The adjusted R-squared is 0.067494, which indicates that only 6.75% of the of the variation in USD/INR returns can be explained by Crude Oil returns.

The coefficient of Crude Oil returns is 0.008192. This indicates that a 1% change in Crude Oil returns will cause a 0.008192 change in Nifty 50 returns, as it is significant at the 1% level. The coefficient of Crude Oil returns is 0.006395. This indicates that a 1% change in Crude Oil returns will cause a 0.006395 change in Nifty Auto returns, as it is significant at the 1% level. The coefficient of Crude Oil returns is 0.005955. This indicates that a 1% change in Crude Oil returns will cause a 0.005955 change in Nifty Energy returns, as it is significant at 1% level and the coefficient of Crude Oil returns is -0.002118. This indicates that a 1% change in Crude Oil returns will cause a - 0.002118 change in USD/INR returns, as it is significant at the 1% level. Hence, it has a significant negative impact.

The value of Durbin Watson is 2.014572. Usually, the value should be close to 2, which means that there is no Autocorrelation. When it is said that the model should be close to 2, it is restricted to a certain limit. The value should not be less than 1.5 and not more than 2.5.

In the model, it can be seen that the Durbin Watson value of Nifty 50 returns is 2.014572 and USD/INR returns are 2.009788. Which tells us there is no Autocorrelation. The value of Nifty Auto returns is 1.940136, and Nifty Energy returns are 1.975332. Which tells us there is positive Autocorrelation; thus, it complies with the CLRM assumption.

5 GRANGER CAUSALITY TEST

Objective 3: To investigate the presence of short run causal relationship between daily Crude Oil prices and Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

The Granger Causality Test states the impact of one variable on another variable. It also explains whether past events will influence future events. The most important condition for the Granger causality test is that all the variables should be stationary. The lags to be included for the variables under the study have been found with the help of VAR lag

selection criteria.

This test is performed to investigate the presence of short run causal relationships between daily Crude Oil returns and Nifty 50 returns, Nifty Auto returns, Nifty Energy returns & USD/INR exchange rate returns.

Hypothesis:

H0: There is no causal relationship between Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

H1: There is causal relationship between Crude Oil prices, Nifty 50 Index, Nifty Auto Index, Nifty Energy Index & USD/INR Exchange rate.

Table No. 5: Granger Causality Test (At 2 Lags)

Null Hypothesis	F-Statistic	Prob.	Decision	Relationship
Crude Oil Returns Does Not Granger Cause Nifty 50 Returns	21.2626	7.E-10	Reject	Bi-directional relationship
Nifty 50 Returns Does Not Granger Cause Crude Oil Returns	4.02286	0.0180		
Crude Oil Returns Does Not Granger Cause Nifty Auto Returns	19.6939	3.E-09	Reject	Uni-directional relationship
Nifty Auto Returns Does Not Granger Cause Crude Oil Returns	0.99984	0.3681	Accept	
Crude Oil Returns Does Not Granger Cause Nifty Energy Returns	31.4267	3.E-14	Reject	Bi-directional relationship
Nifty Energy Returns Does Not Granger Cause Crude Oil Returns	7.29805	0.0007		
Crude Oil Returns Does Not Granger Cause USD/INR Returns	3.48536	0.0308	Reject	Uni-directional relationship
USD/INR Returns does not Granger Cause Crude Oil Returns	1.75788	0.1726	Accept	
Source: Author’s Compilation				

From the above table 5. The Uni-directional & Bi-directional relationship can be noticed between Crude Oil returns and Nifty 50 returns, Nifty Auto returns, Nifty Energy returns, and USD/INR exchange rate returns.

The probability values when we calculate the impact of Crude Oil returns on Nifty 50 returns are 7.E-10 (0.00000000007) and Nifty 50 returns on Crude Oil returns are 0.0180, which is ultimately less than 0.05 at the 5% significance level, which means that the null hypothesis is rejected and there is a bi-directional relationship. Therefore,

there is a causal relationship between Crude Oil returns and Nifty 50 returns.

The probability values when we calculate the impact of Crude Oil returns on Nifty Auto returns are $3.E-09$ (0.0000000003) which is less than 0.05 at the 5% significance level and Nifty Auto returns on Crude Oil returns are 0.3681, which is more than 0.05 at the 5% significance level, which means that the null hypothesis is rejected and there is a Uni-directional relationship. Therefore, there is a causal relationship between Crude Oil returns and Nifty Auto returns.

The probability values when we calculate the impact of Crude Oil returns on Nifty Energy returns are $3.E-14$ (0.000000000000003) and Nifty Energy returns on Crude Oil returns are 0.0007, which is less than 0.05 at the 5% significance level, which means that the null hypothesis is rejected and there is a bi-directional relationship. Therefore, there is a causal relationship between Crude Oil returns and Nifty 50 returns.

The probability values when we calculate the impact of Crude Oil returns on USD/INR Exchange rate returns are 0.0308 which is less than 0.05 at the 5% significance level and USD/INR Exchange rate returns on Crude Oil returns are 0.1726, which is more than 0.05 at the 5% significance level, which means that the null hypothesis is rejected and there is a Uni-directional relationship. Therefore, there is a causal relationship between Crude Oil returns and Nifty Auto returns.

FINDINGS

The current study is an attempt to Probe the impact of Black Gold influence on the Nifty 50 Index, Nifty Auto sector, Nifty Energy sector and the USD/INR Exchange rate. For the purpose of normality of data, returns of each data set is being used in the study period from 6th January 2014 to 9th January 2024.

The Crude Oil prices, Nifty 50, Nifty Auto, Nifty Energy, and USD/INR exchange rates were found to be stationary.

Crude Oil had the maximum average return, whereas the USD/INR exchange rate had the minimum average return.

The Nifty Auto had the maximum median value, whereas the USD/INR exchange rate had the minimum median value.

Crude Oil has more variations in data as compared to the other variables.

The USD/INR exchange rate has less variation in data as compared to other variables. Crude Oil returns and USD/INR returns are positively skewed.

Nifty 50 returns, Nifty Auto returns, and Nifty Energy returns are negatively skewed. Therefore, the series is asymmetric.

In the present study, all the variables fall under the Leptokurtic range since the kurtosis value of all the variables is above 3.

It was found that the residuals were not normally distributed and do not comply with the Classical Linear Regression Model (CLRM).

There is a positive correlation between Crude Oil returns and Nifty 50 returns. There is a positive correlation between Crude Oil returns and Nifty Auto returns. There is a positive correlation between Crude Oil returns and Nifty Energy returns. There is a negative correlation between Crude Oil returns and USD/INR returns.

It is found that Crude Oil returns are having a significant impact on Nifty 50 returns

It is found that Crude Oil returns are having a significant impact on Nifty Auto returns

It is found that Crude Oil returns are having a significant impact on Nifty Energy returns

It is found that Crude Oil returns are having a significant negative impact on USD/INR returns. The Adjusted R-squared indicates that:

Only 0.30% variation in Nifty 50 returns can be explained by Crude Oil returns. Only 0.08% variation in Nifty Auto returns can be explained by Crude Oil returns. Only 0.07% variation in Nifty Energy returns can be explained by Crude Oil returns. Only 6.75% variation in USD/INR returns can be explained by Crude Oil returns.

Results shows that a 1% change in Crude Oil returns will cause 0.008192% change in Nifty 50 returns. It is found that a 1% change in Crude Oil returns will cause 0.006395% change in Nifty Auto returns, It is found that a 1% change in Crude Oil returns will cause 0.005955% change in Nifty Energy returns.

It is found that a 1% change in Crude Oil returns will cause -0.002118% change in USD/INR returns, which has a negative impact.

The Durbin Watson value of Nifty 50 returns is 2.014572 and USD/INR returns are 2.009788. Which tells us there is no Autocorrelation.

The value of Nifty Auto returns is 1.940136, and Nifty Energy returns are 1.975332. Which tells us there is positive Autocorrelation thus, it complies with the CLRM assumption.

There is Bi-directional relationship between Crude Oil returns and Nifty 50 returns. There is Uni-directional relationship between Crude Oil returns and Nifty Auto returns There is Bi-directional relationship between Crude Oil returns and Nifty Energy returns

There is Uni-directional relationship between Crude Oil returns and USD/INR exchange returns.

CONCLUSION

Stock market indices can be used to estimate our country's economic development. The Indian economy's performance barometer is Nifty 50. A variety of factors influence a country's economic growth, one of which is Crude Oil, which impacts the Nifty 50, Nifty Auto, Nifty Energy, and USD/INR exchange rates. The study investigates the causal relationship and impact of Crude Oil on the Nifty 50, Nifty Auto, Nifty Energy, and USD/INR exchange rates. The study is based on secondary data. The study period was from January 6, 2014, to January 9, 2024. The study employs a variety of methods, including descriptive statistics, unit root, the OLS model (regression analysis), correlation, Granger causality, and the ARCH and GARCH models. The dependent variables are Nifty 50 Index, Nifty Auto Index, Nifty Energy Index and USD/INR exchange rates. Whereas the independent variable is Crude Oil.

Descriptive statistics indicate that Nifty IT returns have the highest average returns, while Crude Oil returns have the highest volatility. The kurtosis and Skewness data indicate that the variables above are not normally distributed. The unit root rejected the null hypothesis, indicating that all variables are stationary at level. The study reveals that Crude Oil returns have a significant impact on Nifty 50, Nifty Auto, and Nifty Energy returns and USD/INR exchange rate returns. Crude Oil returns have a Bi-directional causal relationship between Nifty 50 and Nifty Energy returns, but there is a Uni-directional relationship between Crude Oil returns, Nifty Auto, and the USD/INR exchange rate returns. The regression study (OLS model) indicates that Crude Oil returns have a significant impact on Nifty 50, Nifty Auto, and Nifty Energy returns, as well as a negative impact on USD/INR exchange rates. While the OLS model explains a small percentage of the variation in the dependent variables (Nifty 50, Nifty Auto, Nifty Energy, and USD/INR exchange rate returns), it sheds light on the direction and size of the relationship with Crude Oil returns. The Durbin-Watson test shows that the Nifty 50 and USD/INR exchange rate returns have no Autocorrelation. However, the Nifty Auto and Nifty Energy returns have positive Autocorrelation. The study reveals that Crude Oil returns have a significant impact on Nifty 50, Nifty Auto, and Nifty Energy returns, but no significant causal relationship is found between Crude Oil returns and USD/INR exchange rate returns.

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