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## Article

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## Nexus between Crude Oil, Exchange Rate and Stock Market Returns: An Empirical Evidence from Indian Context

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### ABSTRACT

Crude oil is considered as 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 analyse the monthly observations from April 1, 2003 to March 31, 2019 with the help of Co integration, Granger causality, Variance Decomposition. The overall findings of the study indicate a significant effect of Crude oil on 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 Stock Market.

**Keywords:** Crude Oil, Exchange Rate, Stock Market Returns, Co-integration, Variance Decomposition

**JEL Classifications:** E3, F31, Q4

### 1. INTRODUCTION

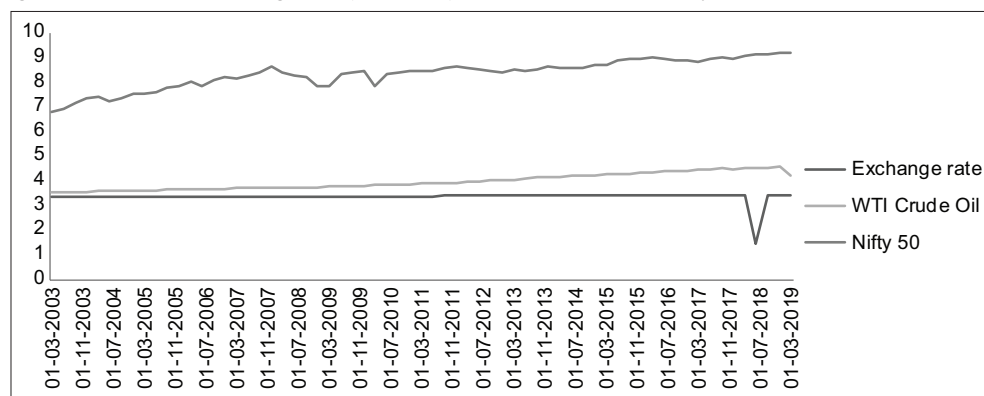
Crude Oil is seen as a significant resource for the economy. Changes in Oil prices influence all facets of the economy in political, economic and commercial terms, etc. In the last few years, oil has influenced the Indian economy in a number of ways, and the stock market is considered to be one of the main factors that have impacted the economy in recent years. Owing to the rise in crude oil prices, the exchange rate will have an impact and will lead to changes in the macro-economic conditions of the importing countries. Thus, the relationship between the exchange rate and Crude Oil makes it possible to understand the stock market of any country.

Theoretically, changes in Crude Oil price can affect stock market in two different ways. First, if there is an increase in production costs as Crude Oil price increases, the other factor remains the same which will adversely reduce the company's earnings. Second, if only selling price increases due to the increase in Crude Oil price which

will result in lower demand for the product and again adversely affect the earnings. So in both scenarios the economy will face various long-term and short-term challenges. The entire scenario depends on one factor being Exchange rate. So the relationship between Crude Oil, Exchange rate and Stock Market will be defiantly arises.

Figure 1 indicates the fluctuations occurred in Exchange rate (USD/INR), WTI Crude Oil and Nifty 50. We can clearly elaborate the changes caused due to change in Crude oil leads to change in Exchange rates and Nifty 50 index. That's make this study more important to investigate the relationship between the variables.

Oil price affects economies in various ways, including supply side shock, demand side shock, transfer of wealth from oil importing countries to exporting countries, oil price shocks, change in production structure and decrease in investment Expenditure (Abdalla and Abdelbaki, 2014). In the past literature it has been theoretically explained the interlinkages between Crude Oil

**Figure 1:** Logarithmic Trend of Exchange rate (USD/INR), WTI Crude Oil and Nifty 50 from March 1, 2003 to March 1, 2019

Source: Authors Computation

and Exchange rate. Which includes (Caprio and Clark, 1981), (Golub, 1983), (Krugman, 1980) Whereas they have attempted to explain that as the price of crude oil increases the value of the dollar decreases so that they share an inverse relationship. The exchange rate and share price shares reverse relationship because it will attract more Foreign Institutional Investors as the domestic currency depreciates, and the demand will rise which will lead to higher share prices and vice versa. Devaluation will help the country export more and import less while in appreciation it exports more and less. Devaluation for the exporting countries and appreciation for the importing countries is therefore always considered better.

It's an important study which will help to understand the dynamic relationship between Exchange rate, Crude Oil and Stock Market. Additionally, India is considered as a developing nation which will continue to grow and prosper in the global economy. Our study is divided into five sections. This includes literature review in second section to find out the gap. Third section deals with Research Methodology and design. Further; Fourth section elaborates the analysis and findings of the results and finally section five concludes the study.

## 2. LITERATURE REVIEW

The relationship between Crude Oil, Exchange rate, and Stock prices has always attracted the researcher and academicians from late 90's. (Pogue, 1921) Studied the price index of Oil stocks in USA and concluded that there is a relationship between Crude Oil prices and Stock Market. Whereas (Bjornland, 2008; Constantinos et al., 2010; Constantinos et al., 2010; Ono, 2011) explained the impact on the Stock Market of Oil price shocks. They claimed that it would lead to changes in Macroeconomic variables as Crude Oil fluctuates and contributes to changes in returns of the stock market.

Similarly, (Salma, 2015; Mohamed, 2011; Fatima and Bashir, 2014; Jennings, 2012; Nath and Samanta, 2003; Sahu et al., 2014), Investigated the effects of crude oil prices on the stock market and argued that the impact of Crude Oil price changes on sectoral stock market indices is significant. Additionally, (Oskooe, 2012; Barragan et al., 2013; Gulathi and Khakani, 2012; Kutty, 2010; Pathak, 2009), explained the volatility caused by changes in crude

oil prices using the GARCH model for oil exporting countries and stated that the price of oil did not result in a variation in stock returns. Inversely, (Jain, 2013), (Gatuhi, 2013), (Ratti and Hasan, 2013), (Alsalman, 2013) It has been stated that the relationship between variables is positive. Thus the changes in the price of oil will affect the exchange rate and returns of the Stock Market.

The relationship between Crude Oil and Stock Market is also influenced by various shocks in terms of Demand side shock, Supply side shock, or any other shocks that have resulted in changes in Crude Oil prices and Stock market returns. (Hamma et al., 2014), (Unalmis et al., 2012), (Abhyankar et al., 2013; Carstensen et al., 2013; Li et al., 2015; Caporale et al., 2015; Tian, 2016; Kilian and Park, 2009; Kilian, 2009; Malarvizhi and Jaya, 2012; Masih et al., 2011; Shirodkar, 2017) It stated that there is an impact on the stock market of the Crude Oil price shock as well as a variability in the sectoral returns on the Stock Market.

The relationship between Crude Oil and Exchange rate is also the major concern among the researchers in twentieth century. There are many articles which have studied the relationship between them and found that there is positive as well as negative relationship among the variables. This studies includes (Kaushik et al., 2014; Adam et al., 2018; Arfaoui and Rejeb, 2017; Sahu et al., 2014; Gocekli, 2015; Beckmann et al., 2017; Qiang et al., 2019; Fratzscher et al., 2014; Hidayathulla and Mahammad, 2014; Pavlova, 2011; Siddique, 2014; Zhang, 2013). All the study concludes that there is a relationship between the Crude oil and Exchange rate.

Whereas many studies has focused on all the three aspects including Crude Oil, Exchange rate (USD/INR) and Stock Market returns which includes (Rastogi, 2016; Sathyanarayana et al., 2017; Singh and Kapil, 2016; Basher et al., 2010; Najaf and Nazaf, 2016; Poornima and Ganeshwari 2013; Zakaria and Shamsuddin, 2012), Concludes that the exchange rate, Crude Oil and stock-market returns are related.

The present study tries to see in the Indian Context the similar relationship between the variable. The study attempted to examine the dynamic interactions between Crude Oil Prices, USD/INR exchange rates and Nifty Index in Indian economy. Understanding the integration among these variables is of utmost importance as India is heavily dependent on crude oil imports. In 2018 India

ranked third in terms of oil imports dollar value worth of \$114.5 billion (9.7%) crude oil. A very small portion of the prior literature has been focused on understanding the simultaneity of oil prices, exchange rate, and stock market returns, especially for India alone. It is very crucial to consider the simultaneity of these factors so that investors, portfolio managers and policy makers can make better choices. This paper is a novel attempt to explore the dynamics between WTI crude oil prices, USD / INR exchange rates, and Nifty Index in Indian economy.

### 3. MATERIAL AND METHODS

The research aims to analyze the complex relationship between Nifty Index, the USD/INR Exchange rate, and WTI Crude oil prices per barrel (dollars), using monthly data from April 1, 2003, to March 31, 2019. We have use closing returns of Nifty Index, West Texas Intermediate (WTI) oil price per barrel (in dollars), USD/INR Exchange rate which is used to trade in Crude Oil and with the help of this we analyzed the data.

#### 3.1. Unit Root Test

Before proceeding with any econometric tool, it is crucial to determine the Stationarity of the Variables. In time series we always face a problem of non-stationarity series. When the observations are correlated with its own lags and mean and variance are not constant over the period of time then the variable

**Table 1: Unit root test (Augmented Dickey-Fuller test)**

Instrument/Indices	At levels	At first difference
Nifty index	1.356 (0.955)	-10.227 (0.000)
USD/INR exchange rate	1.150 (0.935)	-10.123 (0.000)
WTI crude oil price	-0.729 (0.399)	-8.239 (0.000)

**Table 2: Granger Causality Test between Nifty Index, the USD/INR Exchange rate, and WTI Crude Oil prices**

Null hypothesis	F-Stat	p-value	Result
Rupee/Dollar Exchange rate does not Granger cause Nifty Index	4.659	0.003	Rejected
Nifty Index does not Granger cause USD/INR Exchange rate	5.105	0.002	Rejected
WTI Crude oil prices does not Granger cause Nifty Index	2.663	0.040	Accepted
Nifty Index does not Granger cause WTI Crude oil prices	3.347	0.020	Rejected
WTI Crude oil prices does not Granger cause USD/INR Exchange rate	3.119	0.027	Rejected
USD/INR Exchange rate does not Granger cause WTI Crude oil prices	0.944	0.420	Accepted

Source: Authors Computation

**Table 3: Result of Johansen Co-integration Test**

Hypothesised number of cointegrating equations	Eigen value	Trace statistics	Critical value at 5% (P-value)	Maximum Eigen statistics	Critical value at 5% (P-value)
None	0.097067	25.22924	29.7970 (0.1534)	16.23499	21.13162 (0.2114)
At most 1	0.054340	8.994250	15.4947 (0.3659)	8.883668	14.26460 (0.2960)
At most 2	0.000695	0.110582	3.84146 (0.7395)	0.110582	3.84146 (0.7395)

\*Denotes rejection of the hypothesis at the 0.05 level

under study is non stationary. Whereas to transform the series from non-stationary into stationary the difference stationary process is used. The regression equation of the same is as follows:

$$\Delta(\Delta Y_{\text{unit}}) = \alpha + \delta \Delta Y_{-} + e$$

#### 3.2. Granger Causality Test

The Granger Causality test is used to study the causal relationship between variables empirically. It helps to determine whether one series is useful in estimating and forecasting the other series. In the bivariate framework if  $Y_1$  causes  $Y_2$  means the forecast for  $Y_2$  will improve when the lag of  $Y_1$  is taken into consideration.

#### 3.3. Johansen Co-integration Test

For investigating the long term relationship between Crude Oil, Stock market returns and Exchange rate. Johansen's co-integration test has been used. In this test we study the co-integrating properties of independent variables with dependent. If the stationary variables having a linear combination and integrated at the same order then these variables are called Co-integrated.

#### 3.4. Variance Decomposition or Forecast Error Variance Decomposition (FEVD)

The variance decomposition or Forecast Error Variance Decomposition (FEVD) is used in econometric and multivariate time series analysis. It indicates that the information of each variable contributes to the other variable in auto regression. Determines how much exogenous shocks to the other variables can explain the variances in forecast error of each variable.

### 4. ANALYSIS AND DISCUSSION

All variables are non-stationary at the level where the p-value is more than 0.05%. As a result, we conduct the Unit Root Test in the first difference. All the series are stationary at a 1% level of significance at the first difference (Table 1). Since all variables are integrated in the same order we could proceed with the Co-integration to explore the long-term relationship between the Nifty Index, the WTI Crude Oil Prices and the USD/INR Exchange rate.

The results of Granger Causality for Nifty Index, the USD/INR Exchange rate, and WTI Crude oil prices are shown in Table 2. There is a bi-directional causality among the USD/INR Exchange rate and the Nifty Index, since the p-value is less than 5 per cent. It could be inferred that in the short run, stock market is affected by the USD/INR Exchange rate and vice versa. We could also observe a Bi-directional causal link among Nifty Index and WTI Crude oil prices. However, there exists a unidirectional causality flowing from Crude oil prices to Exchange rates.

Table 3 displays Co-integration test estimates. The test was performed by taking appropriate lag interval as 1 to 2, chosen according to the optimum lag length criterion. The outcome of Co-integration test indicates the absence of cointegrating vectors at 5% significance level. Therefore, the null hypothesis of no Co-integration cannot be rejected at 5% significance level. Thus, no long-term co-integrating relationship exists between these variables. Therefore, in an unrestricted framework, we applied the VAR model to forecast the joint dynamics and causative relationships between the Nifty Index, the USD/INR Exchange rate, and Crude oil prices (Table 4).

$$\text{NIFTY} = C(1) * \text{NIFTY}(-1) + C(2) * \text{NIFTY}(-2) + C(3) * \text{USD/INR}(-1) + C(4) * \text{USD/INR}(-2) + C(5) * \text{WTI CRUDE OIL}(-1) + C(6) * \text{WTI CRUDE OIL}(-2) + C(7) \quad (1)$$

$$\text{USD/INR} = C(8) * \text{NIFTY}(-1) + C(9) * \text{NIFTY}(-2) + C(10) * \text{USD/INR}(-1) + C(11) * \text{USD/INR}(-2) + C(12) * \text{WTI CRUDE OIL}(-1) + C(13) * \text{WTI CRUDE OIL}(-2) + C(14) \quad (2)$$

$$\text{WTI CRUDE OIL} = C(15) * \text{NIFTY}(-1) + C(16) * \text{NIFTY}(-2) + C(17) * \text{USD/INR}(-1) + C(18) * \text{USD/INR}(-2) + C(19) * \text{WTI CRUDE OIL}(-1) + C(20) * \text{WTI CRUDE OIL}(-2) + C(21) \quad (3)$$

In Equation 1, Lag (1) and Lag (2) coefficient of Nifty Index are C (1) and C (2) for which the probability values are 0.000 and 0.007, respectively. Since the associated p-values are <0.05%, it is possible to reject the null hypothesis that Nifty lag (1) and lag (2) are not significant to influence Nifty. Therefore it could be inferred that past values of Nifty Index influence Nifty's monthly closing rates.

Further, in equation two, lag (1) lag (2) coefficient of the Nifty Index is significant. This implies that the Nifty Index has a significant impact on the USD/Rupee Exchange rate. Coefficients associated with lag (1) and lag (2) of USD/INR Exchange rate are significant. This explains that USD/INR Exchange rate is affected by its own past values.

(Lag 1 and Lag 2) coefficient of Nifty Index and (Lag 1 and Lag 2) coefficients of WTI Crude Oil prices are significant in Equation 3. Therefore it states that the Nifty Index and past WTI Crude oil values are useful to understand the WTI Crude oil prices. Coefficients derived through VAR model estimation may not be

**Table 4: VAR coefficients and probabilities**

Coefficients	P-value	Coefficients	P-value
C (1)	0.000***	C (12)	0.177
C (2)	0.007***	C (13)	0.353
C (3)	0.240	C (14)	0.958
C (4)	0.170	C (15)	0.000***
C (5)	0.397	C (16)	0.001***
C (6)	0.338	C (17)	0.158
C (7)	0.686	C (18)	0.346
C (8)	0.003***	C (19)	0.000***
C (9)	0.002***	C (20)	0.000***
C (10)	0.000***	C (21)	0.005***
C (11)	0.014***		

\*, \*\*, \*\*\* Denote significance at 10%, 5%, 1% respectively

**Table 5: Estimates of variance decomposition**

Variance decomposition of:	Period	Percentage of forecast error variance explained by innovation in:		
		Nifty index	WTI Crude oil	USD/INR Exchange rate
Nifty index	1	100.0000	0.000000	0.000000
	2	99.53439	0.311798	0.153810
	3	99.26621	0.494331	0.239454
	4	99.19805	0.546418	0.255532
	5	99.23738	0.525596	0.237020
	6	99.31852	0.473424	0.208058
	7	99.40287	0.416024	0.181110
	8	99.46915	0.369646	0.161199
	9	99.50623	0.344492	0.149279
	10	99.50870	0.346961	0.144339
WTI crude oil	1	3.067125	96.93288	0.000000
	2	1.305519	98.29946	0.395016
	3	0.885615	98.19039	0.923996
	4	0.659076	97.79081	1.550113
	5	0.524891	97.20648	2.268629
	6	0.500357	96.43594	3.063700
	7	0.603348	95.48439	3.912258
	8	0.840714	94.36969	4.789596
	9	1.210722	93.11653	5.672747
	10	1.706243	91.75170	6.542058
USD/INR exchange rate	1	0.029356	0.248307	99.72234
	2	2.879120	0.153876	96.96700
	3	5.949819	0.568031	93.48215
	4	8.546622	1.222960	90.23042
	5	10.65044	1.980214	87.36935
	6	12.35846	2.781663	84.85988
	7	13.76423	3.603227	82.63254
	8	14.93740	4.433461	80.62914
	9	15.92639	5.265096	78.80851
	10	16.76461	6.092051	77.14334



sufficient to describe the complex relationship between variables. Therefore variance decomposition is applied.

Table 5 estimates the variance decomposition of the WTI Crude Oil price, USD/INR exchange rate and stock prices in India under the VAR framework. Nifty Index closing prices are extremely endogenous in nature since approximately 99.50% of its own variances are explained by their own short- and long-term shocks, whereas the explanatory powers of oil prices and exchange rates to forecast Nifty's error variance are considered insignificant. The Nifty Index is strongly affected by its past values.

It is interesting to note that Nifty explain 3.06% of forecast Error Variance in WTI Crude Oil Prices in short-run, whereas it is reduced to 1.70% in the long run. Further, it could be noted that USD/Rupee exchange rate explains 6.54% of Forecast Error Variance in Crude Oil Prices in the long run. This suggests that Crude oil prices are strongly Exogenous as 91.75% of the Forecast Error Variance is explained by its own values in the long run, and they are weakly influenced by the Nifty Index and USD/INR Exchange rate.

The forecast error variances are USD/INR Exchange rate is significantly explained by the value of Nifty, i.e. by 16.74% in the long run. This implies that USD/INR Exchange rate is relatively less exogenous as we could observe that there is a gradual increase in the Forecast Error variance in Exchange rate explained by Nifty Index and Crude oil prices over a period of time.

## 5. CONCLUSION

The study attempted to examine the dynamic interactions between Crude Oil Prices, USD/INR exchange rates and Nifty Index in India. The findings of the Co-integration test indicate that there is no long-term relationship between the variables. The lack of long-term relationships between these variables is consistent with existing literature (Kumar, 2014; Nath and Samanta, 2003; Basher et al., 2010; Adebisi et al., 2010; Agrawal, 2010; Dhaoui and Khraief, 2014; Huang et al., 1996; Hussin et al., 2012; Imarhiagbe, 2010; Olufisayo, 2014).

The output of the USD/INR exchange rate forecast error variance is significantly explained by the Nifty value, i.e. 16.74%. This indicates that USD/INR exchange rates are guided by the performance of the stock market. The findings of the study show a significant impact of the Nifty Index on the Foreign USD/INR Exchange rate. Over a period of time, SEBI has liberalised the rules to allow for free foreign investor entry and exit. The Growth of the Indian stock market has attracted more and more investors from around the world, which in turn increases the demand for local currency. This Growth in demand, in turn, pushes up the value of the currency.

The overall findings of the study also indicate a significant impact of Crude oil on 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. Given the lack of literature analysing the integration

among oil prices, exchange rate, and stock market returns in India; this paper can motivate further research in this area.

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