Impact of Crude Oil Prices - coupled with Exchange Rate movements - on Indian Stock Market

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ABSTRACT

Crude oil imports constitute more than one-fifth of India's imports, and consequently affect the Indian economy significantly. The purpose of this paper is to understand how oil price changes affect the Indian stock market and economy. BSE Sensex is chosen as the ideal parameter to reflect movement in Indian stock market and economy, and Brent Crude quotations to represent the Crude Oil price. Various statistical tools and econometric tools have been applied on monthly information of Crude Oil prices, US$-INR conversion scale and Sensex movements, over last ten years, collected from different websites.

Keywords
Brent Crude, Sensex, Exchange Rate

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Introduction

Crude Oil price is an essential factor in determining volatility in stock prices. A rise in oil price may improve trade balance in oil exporting countries and thus increase current account surplus, resulting in a stronger currency. However, a rise in oil price may negatively impact trade balance and create a deficit in current account of importing countries, thereby affecting their currency. India being an unrefined petroleum importing country, any rise in unrefined petroleum price impacts both the economy and the stock market of the country, apart from affecting the rate of exchange.

(Krugman, 1983), (Golub, 1983): In countries importing oil, if elasticity of Crude Oil price is found to be more than 1, any increase in oil price reduces expenditure on Crude Oil, simultaneously increasing the demand for dollar and affecting the conversion scale.

A. Objectives

- To analyse the impact of changes in crude oil cost on stock market and conversion scale.
- To establish long-term link, if any among stock market, crude oil cost and conversion scale.
- To establish short-run connect, if any among the three factors.

B. Hypotheses Used

- For Unit Root Test, we use hypothesis testing to find out if the variables are stationary or not.
- To conduct Johansen Cointegration test, we need to perform hypothesis testing to find out if there exists a cointegrating equation in the long run.
- For establishing Granger Causality Test, hypothesis testing is used and short-run relationships among variables are tested.
- Correlation analysis uses hypothesis testing to determine if the values are statistically significant, i.e. there exists correlation in the population.
- Regression statistics uses theory testing to understand the variety in subordinate variable because of variety in free factor.

Crude Oil Price, Exchange Rate and BSE 500 all have time-series data and study of past papers and articles gives an idea on methods to be undertaken to define relationships between variables involving such data. The statistical tools enumerated above are used to study how each of the three variables affect the other two over a short and long period. We make forecasts for future based on past trends and analyse how each variable reacts to itself and other variables in the forecasted long and short terms.

Literature Review

Crude oil price, conversion scale and stock price coupled together have been subjected to a lot of attention from researchers, who want to draw out any linkage present among the three variables. Oil price affect the health of an economy, Crude Oil holds an important position in the commodities market and any change to this subject to shaping global economic and political development. Crude oil also happens to be world economy's most significant wellspring of vitality. Following are studies made in this domain:

(Hamilton, 1983): In this study, Granger Causality Test was applied and the impact of oil value driving forces on US economy was considered. The conclusion so obtained specified that oil price Granger Cause change in unemployment and Gross National Product.

(Solink, 1987): A significant negative connection between stock prices and conversion scale was reported.

(Ma, 1990) (Kao, 1990): There is a constructive outcome of cash devaluation on household securities exchange for a fare arranged/prevailing nation and negative impact of money

deterioration on local financial exchange of an import situated/predominant nation.

(Jorion, 1991), (Jorion, 1990), (Bodnar, 1993) (Gentry, 1993), (Bartov, 1994) (Bodnar, 1994): They could not discern a clear relationship between continuous dollar changes and returns for U.S. firms.

(Clarida, 1994) (Gali, 1994): A study of volatility in exchange rate through Vector Auto Regression Model was conducted. The study constituted of variables such as output levels, price changes and real exchange rate.

(Jones, 1996) (Kaul, 1996): They considered the effect of unrefined petroleum prices on securities exchanges by examining present and not so distant future fluctuations in income in anticipated comes back from the market.

(Sadorsky, 1999): Representing US organizations, connections among change in unrefined petroleum price unpredictability and financial exchange return show noteworthy and one of a kind changes in oil advertise because of oil stuns. This was performed using an unrestricted VAR Model.

(Granger et, 2000), (Chortareas et, 2000), (Apte, 2001), (Mishra, 2004): They established a clear positive relationship between price movement of securities and conversion scale fluctuations.

(Papapetrou, 2001): It was concluded that there would be a negative effect on stock prices, due to an oil price shock, as it negatively affects output and employment growth.

(Sadorsky, 2001): An exploration was led on Canadian organizations utilizing securities exchange record, vitality value, loan costs and trade rates as factors. It was discovered that oil organizations' profits are emphatically affected by financial exchange record and oil cost though the expansion in loan fee and trade rates has a negative effect.

(Maghyereh, 2004) (Ahktam, 2004): They refuted the view of **(Jungwook, 2008) (Ronald, 2008)** by utilizing VAR models. Their conclusions stated that unrefined oil cost shocks have no clear impact on index returns.

(Anoruo, 2007) (Mustafa, 2007): They tested and concluded that there was a long-term connect between stock market returns and unrefined petroleum prices in the US, during 1996 to 2006.

(Choi, 2008) (Fang, 2008) (Fu, 2008): Their report showed that there may not be any link (or may be at best a weak link) between stock price movements and conversion scale fluctuations.

(Jayasinghe, 2008) (Tsui, 2008): They have distinguished the connection between stock cost and swapping scale in Japan. They have contended that there is an overflow impact between the unpredictability of stock costs. They have attempted the examination for six businesses of Japan. In these parts the unpredictability of values expands considerably more than the instability of the conversion scales.

(Rong- Gang, 2008) (Yi-Ming, 2008) (Jian-Lin, 2008) (Ying, 2008): They searched out the connection between oil value stun and financial exchange of China utilizing VAR model. Their outcomes demonstrate which that oil value stuns have no critical effect on genuine stock returns of most Chinese securities exchange lists.

(Miller, 2009) (Ratti, 2009): Their examination of eventual connection between the oil costs and securities exchanges utilizing VECM show decisive outcomes, whereby a relationship is set up between unrefined petroleum cost and financial exchange returns.

(Narayan, 2010) (Narayan, 2010): The research was aimed at determining correlation between unrefined petroleum prices and stock market movements in Vietnam. He observed positive correlation between the two as well as exchange rate affecting stock market over a period of time in both long and short spans. The impact appeared to be statistically significant.

(Imarhiabel, 2010): He utilizes Vector-Error Correction Model for ascertaining the effect of Crude Oil prices on stock market returns. The outcomes affirm that oil costs and trade rates impact the stock market.

(Sharma et, 2012): This study analyses trend in unrefined petroleum prices and the elements affecting the prices. Their focus was on the impact of raw petroleum costs on Indian economy growth. Also, another aspect covered in the study is the association of oil price movements with inflation.

(Khan, 2013) (Yousuf, 2013): Their findings show a negative connect between stock market and conversion scale movements in Bangladesh.

(Fang, 2014) (You, 2014): VAR (Vector Auto Regression) has been used to analyze results when 70% Crude Oil was imported, and it is observed that no direct causal relationship could be identified.

(Saini, 2014) (Dhameja, 2014): Their examination utilizes factors, for example, worldwide occasions, returns on BSE Sensex, raw petroleum costs and intercession by RBI and shows the effect it has on trade rates. They find a negative connection between dollar and BSE Sensex execution.

(Kumar, 2014): An examination was performed to comprehend the effect of conversion standard and raw petroleum costs on Indian securities exchange. Results finish up a noteworthy positive effect of the two factors on financial exchange.

To summarize, we have established the fact that many papers have been written and numerous tests undertaken to examine the connect among Crude Oil prices, stock market and conversion scale in various countries. However, our focus for the purpose of the study is on BSE 500, Brent Crude price and exchange rate (US$-INR). Also, we can conclude that most of the researchers have used VAR, VECM and Variance Decomposition to determine their results believing it to be the most efficient form of computation for a time series analysis.

It has also been established that these methods are affirmative in determining impact of the variables in question with one another in both the long and short durations and in forming cyclical trends in a broader sense. The hypotheses used for the tests conducted by us are the same as those established in previous studies, so as to determine the deviations in results obtained with the current data, as compared to the previous studies.

Research Methodology

Data is collected from secondary sources through websites, such as BSE, Yahoo Finance and EIA. The time frame of the study is ten years; monthly data from April 2010 to March 2020 is taken. Month to month closing figures of S&P BSE 500 have been taken to represent Indian Stock Market. Brent Crude price (US$ per bbl.) has been used to

represent the oil cost for Indian economy. US$ is taken to be the remote money against which INR change scale is thought of. It has remained as influencing remote cash for trading oil through the hour of the examination.

The gathered information has been subjected to Unit Root covering ADF Test to check whether the arrangement is fixed or not. The optimal lag length choice, based on Schwarz Information Criteria (SIC), is essential to run autoregression model. Granger Causality Test has been administered on the data to determine whether one time series can be used to forecast another times series and short-term implications of the series. To comprehend the short run and a long run connection among factors, Johansen Cointegration Test as it is important to build up a long term connection either between or among factors is conducted; Vector Autoregression Test evaluated by Ordinary Least Squares (OLS) and Variance Decomposition examination is utilized on the arrangement so as to discover any stun or motivation in present moment and long haul. This analysis maps out the response path or forecast error variance of a variable due to exogenous shocks to other variables. Other tools used for data analysis are Trend Analysis, Correlation and Regression Analysis.

An analysis of the literature review clearly indicates the kind of tests used to demonstrate the relationship among the variables. These tests are clear indicators of relationship in both long and short terms. The tests used also map out one to one relationship of each variable with the other two. The tests also estimate shocks / fluctuations to the variables under normal market conditions and their impact in such a scenario.

All tests performed were conducted using EViews and the graphs drawn out using the 10-year data on unrefined petroleum prices, exchange rate and S&P BSE 500 values. The graphs have been constructed using Excel and EViews.

Results and Analysis

The first phase of the study deals in computing the basic statistical values which provides a background for the behavior of data used. Next we perform long-run and short-run analysis to examine the performance of the variables. We at that point explore the dynamic relationship among raw petroleum value, conversion standard and stock cost. Finally, we observe the trend of crude oil price over the period of time and establish correlation and regression output.

A. Descriptive Statistics

From the descriptive statistics, it is observed that there is no stability in terms of all three variables during the period. For unrefined petroleum price and conversion scale, the maximum quantities are 113.93 and 75.40. The base values for the same are 20.28 and 44.01 respectively, with a normal of 71.724 and 60.873. This difference in values also expose that the Indian stock market has been quite volatile during this period, suggesting that the variables lack normality. Measuring skewness, we notice exchange rate to be negatively skewed, whereas BSE 500 and Crude Oil price are positively skewed. Next, the Kurtosis values reflect that the variables are less inclined than in normal distribution. Jarque-Bera test results also confirm that no series is normal in nature.

TABLE I. DESCRIPTIVE STATISTICS

	BSE 500	$ US / Bbl	USD/INR
Mean	10443.090	71.724	60.873
Median	10558.630	67.805	63.583
Maximum	15846.200	113.930	75.400
Minimum	5778.680	20.280	44.010
Std. Dev.	3171.905	22.578	8.611
Skewness	0.249	0.067	-0.618
Kurtosis	1.613	1.672	2.215
Jarque-Bera	10.858	8.904	10.718
Probability	0.004	0.012	0.005

For conducting the long-term analysis, we have used Johansen Cointegration Test, to ascertain any long-term relationship among variables, assuming that such a relationship may exist. The test involves four sequential steps. Firstly, we check if the values are integrated in the same order, by conducting Unit Root tests. Secondly, we obtain the optimal lag for VAR Model to ascertain that the computed values are not auto-correlated. Thirdly, we conduct the Cointegration Test to determine any long-term relationship. Lastly, if no long-term relationship is observed, then we move on to check for a short-term relationship among variables.

For conducting short-term analysis, we have used Vector Autoregression Test, Variance Decomposition Test and Granger Causality Test.

B. Unit Root Test

For the purpose of the testing stationarity, we have used these hypothesis.

Hypothesis*:*

H_0: Unit Root exists; non – stationary
H_1: Unit Root does not exist; stationary

We conduct ADF test to check whether or not we can reject null. The data has been subjected to critical values at 1%, 5% and 10% levels of significance at both level and first difference.

From the results we observe that the null hypothesis cannot be rejected at level for both intercept and trend & intercept, implying that unit root exists. However, the null hypothesis can be dismissed after first difference, i.e. at I (1), implying that unit root does not exist. At first difference, H_0 is rejected even at 1% level of significance.

TABLE II. ADF TEST (FOR STATIONARITY)

Results					
Variables	Level		First Difference		Results
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	
BSE 500	-1.245508 [0]	-1.845543 [1]	-7.181881 [0]	-7.150886 [0]	I (1)
	-0.6529	- 0.6762	0.0000	0.0000	
Crude Oil	-0.758784 [0]	-2.000547 [0]	-8.710837 [0]	-8.759241 [0]	I (1)
	-0.8266	- 0.5948	0.0000	0.0000	
Exchange	-1.148791 [0]	-2.604561 [0]	-11.13815 [0]	-11.07671 [0]	I (1)
	-0.6946	- 0.2792	0.0000	0.0000	
Notes: [] Lag lengths; I (1): Stationary after first difference					

C. Choosing Optimal Lag Length

The auto-regressive model is responsive to optimal lag choice; we therefore compute correct lag length before applying Johansen Cointegration Test. Commonly, it is based on three criteria namely AIC, SIC and HQ. As we can see from the table **(Refer Annexure)** that every one of the three measures show a similar slack length, we select SIC to acquire ideal slack length. With the end goal of this investigation, the ideal slack length is taken as 1.

D. Johansen Cointegration Test

Cointegration test is performed on level form of data and not 1st difference.

Hypothesis:

H_0: No cointegrating equation exists.
H_1: There exists a cointegrating equation.
We use log transformation of variables to determine the output. The decision criteria for the test is rejection of H_O is if value of trace and Max-Eigen value statistics is <= 5% critical value, else we fail to reject H_O.

TABLE III. JOHANSEN COINTEGRATION TEST

Results				
Trace Test				
Number of Ces	Eigenvalue	Trace Statistic	5% Critical Value	Prob.**
None	0.094219	18.87984	29.79707	0.5016
At most 1	0.04455	7.202859	15.49471	0.5542
At most 2	0.01535	1.825305	3.841465	0.1767
Indication - No cointegration at 5%				
*Rejection of H_0 at 5%				
**p-values				
Maximum Eigenvalue				
Number of Ces	Eigenvalue	Max-Eigen Statistic	5% Critical Value	Prob.**
None	0.094219	11.67698	21.13162	0.5798
At most 1	0.04455	5.377555	14.2646	0.6936
At most 2	0.01535	1.825305	3.841465	0.1767
Indication - No cointegration at 5%				
*Rejection of H_0 at 5%				
**p-values				

As we can observe from the table that the probability for both trace and Max-Eigen value exceeds 5% critical value, therefore we accept null, i.e. no cointegrating equation exists. This implies that the series are not related and cannot be combined in a linear trend. We can therefore say that there is no long-run relationship among the variables. Therefore, we have used only the short-run model, i.e. VAR - instead of VECM.

E. VAR Model

This model is constructed only if variables are integrated of order 1 - meaning they are stationary after first difference. VAR must be specified in level and not in difference form. We have specified our VAR in log form. We found that the variables are not cointegrated; therefore, we only construct VAR model and not VECM. All the factors in a VAR framework are endogenous, there are no exogenous factors. The needy variable is an element of its slacked qualities and slacked estimations of different factors in the model. The VAR model is assessed by ordinary least squares (OLS). Interpretation of short-term coefficients is assuming other things being equal, and the inferences are based on OLS standard errors (defined in parentheses) and t-statistics (defined in square brackets). We have assumed the lag as 1 (as found during optimal lag selection) defined as (-1). The decision criteria being if t-statistics is close to 2, it implies a strong influence or poses as a strong predictor.

TABLE IV. VECTOR AUTOREGRESSION ESTIMATES

Results			
	LOG_500	LOG_Exchange	LOG_Oil
LOG_500(-1)	0.945279	0.000136	-0.000266
	(0.02912)	(7.30E-05)	(0.00033)
	[32.4580]	[1.85434]	[-0.80497]
LOG_Exchange(-1)	16.43000	0.951480	-0.131102
	(10.4513)	(0.02630)	(0.11867)
	[1.57205]	[36.1783]	[-1.10474]
LOG_Oil(-1)	0.163244	0.005492	0.918539
	(3.38006)	(0.00851)	(0.03838)
	[0.04830]	[0.64572]	[23.9328]
C	-404.6762	1.394656	16.06740
	(672.003)	(1.69103)	(7.63046)
	[-0.60219]	[0.82474]	[2.10569]

Interpretation: T-statistics of BSE 500 on itself is 32.4580. The past realization of BSE 500 is associated with 94.53% increase in itself on average ceteris paribus. T-statistics of Exchange Rate on itself is 36.1783 and BSE 500 on Exchange Rate is 1.85434. The past realization of Exchange Rate is associated with 95.15% increase in itself on average ceteris paribus. Also, a percentage increase in BSE 500 accounts for increase in Exchange Rate on average ceteris paribus. T-statistics of Crude Oil Price on itself is 23.9328. The past realization of Crude Oil Price is associated with 91.85% increase in itself on average ceteris paribus.

F. Variance Decomposition Test

Variance Decomposition examination is directed on the arrangement so as to discover any stun or drive in present moment and long-haul variable accounting to percentage variety in different factors. We now perform Variance Decomposition analysis for a period of 10 years. This basically means making future forecasts based on our period of study (past data) and as it is conducted taking yearly data, the period here would reflect number of years. The table shows influence of Variance Decomposition of BSE 500, conversion scale and unrefined petroleum prices, respectively. Across the rows, the data indicates percentage of forecast variance by the variable at the top head. This implies that each variable in the first part would tell percentage forecast of variance in BSE 500, the middle part of the table reflects percentage forecast of variance in exchange rate and the final part percentage forecast of variance in unrefined petroleum prices. For short-term relationship, we have checked the likelihood estimation of third year, and for the long-term relationship, we have checked the likelihood estimation of tenth year.

TABLE V. VARIANCE DECOMPOSITION TEST

Results				
Variance Decomposition of LOG_500:				
Period	S.E.	LOG_500	LOG_Exchange	LOG_Oil
1	555.3979	100	0	0
2	756.42	99.9337	0.066128	0.000171
3	894.0484	99.78197	0.217195	0.000838
4	998.2876	99.54811	0.449516	0.002374
5	1081.36	99.23662	0.758171	0.005206
6	1149.779	98.85297	1.137257	0.009778
7	1207.516	98.40332	1.580146	0.016534
8	1257.195	97.89437	2.079739	0.025893
9	1300.644	97.33306	2.628705	0.03823
10	1339.185	96.72645	3.219685	0.053865
Variance Decomposition of LOG_Exchange:				
Period	S.E.	LOG_500	LOG_Exchange	LOG_Oil
1	1.397607	27.92689	72.07311	0
2	1.899303	25.70242	74.26687	0.030717
3	2.241184	23.63071	76.26975	0.099538
4	2.499677	21.72525	78.07152	0.203222
5	2.705978	19.99472	79.66731	0.337971
6	2.876676	18.44313	81.05725	0.499623
7	3.021831	17.07022	82.24594	0.683848
8	3.148024	15.87199	83.24169	0.88632
9	3.259776	14.84137	84.05576	1.10287
10	3.360296	13.96893	84.70148	1.329592
Variance Decomposition of LOG_Oil:				
Period	S.E.	LOG_500	LOG_Exchange	LOG_Oil
1	6.306429	7.465127	1.73E-01	92.36203
2	8.559595	7.254371	0.308271	92.43736
3	10.07281	7.038225	0.486135	92.47564
4	11.18876	6.819483	0.706508	92.47401
5	12.04814	6.600972	0.969063	92.42997
6	12.72692	6.385502	1.273051	92.34145
7	13.27229	6.175817	1.617294	92.20689
8	13.71613	5.97454	2.000193	92.02527
9	14.08123	5.78413	2.419748	91.79612
10	14.38447	5.606831	2.873583	91.51959
Cholesky Ordering: LOG_500; LOG_Exchange; LOG_Oil				

Interpretation: If there should arise an occurrence of BSE 500, in the short-term 99.78% of estimate difference is clarified by the variable itself, different factors in the model don't have a solid impact. These factors have a solid exogenous effect on BSE 500 or are a frail indicator of future for the variable. Also, in the long-term BSE 500 shows a strong influence on itself, other variables still pose as weak predictors. In case of exchange rate, in the short-term 76.27% of forecast variance is explained by the variable itself, BSE 500 does reflect an impact of 23.63% but is not a strong influencer and unrefined petroleum price movement is not effective in predicting the exchange rate. These factors have a solid exogenous effect on exchange rate or are a powerless indicator of future for the variable. Again, in the long-term exchange rate shows a strong influence on itself, impact of BSE 500 constantly declines, and unrefined petroleum price still shows no significant impact. Therefore, other variables are still weak predictors of conversion scale in both short and long periods. For Crude Oil price, in the short-term 92.47% of estimate change is clarified by the variable itself, different factors in the model don't have a solid impact. These factors have a solid exogenous effect on Crude Oil price or are a feeble indicator of future for the variable. Also, in the long-term BSE 500 shows a strong influence on itself, other variables still pose as weak predictors. We also observe that Crude Oil price forecast % remains somewhat constant during both long and short runs.

There is a close relationship between VAR and Variance Decomposition results. We observe a similar trend in both the results. BSE 500, conversion scale and Crude Oil price are strong predictors of future forecasts on itself. Conversion Scale and Crude Oil price have an impact on BSE 500, but the impact is not significant as observed from both the results; same is the case of BSE 500 and Crude Oil price on Exchange Rate. Similar is the situation of impact of BSE 500 and Exchange Rate on Crude Oil price.

G. Granger Causality Test

For this study, Pairwise Granger Causality Test is conducted to determine the short-run causal effects of the variables.

Hypothesis:

H_0: No Granger Causality exists.
H_1: Granger Causality exists.
The decision criteria for the test is rejection of null hypothesis is if probability value of F-statistic is <= 5% critical value.

TABLE VI. PAIRWISE GRANGER CAUSALITY TEST

Results				
Null Hypothesis:	**Obs.**	**F-Statistic**	**Prob.**	**Accept/Reject H_0**
LOG_Exchange does not Granger Cause LOG_500	119	2.63203	0.1074	Reject
LOG_500 does not Granger Cause LOG_Exchange	119	3.0387	0.084	Reject
LOG_Oil does not Granger Cause LOG_500	119	0.13863	0.7103	Reject
LOG_500 does not Granger Cause LOG_Oil	119	3.67373	0.0577	Reject
LOG_Oil does not Granger Cause LOG_Exchange	119	0.00176	0.9666	Reject
LOG_Exchange does not Granger Cause LOG_Oil	119	4.26614	0.0411	Accept

We observe a two-way causality between exchange rate and BSE 500, we can say that conversion scale and BSE 500 affect each other. We also see a two-way causality between unrefined petroleum prices and BSE 500; hence, we can say that unrefined petroleum prices and BSE 500 affect each other. Lastly, we see a unidirectional causality between unrefined petroleum prices and conversion scale, thus concluding that unrefined petroleum price affects exchange rate.

H. Cholesky Charts (Impulses and Residuals)

The consequences of impulse response analysis for period of 10 years to a '1 S.D' shock on BSE 500, conversion scale and unrefined petroleum price is shown in the graph **(Refer Annexure).** Negative shock in stock value will in general negatively affect itself. Stock cost reacts broadly to oil cost and swapping scale. The reaction delivered from a drive on oil cost has a declining sway on Indian Stock market. We also establish residual responses of the variables for the duration of the study.

I. Trend Analysis

We check the trend of Brent Crude price over the period of our study to obtain a macro view on how it has moved over time.

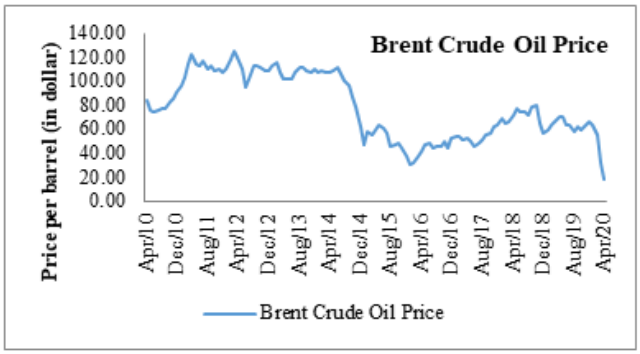

Fig. 1. Trend Analysis

J. Correlation

The correlation study of the variables shows that there is a high negative correlation between unrefined petroleum prices and exchange rate - and between unrefined petroleum prices and BSE 500. This means that unrefined petroleum price changes impact the exchange rate and the stock market returns negatively, i.e. increase in unrefined petroleum prices decreases stock returns as well as exchange rate value and vice versa.

Hypothesis:

H_0: Statistically significant.
H_1: Not statistically significant.

TABLE VII. CORRELATION ANALYSIS

Correlations				
		Crude Oil	**Exchange**	**BSE 500**
Crude Oil	Pearson Correlation	1	-.688**	-.696**
	Sig. (2-tailed)		0.000	0.000
	N	120	120	120
Exchange	Pearson Correlation	-.688**	1	.798**
	Sig. (2-tailed)	0.000		0.000
	N	120	120	120
BSE 500	Pearson Correlation	-.696**	.798**	1
	Sig. (2-tailed)	0.000	0.000	
	N	120	120	120
**. Significant at the 1% level (2-tailed).				

Result						
	Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	811235483.483	2	405617741.742	122.940	.000 b
	Residual	386021022.327	117	3299324.977		
	Total	1197256505.811	119			
a. Dependent Variable: BSE 500						
b. Predictors: (Constant), Exchange Rate, Crude Oil						

We observe that exchange rate and BSE 500 show a high positive correlation. This implies that if exchange rate increases so does BSE 500 returns and vice versa. The result so obtained is statistically significant as it does not exceed our set significant level of 1% i.e. p value < 0.01. Therefore, we accept null hypothesis. This clearly indicates enough evidence is present to suggest that this correlation exists in the population.

K. Regression

BSE 500 is considered as the needy variable while Exchange Rate and Crude Oil cost are considered as autonomous factors.

Hypothesis:

H_0: Variation in dependent variable is unrelated to variation in independent variable.

H_1: Variation in dependent variable is related to variation in independent variable.

TABLE VIII. REGRESSION STATISTICS

Stock Market	Economy	Demand for Goods and Services	Demand for Oil	Oil Prices
Bull	↑	↑	↑	↑
Bear	↓	↓	↓	↓

The Summary table gives the R and R^2 values. The R value represents a simple correlation and is 0.823, which shows a serious extent of connection. The R^2 esteem (the "R Square" section) shows the amount of the complete variety in the needy variable, BSE 500, can be clarified by the free factors, Exchange Rate and Crude Oil cost. For this situation, 67.8% can be clarified, which is exceptionally huge.

TABLE IX. REGRESSION STATISTICS

Summary of Results				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.823[a]	0.678	0.672	1816.40441
a. Predictors: (Constant), Exchange, Crude Oil				

The results demonstrate that the relapse model properly predicts the needy variable. It shows the actual centrality of the relapse model used. The p value at < 0.05 or Sig = .000, which is under 0.05, implies that the relapse model is factually critical in anticipating the result variable, i.e. it is fits the information well. Based on this outcome, we can securely dismiss the null hypothesis. This infers variety in needy variable is identified with variety in autonomous variable.

Discussions and Findings

We understand that bullish nature of market increases demand for goods and services, and correspondingly increasing the oil prices, whereas bearish nature of market performs vice versa.

The series have been integrated of order-1 during the Unit Root Test, i.e. stationary after 1st difference I (1). We find optimal lag length for testing cointegration as 1. Johansen Cointegration Test is conducted that shows there is no long-term relationship among variables. We now estimate VAR model and not VECM as no long-term relationship was obtained. The VAR model results state that BSE 500 is associated with 94.53% increase in it, Exchange Rate is linked to 95.15% increase in itself, Crude Oil price is associated with 91.85% increase in itself.

We next make forecast for 10 years in the future (forecast span is taken yearly in accordance with yearly data taken to define relationships). We consider 3 years as short-term and 10 years as long term. From the Variance Decomposition Analysis, a result similar to VAR is obtained. BSE 500, Exchange Rate and Crude Oil price are strong predictors of future forecasts on itself. Exchange Rate and Crude Oil price have an impact on BSE 500, but the impact is not significant as observed from both the results; same is the case of BSE 500 and Crude Oil price on Exchange Rate. Likewise, is the situation of impact of BSE 500 and Exchange Rate on Crude Oil price. We then check for short-term relationship by way of Granger Causality Test and observe a two-way causality between Exchange Rate and BSE 500, another two-way causality between Crude Oil price and BSE 500, but a one-way causality between Crude Oil price and Exchange Rate.

Next we replicate consequences of our impulse response analysis over the 10 years to a '1 S.D.' shock on BSE 500, conversion scale and unrefined petroleum in the form of a chart. We also establish residual responses of the variables for the duration of the study.

In the final phase of the study, we look at the correlation and regression output statistics and a trend analysis of unrefined petroleum. Correlation output shows a high negative correlation between unrefined petroleum prices and exchange rate as also between unrefined petroleum prices and BSE 500. Also, exchange rate and BSE 500 show a high positive correlation. From the regression output, we get the *R* value as 0.823, implying a high level of correlation and the variation in BSE 500 as explained by conversion scale and unrefined petroleum which comes to 67.8%. The regression model is a good fit in predicting the outcome variable.

The paper provides a trend forecast for 10 years in the future, considering the past 10 years' trend, which has not been subjected to the cataclysmic effects of any Black Swan event - such as the ongoing COVID-19 pandemic. The results of such events cannot be predicted well in advance as they do not signal before beginning. Considering the current pandemic, the world is facing, in the very initial phase itself a drop in unrefined petroleum prices was observed across the world, which appreciated the value of Dollar and caused the stock market indices to fall. Such events cause unprecedented changes to the three variables and impact their relationship with each other.

Conclusions and Suggestions

The study shows extensive evidence on relationships among these variables. The evaluated outcome demonstrates no long-term connection among the three variables; however, a short-term relationship exists as established by Granger Causality Test. In the short span, BSE 500 is impacted by both unrefined petroleum prices and conversion scale and in turn impacts both these variables. Also, unrefined petroleum impacts conversion scale change policy of an economy.

We also establish that impact on each variable is associated majorly to the variable itself as found during both VAR and Variance Decomposition Analysis. Future forecast shows a short and long run impact of the variable on itself and a weak or insignificant impact of the other two variables. Correlation output shows high positive correlation between exchange rate and BSE 500 and the regression output is statistically significant in predicting the outcome. This implies that variations in the dependent variable are related to variations in the independent variable.

The tests conducted during the course of this paper reflect similarity in direction to the results obtained that a relationship exists among the three variables - in short and long run, and also bring out the effect of changes in one

variable on the other. Therefore, this fulfils the objectives of the study.

The examination is relied upon to be of significance to money related controllers and policymakers in figuring budgetary and financial arrangements. The between relationship is useful to investors, speculators and portfolio directors in settling on better venture choices as it gives a superior information on portfolio structure and creates scope for development in portfolio plan. It is additionally gainful for understudies' keen on dissecting the exogenous and endogenous effects among the three factors and effect of shocks on such factors.

In the literature review, we looked at how there have been attempts at determining relationships either between two of these variables or all three using either econometric or statistical tools. No attempt has however been made for particularly determining the relationship that Sensex (used as proxy for economic growth) has with the two other variables, using both statistical and econometric tools for the time period covered in the Study.

The results obtained in this Study provide clear indication - and hence a better understanding - of the direction of such relationship.

Limitations

- Major limitations encountered during the research were in terms of conducting the time series tests.
- In running the model for more than three variables, the results were not clear.
- Just a single intermediary for the Indian Stock Market could be taken at an offered point to show reliance in deciding connection and relapse measurements.

Annexure

TABLE I. VAR LAG LENGTH SELECTION CRITERIA

Lag Length	AIC	SIC	HQ
0	33.1325	33.20615	33.16237
1	25.28068*	**25.57527***	25.40017*
2	25.31255	25.82809	25.52165
3	25.39151	26.12801	25.69024
4	25.47258	26.43003	25.86093
5	25.5765	26.75489	26.05446
6	25.68968	27.08902	26.25726
7	25.81438	27.43466	26.47157
8	25.90358	27.74481	26.65039
9	25.97268	28.03487	26.80912
10	26.00689	28.29002	26.93294
Notes: * Lag order selected			

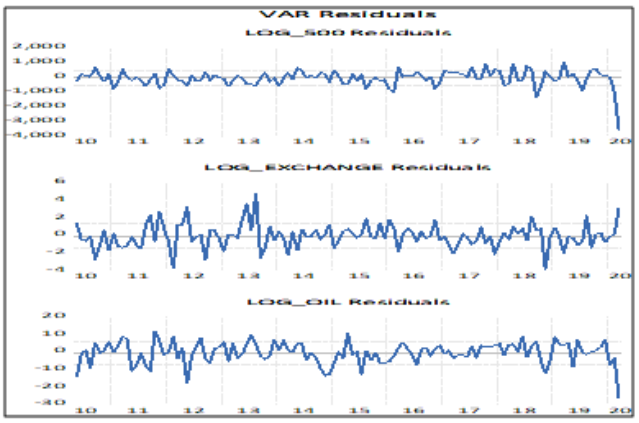

Fig. 1. Cholesky Charts

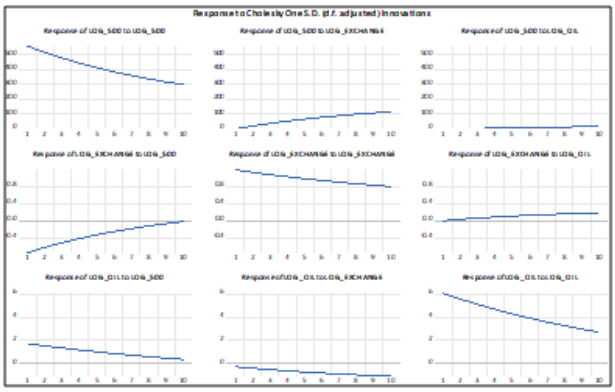

Fig. 2. VAR Residuals Charts

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