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Nexus between crude oil and stock market return: case of India

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ABSTRACT

Crude oil is an important driver of Indian economy and therefore, it is important to investigate whether the movement in crude oil prices affects the return of stock market indices. This paper examines the impact of return from crude oil on the return of some major Indian stock market indices. The construct was made from daily data from 2005 to 2016 to calculate the daily return of crude oil and four different stock market indices. Two different tests were carried out, namely, Granger causality test and Johansen cointegration test. Granger causality test was conducted to know the relationship between the return from crude oil and stock market indices, whereas, Johansen cointegration test was carried out to understand whether the long run equilibrium relationship is there between the dataset of returns? The result from the Granger causality test suggests that there is causality between the crude return and the return from stock market indices. The nature of causality is unidirectional in nature where crude return affects the return of the stock market indices. The results from Johansen cointegration test suggest that there exists a long run equilibrium relationship among these variables.

Contribution/ Originality
Demand for analysis of crude oil and stock market at different time periods arises because of frequent inclusion of crude oil in investment portfolios. The paper carries out an in depth analysis of the influence of crude oil return on the return of different stock market indices. Though researches have been conducted in Indian context but the study of many of the researchers were limited to either Sensex or Nifty. This paper has taken four relevant stock market indices (Sensex, Nifty, BSE Oil & Gas Index & NSE-Energy Index) to study the impact and long term association of crude prices on these indices on the basis of 11 years of daily data points. The data points cover both pre and post subprime crisis period which is considered as a major structural break in the Indian Stock Market.

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1. INTRODUCTION

Fluctuation in crude oil price always created stress on Global economy. There are evidences of sustained increase in oil prices as witnessed in 1990s and further from 2003 to 2008. Subsequently a decline in oil prices started from 2009 and continued further. These fluctuations were more consistent with the movements of driving forces of the world economy rather than international geopolitical stunts. For example the Iran–Iraq war in 1980s and Gulf war in 2003 did not show any major movements in the oil price. The major price rise of crude oil which was witnessed in 2003-08 was due to overwhelming growth in emerging Asian countries. But post subprime crisis in late 2008 price of crude was battered with an expectation of prolonged global recession. But crude price of 32.40 USD on December 19 in 2008 again returned to 100 USD in 2011. In these three years the crude remained in a trading range of 80 USD to 110 USD. Subsequently there was again a collapse in price of crude in 2016 which was reasoned with slowing Chinese Economy and a remarkable supply growth in US through frocking and horizontal drilling.

Crude oil is an indispensable item for any modern economy and their economic growth, especially for the emerging market like India. Oil and gas sector in India falls among the six core industries in India and has an important link with further growth of Indian Economy. India has achieved a decent annual growth rate which will further accelerate resulting in growing independence of energy needs (Arpana, 2013). The demand for crude oil and the growth in industrial production are highly correlated. The developing economy like India is considered as one of the fundamental sources for increasing demand of crude oil, so the escalating demand for the oil without offsetting the increase in supply will pave the way for increasing oil prices. In India the increase in crude price will put pressure on inflation rate and trade balance which will not only lead to current account deficit and deteriorate net foreign asset position but also increase the cost of living resulting in demand for more wages (Manish, 2014). Considering the consumers and producers, an increase in oil prices will decrease the disposable income and reduce spending on goods and services and also the cost of non-oil producing countries will rise further. This will create an inflationary pressure on economy and central bank will have no option but to raise the interest rate. High interest cost further will subdue corporate earnings and also attract investors towards bond markets leading to fall in stock prices (Kapusuzoglu, 2011). India is having a very meager production of crude oil and maximum of requirement is filled up through imports from OPEC countries (Sahu *et al.*, 2014). Gisser and Goodwin (1986) argued that crude oil being an important input used in production of many goods and services, an increase in price of the crude will affect the cash flow of firms. Again, how the effect of changing oil prices react depends on status of the firm whether it is consumer or producer of oil or oil products (Iscan, 2010) Lot of interest has been witnessed in the Indian economy where researchers are tracking crude oil prices because around 80% of crude oil is imported by India from international markets and any significant changes in prices of petroleum products will influence inflation numbers leading to changes in stock market return (Sharma and Khanna, 2012). So, the effect of changing oil prices over the stock prices cannot be ruled out. This research paper attempts to understand the causality effect and long term association between these two variables uniquely by taking a large sample size of daily return for two variables. The paper also tries to understand whether crude oil price effect is having the same impact on different indices of stock market over a long range of data set.

2. LITERATURE REVIEW

Literatures are available in galore presenting the empirical evidences of the impact of return from crude price and return on the stock market. Enough evidences are there to substantiate the inverse relationship between crude price changes on the stock return (Basher and Sadorsky, 2006; Chen, 2010; Filis, 2010). Some researchers have found direct relationship between these two variables also (Kilian and Park, 2009; Narayan and Narayan, 2010). Again some researchers have also reported oil price changes have no effect on stock market return (Blanchard and Gali, 2007). The study of the impact of oil price shocks on returns of stock market was probably first initiated by (Kling, 1985) where he established an adverse relationship between oil price movement and stock market returns.

Kaneko and Lee (1995) established that there is significant relationship between movement of crude oil prices and returns from stock market. Jones and Kaul (1996) found an adverse relationship between oil prices and stock markets in developed countries like US, Canada, UK and Japan by using cash flow valuation model. Many researches have been conducted to find relation between oil prices and stock returns. For example Sadorsky (1999) studied the relationship of oil prices in USA and stock exchange return for a period of fifty years (1947-1996) using VAR and GARCH. They found that volatility in oil prices plays a significant role on stock return. Again, Sadorsky (2001) found that return of Canadian oil and gas companies has a positive correlation towards the change in oil prices using a multifactor market model. Contrary to Sadorsky (2001), the interaction between stock market of relevant countries and changes in oil prices was studied by Maghyereh (2004), where he found that stock index returns of developing countries were not affected by oil shocks. Sari and Soytas (2006) examined the relationship between crude oil price and stock returns with some other variables for a period of seventeen years (1987-2004) and found that there was no meaningful effect on the returns of stocks. Anoruo and Mustafa (2007) used co-integration technique and modified VECM to study the relationship between stock market returns for USA and oil prices. He found that there is a long term association between stock market returns and movement in oil prices. Park and Rati (2008) found that there is negative impact of oil price shock on the oil importing countries and positive impact on the oil exporting countries by analyzing the data of 13 European Nations and USA.

Halac *et al.* (2013) studied relationship between oil prices and stock prices post structural break in emerging market (Turkish Stock Market) and found that stock returns, oil prices and exchange rates are co-integrated. Bhunia (2013) investigated the co-integration relationship among crude oil prices, domestic gold price and stock price indices in India and found that there exists a long term relationship among selected variables. Sahu *et al.* (2014), studied the impact of changed crude oil prices on stock markets and found a long term co-integrating relationship between these two variables and volatility of crude oil price affects the volatility of stock prices in India. Bhat (2014) studied the linear and non-linear causal nexus between oil price shocks and sock returns in India using standard VAR model and Diks and Panchenko (2006) frameworks and found the evidence of unidirectional causality from stock returns to crude oil price changes. It was also concluded that there is an evidence of bidirectional non-linear causality between the two variables. Till date in Indian context most of the researchers has considered either the Sensex or Nifty for analysis but in this paper all the four relevant stock market indices have been taken to understand any difference in the pattern of cointegration effect on different indices.

3. RESEARCH METHODOLOGY

3.1. Sample size

The objective of the paper is to check the causality and cointegration of return form crude prices with the return on index. Four stock market indices were chosen namely BSE-SENSEX (Bombay Stock Exchange Sensitive Stock Index), BSE- Oil and Gas Index, NSE-Nifty (National Stock Exchange's Fifty) and NSE-Energy Index. The daily closing prices of the indices were recorded from September, 2005 to October, 2016 for an 11 years' time period. The daily closing of Brent-crude prices were also recorded for the same period and the closing prices of the crude was multiplied with the USD-INR closing rate to convert it into Indian currency so that the volatility of dollar can also be included in the crude price return. Two indices were chosen representing two major stock exchanges from India i.e. Bombay Stock Exchange (BSE) and National Stock Exchange (NSE). Sensex is consisting of 30 stocks, a less diversified but a prominent index of BSE as compared to Nifty which is a well-diversified index of NSE constituted of 51 stocks. The NSE-energy index and BSE gas and oil index were also included to understand the effect of crude oil price movements in energy index also. The daily closing data of indices were collected from BSE and NSE website and the crude prices were taken from Bloomberg and the USD-INR rates were taken from closing rate published in the Reserve Bank of India's website. Dividend is not included in the data as it was not available and no break in the sample period was found. Stock market operates for five days where as exchange rate is published for six days

hence common data points are taken to create homogeneity in the time frame for the said period. E-views software is used for data analysis.

3.2. Techniques used

Collected data are used to generate the log normal return following continuously compounded return concept using the following formula

Log Normal Returns (Rn) = Ln (P_1/P_0)

Here P_1 is the current day's price and P_0 is previous day's price.

Non-stationarity and trending behavior in the mean may be witnessed in financial time series. So an important econometric task should be to determine the most appropriate form of the trend in data. When the data are trending then the trend removal will be required. Unit root test helps in determining whether trending data should be determined first or regressed on deterministic functions of time to identify the stationarity of data. The theory suggests that there exists a long run equilibrium relationship among non-stationary time series variables. When the variables are I (1) one can use cointegration techniques to know the long term relations. Therefore, pre-testing for unit roots becomes the first step in the cointegration modeling (Hatanaka, 1995). So Augmented Dickey Fuller (ADF) test is conducted to check the stationarity of the data and the test suggests (Refer Table 1 to 5 in Appendix for details) that null hypothesis of unit root is rejected at their return levels for all the variables. All the series are found stationary at their first difference (Refer Table no 6).

Table 6: Unit Root Test (Summary)

Summary of ADF TEST Statistics		
Exogenous: Constant	**Lag Length**	**0**
Variables	t-Statistic	Prob.*
Sensex	-48.2556	0.0001
BSE Oil Index	-49.6080	0.0001
Nifty	-49.1823	0.0001
Nifty Energy Index	-50.0157	0.0001
Crude Oil	-50.2828	0.0001

To test whether one time series is necessary to forecast another time series was first proposed by Clive Granger in 1969. This test popularly known as Granger causality test measures whether a time series variable can predict the future value of another time series. The empirical results carried out in this paper are derived through a simple Granger causality test to understand whether return from the crude price movements Granger cause the return of different stock indices and vice versa. Johansen Cointegration Test is used to determine the long run association among the variables.

3.3. Data analysis

Pairwise Granger Causality test is performed to test the direction of causality between return of BSE OIL Index and return from crude prices. The test was performed at 2 lags. In table 7 the P value for the null hypothesis ($H0_1$) Crude does not Granger Cause BSE OIL Index is less than 0.05. Hence the null is rejected at 5 % level of significance. Again as the P value for the null hypothesis ($H0_2$) BSE OIL Index does not Granger cause Crude oil return is greater than 0.05, it cannot be rejected at 5 % level of significance. So from the result it is concluded that return form crude Granger causes BSE-Oil-Index but BSE-Oil-Index does not granger cause the return from crude. The relationship is unidirectional in nature.

Table 7: Causality test result crude oil and BSE OIL Index

Null Hypothesis	F-Statistic	Prob.
$H0_1$ CRUDE does not Granger Cause BSE_OIL_INDEX	6.1217	0.0022
$H0_2$ BSE_OIL_INDEX does not Granger Cause CRUDE	1.9629	0.1406

Note: Lags 2

In table 8 also while performing the Pairwise Granger Causality test to test the causality between return of crude and return of SENSEX it was found that P value for the null hypothesis ($H0_3$) crude does not granger cause Sensex is found less than 0.05. So the null is rejected at 5% level of significance. But the P value for null hypothesis ($H0_4$) Sensex does not granger cause crude oil return is greater than 0.05 which means null cannot be rejected at 5% level of significance. So from the result it is concluded that return from crude granger causes Sensex but Sensex does not granger cause the return from crude oil.

Table 8: Causality test result crude oil and BSE SENSEX

Null Hypothesis	F-Statistic	Prob.
$H0_3$: CRUDE does not Granger Cause SENSEX	3.2441	0.0392
$H0_4$: SENSEX does not Granger Cause CRUDE	1.7677	0.1709

Note: Lags 2

Similarly the pairwise granger causality tests were carried out for testing the direction of causality between return of crude and return of Nifty (Refer Table 9) and also between return of crude and return of NSE-Energy-Index (Refer Table No 10). In table number 9 the p-value suggested that null ($H0_5$) crude does not granger cause the return of nifty is rejected at 5% level of significance but the null ($H0_6$) return from Nifty does not granger cause the return from crude cannot be rejected at 5% level of significance pointing towards an unidirectional causality that return from crude granger causes the return from nifty. Again the results suggested in Table no 10 states that null ($H0_7$) return from crude does not granger cause NSE-Energy-Index is rejected at 5% level of significance and null ($H0_8$) return from NSE-Energy-Index does not granger cause return from crude cannot be rejected at 5% level of significance. Hence it is concluded that return from crude granger causes the return of NSE-Energy-Index and it is unidirectional in nature.

Table 9: Causality test result crude oil and NIFTY

Null Hypothesis	F-Statistic	Prob.
$H0_5$: CRUDE does not Granger Cause NIFTY	3.3265	0.0361
$H0_6$: NIFTY does not Granger Cause CRUDE	1.6418	0.1938

Note: Lags 2

Table 10: Causality test result crude oil and NSE Energy Index

Null Hypothesis	F-Statistic	Prob.
$H0_7$: CRUDE does not Granger Cause NSE_ENERGY_INDEX	4.2132	0.0149
$H0_8$: NSE_ENERGY_INDEX does not Granger Cause CRUDE	1.2175	0.2961

Note: Lags 2

To test the long run equilibrium relationships between the variables the cointegration tests were carried out. To check the cointegration between the variables max-eigenvalue cointegration rank test was conducted. The following three hypotheses were framed.

$H0_9$: There is no cointegration among the variables.
$H0_{10}$: There is at most 1 pair of cointegration exist among the variable
$H0_{11}$: There is at most 2 pair of cointegration exist among the variable

To test the long run equilibrium relationships between two non-stationary time series data X and Y a cointegration test is necessary. If two non-stationary time series data is differenced [integrated of order one series I (1)] such that some of their linear combination is stationary [I (0)] then one can say these

two series are cointegrated which means neither of the variable series hovers around a constant value but some of their combination does. In this paper Johansen cointegration test has been used to determine whether there exists a long-run equilibrium series between return of crude oil prices and return from stock indices.

From the table no 11 it is suggested that in null ($H0_9$) no variables are cointegrated. The p-value is 0.0001 indicating rejection of the null hypothesis ($H0_9$) at 5% level of significance. Hence it can be concluded that the cointegration is present between the variables. Further investigation suggests that the null hypotheses ($H0_{10}$ & $H0_{11}$) can be rejected if we check the p-value in (At most 1* to At most 4*) at 5 % level of significance. Hence based on the output of cointegration test it can be concluded that all the variables i.e. return from crude, BSE-Oil Index, Sensex, Nifty and NSE-Energy-Index are cointegrated. Hence there exists a long run equilibrium relationship among these variables. The results from Johansen cointegration test suggests there exists a long run equilibrium relationship among these variables.

Table 11: Unrestricted cointegration rank test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.2152	644.3693	33.8768	0.0001
At most 1 *	0.1983	587.5433	27.5843	0.0001
At most 2 *	0.1910	563.6277	21.1316	0.0001
At most 3 *	0.1842	541.3088	14.2646	0.0001
At most 4 *	0.1696	494.1254	3.8414	0.0000

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

4. CONCLUSION

The main objective of the paper was to examine the effect of return from crude price on the return of different stock market indices. The study proves that return on all the stock indices were affected by the changes in crude oil price. The testing of Granger causality proves that there is unidirectional causality among these two returns where the return of crude price is affecting the return of different stock market indices. However, the return from different stock indices has no influence on the changes in crude oil price. The cointegration test was conducted to understand the long run association among the variables taken for study. The test finds that in long run the return from crude price changes and return from stock market indices are tied together and all the return variables were found cointegrated with each other. Therefore one can conclude that influence of change in crude oil price is there on the return of different Indian stock indices and both the variables have a long run association too.

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Appendix

Table 1: Unit Root Test (SENSEX)

Null Hypothesis: SENSEX has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=27)		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-48.2556	0.0001
Test critical values:	1% level	-3.4326	
	5% level	-2.8624	
	10% level	-2.5672	

*MacKinnon (1996) one-sided p-values

Table 2: Unit Root Test (NIFTY)

Null Hypothesis: NIFTY has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=27)		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-49.1823	0.0001
Test critical values:	1% level	-3.4326	
	5% level	-2.8624	
	10% level	-2.5672	

*MacKinnon (1996) one-sided p-values

Table 3: Unit Root Test (CRUDE)

Null Hypothesis: CRUDE has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=27)		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-50.2824	0.0001
Test critical values:	1% level	-3.4326	
	5% level	-2.8624	
	10% level	-2.5672	

Table 4: Unit Root Test (BSE-OIL-INDEX)

Null Hypothesis: BSE_OIL_INDEX has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=27)		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-49.608	0.0001
Test critical values:	1% level	-3.4326	
	5% level	-2.8624	
	10% level	-2.5672	

*MacKinnon (1996) one-sided p-values

Table 5: Unit Root Test (NSE-ENERGY-INDEX)

Null Hypothesis: NSE_ENERGY_INDEX has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=27)	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-50.0157	0.0001

Test critical values:	1% level	-3.4326
	5% level	-2.8624
	10% level	-2.5672

*MacKinnon (1996) one-sided p-values