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Crude Oil Price, Exchange Rate and Emerging Stock Market: Evidence from India

(Harga Petroleum Mentah, Kadar Tukaran Asing dan Pasaran Saham Baru Muncul: Bukti India)

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ABSTRACT

Oil is one of the most important forms of energy and is a significant determinant of global economic performance. Commodities like oil are fairly homogeneous and internationally traded. The impact of dollar nominated oil prices on stock prices may not be quite relevant for Indian context. In this context, the study of crude oil prices in dollar terms along with the exchange rate would be more meaningful to understand the impact of oil prices on stock market. The study investigates the dynamic relationships between oil price, exchange rate and Indian stock market during 1993 to 2013. The estimated results of the Johansen's cointegration test and vector error correction model suggest that there exist a long run cointegrating relationships between crude oil price and Indian stock indices, but it cannot be said with sufficient confidence that the direction of the relation in the long run is from the oil price to the Sensex. The Granger causality test also reveals that the volatility of stock prices in India can be explained to cause the movement of oil price and exchange rate in short run. The observed relationship between oil price and stock indices is not due to the effect of the exchange rate fluctuations, because the change in exchange rate has no significant impact on oil prices or stock prices in India during the study period. The variance decomposition analysis reveals that the Indian stock prices are strongly exogenous in the sense that the crude oil price or exchange rate explains only a very small portion of the forecast variance error of the market index. Finally, from the impulse response functions analysis it is noticed that a positive shock in one variable have a persistent and prolonged effect on other variables.

Keywords: Crude oil price; exchange rate; stock market; cointegration; granger causality test

ABSTRAK

Petroleum adalah salah satu bentuk tenaga yang penting dan menjadi satu faktor yang mempengaruhi prestasi ekonomi global. Komoditi seperti petroleum adalah homogen dan didagangkan di peringkat antarabangsa. Impak harga petroleum dalam dolar ke atas harga saham mungkin tidak relevan di India. Namun kajian berkaitan harga petroleum dalam nilai dolar selaras dengan kadar tukaran lebih memberi makna untuk memahami kesan harga petroleum ke atas pasaran saham. Kajian ini mengkaji hubungan dinamik di antara harga petroleum, kadar tukaran dan pasaran saham di India pada tahun 1993 hingga 2013. Keputusan ujian ko-integrasi Johansen dan model pembetulan ralat vektor menunjukkan bahawa wujudnya hubungan kointegrasi jangka panjang antara harga petroleum mentah dan indeks saham India. Namun, kajian ini tidak boleh menyatakan dengan keyakinan wajar bahawa arah hubungan jangka panjang adalah berpunca daripada harga petroleum kepada Sensex. Ujian Kausaliti Granger turut menunjukkan bahawa ketaktentuan harga saham India boleh diterangkan oleh pergerakkan harga petroleum dan kadar tukaran jangka pendek. Hubungan yang dikenalpasti antara harga petroleum dan indeks pasaran saham bukanlah disebabkan turun naik kadar tukaran kerana perubahan dalam kadar tukaran tidak memberikan kesan signifikan ke atas harga petroleum atau pasaran saham India sepanjang tenpoh kajian. Analisis penguraian varians menunjukkan harga saham India adalah sangat eksogen di mana harga petroleum mentah atau kadar tukaran menerangkan sebahagian kecil ralat varians jangkaan indeks pasaran. Akhir sekali, daripada analisis fungsi tindakbalas impuls didapati kejutan positif dalam satu variabel memberi kesan yang lama dan berterusan ke atas variabel lain.

Kata kunci: Harga petroleum mentah; kadar tukaran; pasaran saham; kointegrasi; ujian kausaliti Granger

INTRODUCTION

All the economies of the world are dependent on crude oil. So, crude oil prices are supposed to affect the different components of an economy. The prices of oil are very much volatile in last few years. Thus, the oil prices may have impacted the Indian economy in last few years in different ways. With a lead lag relationship, the stock market may be considered a barometer for the economy. So, there may be a possible relation between crude oil prices and Indian Stock Market. However, in case of India, the domestic production of crude oil is marginal. The huge requirement is filled up by importing from OPEC countries. So, impact of oil prices in dollar terms may not be very relevant for India. In this context, the study of crude oil prices in dollar terms along with the study of

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dollar- rupee exchange rate would be more meaningful to understand the impact of oil prices on stock market. Trehan (1986) is of the view that inclusion of exchange rate in the VAR reduces the impact of changes in oil prices on macroeconomic variables. Being a macroeconomic variable, exchange rate may also directly influence the stock prices. Therefore, consideration of exchange rate along with crude oil prices may improve the explanatory power of the model.

Theoretically, the changes in oil prices affect stock prices in two ways. The increase in oil prices lead to an increase in the cost of production that may reduce the earnings of the company, if selling price remains unchanged. However, if selling price is increased, the reduced demand of the product may affect earnings adversely. Thus, changes in oil prices may affect the stock market by influencing earnings of the firms. Again, higher crude oil prices may induce inflationary condition in the economy. To combat the inflation, interest rate is increased by the central bank that may affect the profitability of the firm adversely. Moreover, higher interest rate results into higher discounting rate for determining lower fundamental value of share.

The crude oil prices and exchange rates are also interlinked at least theoretically. Except in case of OPEC countries, the increase in oil prices may increase current account deficit which results in the increase in the exchange rate. This urges for adjustment in fiscal front which may impact exchange rate. If price elasticity of oil in oil importing countries is more than one, an increase in oil prices will lower expenditure on oil and thus demand for dollar, which in turn raises the exchange rate (Krugman 1983; Golub 1983).

There is a relationship between exchange rate and share prices. The increase in exchange rate may reduce value of domestic currency; as such it may attract FIIs which in turn may increase the demand and thus prices of shares. Again, devaluation of domestic currency may increase export and reduces import. If the economy is export oriented, then devaluation may positively affect the economy and the stock market as well. The reverse would be the case for import oriented economy. The exchange rate also affects international competitiveness of the economy. Dornbusch and Fisher (1980) find increase in the value of domestic currency changes the competitiveness of local firms due to lower cost of goods in dollar terms which may change profitability of the firm. However, Frankel (1993) proposes a different theoretical argument for this. He argues that portfolio balance approach assumes a positive relationship between stock prices and exchange rates. An appreciation of local currency relative to the foreign currency is expected to decrease the cost of imported goods which may be beneficial for a country that has substantial trade relation with foreign market. Moreover, he further argues that if the country depreciates it currency rapidly, foreign portfolio investors may redirect their investment to other attractive market of other countries causing the market to fall.

Understanding the relationship between oil prices, exchange rates and emerging stock market prices is an important topic to study because as emerging economies continue to grow and prosper, they will exert a larger influence over the global economy. The relationship among crude oil price, exchange rate and stock prices has been the subject of extensive research. In this backdrop, our present study attempts to investigate empirically the dynamic relationship among crude oil price, exchange rate and Indian stock market. The rest of the paper is organized into six sub sections. The second section discusses review of some related literature to find out research gaps; section three discusses the data and methodology used in the study i.e. the research design; while section four presents the analysis and findings of the study; section five summarizes and interprets the results and finally, section six concludes the study.

LITERATURE REVIEW

The linkage among oil prices, exchange rate and stock prices, if any, has drawn the attention of researchers and practitioners since the early twentieth century. From an empirical perspective, a substantial academic and professional literature, especially in the developed and developing countries, explores the interaction among oil prices, exchange rate and stock prices. This section deals with three types of literature. Some literature demonstrated relationship between crude oil prices and stock market, whilst some literature is related to relationship between exchange rate and stock prices. The paper discussed few available literatures on the combined impact of oil prices, exchange rate on stock prices also.

At the outset, the literature related to oil price and stock market has been explored. Miller and Ratti (2009) analyze the long-run relationship between the world price of crude oil and international stock markets, and conclude that stock markets respond negatively to increases in the price of oil. Another group of researchers found that there exist a positive relationship between oil price and stock indices; Sadorsky (2001) shows that stock returns of Canadian oil and gas companies are positive and sensitive to oil price increases using a multifactor market model. In particular, an increase in the oil price leads to increase the returns of Canadian oil and gas stocks. Similarly, Boyer and Filion (2004) find a positive association between energy stock returns and the prices of oil and gases.

Beside the above studies, Anoruo (2010) examines both the linear and nonlinear causal relationships between crude oil price changes and stock market returns in the United States. The results from the application of M-G causality test support the finding of nonlinear bidirectional causality between crude oil price changes and stock market returns. However, from the Granger causality test, Kapusuzoglu (2011) observes that there is one way causal relationship between Istanbul stock market index to oil price, but oil price has no causal relationship with any

other indices in the study. On the other hand, Raheman et al. (2012) have conducted a study to determine the relationship between oil price fluctuations and stock returns of the Asia Pacific countries. In VAR framework, they found a significant short run relationship between oil price fluctuations and stock returns in Asia Pacific countries. Granger causality test reveals that oil price is a cause of stock returns for only Pakistan and Sri Lanka. Similarly, Ciner (2001), Toraman, Basarir and Bayramoglu (2011), Muritala, Taiwo and Olowookere (2012) and Sharma and Khanna (2012) examine the dynamic relationship between oil prices and stock markets by using various econometrical test for example co-integration tests, Vector Error Correction Model (VECM), Granger Causality test etc. Finally they also concluded that there exist a significant long-term relationship between stock market indices and oil price. But after analyzing the monthly data of oil prices, interest rate, industrial production and stock market indices, Al-Fayoumi (2009) findings does not support the hypothesis that oil prices lead to changes in stock market returns.

There were some India specific studies in this regard. In line with the study done by Kapusuzoglu (2011), Chittedi (2012) investigates the long run relationship between oil prices and stock prices in India over the period from April 2000 to June 2011 through Auto Regressive Distributed Lag (ARDL) Model. The study suggests that the changes of stock prices in India have a significant impact on the changes of oil prices. But a change in the oil prices does not have impact on stock prices. Kalra (2012) explores the relationship between oil price and some other selected macroeconomic variables and Sensex during the period of January 2001 to December 2009. With the help of correlation and regression analysis, she found that forex rate, inflation rate and gold prices were the most significant variables that help in forming models for forecasting the Sensex. Sahu, Mondal and Bandopadhyay (2013) and Sahu, Bandopadhyay and Mondal (2014) investigate the dynamic relationship between oil price shocks in Indian Stock market. They consider crude oil prices in rupee terms during the period from 2001 through 2013. The cointegration model result indicates the existence of long-term relationship between the two variables. Again, vector error term of VECM shows a long term causality moves from Indian stock market to oil price but not vice versa. The impulse response function analysis reveals that a positive shock in oil price has a small but persistence and growing positive impact on Indian stock market in the short run. Hosseini, Ahmad and Lai (2011) have conducted a study on India for the period from January 1999 to January 2009. By means of multivariate cointegration and vector error correction model technique, they conclude that there are both long and short run linkages between macroeconomic variable and stock market index in both countries.

Many studies have tried to investigate relationship between exchange rate and stock prices. Unlike changes of crude oil prices that is mainly governed by international demand and supply, changes in exchange rate depends a lot on domestic short term and long term fiscal policies and its implementation in the respective economy. So, instead of considering the above relationship in the context of developed economies, this study is restricted within Asian countries and country-based. In the context of Japan, there are three relevant studies. Mukherjee and Naka (1995) conduct a study for the period from January 1971 to December 1990 and observe that exchange rate has made positive impact on Japanese stock index. Later on, Kurihara and Nezu (2006) examine the relationship between Japanese stock prices and macroeconomic variables during March 2001 to July 2005. Using cointegration analysis and vector error correction method, the results demonstrate that exchange rate is not a significant determinant of Japanese stock prices. However, Hartmann and Pierdzioch (2007) study on the linkage between exchange rate movements and stock returns using monthly Japanese data for the period of 1991-2005 suggest that the link between stock prices and exchange rate movements tends to be stronger in months when central bank intervened than in non-intervention months. Maysami and Koh (2000) and Maysami, Howe and Hamzah (2004) conclude that Singapore stock market is positively and significantly co-integrated with exchange rate. However, the result of an earlier study by Mookherjee and Yu (1997) using data from 1984 to 1993, does not indicate any co-integrating relationship between the Singapore stock market and exchange rate. There are several studies in Malaysian context pre and post financial crisis on 1997. Ibrahim (1999) observes stock prices are caused by exchange rate in the short run during pre-crisis period. The bivariate analysis suggests that there is no evidence of co-integrating relationship between the two variables. But, another study using pre-crisis period data by Ibrahim & Aziz (2003) observes that stock prices are negatively associated with exchange rate. On the contrary, Majid and Yusuf (2009) observe that exchange rate has a significant and direct impact on Islamic stock market in Malaysia. However, Hussin et al. (2012) find that stock market is negatively and significantly co-integrated with exchange rate during post crisis period. Through vector error correction model, Kwon and Shin (1999) observe that during the period of 1980 to 1992 production index, foreign trade balance and money supply, along with exchange rate have significantly influenced the Korean stock market in the short-run.

There are a lot of studies in Indian context as well. Most of the Indian studies find either no evidence or insignificant evidence of exchange rate influencing stock prices. Mishra (2004) examines the dynamic relationship between the Indian stock market and foreign exchange markets for the period April 1992 to March 2002. The major findings of their study include that there is no Granger causality between the exchange rate fluctuation and stock return. Reddy and Sebastin (2008) make an attempt to study the interaction between the stock price and the foreign exchange markets in India by using daily

data on Nifty and the exchange rate from November 1995 to March 2007. The result reveals that there exist a low level of interaction between the stock prices and the forex markets of India. Rahman and Uddin (2009) revisit the issue of the interactions between stock prices and exchange rates in three emerging countries of South Asia, namely Bangladesh, India and Pakistan for the period of January 2003 to June 2008. The empirical result of their study shows that there is no cointegrating relationship between stock prices and exchange rates and no causal relationship between stock prices and exchange rates in these countries. Similarly, Singh (2010), Naik (2013) and Naik and Padhi (2012) examine the relationships between the Indian stock prices and exchange rate and do not find any significant relationship between exchange rate and stock prices in India.

Few studies have found co-integrating relationship between exchange rate and stock prices. Nair (2008) explores the macroeconomic determinants of stock market development in India from 1993/94 to 2006/07. The results reveal that the exchange rate may have significant impact on stock market in the long run but have no significant influence on stock market in India in the short run. Similarly, the findings of Pal and Mittal (2011) and Sampath (2011) also reveal that exchange rate has a significant impact on stock prices in long-run as well as in short run. Tripathy (2011) investigates the market efficiency and causal relationship between selected macroeconomic variables and the Indian stock market during the period from January 2005 to February 2011 by using Ljung-Box Q test, Breusch-Godfrey LM test, Unit Root test, Granger Causality test. He suggests that any change in the exchange rate, interest rate and international market significantly influence the Indian stock market vice-versa. There are contradictory conclusions regarding the impact of exchange rate on stock market not only from one economy to another economy but also within the same economy.

There are few literatures on the combined impact of crude oil and exchange rate on stock market. Sariannidis et al. (2010), analysing the data from January, 2000 to January, 2008, in the context of US, find that changes in returns of crude oil prices affect negatively the US stock market. They also observe that the exchange rate volatility affects negatively the returns of the US stock market. Chinzara (2011) applies the Generalised Autoregressive Conditional Heteroscedastic and Vector Autoregression models to show that oil price and exchange rate uncertainty significantly influences stock market volatility in South Africa. Sujit and Kumar (2011) have studied the relationship between stock market with oil price, exchange rate, gold price from 1998 to 2011. They find that the exchange rate is affected by macroeconomic variables (including crude prices) considered in their study. However, stock market has little influence on exchange rate. Using monthly data from January 1988 to December 2008, Basher, Haug and Sadorsky (2012) have tried to investigate the dynamic relationship between oil prices, exchange rates and emerging market stock prices. Employing vector autoregression model and impulse responses analysis they conclude that positive shocks to oil prices tend to depress emerging market stock prices and US dollar exchange rates in the short run. Batac and Tatlonghori (2013) have studied the impact of peso-dollar exchange rate, oil prices and money supply on Philippines stock market. They consider quarterly data from 1992 to 2010 and conclude that current and several lagged values of the Peso-Dollar exchange rates are found to influence Philippines stock prices. However, crude oil price changes do not affect significantly in the said stock market.

From the review of the earlier literature it is observed that a large number of studies have been made to determine the relationship between crude oil price, exchange rate and stock price movement. Undoubtedly, the above mentioned research studies have a great contribution in this field but the findings of these studies are mixed and inconsistent. These findings are sensitive to the choice of countries, methodology employed and the time period under studied. It is difficult to generalize the results because each market is unique in terms of its own rules, regulations, and types of investors. There are several studies that also examine the impact of macroeconomic variables on Indian stock market. In some studies, macroeconomic variables include oil prices or exchange rate along with other variables. However, we understand that there is no serious study on the combined impact of crude oil prices and exchange rate in Indian stock market. Thus this paper is an attempt to assess the combined impact of crude oil prices and exchange rate on stock market.

DATA AND METHODOLOGY

DATA

The empirical investigation is being carried out using monthly data from April, 1993 to March, 2013. The monthly closing values of S&P BSE Sensex have been considered as a proxy of the Indian Stock Market and have been used to obtain a measure of market price movement of Indian securities. West Texas Intermediate (WTI) crude oil price per barrel (in Dollar) has been used as a proxy of oil price in Indian economy. The US Dollar has been taken to be the foreign currency against which the Indian Rupee exchange rate is considered. This is because the US Dollar has remained to be the most dominating foreign currency used for trading oil throughout the period of this study.

Closing data pertaining to Sensex are collected from the web site of Bombay Stock Exchange, and the crude oil price data are obtained from Bloomberg database and Ministry of Petroleum, Government of India. The monthly exchange rate related data are collected from various issues of Handbook of Statistics on the Indian Economy and Reserve Bank of India Bulletin, published by Reserve Bank of India. Microsoft Office Excel 2007 and Eviews-7 package are used for econometric analyses.

METHODOLOGY

Given the nature of the problem and the quantum of data, we first study the data properties from an econometric perspective with the help of descriptive statistics and unit root test. This approach will show the nature and basic characteristics of the variables used in the analysis and whether the data series are stationary or non-stationary. This would help us to apply Cointegration Test, Vector Error Correction Model (VECM), Variance Decomposition Test and Impulse Response Analysis to establish the long and short-run dynamic relationship between the variables and Granger Causality Test to identify the direction of causality.

The requirement for the data series to be stationary is a prerequisite for drawing meaningful inferences in a time series analysis and to enhance the accuracy and reliability of the models constructed. The unit root test is one of the common methods to find whether a time series is stationary or not. The unit root test result gives an idea whether the data series contain unit root property or not. The test results also indicate the order of integration. When applying regression models or cointegration techniques, the order of integration is essential. If the applied data has no correct order of integration, spurious regressions or wrong test statistics are the consequences and can make the analysis useless. There are a large number of unit root tests available. The decision regarding the unit root property could be taken by considering two popular and widely used unit root test namely Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test.

As the autoregressive model is sensitive to the selection of appropriate lag length, the study ascertains the appropriate lag length prior to estimation. However, a large lag order in the VAR model can rapidly exhaust the degree of freedom in small samples. There is no commonly agreed technique on how to select the lags and variables structure, while the outcome of the estimation heavily depends on the estimated settings. The study determines the optimum lag length based on the Akaike Information Criteria (AIC), Schwarz Information Criteria (SIC) and Hannan-Quinn Information Criteria (HQC).

To determine the long-run relationship among crude oil price, exchange rate and Indian stock market, the study considers VAR-based approach of cointegration test suggested by Johansen (1988). In this approach of cointegration test, Trace test (or Likelihood ratio test) as well as Maximum Eigenvalue test are applied to decipher the stated long term dynamics. The concept of cointegration becomes more relevant when the time series being analysed are non-stationary level and all the variables used in the study should be integrated in same order. In econometric terms, two or more variables are said to be cointegrated if they share common trend. Appropriately, the test provides us information on whether the variables, particularly the crude oil price, exchange rate and measures of Indian stock prices are tied together in the long run. The presence of cointegration indicates interdependence of the endogenous variables, which may be the result of economic linkage between the markets or the arbitrage activities among investors.

There often exists a long-run equilibrium relationship between two or more variables but in the short run there may be disequilibrium. The nature of the relationship among crude oil price, exchange rate and Indian stock market in the short-run can be explored by considering the Vector Error Correction Mechanism. A vector error correction model is a restricted VAR that has cointegration restrictions built into the specification, so that it is designed for use with non-stationary series that are known to be cointegrated. The error correction term of VECM specification indicates the rate at which it corrects its previous period disequilibrium or speed of adjustment to restore the long-run equilibrium relationship.

The study applies the Granger causality test to identify the existence and nature of the causal relationship between the variables. It can be conducted in two different ways depending on the results of the long-run analysis. The Granger test (Granger 1969) is suitable for analyzing the short-run causal relationship if no cointegration exists among the variables. On the other hand, when the variables are cointegrated, the standard Granger test is misspecified and the error correction strategy suggested by Engle and Granger (1987) should be used. The study proceeds with a Granger causality test in the form of vector error correction model, as the variables are found to be cointegrated. VECM allows the modelling of both the short-run and long-run dynamics for the variables involved in the model. The error correction term of VECM indicates the direction of long-run causality and the short term causality among the variables are tested through VEC Granger causality test or Block Exogeneity Wald test.

Despite the importance of conducting causality tests, the empirical inferences based on the causality test do not determine the strength of the causal relationships between the variables nor do they describe the relationship between these variables over time. Variance decomposition test is used to explore the degree of exogeneity of the variables involved in this study. It illustrates the share of the forecast error of one variable as a result of changes in the other variables. Hence, the relative significance of each variable can be determined which causes oscillations in the other variable. Similarly, the empirical inferences based on the Granger causality test helps to qualify the flow of influences but the estimates of the Impulse Response Function (IRF) Analysis can give us a quantitative idea about the impacts for several periods in future. The estimated impulse response of the VAR system enables us to examine how each of the variables responds to innovations from other variables in the system. More specifically IRFs essentially map out the dynamic response path of a variable due to a one standard deviation shock to another variable.

ANALYSIS AND FINDINGS OF THE STUDY

FINDINGS FROM THE DESCRIPTIVE STATISTICS

The basic statistical values of the variables are calculated in the first phase of our study. The descriptive statistics

provide a historical background for the behaviour of the data used in the study. From the descriptive statistics presented in Table 1 it is observed that the Sensex as well as the values of crude oil price and exchange rate are not stable at all during the study period. In respect of crude oil price and exchange rate the maximum values are 133.93 and 56.03 respectively and the minimum values are 11.31 and 31.31 respectively, with an average of 46.42 and 42.90 respectively. These values indicate the volatility of the variables. High values of standard deviations also show the variability of the monthly value of the macroeconomic variables. During the study period the values of Sensex also have very high and significant variability from their mean. The high differences between maximum values and minimum values reveal that the Indian stock markets are also highly unstable during this period.

TABLE 1. Descriptive statistics

Statistics	S&P BSE Sensex	Crude Oil Price	Exchange Rate
Mean	8313.83	46.42	42.90
Median	4754.20	31.45	44.40
Maximum	20509.09	133.93	56.03
Minimum	2122.30	11.31	31.31
Standard Deviation	6010.22	30.51	6.19
Skewness	0.75	0.77	-0.46
Kurtosis	1.89	2.39	2.53
Jarque-Bera Test Statistic	34.66	27.65	10.73
Probability	0.0000	0.0000	0.0046

From the descriptive information it can be said that none of the variables are normally distributed, though, in most of the cases, the median values of variables are very close to average values. The measures of skewness suggest that the variables are not distributed symmetrically. All the variables are skewed positively except exchange rate, which is skewed negatively. The values of the kurtosis indicate that all the variables are less peaked than the normal distribution, i.e., they follow platykurtic distribution. Results obtained from Jarque-Bera statistic confirmed that none of the series are normally distributed.

FINDINGS FROM LONG-RUN ANALYSIS

As mentioned before, the long-run analysis is conducted using the Johansen cointegration test. Typically, the Johansen cointegration test consists of three general steps. First, examine whether all variables in the model are integrated of the same order, which can be established by unit root tests. Second, determine the optimal lag length for the VAR model to verify that the estimated residuals are not autocorrelated. Third, estimate the VAR model to construct the cointegration vectors in order to determine the cointegrating relationship. For this, it is necessary to establish the trace test statistics and the maximum eigenvalue test statistics. The following subsections present the results of each of the steps.

RESULTS OF UNIT ROOT TEST

As already stated, testing stationarity of a data series is a prerequisite for drawing meaningful inferences in a time series analysis. It enhances the accuracy and reliability of the models constructed. So, it is necessary to determine the unit root property and order of integration for each variable included in the system. Both the unit root tests (ADF and PP) are performed with intercept, and time trend and intercept for all variables in their levels and then the tests are performed with their first difference values, and so on.

TABLE 2. Results of Augmented Dickey-Fuller (ADF) unit root test

Variables	Level		First Difference		Result
	Intercept	Trend and Intercept	Intercept	Trend and Intercept	
Sensex	-0.4033 [0] (0.9052)	-2.0411 [0] (0.5754)	-15.2228 [0] (0.0000)	-15.2191 [0] (0.0000)	I(1)
Crude Oil Price	-1.5652 [1] (0.4988)	-4.0178 [1] (0.0094)	-10.2777 [0] (0.0000)	-10.2616 [0] (0.0000)	I(1)
Exchange Rate	-1.2681 [1] (0.6447)	-2.0933 [1] (0.5465)	-10.4985 [1] (0.0000)	-10.4759 [1] (0.0000)	I(1)

Notes: ( ) MacKinnon (1996) one-sided p-values; [ ] Lag lengths for ADF Test; I(1): Stationary after first difference

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Table 2 and Table 3 present the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root test results of the variables in their level and first difference. From the result presented in the tables, it is clear that the null hypothesis of the existence of a unit root in its levels cannot be rejected for any of the series in their levels since the ADF and PP statistics of the variables are not less than the critical values at any significance level, i.e., 1%, 5%, and 10%. Therefore, the unit root tests result concludes that all the series are non-stationary in each level. Applying the same test to their first differences shows that the null hypothesis of a unit root is rejected in all cases even at a 1% significance level.

TABLE 3. Results of Phillips-Perron (PP) unit root test

Variables	Level		First Difference		Result
	Intercept	Trend and Intercept	Intercept	Trend and Intercept	
Sensex	-0.5434 [7] (0.8789)	-2.2705 [7] (0.4480)	-15.2777 [6] (0.0000)	-15.2691 [6] (0.0000)	I(1)
Crude Oil Price	-1.3681 [5] (0.5976)	-3.3829 [6] (0.0534)	-10.3235 [2] (0.0000)	-10.3080 [2] (0.0000)	I(1)
Exchange Rate	-0.9291 [0] (0.7778)	-1.7328 [1] (0.7337)	-11.0407 [10] (0.0000)	-11.0166 [10] (0.0000)	I(1)

Notes: ( ) MacKinnon (1996) one-sided p-values; [ ] Lag lengths for ADF Test; I(1): Stationary after first difference

So, from the unit root tests results, it is observed that the oil prices, exchange rates as well as the values of Sensex are stationary at their first difference i.e., I(1).

SELECTION OF OPTIMUM LAG LENGTH

As the autoregressive model is sensitive to the selection of appropriate lag length, the study is to ascertain the appropriate lag length before conducting the cointegration analysis in line with Johansen.

TABLE 4. VAR lag order selection criteria

Lag Length	AIC	SIC	HQC
0	34.10596	34.15109	34.12417
1	23.96364	24.14413	24.03646
2	23.67268	23.98854*	23.80012*
3	23.61942	24.07065	23.80148
4	23.66196	24.24856	23.89863
5	23.62736	24.34933	23.91866
6	23.58307	24.44040	23.92898
7	23.51146	24.50417	23.91199
8	23.44138	24.56946	23.89653
9	23.44285	24.70629	23.95261
10	23.38941*	24.78822	23.95379
11	23.40281	24.93699	24.02180
12	23.40204	25.07159	24.07565

Notes: * Indicates lag order selected by the criterion

The optimum lag length based on the three commonly used criteria, namely AIC, SIC and HQC are presented in Table 4. The AIC criteria suggest relatively higher lag length i.e. 10, but the present study could not take the risk of over parameterization by considering too higher lags for the VAR model. Here, the SIC criteria or HQC criteria suggest the same lag length as optimum i.e. 2. Therefore, the study chose SIC or HQC criteria to determine the optimum lag length. For this study the optimum lag length is 2, having the lowest SIC and HQC value.

RESULTS OF JOHANSEN COINTEGRATION TEST

Since oil price, exchange rate and Sensex contain unit root at their level values, the study conducts a cointegration test suggested by Johansen's with the purpose of finding whether these variables have a long-term common stochastic trend.

TABLE 5. Results of Johansen cointegration test (trace statistics)

H_0	H_1	Trace Statistics	5% Critical Value	Probability*
r = 0	r = 1	31.97835	29.79707	0.0276
r ≤ 1	r = 2	5.785698	15.49471	0.7207

* MacKinnon-Haug-Michelis (1999) p-values

The calculated values of Trace statistics (presented in Table 5) and maximum eigen statistics (presented in Table 6) of Johansens cointegration test, when the null hypothesis is r = 0 (i.e., no cointegration), are 31.98 and 26.19 respectively.

TABLE 6. Results of Johansen cointegration test (maximum eigen statistics)

H_0	H_1	Maximum Eigen Statistics	5% Critical Value	Probability*
r = 0	r = 1	26.19265	21.13162	0.0089
r ≤ 1	r = 2	5.693022	14.26460	0.6529

* MacKinnon-Haug-Michelis (1999) p-values

Here the null hypothesis of no cointegration when r = 0, is rejected at 5 per cent level of significance, as the calculated value of trace statistics and maximum eigen statistics are higher than the MacKinnon-Haug-Michelis critical value at 5 percent level of significance. This indicates the existence of one cointegrating vector among oil price, exchange rate and the stock prices (Sensex). So the Johansen's cointegration test result supports the hypothesis that oil price, exchange rate and stock prices are cointegrated and there exist long term cointegrating relationship. The long run cointegrating equation is:

$$SEN_t = 4699.257 + 228.0678\ CP_{(t = 12.83)} - 162.5055\ EXR_{(t = -1.85)} + \mu_t$$

Based on the above cointegrating equations, the study concludes that, in long-run there exists a positive and significant (on the basis of t test statistics) relationship between the price of oil and the value of Sensex i.e., they move together in the same direction. But the result fails to describe any significant relationship between Sensex and exchange rate in long run, as the t-value associated with the coefficient of the exchange rate in the cointegrating equation is not significant at 5 percent level of significance.

FINDINGS FROM SHORT-RUN ANALYSIS

Having established that the crude oil price, exchange rate and the Indian stock market are cointegrated, the fundamental question that arises regarding the nature of the dynamic relationship between these variables in the short run can be answered by considering the vector error correction mechanism.

RESULT OF THE VECTOR ERROR CORRECTION MODEL

The results of the vector error correction model presented in Table 7 shows that the t-values associated with the coefficient of the lag value of the crude oil price and exchange rate are not statistically significant when Sensex is used as a dependent variable, which indicate that the oil price and exchange rate do not have any impact on the Indian stock market in short run. The result shows that in the short run the oil prices and the stock prices are not affected by the change of exchange rate, rather the movement of Indian stock market indices positively affect the movement of oil prices and negatively affect the value of exchange rate.

TABLE 7. Results of vector error correction model

Independent Variables	Dependent Variables		
	D(Sensex)	D(CP)	D(EXR)
ECT ( )	0.041504**	-0.115936***	-0.006767**
	[2.12575]	[-4.77878]	[-2.30964]
D(Sensex(-1))	-0.093831	0.001243***	-0.000219***
	[-1.30281]	[3.16820]	[-3.28831]
D(CP(-1))	15.30923	0.370560***	-0.010160
	[1.43872]	[6.39179]	[-1.03403]
D(EXR(-1))	-108.1842	0.164680	0.188926***
	[-1.51818]	[0.42417]	[2.87113]
C	81.91197*	0.087663	0.097713**
	[1.70618]	[0.33515]	[2.20410]

Notes: *** Statistically significant at 1% level; ** Statistically significant at 5% level; [ ] t-values

The VECM result also indicates that the oil price and exchange rate adjusts the disturbances to restore long-run equilibrium significantly and in right direction, but the Indian stock market represented by Sensex does not react significantly. The coefficients of error correction term -0.1159 and -0.0068 are significant at 1 percent and 5 percent level of significance respectively. These values indicate the rate at which they correct the disequilibrium of the previous period. Thus, the speed of adjustment towards the long-run equilibrium is about 11.59 percent and 0.68 percent per month for oil price and exchange rate respectively.

FINDINGS FROM CAUSALITY TEST

As the variables are cointegrated, the standard Granger test is misspecified and the error correction strategy suggested by Engle and Granger (1987) is used to identify the long and short term causal relationship among the variables. The result of the long-run and the short-run causality test under VECM framework are reported below.

LONG-RUN CAUSALITY

The t-values associated with the error correction terms of VECM, reported in Table 7 indicate the existence of significant unidirectional long-run causality. The coefficients of the error correction term -0.1159 and -0.0068 are statistically significant at 1 percent level which indicates that any change in stock prices causes change in oil price as well as the exchange rate in the long run. Furthermore, in the long run, change in oil price and exchange rate do not have any causal effect on stock prices in India.

SHORT-RUN CAUSALITY

The results of short-run causality test among the variables based on VEC Granger Causality test are presented in Table 8.

According to the obtained results, it can be said that there exists a unidirectional short-run causal relationship between the stock prices and the two macroeconomic variables namely crude oil price and exchange rate. In short-run the study shows the same causal direction as in the long-run i.e. the movement of stock price causes the oil price movement and exchange rate fluctuation. In short-run the change in exchange rate does not have any causal effect on oil price and stock price.

TABLE 8. Result of VEC granger causality/block exogeneity wald test

Dependent Variables	Independent Variables	Chi-Square Value	Probability Value	Implication
Sensex	CP	2.069904	0.1502	No Causality
	EXR	2.304871	0.1290	No Causality
CP	Sensex	10.03747	0.0015	Existence of Causality
	EXR	0.179921	0.6714	No Causality
EXR	Sensex	10.81301	0.0010	Existence of Causality
	CP	1.069219	0.3011	No Causality

RESULTS OF VARIANCE DECOMPOSITIONS TEST AND IMPULSE RESPONSE FUNCTIONS ANALYSIS

The study has estimated the variance decompositions and impulse response functions under the VECM framework to investigate the dynamic relationship among the crude oil price, exchange rate and stock prices in India.

Table 9 indicates that the stock prices are strongly exogenous in nature because almost 87 percent of their own variances are explained by its own shock even after 24 months, while the explanatory powers of oil price and exchange rate to forecast the error variance of Sensex are found to be negligible. This is due to the fact that, during the study period, stock prices are more dependent on themselves than the value of the oil price and exchange rate. The results also indicate that the values of oil price and exchange rate are comparatively less exogenous than the Indian stock market in the sense that the percentage of the error variance of oil price and exchange rate accounted by their own are approximately 36 percent and 55 percent respectively at time horizon of 24 months. The forecast error variances of oil price and exchange rate are significantly explained by the value of Sensex (64 percent and 32 percent respectively at time horizon of 24 months). The result also shows that a very small portion of the forecast error variance of oil price and stock price is explained by the value of exchange rate.

TABLE 9. Variance decomposition result

Variance Decompositions of	Period	Percentage of Forecast Error Variance Explained by Innovation in:		
		Sensex	Crude Oil Price	Exchange Rate
Sensex	1	100.0000	0.000000	0.000000
	4	99.26158	0.152834	0.585583
	8	96.72772	2.643674	0.628611
	12	93.24395	6.151443	0.604605
	16	90.47148	8.947799	0.580725
	20	88.50151	10.93543	0.563052
	24	87.10950	12.34010	0.550403
Crude Oil Price	1	1.171093	98.82891	0.000000
	4	16.49708	83.41573	0.087187
	8	33.37254	66.45751	0.169950
	12	46.54719	53.19260	0.260210
	16	54.99481	44.67430	0.330898
	20	60.31172	39.30692	0.381366
	24	63.87183	35.71044	0.417729
Exchange Rate	1	11.75484	0.683368	87.56180
	4	28.39309	0.321982	71.28493
	8	32.21380	2.302675	65.48353
	12	32.55643	6.025664	61.41790
	16	32.25007	9.152810	58.59712
	20	31.90873	11.40282	56.68845
	24	31.63428	12.99516	55.37056

The results of the impulse response analysis for a time horizon of 24 months to a 'one standard deviation' shock on Sensex, crude oil price and exchange rate are shown in Figure 1.

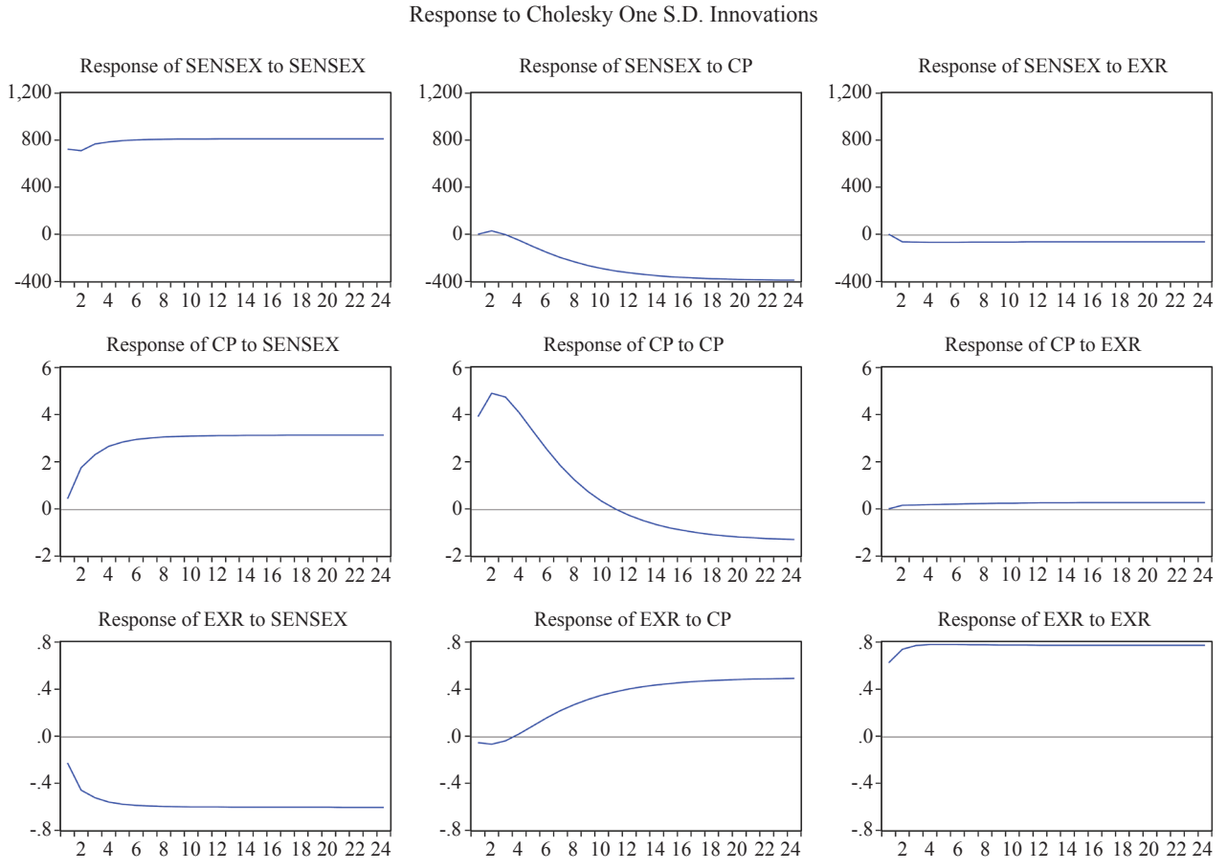

FIGURE 1. Impulse responses of Sensex, Crude Oil Price (CP) and Exchange Rate (EXR) to one standard deviation shock in the variables

A positive shock in stock price will have a positive and persistent effect on itself. The stock prices respond intensively to a shock in the other variables in the system. The response generated from a positive shock on oil prices has a persistent and growing effect on Indian stock markets.

SUMMARY OF THE RESULTS AND ITS INTERPRETATION

Findings of this study provide a comprehensive understanding of the dynamic relationship among the movement of crude oil prices, exchange rate and stock prices in India. In line with the earlier findings made by Sadorsky (2001), Boyer and Filion (2004), Sahu, Mondal and Bandopadhyay (2013) and Sahu, Bandopadhyay and Mondal (2014) our present study based on Johansen's cointegration test confirms the existence of a significant long run cointegrating relationship between oil price and stock indices. The causality test based on VECM framework indicates a significant unidirectional long term causality which runs from Indian stock market to oil price not the vice versa. Moreover, the results obtained from Granger causality -Wald test confirm that the change of oil price and exchange rate do not causes the movement of stock prices.

However, the result of the cointegrating equation and error correction model fails to identify any significant impact of exchange rate on stock market indices. In conformity with the result of the earlier studies of Nair (2008), Rajput and Thaker (2008), Rahman and Uddin (2009), Singh (2010), Naik and Padhi (2012) and Naik (2013) in Indian context, the present study concludes that exchange rate has no significant influence on stock price movement in India, though the result of the study contradicts with the findings of the study of Krugman (1983), Sariannidis et al. (2010) and Basher, Haug and Sadorsky (2012) and this study concludes that there is no significant relationship between the crude oil price and exchange rate in India. Therefore, the study confirms that the existence of this positive relationship between oil price and stock indices is not due to the effect of the movement of exchange rate.

Many of the earlier studies namely Jones and Kaul (1996), Filis (2010), Miller and Ratti (2009), Basher, Haug and Sadorsky (2012) etc. conducted on developed and developing countries, concludes that increase of oil

price affect stock prices adversely. But in our study we find a long-run positive co-movement among the crude oil price and Indian stock market indices. The result is mainly due to the reasons that the positive movement of Indian stock market is an indication of better performance of the economy. As India has been following the policy of liberalization, privatization and globalization from 1991, it has become integrated with the world economy. The movement of the Indian economy in this period which is reflected in the stock market is also a reflection of the movement of the world economy. As a result, a positive long run relation is observed between Indian stock market and crude oil prices, and the direction is from the Indian stock market to the crude oil prices but not the other way round. This does not mean the crude oil price in the international market has been determined by the movement of Indian stock prices. But the interesting result that is coming out from this analysis is that crude oil price has no significant effect on Indian stock prices.

Moreover, during the study period the international price of crude oil (WTI) per barrel has risen from $20.26 (in April 1993) to $ 93.12 (in March 2013) with a maximum of $133.93 in June, 2008. As Indian economy is controlled one and as the oil price is subsidized in India, so, the rise in international crude oil prices as well as increase in exchange rate do not contribute any significant impact on the production cost as well as the profitability of Indian companies. In addition to that, during the study period India's growth rate has significantly improved. And as long as the growth of income remains robust enough, higher inflation and a subsequent rise of interest rates may not affect the overall consumption trend adversely. For these reasons the movement of crude oil prices may not have any adverse impact on Indian stock market.

CONCLUSION

In this study we have presented extensively the evidences on the relationships among crude oil price, exchange rate and the stock prices in India. The estimated results indicate that there exists a long run cointegrating relation between crude oil price, exchange rate and Indian stock market, but crude oil price or exchange rate is not observed to affect the Indian stock prices significantly. Further, the study concludes that the Indian stock prices are strongly exogenous in the sense that shocks to crude oil price or exchange rate explain only a very small portion of the forecast variance error of the market index, though the effect of one standard deviation shock in one variable made a persistent and longer effect on other variables. The observed result is not due to the effect of the exchange rate fluctuations, because the change in exchange rate has no significant impact on oil prices or stock prices in India.

Evidence of this study provides a comprehensive understanding of the relationship among the macroeconomic variables in India. It discusses the theoretical hypotheses on this captioned relationship and compares with empirical evidences from prior research. The study extends the literature by examining the relationship in the emerging markets of Indian economy. This study is expected to offer some insights for financial regulators and policymakers for formulating economic and financial policies. The sense of this inter-relationship is also useful to shareholders and portfolio managers as it provides a better understanding of portfolio structure and evaluation to improve overall portfolio design and performance.

To have better understandings on the issue, future research is suggested. Further research efforts could either eliminate some of the limitations or expand the scope of investigation in this study. The possible extension of this study is to consider the impact of crude oil price and exchange rate along with other important macroeconomic determinants. Future study could empirically test the relationship by considering the potential structural breaks. Moreover, since the long-run relationship between oil price and stock prices is expected to vary from one industry to another, a sectoral analysis of the matter would be more informative.

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