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COINTEGRATION AND CAUSAL RELATIONSHIP AMONG CRUDE PRICE, DOMESTIC GOLD PRICE AND FINANCIAL VARIABLES- AN EVIDENCE OF BSE AND NSE*

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ABSTRACT

The present study investigates the cointegration relationships among crude oil price, domestic gold price and selected financial variables (exchange rates and stock price indices) in India. Increasing crude oil prices will increase the production costs which will affect cash flow and will decrease stock prices. Investors are showing fewer concerns in the stock markets and investing in yellow metals due to increasing trend in gold prices on account of no fear and no future loss. Again, exchange rate fluctuations will affect international trades, thus influence the stock market. This study is based on secondary data obtained from various data sources including BSE database, NSE database and World Gold Council database for the period from January 2, 1991 to October 31, 2012. In the course of analysis, ADF unit root test, Johansen cointegration analysis and Granger causality test have been designed. Johansen cointegration test result indicates that there exists a long-term relationship among the selected variables. Granger causality test result shows that there must be either bidirectional or no causality among the variables.

Keywords: Crude Oil Price; Gold Price; Exchange Rates; Stock Price Indices; Johansen Cointegration Test.

INTRODUCTION

The study of the financial market of a country in relation to macro-economic and financial variables has been the main issue of many researches since LPG. Generally, stock market is influenced by numerous interconnected economic, social, political, and these factors interact with each other in a very intricate approach and stock prices are determined by few macroeconomic variables, for example, the crude oil price, the gold price, the exchange rate and the inflation rate (Abbas Alavi Rad, 2011).

Indian stock market is greatly influenced by three critical factors, i.e., international crude oil price, gold price and exchange rates. Crude oil prices are tracked in the Indian economy with lots of interest. Since India imports around 80% of crude oil from the international market, any significant change in price of petroleum makes an impact on inflation numbers which in turn impacts the stock market (Vivek Sharma, 2012). Increasing crude oil prices will increase the production costs which will affect cash flow and will decrease stock prices (Ayhan Kapusuzoglu, 2011). The global economic turmoil is likely to

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stimulate uncertainty in gold prices, which has already made it a risky asset for investors in India. Gold prices, by and large, rise when attitudes on the economy and the financial markets are bearish or there is uncertainty over future trends. Investment demand will return only when there is some clarity. The domestic gold prices have topped in India for the first time, breaks all time record and the volatile situation in global markets had helped the yellow metal to gain handsomely. However, the coming days will see huge funds moving from gold to sensex and nifty. Many researchers have been done the long-run and short-run relationships among stock price index and gold price in developed and developing countries. Empirical results show that gold price can greatly affect the stock market (Mahmood Yahyazadehfar and Ahmad Babaie, 2012). Again, exchange rate fluctuations will affect international trades, thus influence the stock market. At the same time, exchange rate fluctuations will directly affect the profits; thereby impact the stock prices (Wang et al, 2010).

This paper aims to examine the dynamic relationships between crude oil price, domestic gold price and selected financial variables in India. Section two briefly glimpses the review of related literatures across the world. In section three, the materials and methods adopted are presented. The empirical results and inferences are discussed in section four and section five concludes the paper.

REVIEW OF LITERATURES

Mahmood Yahyazadehfar and Ahmad Babaie (2012) have made a study to examine the impact of macroeconomic variables such as interest rate, house price and gold price on stock price in capital market of Iran based on monthly data from March 2001 to April 2011 using VAR and Johansen-Juselius model. From the study it is clear that most of fluctuation in stock price can be recognized to itself, nevertheless among the selected variables, the house price has main role on stock price fluctuation.

Subarna K. Samanta and Ali H. M. Zadeh (2012) examined the co-movements of selected macro-variables (gold price, stock price, real exchange rate and the crude oil price) based on 21 years data using econometric models for the periods from January 1989 to September 2009. The study exposes that there is a cointegration relationship between the variables.

S. Kaliyamoorthy and S. Parithi (2012) have made a study to examine the relationship between gold price and stock market for the period from June 2009 to June 2010. They prove that there is no relationship with the stock market and gold price and stock market is not a ground for rising gold price.

Jana Šimáková (2011) has made a study to examine the characteristics co-movement relationship between the oil price levels and gold price levels for the period from 1970 to 2010 using cointegration test and Granger causality test method. He established that there is reality of a long-term relationship between selected variables.

Thai-Ha Le and Youngho Chang (2011) made a study on “Dynamic Relationships between the Price of Oil, Gold and Financial Variables in Japan: A Bounds Testing Approach” and they confirmed that the price of gold and stock, among others, can help form expectations of higher inflation over time. In the short run, only gold price impacts the interest rate in Japan.

Gagan Deep Sharma and Mandeep Mahendra (2010) made a study to evaluate the long-term relationship between BSE and Macro-economic variables (exchange rates, foreign exchange reserve, inflation rate and gold price) for the period from January 2008 to January 2009 using multiple regression model. The study reveals that exchange rate and gold price influences the stock prices in India.

Wang et al (2010) used daily data and time series method to investigate the impacts of fluctuations and long and short-term relationships in crude oil price, gold price, and exchange rates of the US dollar vs. various currencies on the stock price indices.

A considerable number of studies on the relationship between crude oil price, gold price, exchange rates and stock price indices have been undertaken. Only a few studies have examined the relationship between crude oil price, gold price, exchange rates with stock market in general and Indian stock exchanges in particular. Based on very few studies in India, it is found that the impact of crude oil price rise, gold price rise and devaluation of currencies in Indian stock market is unvoiced.

The conclusive sum of this retrospective review of relevant literature produced till date on the offered subject reveals wide room for the validity and originates of this work and reflects some decisive evidences that affirm its viability, as may be marked here it. The existence of crude oil price, gold price exchange rates and stock price indices of stock market in India are hardly available. Therefore, the present study aims to examine the changes of exchange rates or increase in daily crude oil price, gold price and its impact on stock price indices in India.

MATERIALS AND METHODS

Data Source

The study is based absolutely on secondary data obtained from various data sources including BSE and NSE database and the world gold council database for the period from January 2, 1991 to October 31, 2012.

Sample Design

The present study considers daily data encompassing the closing stock price indices of both BSE (Sensex) and NSE (Nifty), the daily domestic gold price indices, daily crude oil indices (WCI) and exchange rates. After fitting daily closing indexes with the corresponding gold price, crude oil price and exchange rates, there are 5400 observations. Eviews 7.0 package program has been used for arranging the data and implementation of econometric analyses.

Tools Used

In the course of analysis of the present study, only econometric tools include Augmented Dickey Fuller (ADF) both at levels and 1st differences and Johansen's system co-integration test have been used.

Model Specification

Unit root test. A time series is stationary or not or include unit root for which Augmented Dickey-Fuller (ADF-1979) test method has been used in the study. ADF test considered as an appropriate tool to check the stationariaty of time series data (Mehmood & Ahmad, 2012; Mehmood, 2012a; Naz, 2012, and Mehmood, 2012b). The time series is non-stationary if the critical value is lower than the calculated value, subsequently null hypothesis is rejected and series is decided to be stationary.

H_0: Series is stationary.
H_1: Series is non-stationary.

If all the sets of data are found I (1) (non-stationary), and if the regression produces a I (0) error term, the equation is said to be co-integrated. On the other, if there are two variables, x_t and y_t, which are both non-stationary in levels but stationary in first differences, then x_t and y_t would become integrated of order one, I(1), and their linear combination should have the form:

$$z_t = x_t - ay_t \quad (1)$$

[Claire G. Gilmore et al, (2009)]

However, if there is a I (0) such that z_t is also integrated of order zero, I (0), the linear combination of x_t and y_t is said to be stationary and the selected variables are also to be co-integrated (Engle & Granger, 1987). If two variables are co-integrated, there will be an underlying long-run relationship between them.

However, for determining the presence of unit roots, an extension of the Dickey and Fuller (1981) method has been applied. The ADF test uses a regression of the first differences of the series against the series lagged once, and lagged difference terms, with optional constant and time trend terms:

$$\Delta y_t = a_0 + a_1 t + \gamma y_{t-1} + \Sigma b_i y_{t-1} + e_t \quad (2)$$

In the equation Δ is the first-difference operator, a_0 is an intercept, $a_1 t$ is a linear time trend, e_t is an error term, and i is the number of lagged first-differenced terms such that e_t is the white noise. The test for a unit root has the null hypothesis that signifies $\gamma = 0$. If the coefficient is significantly different from zero, the hypothesis that y_t contains a unit root is considered as rejected. If the test on the level series fails to reject, the ADF procedure is then applied to the first-differences of the series. Rejection leads to the conclusion that the series is integrated of order one, I (1).
A limitation of the Dickey-Fuller test is its assumption that the errors are statistically independent and have constant variances.

Johansen co-integration test. Co-integration tests provide a mean to determine whether a set of endogenous variables share a common long-run stochastic trend. A finding of co-integration indicates interdependence of the endogenous variables, which may be the result of economic linkages between the markets or arbitrage activity between investors.
Hypothesis to be examined with Johansen co-integration test to be applied on the study has been presented below:

- H_0: There is no co-integration relationship between variables
- H_1: There is co-integration relationship between variables

The Johansen (1988) approach to testing for co-integration relies on the relationship between the rank of a matrix and its characteristic roots, or eigenvalues. Let X_t be a vector of n time series variables, each of which is integrated of order (1), and assume that X_t can be modelled by a Vector Auto Regression (VAR):

$$X_t = A_1 x_{t-1} + \ldots + A_p x_{t-p} + \varepsilon_t \quad (3)$$

Rewriting the VAR as

$$\Delta x_t = \Pi X_{t-1} + \Sigma \Gamma \Delta X_{t-i} + \varepsilon_t \quad (4)$$

Where, $\Pi = \Sigma A_i - I$, $\Gamma_i = -\Sigma A_i$. If the coefficient matrix Π has a reduced rank r < k, there exists k x r matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' x_t$ are stationary. The number of co-integrating relations is given by r, and each column of β is a co-integrating vector. There exists three possibilities, according to Johansen's (1995) co-integrated Vector Autoregressive Model: (i) if Π is of full rank, all elements of X become stationary and none of the series has a unit root, (ii) if the rank of $\Pi = 0$, there are no combinations which are stationary and there are no co-integrating vectors, (iii) if the rank of

Π is r such that 0 < r < k, then the X variables are co-integrated and there exists r co-integrating vectors. Equation (4) can be modified to allow for an intercept and a linear trend.

The number of distinct co-integrating vectors can be obtained by determining the significance of the characteristic roots of Π. To identify the number of characteristic roots that are not different from unity we have used two statistics, the trace test and the maximum eigenvalue test:

$$\lambda_{trace}(r) = -T\Sigma \ln(1 - \lambda_i) \quad (5)$$

and

$$\lambda_{max}(r,r+1) = -T\ln(1 - \lambda_{r+1}) \quad (6)$$

Where, λ_i = the estimated values of the characteristic roots (eigenvalues) obtained from the estimated Π matrix, r is the number of co-integrating vectors, and T = the number of usable observations. The trace test evaluates the null hypothesis that the number of distinct co-integrating vectors is less than or equal to r against a general alternative hypothesis (the number of distinct co-integrating vectors is more than or equal to r). The maximum eigenvalue test examines the number of co-integrating vectors versus that number plus one. If the variables in X_t are not co-integrated, the rank of Π is zero and all the characteristic roots are zero. Since ln (1) = 0, each of the expressions ln $(1 - \lambda_i)$ will equal zero in that case. Critical values for the test are provided by Johansen and Juselius (1990) and by Osterwald-Lenum (1992).

Pairwise Granger causality Tests. We test for the dearth of Granger causality by estimating the following VAR model (Olushina Olawale Awe, 2012):

$$Yt = a_0 + a_1Y_{t-1}+\ldots+ a_pY_{t-p}+ b_1X_{t-1}+\ldots+ b_pX_{t-p}+U_t \quad (7)$$

$$Xt = c_0 + c_1X_{t-1}+\ldots+ c_pX_{t-p}+ d_1Y_{t-1}+\ldots+ d_pY_{t-p}+V_t \quad (8)$$

Testing
H_0:b_1=b_2=…=b_p=0 against H_1: Not H_0 is a test that Xt does not Granger-cause Yt.
Similarly, testing H_0: d_1= d_2=…= d_p=0 against H_1: Not H_0 is a test that Yt does not Granger cause Xt.
In case of Granger causality between the two variables, null hypothesis is rejected if the probability value is less than alpha (0.05).

EMPIRICAL RESULTS AND ANALYSIS

Unit Root Test Results

Johansen cointegration analysis is needed where there are any long-term cointegration relationships between crude oil price, gold price, exchange rates and stock price indices of BSE and NSE. Cointegration analysis is possible if the series are stationary. In order to stationarity analysis, unit root test of Augmented Dickey-Fuller (ADF) is conducted with the levels and first differences of each series on the condition that the null hypothesis is non-stationary, so rejection of the unit root hypothesis supports stationarity.

Table-1 and 2 shows the results of unit root test. It reveals that time series are non-stationary at levels. However, table shows that the gold price and BSE and NSE stock price indices are stationary at 1st difference [1(1)]. Augmented Dickey Fuller unit root analysis test reveals that errors have constant variance and are statistically independent. Therefore, cointegration test can be applied on these variables, as supported in (Hina Shahzadi and M.N. Chohan, 2012).

TABLE 1

Results of Augmented Dickey-Fuller Test at level

	Intercept but no trend			Intercept and trend		
Variables	Test statistics	Critical value (5%)	Prob.	Test statistics	Critical value (5%)	Prob.
Exchange rates	-2.58	-2.86	0.0973	-2.71	-3.41	0.2308
Gold price	-1.93	-2.86	0.9998	-1.14	-3.41	0.8999
Sensex	-0.57	-2.86	0.8746	-2.05	-3.41	0.5714
Crude price	-0.53	-2.86	0.8831	-2.44	-3.41	0.3586

TABLE 2

Results of Augmented Dickey-Fuller Test at 1st difference

	Intercept but no trend			Intercept and trend		
Variables	Test statistics	Critical value (5%)	Prob.	Test statistics	Critical value (5%)	Prob.
Exchange rates	-78.98	-2.86	0.0001	-79.00	-3.41	0.0001
Gold price	-20.34	-2.86	0.0000	-20.69	-3.41	0.0000
Sensex	-66.99	-2.86	0.0001	-66.99	-3.41	0.0000
Crude price	-73.69	-2.86	0.0001	-73.69	-3.41	0.0001

Consequently, Johansen cointegration test is used to determine whether there is cointegration as well as the number of co-integrating relationships, that is, whether there are any long-term cointegration relationships between crude oil price, gold price, exchange rates and stock price indices of BSE and NSE or not. Two likelihood ratio tests are used, the Trace Test and the Maximum Eigen Value test, to determine the number of co-integrating vectors. The estimation for each series assumes linear deterministic trend unrestricted with intercepts and no trends. A lag of 1 to 4 (in 1st differences) is used for each series, based on the Swartz Information Criterion (SIC).

TABLE 3

Johansen Cointegration Test Resul

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.044762	313.9751	69.81889	0.0001
At most 1 *	0.010424	76.29773	47.85613	0.0000
At most 2	0.002111	21.91390	29.79707	0.3033
At most 3	0.001402	10.94466	15.49471	0.2149
At most 4	0.000706	3.665222	3.841466	0.0556

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE9s)	Eigen value	Trace Statistic	.05 Critical Value	Prob.**
None *	0.044762	237.6774	33.87687	0.0001
At most 1 *	0.010424	54.38384	27.58434	0.0000
At most 2	0.002111	10.96923	21.13162	0.6504

At most 3	0.001402	7.279441	14.26460	0.4566
At most 4	0.000706	3.665222	3.841466	0.0556

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Included observations: 5201 after adjustments
Trend assumption: Linear deterministic trend
Lags interval (in first differences): 1 to 4

Table-3 demonstrates the johansen cointegration test results. It assures the long-term relationship among the selected variables. The result shows that the series is cointegrated, as both the trace and the maximum eigenvalue tests reject the null hypothesis of no co-integration, suggesting that there are two significant co-integrating vectors in the model. This implies that there are two common stochastic trends, indicating a degree of market integration. Therefore, it may conclude that there exists a stationary, long-run relationship among the variables, as supported in (Saha and Bhunia, 2011).

Pairwise Granger Causality Tests Results

The Granger causality test is a statistical proposition test for determining whether one time series is helpful in forecasting another. The pairwise Granger causality test has been performed in the present study in search of direction of causation among the selected financial variables.

Table-4 reveals that no causality exists between (i) gold price and exchange rates, (ii) Nifty and exchange rates, (iii) sensex and exchange rates, (iv) exchange rates and sensex, (v) WCI and exchange rates, (vi) exchange rates and WCI, (vii) Nifty and gold price, (viii) Gold price and sensex, (ix) WCI and gold price, (xi) gold price and WCI, (xii) Nifty and sensex and (xiii) WCI and Nifty. Bidirectional causality exists between (i) Gold_Price and Nifty, (ii) Sensex and Gold Price, (iii) Exchange_Rates and Gold Price, (iv) Sensex and Nifty, (v) Nifty and WCI, (vi) WCI and Sensex and (vii) Sensex and WCI.

It is important to note that the pronouncement of causality between the selected variables does not mean that movement in one variable actually causes movements in another variable. To a certain extent, causality basically entails in order of movements in the time series (Olushina Olawale Awe, 2012).

Table 4
Pairwise Granger Causality Test Results

Null Hypothesis	Obs	F-Statistic	Prob.	Decision	Type of Causality
Gold_Price ↑ Exchange_Rates	5403	0.89686	0.4079	DNR H_0	No causality
Exchange_Rates↑ Gold_Price	5403	9.69686	6.E-05	Reject H_0	Bi-directional causality
Nifty ↑ Exchange_Rates	5231	0.16902	0.8445	DNR H_0	No causality
Exchange_Rates↑ Nifty	5231	1.42614	0.2403	DNR H_0	No causality
Sensex ↑ Exchange_Rates	5204	0.10361	0.9016	DNR H_0	No causality
Exchange_Rates↑ Sensex	5204	1.25314	0.2857	DNR H_0	No causality
Wci ↑ Exchange_Rates	5261	0.67279	0.5103	DNR H_0	No causality
Exchange_Rates↑ Wci	5261	0.39116	0.6763	DNR H_0	No causality
Nifty ↑ Gold Price	5231	1.54983	0.2124	DNR H_0	No causality
Gold_Price ↑ Nifty	5231	3.23936	0.0393	Reject H_0	Bi-directional causality
Sensex↑ Gold Price	5204	11.6061	9.E-06	Reject H_0	Bi-directional

Null Hypothesis	Obs	F-Statistic	Prob.	Decision	Type of Causality
					causality
Gold_Price ↑ Sensex	5204	0.81860	0.4411	DNR H_0	No causality
Wci ↑ Gold Price	5261	0.40487	0.6671	DNR H_0	No causality
Gold_Price ↑ Wci	5261	2.69530	0.0676	DNR H_0	No causality
Sensex↑ Nifty	5204	107.708	1.E-46	Reject H_0	Bi-directional causality
Nifty ↑ Sensex	5204	0.39086	0.6765	DNR H_0	No causality
Wci ↑ Nifty	5223	0.37290	0.6888	DNR H_0	No causality
Nifty ↑ WCI	5223	19.3713	4.E-09	Reject H_0	Bi-directional causality
Wci ↑ Sensex	5196	3.04679	0.0476	Reject H_0	Bi-directional causality
Sensex↑ WCI	5196	18.6101	9.E-09	Reject H_0	Bi-directional causality

Note. Decision rule: reject H_0 if P-value < 0.05, DNR = Do not reject; ↑ = does not Granger cause.

CONCLUSIONS

This paper aims at exploring the relationship among the crude oil price, gold price and selected financial variables in India. The principal conclusion of the empirical results is that the selected time series exhibit non-stationary and hence provide indication of long-term cointegration relationship. Multivariate cointegration test results indicate that long-term cointegration stable relationships are present under the study period. In a nutshell, selected variables are closely interlinked.

The crude oil price is an essential unpredictable variable that operates as a channel during which the exchange rates and stock prices are associated, with the intention that the oil importing countries policy makers should keep an eye on the effects of changes in oil prices levels on their own economies and stock markets (Mohamed Abdelaziz and Georgios Chortareas, 2008).

During the period from 1991 to October-2012, stock markets crashed due to Asian financial crisis, global financial crisis and recent European crisis but gold price continues to increase in India because of safe haven financial investment as well as jewellery. World Gold Council report says that India stands today as the world’s largest single market for gold consumption.

The measure of the relationship among the selected variables on Indian stock price indices used in this study is based on the financial market indicators. There is necessitate to expand this unambiguity including other macro-economic and financial market indicators (such as interest rate, inflation rate, housing price) relevant to the impact in order to arrive at more robust empirical analysis. This could be a possible area for future research in India (Mishra and Mohan, 2012).

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