DOI 10.70906/20221601005012

Article

Cointegration and Causality among Crude Oil, Gold, Exchange Rate and Sensex – An Empirical Investigation

Dr. Y. Arul Sulochana*

Dr. S. Rajkumar**

Abstract

The principal aim of this study is to identify the integration and causal association among Exchange rate, Gold, Crude Oil and Sensex Index. Around the world, various financial markets are integrated, and links between variables Crude Oil, Gold, Exchange rate, and Sensex invites special attention. The variables are analyzed using Johansen's cointegration Test, VECM and Granger's causality test. The data was collected for 10 years from October 2011 to October 2021. The weekly data of International crude Oil, Exchange rate, Gold and Sensex for the above mentioned period are considered for testing Cointegration and Causality. The result of the study confirmed that there is cointegration exists among Crude Oil, Gold, Exchange rate with Sensex. Vector Error Correction Model shows long term causal relationship from Crude Oil, Gold, Exchange rates to Sensex. Short term causal relationship from Crude Oil and Gold to Sensex. There is no short term causal relationship between the exchange rate and sensex.

Keywords: *Gold, Crude Oil, Exchange Rate, Cointegration, Causality*

How to cite: Arul Sulochana, Y., & Rajkumar, S. (2022). Cointegration and causality among crude oil, gold, exchange rate, and Sensex: An empirical investigation. Journal of Management & Entrepreneurship, 16(1), 5–12, DOI 10.70906/20221601005012

* Assistant Professor, St. Joseph's Institute of Management, St. Joseph's College, Trichy

** Assistant Professor, Xavier Institute of Management and Entrepreneurship, Bangalore

1. Introduction

Oil and Gold are the essential commodities demanded and traded internationally. India is the second-largest importer of Gold. Over the last five years, China accounted for around 30 per cent of the global demand. India's demand accounts for 25 per cent. Investment in Gold is also increasing in nature. Gold is still used as reserves, the percentage in trend is reduced. It has been majorly changed with the aid of using the US dollar. Crude Oil and Gold prices are mentioned in US dollars. The fluctuations in the US Dollar transmitted to the economy through worldwide trade were affected by the changes in gold or crude oil prices. Economic principles indicate that a boom in crude oil charges outcomes in inflation, depreciation of Indian money and fall in the stock market (Raj et al., 2008). To control inflation risk, traders began buying Gold so that the outcomes would flip in an upward push in gold prices. The demand for gold import will influence the exchange rates.

In the global economy, oil prices are considered a critical indicator of exchange rate movements (Amano and van Norden, 1998). Mostly, all the worldwide oil transactions are executed in the US dollar because the local currency is depreciated when the demand for oil increases. For all nations within the world, key economic activities are influenced by oil, mainly in developing countries (Pershin et al., 2016). In the current state of the economy, the association between oil and stock prices has become obvious (Chang and Yu, 2013). Arouri (2011) and Sadorsky (1999) specified that a surge in oil prices causes inflation, leading to a bearish stock market. Two frequently traded commodities with greater liquidity are Gold and Oil (Tiwari and Sahadudheen, 2015). Facts present in the oil markets are very significant for portfolio risk management and asset allocation because traders take the decisions based on this proof (Mensi et al., 2017). Lescaroux (2009), Turhan et al. (2014), Pindyck and Rotemberg (1990) portrayed that energy (Oil) and valuable metal (Silver and Gold) prices have positive connections with each other. Joy (2011), Capie et al. (2005) examined that the USD exchange rate is connected with prices of Gold and Oil. Gold is considered a secured asset when the value of the US Dollar drops in comparison with major currencies, which causes the gold price to rise (Reboredo, 2012). Above stated studies confirmed that price patterns of oil and Gold influence the exchange rate. India is the fourth major importer of oil and one of the greatest consumers of Gold. Any global fluctuations in the prices of Gold and oil take a noteworthy impact on the Indian stock market and further economic doings.

The import of Gold and Oil creates a load of external debt, currency devaluation and economic instability. For making investment decisions, it is essential for the investors to have the right information about the market movements as the stock market swings rapidly. Many factors will affect the performance of the stock market performance including political instability, but we could feel the changes in Exchange rate, Oil prices and Gold prices. At the beginning of the Covid pandemic, the stock market crashed badly, but later, the Indian stock market outperformed. Due to the Bull run in the Indian stock market, FPI increased, which increased the currency value.

Henceforth, analyzing the impact of variation in oil prices, gold prices, and Exchange rates on the stock market will help various investors to make superior investment decisions. Recently Sensex and Nifty reached the historic high, and this study focused on whether any linkages between the selected commodities and exchange rate affect the stock market operations.

This paper investigates the interlinkages among the selected variables in the short and long run. Following the introduction, the review of literature related to the study is presented. Section 3 describes the research framework and section 4 describes the analysis and Interpretation, and Section 5 provides the research conclusion.

2. Literature Reviews:

Several researchers analyze the integration among Gold prices, Exchange rates, oil prices and the stock market. Earlier studies revealed the existence of a causal relationship amongst the variables considered.

Acaravci et al. (2012) examined the long-run relationship between stock price and natural gas price using the Johansen cointegration test and Granger Causality models based on the error correction for the 15 European Union countries. Findings suggested

that there is a long-term equilibrium relationship between industrial production, natural gas prices and stock prices in Denmark, Austria, Germany, Finland and Luxembourg. The Granger causality test indicated an indirect Granger causal relationship between Industrial production, Natural gas with the stock prices.

Ahmad et al. (2011) examined that the stock market of Asia is cointegrated with that of the US and Japan.

Anshual Jain and Biswal (2016) explored the relation among Crude Oil, Global prices of Gold, USD/INR Exchange rate and the Indian stock market. The dynamic concurrent linkages have been studied using DCC-GARCH models. The lead-lag linkages were studied using symmetric and asymmetric Non-Linear Causality tests. Empirical examination designated fall in crude oil prices and gold prices impacts to drop in the value of the Indian currency and Sensex the benchmark stock index.

Arshanapalli et al. (1995)

Atul Shiva and Monica Sethi (2015) investigated the relationship among Sensex, S&P CNX Nifty and USD/INR exchange rate for the period January 1998 to April 2014. The long-run and the short-run causal relation among these variables were studied using the vector error correction model. Cointegration among the variables is analyzed using Johansen cointegration. The presence of forecasting ability Gold price with S&P CNX Nifty and USD/INR exchange rate examined using Granger causality test.

Basher and Sadorsky (2006) examined the influence of oil price changes on a huge set of developing stock market returns. The conditional and the unconditional risk factors are allowed to investigate the association between emerging stock market returns and oil price risk using a Multi-Factor model. It was evident from the results that the oil price risk impacts stock price returns in developing stock markets.

Benhmad (2012) studied the linear and the non-linear causal relationship between the oil prices and the US Dollar exchange rate using the wavelet approach. Findings showed that there is a variation in the linear and the non-linear causal relationship between the real effective US Dollar exchange rate and the real oil price.

Dilip Kumar (2014) investigated Gold and the Indian Industrial sectors for the first and second-order moment transmission with a portfolio design application and effectiveness of hedging using generalized VAR-ADCC-BVGARCH model. Results revealed a uni-directional noteworthy return spillover from Gold to the stock sectors. Moreover, the findings resulted that the stock-gold portfolio delivers improved diversification opportunities than stock portfolios.

Gayatri and Dhanabhakyam (2014) attempted to investigate cointegration and causal relationship between the Nifty and the Gold price. The selected variables of the study witnessed conditional changes over a period of time, and which is necessary to validate the relationship. International gold price/troy ounce and the daily NSE Nifty values for ten years from January 2003 to December 2013 are considered for this study with 2888 observations. The econometric tools are used to analyze the cointegration and the causal relationship of time series variables. The results exhibited a uni-directional causal relationship between the Nifty and the Gold price.

Kasibhatla et al. (2006)

Somnath Mukhuti and Amalendu Bhunia (2013) examined the integration amongst the domestic gold price, the crude oil price, the exchange rate, and India's stock indices for a period of 10 years i.e., from January 1991 to October 2012. In the course of the investigation, the Augmented Dickey-Fuller unit root test, Granger causality test and Johansen cointegration test are applied. The cointegration test results revealed that a long-term relationship exists between the selected variables.

Srivastava and Babu (2016) analyzed the Cointegration between Gold prices and the Nifty Index for a 10-year period from 2005 to 2014. The result found that data is in a stationary condition and a long-run causal relationship exist between the Nifty index and Gold. Also, a bi-directional causal relationship exists between Gold and the Nifty index.

Sujith and Rajesh Kumar (2011) attempted to investigate the dynamic association among Stock returns, gold price, oil price and exchange rate. The selected variables witnessed important changes over

a period of time. Daily data from 2nd January 1998 to 5th June 2011 are considered for this study. VAR and cointegration tools were used for this study. Results revealed that the exchange rate is highly impacted by the changes in other variables and a low-level long term relationship exists amongst the variables.

Suresh Kumar et al. (2020) studied the causal relationship between Gold, exchange rate, international crude oil prices, and the Indian stock market. Daily prices of selected variables for the period of five years from January 1994 to December 2019 are considered. The integration among the selected variables is examined using a Non-linear autoregressive distributed lag model (NARDL). The result indicated that the Indian stock market is affected positively by crude oil prices, and the stock market is negatively affected by exchange rates during the short run. Gold price does not make any impact on Indian Stock market performance.

Varsha Ingalhalli and Poornima (2016) studied the causal relationship between forex, gold, oil, Gold and stock markets for a period ranging from January 2005 till July 2015. The Granger causality test is employed to determine the forecasting ability of one variable over another. The findings suggested that a uni-directional relationship exists among the selected variables on the stock market. The oil price helps to forecast the exchange rate and gold prices. The Sensex index causes changes in the oil price.

3. Objectives of the Study:

1. To study the dynamic interactions among Gold, Crude Oil, Exchange Rate and Sensex
2. To establish the degree of association among Crude Oil, Exchange Rate, Gold with Sensex
3. To find out the short-run and long-run relationship amongst Crude Oil, Exchange Rate and Gold with Sensex
4. To identify the causal relationship among Crude Oil, Exchange Rate, and Gold with Sensex

4. Research Methodology:

4.1 Hypothesis of the study

The following null hypotheses are tested to study the integration and the causal relationship among the selected variables.

a. Data series are generally not distributed.

b. Gold price, Crude oil price, Exchange Rate and Sensex index prices are not stationary.

c. There is no cointegration among Gold price, Crude oil price, Exchange Rate and Sensex index

d. Gold Price, Crude Oil price and Exchange Rate does not Granger cause Sensex Index

4.2 Data and Sources of data

In this study, the closing values of weekly prices of the international gold price, the international crude oil price, the Exchange rate and the Sensex index for the period of ten years from 2011 to 2021 are considered. Investigation of causal relationship and integration is tested using the selected variables. Gold price is taken from World Gold Council, Crude Oil from international Energy Agency, Exchange rate from Foreign Exchange and the Sensex index value from the Bombay Stock Exchange of India. The Gold is measured in the USD/oz, Crude Oil in WTI USD/ Barrel, Exchange rate in Indian rupee per US dollar and Sensex in Indian rupee. All the variables except the Sensex value are taken as per the US dollar because most of the trades are performed using US currency.

Table 1: List of variables studied and the sources

Variable Name	Website	Units
Sensex	www.bseindia.com	Index
Crude Oil	www.eia.gov	WTI crude oil spot price
Gold	www.gold.org	USD per troy ounce
Exchange Rate	www.ofx.com	USD/INR

4.3 Tools used for this study

Returns of the variables are used to identify the causal relationships, and weekly compounded returns have been calculated by using $r=(P_t-P_{t-1})/P_{t-1})*100$, where P_t is the current closing price. *Tools used for this study are*

Descriptive statistics and JB Test: Jarque Bera Method is used to assess whether the data is normally distributed or not. A goodness of fit test indicates whether the sample data have the skewness and Kurtosis that matches a normal distribution.

$$JB = n[\frac{S^2}{6} + \frac{(K-3)^2}{24}]$$

Where n=Sample size, S=Skewness coefficient and K=Kurtosis coefficient.

Unit root test: To check the stationarity of data

The augmented Dickey-Fuller Test Specification used here is as follows.

$$\Delta Y_t = b_0 + \beta Y_{t-1} + \mu_1 \Delta Y_{t-1} + \mu_2 \Delta Y_{t-2} + \ldots\ldots\ldots + \mu_p \Delta Y_{t-p} + u_t$$

Where

Y_t represents time series to be tested

b_0 is the intercept term

β represents the coefficient of the unit root test

μ_p is the parameter of the augmented lagged first difference of Y_t to represent the p^{th} order of the auto regressive process, and u_t is the white noise error term.

The test statistics are compared with the critical values under H0. The critical values are given with 1%, 5% and 10%. If the test statistics are much lower than all critical values, the null hypothesis will be rejected at a particular significance level. Hence we can conclude that the time series has no unit root and reject the null hypothesis. The Augmented Dickey-Fuller test helps the researcher to proceed to the next level. Econometric studies can be continued only if the selected variables are stationary.

Johansen's Cointegration Test and Vector Error Correction Model: To measure the interdependency of the selected variables. Johansen's test results are compared using Trace value and Maximum Eigenvalue. Long-run and short-run relationships are verified using Vector Error Correction Model. The Johansen test approaches the testing for cointegration by examining the number of independent linear combinations (k) for an (m) time series variables set that yields a stationary process.

$$X_{1,t} = \propto_1 + \gamma_1 Z_{1,t} + \gamma_2 Z_{2,t} + \cdots \gamma_p Z_{p,t} + \epsilon_{1,t}$$
$$X_{2,t} = \propto_2 + \emptyset_1 Z_{1,t} + \emptyset_2 Z_{2,t} + \cdots \emptyset_p Z_{p,t} + \epsilon_{2,t} \ldots\ldots\ldots$$
$$X_{m,t} = \propto_m + \varphi_1 Z_{1,t} + \varphi_2 Z_{2,t} + \cdots \varphi_p Z_{p,t} + \epsilon_{m,t}$$

Granger's Causality Test: This test will identify the causal relationship among selected variables with Sensex. Let Y and Y be stationary time series. "*X* is said to Granger-cause *Y* if *Y* can be better predicted using the histories of both *X* and *Y* than it can by using the history of *Y* alone."

$$Y_t = a_0 + a_1 Y_{t-1} + \ldots\ldots + a_p Y_{t-p} + b_1 X_{t-1} + \ldots\ldots + b_p X_{t-p} + u_t \quad (1)$$
$$X_t = c_0 + c_1 X_{t-1} + \ldots\ldots + c_p X_{t-p} + d_1 Y_{t-1} + \ldots\ldots + d_p Y_{t-p} + v_t \quad (2)$$

We can test for the absence of Granger causality by estimating the following VAR model:

Then, testing H_0: $b_1 = b_2 = \ldots\ldots = b_p = 0$, against H_A: 'Not H_0', is a test that X does not Granger-cause Y. Similarly, testing H_0: $d_1 = d_2 = \ldots\ldots = d_p = 0$, against H_A: 'Not H_0', is a test that Y does not Granger-cause X. In each case, a rejection of the null implies there is Granger causality.

5. Analysis and Findings:

5.1 Descriptive Statistics:

Descriptive statistics helps to explore the distribution properties of daily returns and summarize the data to find out the normality of time series.

Table 2: Descriptive Statistics

	Crude Oil	Exchange Rate	Gold	Sensex
Mean	0.140478	0.084874	0.031751	0.280923
Std. Dev.	5.169376	0.900625	2.122262	2.320149
Skewness	-0.012264	0.117781	-0.163104	0.004113
Kurtosis	9.634963	4.73017	4.660584	7.160322
Jarque-Bera	963.0103	66.69637	62.64889	378.6201

The above statistics clearly show that the index Sensex resulted in a higher return (0.28) with a lower risk (2.32). Crude oil possessed the highest risk level (5.16) compared to all the variables. For any data to be random, it should possess the characteristics of a normal distribution. Skewness and Kurtosis are considered as the important distribution properties of normal distribution. Both the values are equal to 0 and 3, respectively. Hence we conclude that the data is not normally distributed.

5.2 Unit Root Test

Unit Root Test helps to check the stationarity and find out shocks in time series. Data series mean and variance are consistent over time. It is said to be stationary and vice versa. The most suitable and commonly used test is the Augmented Dickey-Fuller test. The below table shows the results of unit root for Level and First difference.

Table 3: Augmented Dickey-Fuller Test Result

Variables	Level		1st difference		Decision
	t-Statistics	Probability	t-Statistics	Probability	
Crude Oil	-1.506444	0.5298	-20.54984	0.0000	I(1)
Gold	-1.364740	0.6003	-23.93970	0.0000	I(1)
Exchange Rate	-1.835159	0.3633	-20.76210	0.0000	I(1)
Sensex	1.473133	0.9993	-22.79784	0.0000	I (1)

If we consider the first difference of all the variables, there is no evidence for unit root because the probability value is less than 5%. The null hypothesis can be rejected, and the variables are stationary at the first-order difference I(1) for all the selected variables. Hence, we can employ Johansen's Cointegration test to see these variables are cointegrated or not.

5.3 Cointegration Test

Johansen's Cointegration test was used to find out the presence of cointegration between the variables in the long run. The Trace test result indicates that four cointegrating equations are at a 5% significant level. It clears that four linear combinations exist between the variables over the entire time period. If trace statistics is more than the critical value, we will reject the null hypothesis, which means there is a Cointegration between the variables.

Table 4: Johansen's Cointegration Test Result

Sample (adjusted): 11/06/2011 10/17/2021				
Included observations: 520 after adjustments				
Trend assumption: Linear deterministic trend				
Series: SENSEX CRUDE EXCHANGE_RATE GOLD				
Lags interval (in first differences): 1 to 4				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**5% Critical Value**	**Prob.****
None *	0.256546	420.9170	47.85613	0.0001
At most 1 *	0.188780	266.7636	29.79707	0.0001
At most 2 *	0.154940	157.9714	15.49471	0.0001
At most 3 *	0.126672	70.43088	3.841466	0.0000
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The result of Maximum Eigenvalue was also analyzed to verify the result of Johansen's trace test. When the variables are more than two, the maximum eigenvalue test result is used to evaluate the cointegration among variables.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**5% Critical Value**	**Prob.****
None *	0.256546	154.1534	27.58434	0.0001
At most 1 *	0.188780	108.7923	21.13162	0.0001
At most 2 *	0.154940	87.54049	14.26460	0.0000
At most 3 *	0.126672	70.43088	3.841466	0.0000
Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The result of the Maximum eigenvalue test statistics shows that four cointegrating equations exist at a 5% critical value. Hence we can conclude that a cointegrating relationship exists between the variables throughout the sample study period of 10 years.

5.4 Vector Error Correction Model

The Cointegration results showed that a Cointegration exists among the variables. If variables are

cointegrated, it is necessary to identify the existence of long-run or short-run causality relationships among the selected variables. The necessity is fulfilled with the help of running a restricted VAR model, i.e. Vector Error Correction model.

Table 5: Long run causal relationship running from Crude Oil, Gold, Exchange Rate to Sensex

Dependent Variable: D(SENSEX)				
Method: Least Squares				
Sample (adjusted): 10/23/2011 10/17/2021				
D(SENSEX) = C(1)*(SENSEX(-1) - 0.280333668298* CRUDE(-1) + 1.16518821283*EX(-1) + 0.434570370841* GOLD(-1) - 0.358221613515) + C(2)*D(SENSEX(-1)) + C(3)*D(SENSEX(-2)) + C(4)*D(CRUDE(-1)) + *D(EX(-2)) + C(8)*D(GOLD(-1)) + C(9)*D(-GOLD(-2)) + C(10)C(5)* D(CRUDE(-2)) + C(6)*D(EX(-1)) + C(7)				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.761584	0.064175	-11.86728	0

Long-run causality will be running from independent variables to dependent variables if C(1) is negative in sign and significant. From the above table, it is interpreted that the long-run causality runs from independent variables viz. Crude oil, Gold and Exchange rate to Sensex, the dependent variable. This study reveals that there is a negative coefficient for C(1), i.e. -0.761, and the probability value is less than 5%.

Table 6: Short-run Casual relationship running from Crude Oil, Gold, Exchange Rate to Sensex

Test Statistic: Chi-Square				
Variables	**Null Hypothesis**	**Value**	**df**	**Probability**
Crude Oil	C(4)=C(5)=0	36.87068	2	0
Exchange Rate	C(6)=C(7)=0	1.753132	2	0.4162
Gold	C(8)=C(9)=0	23.67051	2	0

From the above result, it is interpreted that short-run causality runs from the independent variables Crude oil and Gold to Sensex. The probability value of the Exchange rate is 0.4162, which is more than 5%, which indicates that there is no short-run causal relationship running from the Exchange rate to the Sensex index.

5.5 Granger's Causality Test:

After examining stationarity and cointegration, the next step is to know the direction of causality. For this purpose, we are applying the Granger causality test. Table 7 represents the result of Granger's causality test.

Table 7: Pairwise Granger's Causality Test

Null Hypothesis	F-Statistic	Prob.
CRUDE does not Granger Cause SENSEX	9.11091	0.0001
SENSEX does not Granger Cause CRUDE	3.98741	0.0191
EXCHANGE RATE does not Granger Cause SENSEX	62.1045	7.00E-25
SENSEX does not Granger Cause EXCHANGE RATE	0.07867	0.9244
GOLD does not Granger Cause SENSEX	0.12784	0.88
SENSEX does not Granger Cause GOLD	1.00778	0.3657

The above table shows the result of the pairwise Granger's causality test. This test helps to determine the causal relationship between independent variables and the dependent variable. There is a bidirectional causal relationship between Sensex and Crude Oil, and a uni-directional causal relationship between Exchange Rate and Sensex. The null hypothesis is accepted, and Sensex does not Granger cause Exchange Rate because the probability value is more than 5%. There is no causal relationship between Sensex and Gold, and the probability value is greater than 5%.

Conclusion:

The empirical analysis attempts to study the interdependence and causal relationship among Crude Oil, Gold, and Exchange Rate with Sensex Index. By employing Johansen's cointegration test, Vector Auto Regression Error Correction Model and Granger's causality test. The result indicates that there are four cointegrating equations that exist at a 5% significance level which supports Cointegration among Crude Oil, Exchange Rate and Gold with Sensex. Vector Error Correction model supports that there is a long-run causal relationship running from Crude Oil, Gold and Exchange Rate to the Sensex index. Moreover, a short-run causal relationship runs from Crude Oil and Gold to Sensex, where there is no short-run causal relationship from Exchange Rate to Sensex. Granger's causality result indicates that there is a bidirectional relationship between Crude Oil and Sensex, and there is no causal relationship between Gold and Sensex. The study results would help the

investors to understand the market condition. The changes in Gold price and Crude Oil will impact the stock market performance.

References:

Kumar, S., Kumar, A., & Singh, G. (2020). Causal relationship among international crude Oil, Gold, exchange rate, and stock market: Fresh evidence from NARDL testing approach. *International Journal of Finance & Economics*.

Basher, S. A., & Sadorsky, P. (2006). Oil price risk and emerging stock markets. *Global finance journal*, 17(2), 224-251.

Acaravci, A., Ozturk, I., & Kandir, S. Y. (2012). Natural gas prices and stock prices: Evidence from EU-15 countries. *Economic Modelling*, 29(5), 1646-1654.

Benhmad, F. (2012). Modeling non-linear Granger causality between the oil price and US dollar: A wavelet based approach. *Economic modelling*, 29(4), 1505-1514.

Srivastava, M. A., & Babu, S. H. (2016). Causal Relation Between Gold and Stock Returns In India: A Study. *Research Journal of Social Science and Management*, 6, 1-11.

Gayathri, V., & Dhanabhakyam, D. (2014). Cointegration and causal relationship between gold price and nifty–an empirical study. *Abhinav International Monthly Refereed Journal of Research in Management & Technology*, 3(7), 14-21.

Kumar, D. (2014). Return and volatility transmission between gold and stock sectors: Application of portfolio management and hedging effectiveness. *IIMB Management Review*, 26(1), 5-16.

Sujit, K. S., & Kumar, B. R. (2011). Study on dynamic relationship among gold price, oil price, exchange rate and stock market returns. *International journal of applied business and economic research*, 9(2), 145-165.

Shiva, A., & Sethi, M. (2015). Understanding dynamic relationship among gold price, exchange rate and stock markets: Evidence in Indian context. *Global Business Review*, 16(5_suppl), 93S-111S.

Jain, A., & Biswal, P. C. (2016). Dynamic linkages among oil price, gold price, exchange rate, and stock market in India. Resources Policy, 49, 179-185.

Bhunia, A. (2013). Cointegration and causal relationship among crude price, domestic gold price and financial variables: an evidence of BSE and NSE. *Journal of contemporary issues in business research*, 2(1), 1-10.

Ingalhalli, V., & Reddy, Y. V. (2016). A study on dynamic relationship between oil, gold, forex and stock markets in Indian context. Paradigm, 20(1), 83-91.