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## **INVESTIGATING THE COINTEGRATION AND CAUSAL RELATIONSHIP AMONG DOLLAR, GOLD PRICE AND SENSEX**

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### **Abstract**

The present paper explores the cointegration and causal impact of dollar, gold price and sensex in India for the period from January 2, 1991 to December 31, 2018 using daily data with the application of unit root test, Johansen cointegration test and Granger causality test. In recent times, Indian investors are demonstrating uncase in the stock markets due to continuous rising of gold prices on account of no fear and no future loss. Again, dollar rate fluctuations will affect international trades, thus influence the stock market. 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 unidirectional or no causality among the variables.

**Keywords:** Gold price, dollar, sensex, unit root test; Granger causality test, Johansen cointegration test.

### **1. Introduction**

Internal developments like earnings reports, approval of new innovative product, professionalization etc., world events like war and civil unrest, natural disasters, terrorism, etc, interest rates, inflation and deflation, exchange rates, hype like financial reports of the company, stock market newsletter, release of new products or services etc., foreign markets, economic condition, market perception, news about world events, financial stability etc. affect the stock market in any country including India. Indian stock market counting sensex is very much prejudiced through gold price and dollar rate fluctuations. There is no direct relationship between gold price and stock market. Gold prices are changed on that factors on which stock prices depend. Therefore, we have to know about the factors that affect gold price. At the times of general economic and financial crisis, gold is a safe haven investment. When paper currencies are over-produced, gold rises in anticipation of future inflation. When



bank credit is over-produced and society can no longer sustain elevated debt levels, gold rises in anticipation of deflation, stock market collapses and bond failures (Gaur and Bansal, 2010).

The exchange rate of dollar is the value of the American dollar in terms of other currencies. The value of the dollar is both caused and reflected by interest rates and interest rates have much to do with stock prices. Therefore, dollar exchange rates affect stock prices and can be used to make predictions about the market. In times of national crisis, bank failures, war and invasions and in case of negative real interest rate people consider gold as a solid asset and like to invest in such precious metal because there is a little chance of getting better returns in the stock investment due to a fragile economic and financial position. Therefore, in addition to various other factors demand of gold has appreciated the value of gold price and many economic variables including gold price have an impact on the stock market.

Generally, gold price and stock market moves in an opposite direction. When the economy is in a downturn and stock markets are going down, investors tend to park their funds in gold and wait out the storm. As the gold price rises, Indian investors tend to invest less in stocks, causing stock prices to fall (Bhunia and Mukhuti, 2013, Yahyazadehfar and Babaie, 2012, Bhunia, 2013). The connection between dollar exchange rates and stock prices has always been in mind of the economists because both play a vital role in persuading the development of an economy including India. Generally international trades are exaggerated by changes in the dollar exchange rates and consequently it influences the stock market also. However, when Indian rupee is increasing, an importer of India has to disburse lower amount in exchange of dollar at the time of import. Thus it reduces the import bill and while such imported item is sold at matching price, the profit for the firm goes up and accordingly the stock price of the firm increases and vice versa (Arora, 2012). The link between gold price and dollar exchange rates has also been important since both play a vital role in persuading the investor's confidence. When the dollar's exchange value falls, it takes more dollars to buy gold so the dollar gold price rises. On the contrary, when the dollar's exchange value rises, by reason of a bear-market assembly or any other reason, it takes smaller amount dollars to buy gold hence the dollar gold price falls (Mills, 2010). In view of that, Capie et al (2005) advocated that gold and exchange rates are typically depressingly associated but the influence of the association may be shifted over time. Keeping in view of this, this paper examines and



investigates the cointegration and causal relationship among gold price, dollar exchange rate and Sensex for the period starting from 2.1.99 to 31.12.2018 using daily data. The remainder of the paper is organized in the following sections. Section 2 provides Review of Literature. Section 3 discusses Materials and Methods. Empirical Analysis is presented in Section 4. The study is concluded in Section 5.

## **2. Review of Literatures**

Bhunia and Ganguly (2015) observed the relationship between selected macroeconomic indicators based on annual time series data between 1991 and 2013 using financial econometrics in terms of crude oil price, gold price, exchange rates, GDP growth and Indian stock market. The results established that chosen macroeconomic indicators and Indian stock market were connected in the long run. Sur and Bhunia (2015) examined with the application of financial econometrics, the influence of preferred macroeconomic variables and Indian stock market based on monthly time series data between July 1997 and July 2015. The results established that wholesale price index, oil price, exchange rates inclined positively to the Sensex and nifty but real interest rates negatively inclined the stock market. Rafay et al (2014) observed the principal connection between macroeconomic variables in terms of rates of interest, foreign exchange rate, consumer price indices, the value of imports and exports and stock market index of KSE based on annual data between 1992 and 2010 using regression analysis and granger causality test. Forson and Janrattanagul (2013) examined the long term stability association between the Thai stock exchange index and preferred macroeconomic variables in terms of rates of interest, the index of industrial production, money supply and consumer price index based on secondary monthly data of 20 year periods between January 1990 and December 2009 with the application of financial econometrics. Empirical results established that the Thai stock exchange index and preferred macroeconomic variables are co integrated at first difference. Samanta and Zadeh (2012) examined the co-movements of four macro-economic variables in terms of gold price that there is a cointegration relationship between the variables. Yahyazadehfar and 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. Kaliyamoorthy and 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. Sharma and Dasgupta (2012) has made a study to examine the long-run and short-run relationships between SENSEX and four key macroeconomic variables (wholesale price index, index of industrial production, exchange rate and call money rate) of Indian economy by using monthly data from April, 2007 to March, 2012 with the application of financial econometrics. Empirical results of the study showed that there are no short-run causal relationships between SENSEX and four macro-economic variables but confirmed long-run relationships between BSE SENSEX with index of industrial production and call money rate. Le et al (2011) have made a study to investigate the relationships between the prices of two strategic commodities, that is, gold and oil in terms of index of US dollar by using monthly data from January, 1986 to April, 2011 with the application of financial econometrics. Empirical results of the study showed that there is a long-run relationship existing between the prices of oil and gold and the oil price can be used to predict the gold price. Sharma and Mahendra (2010) estimated the long-term relationship between BSE and four macroeconomic variables consisting of exchange rates, foreign exchange reserve and inflation rate and gold price based on the secondary data between January 2008 and January 2009 using multiple regression models. The study divulges that exchange rate and gold price influences the stock prices in India. The conclusive sum of this retrospective review of relevant literature produced till date on the offered subject reveals wide room for the soundness and instigates of this work and replicates a few crucial supports that emphasize its feasibility, as may be marked here it. The subsistence of gold price, dollar exchange rates and sensex of stock market in India are hardly available. Therefore, the present study aspires to observe the cointegration and causal impact of gold price, dollar exchange rates and sensex in India for the period starting from 2.1.99 to 31.12.2018 using daily data.

### **3. Materials and Methods**

#### **3.1 Data source**

The study is based enormously on time series data. The secondary data has been acquired from RBI database, BSE database and World Gold Council database for the period from January 2, 1991 to December 31, 2018.



### **3.2 Sample design**

This study considers daily data encircling the closing stock price indices of BSE (SENSEX), the daily Indian gold price and exchange rates between dollar and rupee. After appropriate fitting the data, there are 8567 observations. Eviews 7.1 package program has been used for arranging the data and execution of econometric analyses.

### **3.3 Tools used**

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

### **3.4 Hypotheses taken**

#### Hypothesis-1

H<sub>0</sub>: Gold price, dollar exchange rates and sensex are not stationary.

H<sub>1</sub>: Gold price, dollar exchange rates and sensex are stationary.

#### Hypothesis-2

H<sub>0</sub>: Gold price, dollar exchange rates and sensex are not associated in the long period.

H<sub>1</sub>: Gold price, dollar exchange rates and sensex are particularly associated in the long period.

#### Hypothesis-3

H<sub>0</sub>: Gold price, dollar exchange rates and sensex are not related pairwise.

H<sub>1</sub>: Gold price, dollar exchange rates and sensex are very much related pairwise.

## **4. Empirical Results and Analysis**

### **4.1 Unit root test results**

There exist several test to check the presence of unit root in the series. To check the stationarity of the underlying data series, the standard procedure of unit root testing has been applied by employing the Augmented Dickey Fuller (ADF) test. Nevertheless, the ADF test is often criticized for low power. Thus we supplement this test with the Phillips-Perron (PP) test. The application of unit root test is initial step before proceeding to the Granger's causality test. . In the present research paper, three indicators, namely, Indian gold price and dollar exchange rates may be connected in the long period with sensex on the prerequisite that they are not unpredictable or stationery. For the purpose of stationarity test, we follow in



the present study ADF and PP unit root test, both at levels and at 1st differences (intercept without trend and intercept with trend) in hypothesis-1 above

**Table-1: Unit Root Test Results**

ADF		
Test equation-intercept	at level	at 1st difference
LBSX	-0.701141 (0.6181)	-51.28203 (0.0000)
LGLP	-0.325856 (0.9223)	-65.43164 (0.0001)
LDER	0.658342 (0.8821)	-23.49231 (0.0000)
Critical values		
1%	-3.432221	-3.432221
5%	-2.862252	-2.862252
10%	-2.567193	-2.567193
PP		
Test equation-intercept	at level	at 1st difference
LBSX	-0.728283 (0.6122)	-49.16472 (0.0001)
LGLP	-0.514212 (0.7036)	-68.44354 (0.0001)
LDER	0.525213 (0.5829)	-55.53773 (0.0001)
Critical values		
1%	3.432219	3.432219
5%	-2.862251	-2.862251
10%	-2.567193	-2.567193

\*MacKinnon (1996) one-sided p-values.

Table-1 demonstrate the ADF and PP unit root test results at level and at 1<sup>st</sup> difference where it authenticates that Indian gold price, dollar exchange rates and sensx are not stationary at levels [I(0)] and are stationary at 1st difference [I(1)] because test statistics are less than critical value at 1% level of significant both in the intercept without trend and intercept with



trend. The unit root test moreover authenticates that constant variance is seen in case of error terms that indicates statistical dependency, as supported in (Shahzadi and Chohan, 2012). Thus all the three stationary tests indicate that all series are individually integrated of the order I(1).

#### **4.2 Cointegration test results**

The presence and the number of co-integrating relationships among the underlying variables are tested through applying the Johansen procedure. The series of Indian gold price, dollar exchange rates and sensex are stationary at 1st difference [I(1)]. For that reason, Multivariate cointegration method in Johansen approach can be applied to identify the cointegration connection between the variables in the long period. Simultaneously, this method can be applied to determine the cointegration vectors. Specifically, trace statistic and the maximum eigenvalue are used to test for the number of cointegrating vectors. At the time of testing, the present research study accepts linear deterministic trend unrestricted with intercepts without trends on account of using a lag of 1 to 4 at 1st differences derived from Swartz Information Criterion (SIC) for the selected indicators under the study.

Table-2 reveals the multivariate cointegration test results in the sequence of Johansen approach that offers indemnity regarding connection between Indian gold price, dollar exchange rates and sensex in the long period as trace statistics is more than critical value in case of both the likelihood ratio test, to be exact, the trace test and the maximum eigenvalue test. Consequently, the results of the multivariate cointegration test do not accept the null hypothesis (talked about in hypothesis-2 above). Both the trace statistic and the maximum eigenvalue statistics identify one co-integrating vector. This test also established the number (1) of cointegration vectors. It is moreover indicating that two common stochastic trends or a degree of market integration are present there

#### **Table-2: Cointegration Test Results**

Included observations: 8567 after adjustments

Trend assumption: Linear deterministic trend

Series: LBSX, LGLP, LDER

Lags interval (in first differences): 1 to 4



### Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None*	0.008520	17.62863	12.79707	0.0034
At most 1	0.001158	4.623787	18.58465	0.8726
At most 2	2.47E-03	1.205618	4.952567	0.9763

Trace test indicates one cointegration 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		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.008520	13.94325	11.24250	0.0017
At most 1	0.001158	3.487643	14.26460	0.7892
At most 2	2.47E-03	1.205612	3.752576	0.8445

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

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

#### 4.3 Pairwise causal test

Granger causality test has been applied to check the direction of causation existing among macroeconomic variables and stock indices. As the study includes three variables, so there appears the likelihood of either side of relationship in the explained and explanatory variables. There may be three type of relationship among the variables - unidirectional, bidirectional and no relationship existing among the variables. To establish the causal



relationship with movement of causation between Indian gold price, dollar exchange rates and sensex, pairwise causal (Granger) test has been applied in the present study. Table-3 illustrates the results of pairwise causal test and point up that there exist no causal relationship (talked about in hypothesis-2 above) between (i) Indian gold price and Sensex, (ii) Sensex and Indian Gold price, (iii) Dollar exchange rates and Sensex, (iv) Dollar exchange rates and Indian gold price because the probability is more than 0.05. Table-3 also shows that there exist uni-directional causal relationship between (i) Sensex and Dollar exchange Rates and (ii) Indian gold price and dollar exchange rates because the probability is less than 0.05. Hence, pairwise causal assertion linking Indian gold price, dollar exchange rates and sensex indicates that trend in one indicator is not the grounds for trend in other indicator under the study. There is no any bidirectional relationship among the variables. Thus, null hypotheses of no causal relationship among macroeconomic determinants and stock market is rejected for Sensex and Dollar exchange Rates and Indian gold price and dollar exchange rates. The hypotheses gets accepted for rest other pairs

**Table-3: Pairwise Granger Causality Tests (Lags: 2)**

Null Hypothesis	Obs	F-Statistic	Prob.	Decision	Type of Causality
Indian Gold price $\uparrow$ Sensex	8567	0.16398	0.7485	DNR $H_0$	No causality
Sensex $\uparrow$ Indian Gold price		1.89860	0.1589	DNR $H_0$	No causality
Dollar exchange Rates $\uparrow$ Sensex	8567	0.49377	0.6705	DNR $H_0$	No causality
Sensex $\uparrow$ Dollar exchange Rates		1.24163	0.0024	<b>Reject <math>H_0</math></b>	<b>Uni-directional causality</b>
Dollar exchange Rates $\uparrow$ Indian Gold price	8567	0.73257	0.5697	DNR $H_0$	No causality
Indian Gold price $\uparrow$ Dollar exchange Rates		3.41065	0.0325	<b>Reject <math>H_0</math></b>	<b>Uni-directional causality</b>

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



## **5. Conclusions**

The empirical results exhibit significant impact of macroeconomic determinants on Indian stock market. Selected three financial variables are stationery time series data at I(1) that is an indication of the affiliation between Indian gold price, dollar exchange rates and sensex in the long period. The empirical results of cointegration method in the course of Johansen approach indicates protected cointegration association between the selected variables under the study in the long period. This research moreover illustrates that there exist Uni-directional causal connection between Sensex and Dollar exchange Rates and Indian gold price and dollar exchange rates in the study period.

The present study confirms the beliefs that macroeconomic factors continue to affect the Indian stock market. However, the limitations of the study should not be over looked. The present study is limited to only two selected macroeconomic variables. Inclusion of more variables like international crude oil price, import duty, interest rate, current account deficit, inflation, world economic situation, Indian political condition with a longer time period may improve the results. A logical extension of the study can be done by including sector wise stock index.

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