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Impact of Gold Price on Stock Market Return – An Econometric Analysis of BSE and NSE

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ABSTRACT

The present study examines the shock of domestic gold price on stock price indices in India for the period from January 1, 2008 to August 17, 2018 by using appropriate statistical and financial econometric techniques. The study is based on completely secondary data obtained from World Gold Council (WGC) database, BSE and NSE database and RBI database. In the process of analysis, Correlation statistics indicates the BSE-Sensex and NSE-Nifty are positively correlated with gold prices and multiple regression results is unauthentic. Further, unit root test indicates that the time series data are not stationary at levels and stationary at 1st difference. Granger causality test illustrate that no causality exists between Nifty and Gold price, Sensex and Gold price, Sensex and Nifty return, Nifty and Sensex and Bi-directional causality exists between Gold return and Nifty and Gold_Price and Sensex return.

Keywords: Gold Price, Stock Market, Correlation and Multiple Regression, ADF and PP unit root test, Johansen Cointegration Test, Granger causality test.

INTRODUCTION:

Investors have historically used risky strategies in their portfolios such as diversifying across countries, including gold investments, because such investments typically have had an inverse relationship with stock market movements. Technology has changed the environment in which there are very few obstacles today to hinder investors from buying or selling assets anywhere in the world. There are also many other options for investors to avert risk so that gold are not considered merely another commodity. In the commodity market, gold has its exceptional significance and gold is still considered as a safe investment when compared to equity and constantly rising because of its big demand in the country and mainly gold proposes the full security for short term and long term return. As per World Gold Council (WGC), Indians hold more than 18 thousand tons of gold, which signifies more than eleven percent of the total gold stock and it is largest in the world. According to the Gems and Jewellery Export Promotion Council (GJEPC), the apex institution of Gem and Jewellery in India will organise the first Indian Gold and Jewellery Summit 2018. The Summit will mainly concentrate on four large areas i.e. export of Jewellery $25 billion, code of conduct and values for jewellery industries in India, spot exchange of gold in India and value addition through Jewellery manufacturing (GJEPC India).

After the global financial crisis in 2008, day by day the capital flows of emerging economies stock markets have incessantly much better and their removal of the international capital controls due to the liberalisation of economies(Acikalin, 2008). At the same time, it was very difficult and risky to make their investment decisions because the unexpected volatility of stock market returns. Therefore, the bottomless insecurity in stock market returns as a result of its volatility has a causal relationship and influencing the demand for gold (Bhuyan and Dash, 2018). In this context, this paper investigated the relationships between gold price and Indian stock market indexes i.e. NSE-Nifty and BSE-Sensex. Results show that there is a positive association with Indian

stock indexes while gold price expected inverse relationship with stock prices has changed over time. Positive associations recommend that several long-established portfolio risk procedures may no longer be applicable. Gold prices no longer have significant effects on the economy outside of industry-specific issues.

Origin of the Research Problem:
Gold prices are a good indicator of how healthy the Indian economy is. Investors congregate towards gold when they are defending their investments from either a crisis or inflation and when the price of gold is fall that generally means the market is strong and healthy because investors have gone gold for other, more profitable investments i.e. stocks, bonds, real estate business and other investments. Therefore, this section to determine the shock of gold price on stock price indices, the proposed study has been carried out.

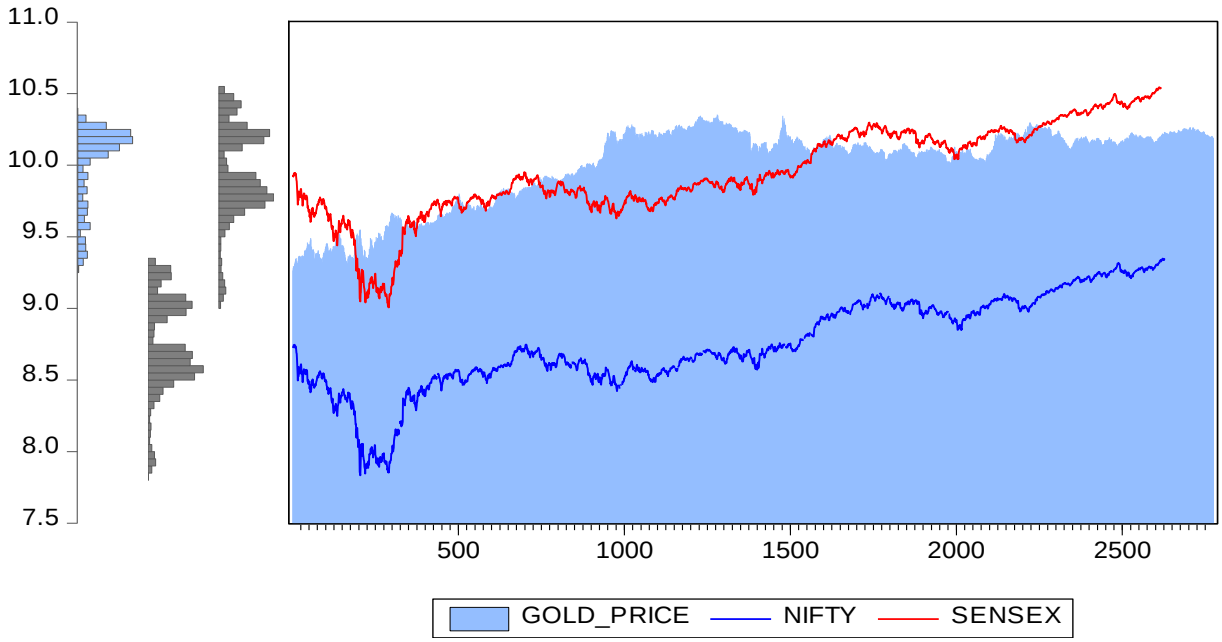
Need for the Study:
Volatility judgment is very essential for a number of reasons and for many people and investors in the market. In India, daily average return and daily volatility across the markets vary over time and space. Their detergency and discrepancies are greatly comprehensible.

- In recent days, has the global financial structure become extra volatile?
- Has the monetary decontrol and modernization guide to an increase in financial volatility?
- Has it effectively allowed its redistribution away from risk adverse operators to extra risk impartial market participants?
- Has the overall financial incorporation led to more rapidly show of volatility and risk from corner to corner national frontiers?
- Can financial managers largely able to control risk in present conditions and what responsibility the regulators must participate in the progression?

In this way, gold prices, rootless stock prices with their volatility which have currently turn into widespread characteristics of securities markets. The matters of volatility and risk have become more and more essential in present days to market participants and investors, financial practitioners, regulators and researchers also.

Scope of the Study:
The shock of the increase in international gold prices is reflected in its domestic prices as well. Although, in India, the sharp of recent price rises, demand for gold has sustained, not only as a part of safe investments but as well due to its societal and cultural significance. Therefore, gold price movements in India are of excited interest to every section of the people with investors. From the strategy point of view, increase of gold prices has raised a concern as to whether a coming fall in gold prices would have economic stability inferences. Therefore, the proposed study will be covered for 10 years**,** starting from January 1, 2008 and ending on latest daily data.

Movement of Gold Price, Nifty and Sensex



REVIEW OF PREVIOUS LITERATURE:

A considerable economic literature has been devoted to explore the long-term impact of gold prices on macroeconomic variables like inflation, growth rate, employment effects, and monetary policy. However, there is very little research on how the stock markets react to gold price changes or, in other words, how strong the relation is between gold price and stock price indices. A number of studies have examined the relationship between gold prices and stock market index. Only selected papers relating to the similar work are discussed. Bhuyan and Dash (2018) assessed the dynamic causality analysis between Indian gold price movements and Indian stock market returns by using secondary monthly time series data with causality and Johansen co-integration test. Johansen co-integration indicated that there is a long term relationship exists between gold price and stock returns and Granger causality test results pointed out that there is no causal relation between gold and stock return. Afsal and Haque (2016) specified the market interactions in the very important macroeconomic indicator i.e. gold price and stock markets based on Saudi Arabia. They mainly pointed out the non-linear dependencies with stock market in the Saudi Arabian perspective by the help of univariate and multivariate models of generalized autoregressive conditional heteroskedasticity (GARCH) analysis. The findings chiefly proved that there is no dynamic relationship between gold price and stock market. Srivastava and Hari Babu (2016) illustrated causal relation between gold and stock returns in India and daily prices of gold and NSE-Nifty index has been considered and also the results of unit root test is stationary condition and have a long run relationship between the variables, but as per causality relationship model it is suggested that the data have bidirectional impact of variables. Sur and Bhunia (2016) observed the impact of selected macroeconomic variables on Indian stock market by using so many important macroeconomic indicators i.e. BSE-Sensex, NSE-Nifty, Gold price, Crude oil price, Real Interest rate, Wholesale price index and Exchange rate with monthly time series data for the period from 1997 to 2015. The results revealed that the positive reaction of sensex and nifty on crude oil prices, exchanges rates, real interest rates and whole prices indices but a negative impact from sensex and nifty to real interest rates.

According to Taheri (2014), Canada as oil producer to the increase of oil price was positive and other developed countries which were oil purchaser act in response to this transform negatively after analyzing of unit root and co-integration test and error correction model were implied to the study. Actually researcher tries examining the impact of crude oil price on evidence from selected developed countries stock markets after considering the real interest rate, industrial production index, real stock return in stock markets and real oil price (in USD) of Canada, UK, US and France for the period of 1990 to 2012. Hussin et al. (2013) examine the linkages between gold price, oil price and Islamic stock market on evidence from malaysia. The results confirmed that Islamic stock market returns were not co-integrated with other variables in the long run and Granger causality test also observed that there was a bi-directional causality between Islamic stock returns with oil prices but only oil price variables influenced the Islamic stock market return in the short run in Malaysia.

In my existing research jointly with Professor Amalendu Bhunia, the publication reference was Bhunia and Mukhuti (2013) examined the impact of the domestic gold price on stock price indices in India for the period for the period from 1991 to 2012 by using ADF and PP unit root test and Granger causality test. Unit root test confirmed that the time series data were not stationary at levels but stationary at 1st difference and Granger causality test also pointed out no causality exists between nifty and gold price, gold price and sensex and nifty and sensex and bi-directional causality exists between gold price and nifty, sensex and gold price and sensex and nifty. Similarly, our another research, is there any influenced of Indian gold price on Indian stock market reaction? The publication reference was Mukhuti and Bhunia (2013). After analysis, bivariate co-integration test results specified that there is no cointegration relationship between gold price and the two stock market indices (NSE-Nifty and BSE-Sensex). However multivariate co-integration test results confirmed that there is a presence of stable co-integrating connection between gold price and two stock market indices in India. Chittedi (2012) illustrated the matter of oil prices for Indian stock markets. After analysis, ADF-unit root test, co-integration test and Auto Regressive Distributed Lag (ARDL) model confirmed the volatility of stock prices in India has a significant impact on the volatility of oil prices. But a change in the oil prices does not have impact on stock prices. Le and Chang (2011) examined the dynamic relationships based on a Bounds testing approach among oil, gold and financial variables in Japan and the findings of this study benefited both the investors and Japanese monetary authority that hold the Japanese yen in their portfolios. Lee et al. (2012) analysed the asymmetric long-run relationship among crude oil and gold futures. Finally, the findings proved that an asymmetric long-run alteration exists between gold and oil. Moreover, the causal relationship shows to West Texas Intermediate Crude Oil acts a principal position. Hinashahzadi and chohan (2010) have examined the impact of gold prices on Karachi stock exchange. Aloui and Jammazi (2009) scrutinized the effects of crude oil

shocks on stock market shifts behaviour by using crude oil price and UK, France and Japan stock market indices over the period from 1989 to 2007 with Markov-switching EGARCH technique. The results represented that rises in oil price had significant role in determining both the volatility of stock returns and probability of transition across regimes. Gilmore et al. (2009) described the dynamics of gold prices, gold mining stock prices and stock market prices co-movements. A vector error-correction model revealed that the long-term association between the variables and short-term unidirectional causality existed from large-cap stock prices to gold mining company stock prices and from gold mining company stock prices to gold prices. Smith (2001) showed the price of gold and stock price indices for the US stock market with 10 years gold price and six stock price indices of US stock market. After analysis, it has been carried out gold prices and United States stock index levels were non stationary but stationary at first differences and there is no joint long-term or co-integrating relationship between gold price and stock market. In addition, negative short-term causality exists between United States stock indexes to gold returns.

The previous maximum numbers of studies have been revealed the short term and long term relationship between gold price and stock price indices and a large number of national and international research works has been carried out the impact of gold price on stock market mainly based on Indian scenario. A very small number of studies have so far been carried out in India on these issues. Therefore the main aim of this present study is the short and long run relationship among gold price and stock market (Nifty and Sensex) on the basis of daily returns by using up to date data and information.

RESEARCH METHODOLOGY:

Sources of data:

This study is based on completely secondary data and information obtained from various appropriate databases including World Gold Council (WGC) database, BSE and NSE database, RBI database etc. In addition, the facts and shapes, outlines and findings highly developed in comparable previous studies and the government publications and reports are also used to supplement the secondary data.

Research design:

A good number of samples relating to the proposed research work will be taken using accepted appropriate sampling technique to represent the universe out of daily data of gold price after converted (troy ounce to gram) and daily stock market indexes (comprising the price of SENSEX (BSE) and closing price of NIFTY (NSE).

The Time Series Data Transformation Variable/Natural Log by using the equations:

$$\Delta \text{ LNGOLD\_PRICE} = \text{Log}\,[\text{GOLD\_PRICE}_{t} / \text{GOLD\_PRICE}_{(t-1)}] \quad \ldots\ldots 1$$

$$\Delta \text{ LNSENSEX} = \text{Log}\,[\text{SENSEX}_{t} / \text{SENSEX}_{(t-1)}] \quad \ldots\ldots 2$$

$$\Delta \text{ LNNIFTY} = \text{Log}\,[\text{NIFTY}_{t} / \text{NIFTY}_{(t-1)}] \quad \ldots\ldots 3$$

Period of the Study:

The study will be associated to a period of more than 10 years**,** starting from January 1, 2008 to August 17, 2018 (01.01.2008-17.08.2018).

Tools used:

In the course of analysis in the proposed study, various accepted statistical end econometric tools used. Statistical tools include the descriptive statistics, test of significance, correlation and regression and econometric techniques include unit root test, co-integration test, Granger causality test has been applied. The use of all these tools at different places will be made in the light of requirement of analysis. Logical inferences will be arrived at on the basis of analysis of data. Before starting the analysis process, all daily time series data has been altered to natural logarithms for minimisation the heteroskedasticity problem. In the absolute stage of analysis of the present research work, there are only econometric tools including Augmented Dickey-Fuller (ADF-1979) and Phillips-Perron (PP-1988) unit root test to look at the series is stationary or not. The highest possibility based Johansen (1988, 1991) and Johansen-Juselius (1990) test for long-run relationship between the variables. The Johansen cointegration test can be seen as a multivariate over simplification of the Augmented Dickey-Fuller (ADF) test. The over simplification is the test of linear combinations of variables for unit roots. Two types of Johansen cointegration test, either with trace or with Eigen value. Vector Error Correction (VECR) model has been applied to uses Granger causality test which indicate the relationship direction of causality between the variables.

Augmented Dickey-Fuller (ADF): Decision rule:
When **t-stat < ADF-C.V., not Reject H_0 or not reject the null hypothesis i.e. variable is non-stationary. When **t-stat > ADF-C.V., Reject H_0 or reject the null hypothesis, Variable is Stationary. Under the unit root test, the unit root hypothesis is H_0: Gold returns/Stock market returns have unit root and H_1: Gold returns /Stock market returns do not have unit root.
Johansen's co-integration: This test will be applied to check whether the long run equilibrium exists between variables. Co-integration test hypothesis is H0: Gold returns/Nifty returns does not have long run relationship H1: Gold returns/Nifty returns have long run relationship.
Lag length criteria: This test is used to find proper lag length for accurate result. The minimum the lag length better the model.

Granger Causality Test:
This test determines the one time series is valuable in predicting an additional and attempts to investigate the direction of causality (No Causality, Unidirectional and Bi-directional Causality) between the paired variables. Normally, Granger causality test hypothesis is,
Hypothesis-I
H_0: Nifty Returns does not Granger cause Gold Returns
H_1: Nifty Returns cause Gold Returns
Hypothesis-II
H_0: Sensex Returns does not Granger cause Gold Returns
H_1: Sensex Returns cause Gold Returns
Hypothesis-III
H_0: Sensex does not causes Nifty Returns
H_1: Sensex causes Nifty returns

Hypotheses Selection:
This research work desires to study the change in daily gold price and its impact on stock price indices based on the following hypotheses:
Hypothesis 1
H_{0A}: There is no relationship between gold prices and Indian stock price indices (Sensex and Nifty);
H_{1A}: There is a significant relationship between gold prices and Indian stock price indices (Sensex and Nifty);
Hypothesis 2
H_{0B}: The selected variables are not non-stationary variables (there is unit root);
H_{1B}: The selected variables are stationary variables (there is unit root).
Hypothesis 3
H_{0C}: There is no co-integration relationship between the selected variables;
H_{1C}: There is a co-integration relationship between the selected variables.
Hypothesis 4
H_{0D}: Sensex and Nifty returns doesn't cause Gold returns in long run or Gold returns does not causes Sensex and Nifty returns in long run;
H_{1D}: Sensex and Nifty returns cause Gold returns in long run **or** Gold returns causes Sensex and Nifty returns in long run;
Note: **0A**: First Selection of Null Hypothesis, **1A**: First Selection of Alternative Hypothesis
0B: Second Selection of Null Hypothesis, **1B**: Second Selection of Alternative Hypothesis
0C: Third Selection of Null Hypothesis, **1C**: Third Selection of Alternative Hypothesis
0D: Fourth Selection of Null Hypothesis, **1D**: Fourth Selection of Alternative Hypothesis

EMPIRICAL ANALYSIS AND RESULTS:

Descriptive Statistics:
Table-1 indicates the picture of mean, median, standard deviation of both the variables and also includes skewness, kurtosis, Jarque-Bera statistics and probability of the daily sensex, nifty indices and daily gold price. Descriptive statistics results explained that the highest mean value of the selected variables i.e. Gold price (10.0039), Nifty (8.7527), Sensex (9.9484) and standard deviation of Gold price (0.2770), Nifty (0.3205), Sensex (0.3149). The standard deviation is very small than mean value which indicates the data points are more packed approximately the mean and the data points tend to be closer to the mean also called the expected value.

Table 1: Descriptive Statistics Results

	GOLD PRICE	NIFTY	SENSEX
Mean	**10.00391**	**8.752738**	**9.948460**
Median	10.11772	8.697279	9.898376
Maximum	10.35371	9.347556	10.54598
Minimum	9.265345	7.833679	9.007048
Std. Dev.	0.277022	0.320504	0.314915
Skewness	**-1.075829**	**-0.312050**	**-0.402658**
Kurtosis	**2.878401**	**2.858049**	**3.049788**
Jarque-Bera	**536.8170**	**44.41308**	**70.96029**
Probability	0.000000	0.000000	0.000000

Skewness, kurtosis and Jarque-Bera statistics have considered that the series are normally distributed or not. Negative skewness indicates an asymmetric tail (left tail) or the data that are skewed left and positive kurtosis point to the series are more peaked than normal distribution and kurtosis value of Gold price and Nifty is less than 3 and kurtosis is more than skewness in case of both the stock markets, which means the distribution was platikurtic. On the other hand, only kurtosis value of Sensex is more than 3 and also more than skewness, which means the dataset has heavier tails than a normal distribution. The probability of Jarque-Bera statistics confirmed that all the series were not normally distributed.

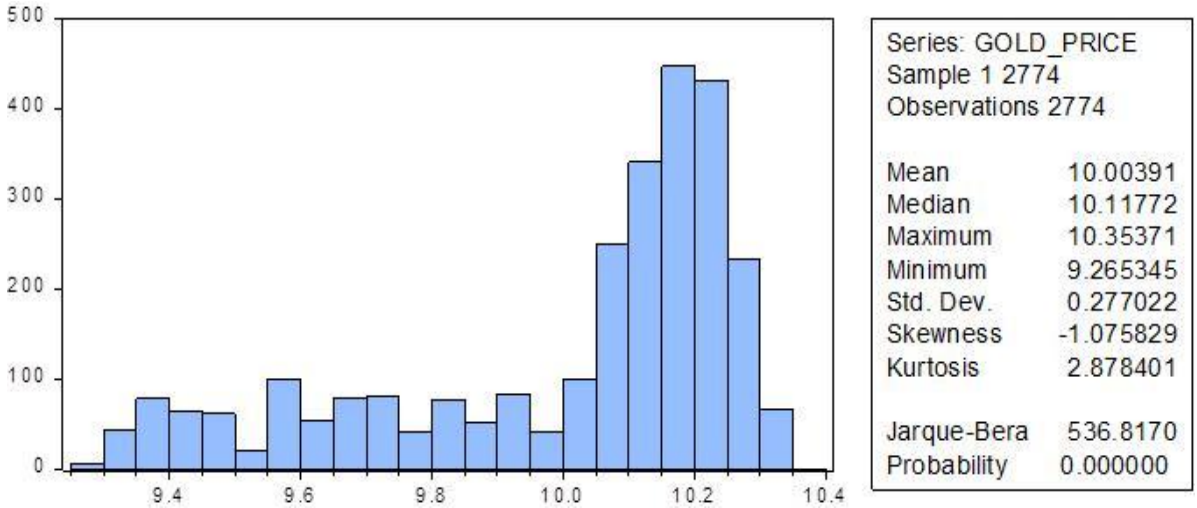
Table 2: Test for Equality of Means between the Series

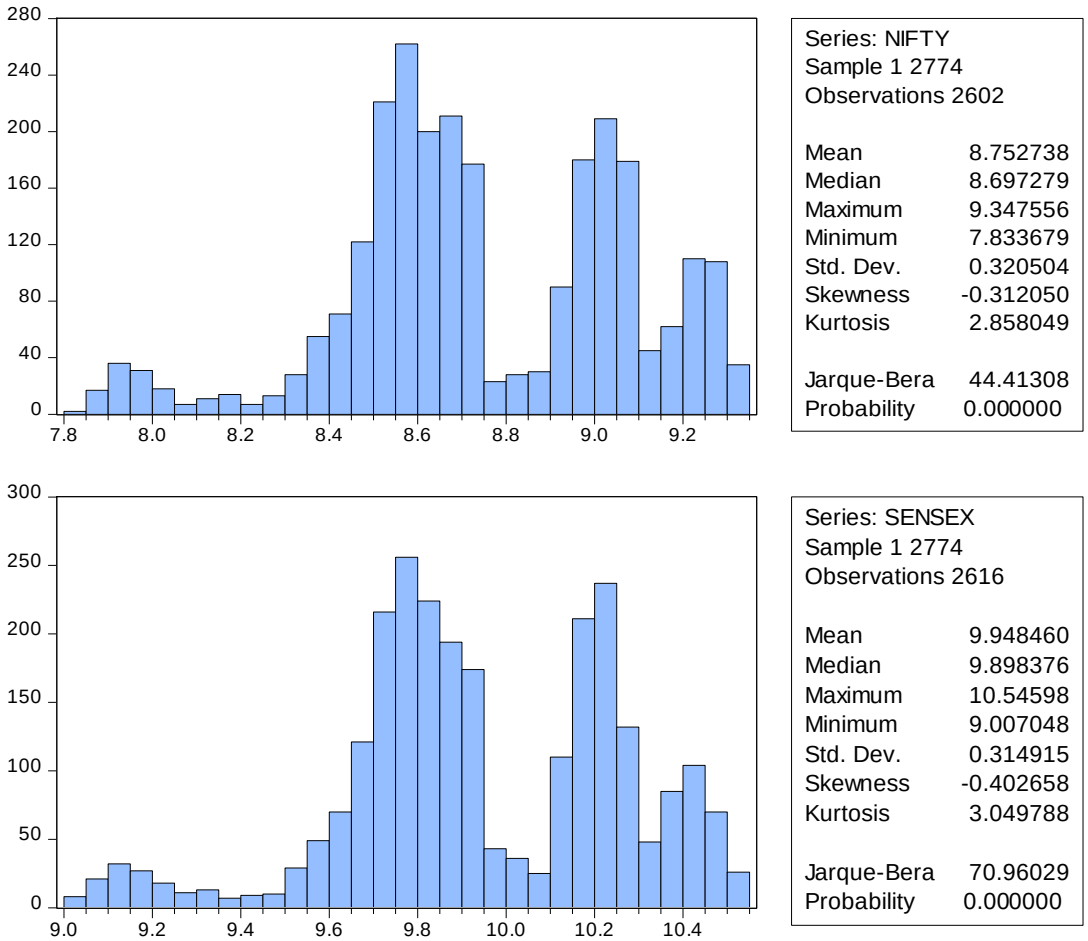
Method	df	Value	Probability
Anova F-test	(2, 7989)	14233.15	0.0000
Welch F-test*	(2, 5260.73)	13609.19	0.0000
*Test allows for unequal cell variances			

Category Statistics				
Variable	**Count**	**Mean**	**Std. Dev.**	**Std. Err. of Mean**
GOLD_PR...	2774	10.00391	0.277022	0.005260
NIFTY	2602	8.752738	0.320504	0.006283
SENSEX	2616	9.948460	0.314915	0.006157
All	7992	9.578409	0.649755	0.007268

Table-2 indicates the test of equality of means between the series. It includes the ANOVA-F-test and Welch-F test with probability where only Welch-F test allows for unequal cell variances. Category statistics shows the total number of observation and comparable means with standard deviation.

Histogram and Statistics





Correlation Statistics:

Table-3: Correlation Statistics Results

	GOLD_PRICE	NIFTY	SENSEX
GOLD_PRICE	1		
NIFTY	0.6574	1	
SENSEX	0.6542	0.9963	1

If the correlation coefficient value lies between ± 0.50 and ± 1, then it is said to be a strong correlation or high degree (James Lani,**). Therefore in Table-3, BSE-Sensex and NSE-Nifty are positively correlated with gold prices under the study period. Correlation test result is very powerful but it does not indicate on the matter of cause and impact. So, it is necessary to carry out multiple regression test and cointegration test between the selected variables (Bhunia, 2012).

Multiple Regression Statistics (OLS Method)

Table-3 shows multiple regression test results. Multiple regression tests have been assessed with non-stationary data and residuals. Multiple regression results have been carried out by the help of ordinary least square (OLS) method and under the following equation:

- Estimation Equation:
  GOLD_PRICE = C(1) + C(2)*NIFTY + C(3)*SENSEX
- Substituted Coefficients:
  GOLD_PRICE = 5.06028496558 + 0.66198462829*NIFTY - 0.08677452863*SENSEX

Table 4: Multiple Regression Test Results

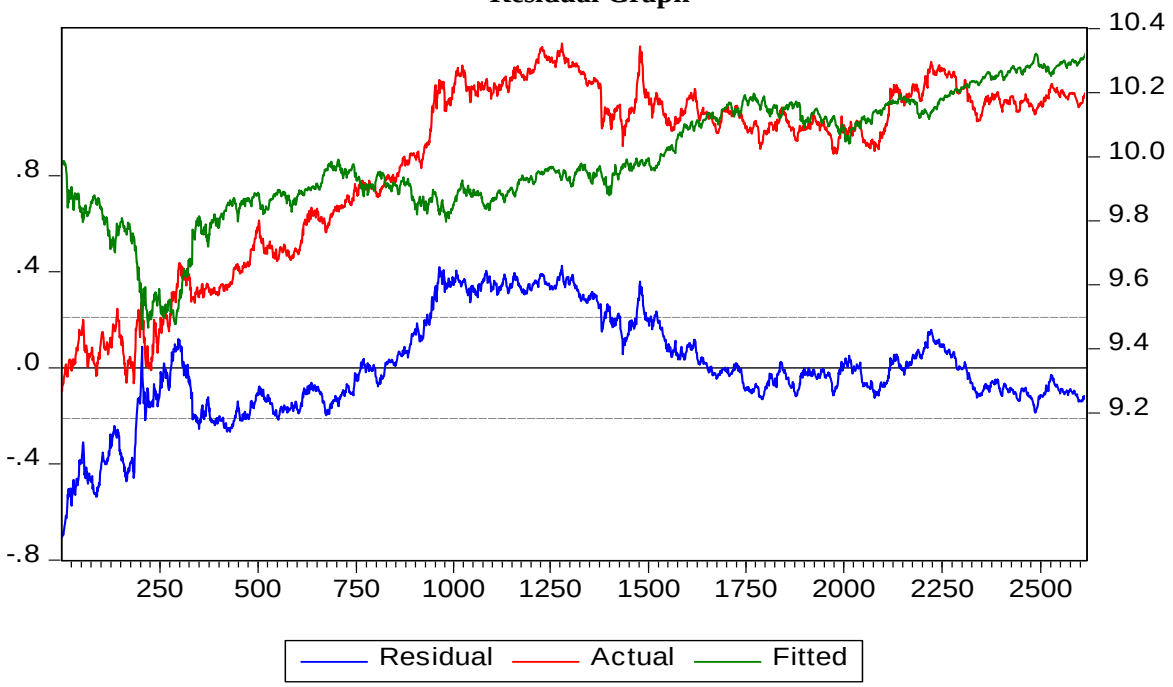
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.060285	0.233528	21.66882	0.0000
NIFTY	0.661985	0.150731	4.391834	0.0000
SENSEX	-0.086775	0.152574	-0.568738	**0.5696**

R-squared	**0.432246**	Mean dependent var	9.989477
Adjusted R-squared	0.431807	S.D. dependent var	0.279672
S.E. of regression	0.210813	Akaike info criterion	-0.274533
Sum squared resid	115.0162	Schwarz criterion	-0.267749
Log likelihood	358.6580	Hannan-Quinn criter.	-0.272075
F-statistic	985.1570	Durbin-Watson stat	0.004870
Prob(F-statistic)	0.000000		

Dependent Variable: Gold_Price
Method: Least Squares
Sample Adjusted: 2616
Included Observations: 2591 after adjustment

In this course of analysis, the P value of SENSEX is more than 5% and P value of NIFTY is zero. Therefore, NIFTY is a significant variable to our explained dependent variable which is GOLD_PRICE. It is a good sign of regression analysis to show that one variable is significant out of two variables. The probability of F-statistics is zero, it is also indicates that the two independent variables NIFTY and SENSEX jointly influence to dependent variable GOLD_PRICE. This is also a good sign of regression.

Residual Graph



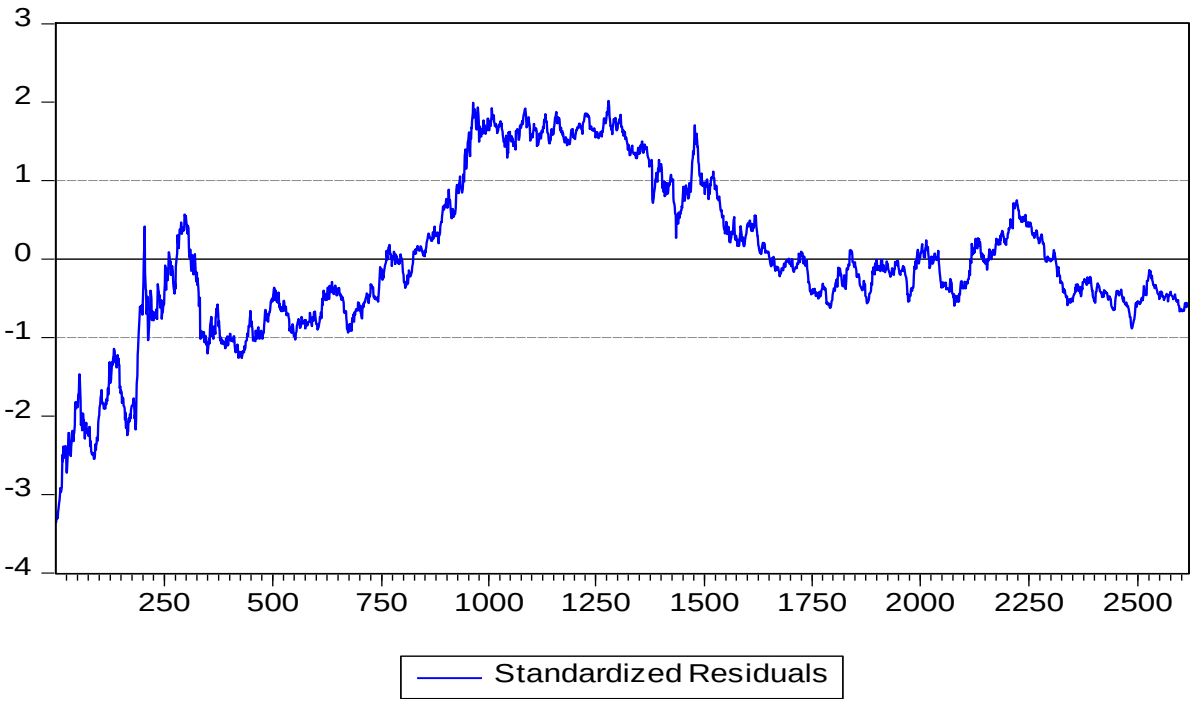


Table 4.1: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	90960.91	Prob. F(2,2586)	0.0000
Obs*R-squared	2554.685	**Prob. Chi-Square(2)**	**0.0000**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.037754	0.027658	-1.365054	0.1724
NIFTY	-0.067304	0.017854	-3.769651	0.0002
SENSEX	0.063108	0.018072	3.492017	0.0005
RESID(-1)	0.626415	0.012294	50.95263	0.0000
RESID(-2)	0.376286	0.012295	30.60463	0.0000

R-squared	0.985984	Mean dependent var	-4.62E-16
Adjusted R-squared	0.985963	S.D. dependent var	0.210732
S.E. of regression	0.024967	Akaike info criterion	-4.540569
Sum squared resid	1.612029	Schwarz criterion	-4.529261
Log likelihood	5887.307	Hannan-Quinn criter.	-4.536471
F-statistic	45480.46	Durbin-Watson stat	0.832518
Prob(F-statistic)	0.000000		

Dependent Variable: RESID
Method: Least Squares
Sample Adjusted: 2616
Included Observations: 2591

The Breusch-Godfrey Serial Correlation LM test shows that the observed R-squared corresponding probability of Chi-Square is zero, meaning that null hypothesis residuals are serially correlated or multi-collinearity. This result is unauthentic.

Table 4.2: Breusch-Pagan-Godfrey-Heteroskedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	180.1314	Prob. F(2,2588)	0.0000
Obs*R-squared	316.6071	Prob. Chi-Square(2)	0.0000
Scaled explained SS	338.7790	Prob. Chi-Square(2)	0.0000

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.458667	0.067515	6.793558	0.0000
NIFTY	-0.217027	0.043578	-4.980252	0.0000
SENSEX	0.149235	0.044110	3.383225	0.0007

R-squared	0.122195	Mean dependent var	0.044391
Adjusted R-squared	0.121517	S.D. dependent var	0.065027
S.E. of regression	0.060948	Akaike info criterion	-2.756440
Sum squared resid	9.613485	Schwarz criterion	-2.749655
Log likelihood	3573.968	Hannan-Quinn criter.	-2.753981
F-statistic	180.1314	Durbin-Watson stat	0.016350
Prob(F-statistic)	0.000000		

Dependent Variable: RESID2
Method: Least Squares
Sample Adjusted: 2616
Included Observations: 2591

Again, Breusch-Pagan-Godfrey-Heteroskedasticity test shows that the probability value is again zero, so that the overall results become unauthentic.

Unit Root Test:

For measuring the long-term impact of gold price on stock price indices of BSE and NSE co-integration analysis is necessary. The theory and concept of stationarity test, Augmented Dickey-Fuller (ADF) unit root test and Phillips-Perron (PP) method used at the level and first differenced of the three variables in this study covering the requirement in line that the null hypothesis is stationary. Therefore, the floating response of the ADF unit root hypothesis supported stationarity. ADF unit root test results based on Schwarz Info Criterion (SIC) are shown in Table-5A, 5B and 5C.

Table 5A: Unit Root Test Result (ADF)

[Condition: Null Hypothesis: Three Variables and Indices series have unit root]
ADF Test

Variables	**At Level (No Intercept)**				
	ADF t-statistic	**Test of Critical Values**			**Prob.**
		1% Level	**5% Level**	**10% Level**	
*GOLD_PRICE[1]	1.4460	-2.5657	-1.9409	-1.6166	0.9636
NIFTY[2]	0.7561	-2.5657	-1.9409	-1.6166	0.8772
SENSEX[3]	0.8591	-2.5658	-1.9409	-1.6166	0.8953
Variables	**At 1st Difference (No Intercept)**				
	ADF t-statistic	**Test of Critical Values**			**Prob.**
		1% Level	**5% Level**	**10% Level**	
*GOLD_PRICE[1]	-54.1437	-2.5657	-1.9409	-1.6166	0.0001
NIFTY[2]	-47.1446	-2.5657	-1.9409	-1.6166	0.0001
SENSEX[3]	-47.6270	-2.5658	-1.9409	-1.6166	0.0001

*Gold Price has a unit root, Nifty has a unit root, Sensex has a unit root.
Dependent Variable: D(Gold_Price), Mackinnon (1996) one sided P values.
Test does not include Trend and Intercept.

Table 5B: Unit Root Test Result (PP)

PP Test

Variables	At Level (No Intercept and Trend)				
	ADF t-statistic	Test of Critical Values			Prob.
		1% Level	5% Level	10% Level	
**GOLD_PRICE[1]	1.4959	-2.5657	-1.9409	-1.6166	0.9672
NIFTY[2]	0.7306	-2.5659	-1.9409	-1.6166	0.8725
SENSEX[3]	0.8574	-2.5658	-1.9409	-1.6166	0.8950
Variables	**At 1st Difference (No Intercept and Trend)**				
	ADF t-statistic	**Test of Critical Values**			**Prob.**
		1% Level	**5% Level**	**10% Level**	
**GOLD_PRICE[1]	-54.1537	-2.5657	-1.9409	-1.6166	0.0001
NIFTY[2]	-47.1290	-2.5658	-1.9409	-1.6166	0.0001
SENSEX[3]	-47.5269	-2.5658	-1.9409	-1.6166	0.0001

**Gold Price has a unit root, Nifty has a unit root, Sensex has a unit root.
Dependent Variable: D(Gold_Price), Mackinnon (1996) one sided P values
Test does not include Trend and Intercept.

Table 5C: Clear View of Hypothesis Decision

Variables	Null Hypothesis	Results	Cause
At Level			
GOLD_PRICE	Failed to Reject H_0	Variable is Non-Stationary 1(0)	t-stat < C.V. at 1%, 5%, 10%
NIFTY	Failed to Reject H_0	Variable is Non-Stationary 1(0)	t-stat < C.V. at 1%, 5%, 10%
SENSEX	Failed to Reject H_0	Variable is Non-Stationary 1(0)	t-stat < C.V. at 1%, 5%, 10%
At 1st Difference			
GOLD_PRICE	Reject H_0	Variable is Stationary 1(1)	t-stat > C.V. at 1%, 5%, 10%
NIFTY	Reject H_0	Variable is Stationary 1(1)	t-stat > C.V. at 1%, 5%, 10%
SENSEX	Reject H_0	Variable is Stationary 1(1)	t-stat > C.V. at 1%, 5%, 10%

Source: Values Calculated by the Author
C.V.: Critical Values
Stationarity status: 1(0)-at level and 1(1)-at 1st difference.

Table-5A and 5B disclosed the ADF and PP test where null hypothesis assumptions of lnfty and lsci has a unit root at level and both the observed values are less than its absolute critical values, therefore both the series were not stationary at level but again observed values of variables are more than its absolute critical values, so the series stationary at 1st differenced.
As the time series data was non-stationary at level, it is clear that regular regression technique may create unauthentic regression. At that time it is very much better to test out Johansen cointegration test whether there are long-term relationships between the three variables or not.

Johansen Cointegration Test:
Bivariate Co-integration Test [Gold_Price with Nifty]:
Bivariate Cointegration test has been performed to find out the long-term relationships between gold price and nifty by using two likelihood ratio tests i.e. Trace statistic and Maximum Eigen Value statistic to observe the number of cointegrating vectors. Two lag interval is used and analysis based on the Swertz Information Criterion (SIC).

Table 6A: Bivariate Co-integration Test Results (Lags Interval-2)

Unrestricted Cointegration Rank Test (Trace Test)						
Hypothesized No. of CE(s)		**Eigen value**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****	**Remarks**
Nifty	$r \leq 0$	0.0042	11.8853	15.4948	0.1625	No Cointegration
Gold_Price	$r \leq 1$	0.0005	1.3573	3.8415	0.2440	No Cointegration
Trace test indicates no 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-Eigen Value Test)						
Hypothesized No. of CE(s)		**Eigen value**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****	**Remarks**
Nifty	$r \leq 0$	0.0042	10.5280	14.2646	0.1795	No Cointegration
Gold_Price	$r \leq 1$	0.0005	1.3573	3.8415	0.2440	No Cointegration
Max-eigenvalue test indicates no cointegration at the 0.05 level						
* denotes rejection of the hypothesis at the 0.05 level						
**MacKinnon-Haug-Michelis (1999) p-values						

In Table-6A, the results confirmed that trace statistics (11.88) was less than its critical values (15.49) in 5% significance level between $r \leq 0$ and $r \leq 1$ with no cointegrating equation and maximum eigen value statistics was less than its critical values between $r \leq 0$ and $r \leq 1$ with no cointegrating equation, which was not significant at 5% level. Therefore, both the test results confirmed that there was no long-run association between gold price and nifty.

Bivariate Co-integration Test [Gold_Price with Sensex]:

On the other hand, Table-6B also confirmed that there was no long term cointegration between gold price and sensex. Because the trace statistics (12.65) was less than its critical values (15.49) in 5% significance level between $r \leq 0$ and $r \leq 1$ with no cointegrating equation and maximum eigen value statistics was less than its critical values between $r \leq 0$ and $r \leq 1$ with no cointegrating equation, which was not significant at 5% level.

Table 6B: Bivariate Cointegration Test Results (Lags Interval-2)

Unrestricted Cointegration Rank Test (Trace Test)						
Hypothesized No. of CE(s)		**Eigen value**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****	**Remarks**
Sensex	$r \leq 0$	0.0042	12.6568	15.4947	0.1280	No Cointegration
Gold_Price	$r \leq 1$	0.0006	1.6988	3.8415	0.1924	No Cointegration
Trace test indicates no 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-Eigen Value Test)						
Hypothesized No. of CE(s)		**Eigen value**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****	**Remarks**
Sensex	$r \leq 0$	0.0042	10.9579	14.2646	0.1563	No Cointegration
Gold_Price	$r \leq 1$	0.0005	1.6988	3.8415	0.1924	No Cointegration
Max-eigenvalue test indicates no cointegration at the 0.05 level						
* denotes rejection of the hypothesis at the 0.05 level						
**MacKinnon-Haug-Michelis (1999) p-values						

Multivariate Co-integration Test:

Now, Johansen multivariate cointegration test is used to find out the variables are co-integrated or not as well as the number of co-integrating relationships. Two likelihood ratio tests is used in this method i.e. Trace statistic and maximum Eigen Value statistic to observe the number of co-integrating vectors. 1 to 4 lag (in 1st differences) is used for each series, based on the Swartz Information Criterion (SIC).

Table 7: Multivariate Co-integration Test Results (Lags Interval-4)

Unrestricted Co-integration Rank Test (Trace Test)				
Hypothesize No. of CE(s)	**Eigen value**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None*	0.0662	179.0563	29.7971	0.0000
At most 1	0.0038	10.3517	15.4947	0.2546
At most 2	0.0004	0.9366	3.8415	0.3331
Trace test indicates 1 co-integrating equation at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integration Rank Test (Maximum-Eigen Value Test)				
Hypothesized No. of CE(s)	**Eigen value**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None*	0.0662	168.7046	21.1316	0.0000
At most 1	0.0038	9.4150	14.2646	0.2532
At most 2	0.0004	0.9366	3.8415	0.3331
Max-eigenvalue test indicates 1 co-integrating equation at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Table 7.1: Acceptance and Rejection Decision

Unrestricted Co-integration Rank Test (Trace Test)				
Hypothesized No. of CE(s)	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****	**Decision as per rule/Remarks**
None*	168.7046	21.1316	0.0000	Reject Null Hypothesis
At most 1	9.4150	14.2646	0.2532	Failed to Reject Null Hypothesis Or, Long run Association between the Variables
At most 2	0.9366	3.8415	0.3331	Failed to Reject Null Hypothesis Or, Long run Association between the Variables
Unrestricted Co-integration Rank Test (Maximum-Eigen Value Test)				
Hypothesized No. of CE(s)	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****	**Decision as per rule/Remarks**
None*	168.7046	21.1316	0.0000	Reject Null Hypothesis
At most 1	9.4150	14.2646	0.2532	Failed to Reject Null Hypothesis Or, Long run Association between the Variables
At most 2	0.9366	3.8415	0.3331	Failed to Reject Null Hypothesis Or, Long run Association between the Variables

In Table-7 shows that the unrestricted co-integration rank test trace test and maximum Eigen value test. As a result, null hypothesis 1st time the trace statistics is more than its critical value and probability is zero in trace test and in maximum Eigen value test, it is also the trace statistic is more than its critical value and probability is zero means the probability value is less than 5% or zero means reject the null hypothesis or no co-integration, suggesting to there is single significant co-integrating vector in this model. In this model, two other stochastic trends is at most 1 and at most 2 which indicate the long run association between the variables because the P value of both the test is more than 5%, therefore, failed to reject null hypothesis or accept the null hypothesis.

Granger Causality Test:

This section attempts to investigate the direction of causality between the paired variables. The standard regression method generally works out the nature of causality and its significance level. Table-8 describe that no causality and bi-directional causality subsists between gold price and stock price indices under the study period and selection of lag length 2 to 4.

Table 8: Pair-wise Granger Causality Tests Results (Lag-2)

Null Hypothesis	Obs.	F-Stat.	P-Value	Hypothesis Decision	Causality Direction
NIFTY does not Granger Cause GOLD_PRICE	2550	0.48	0.62	Accept H_0	No Causality
GOLD_PRICE does not Granger Cause NIFTY		3.53	0.03	Reject H_0	Bi-directional
SENSEX does not Granger Cause GOLD_PRICE	2614	0.43	0.65	Accept H_0	No Causality
GOLD_PRICE does not Granger Cause SENSEX		5.20	0.005	Reject H_0	Bi-directional
SENSEX does not Granger Cause NIFTY	2539	104.66	2.E-44	Accept H_0	No Causality
NIFTY does not Granger Cause SENSEX		13.04	2.E-06	Accept H_0	No Causality

P value is more than 5%- Cannot reject null hypothesis, otherwise accept null hypothesis
P value is less than 5%-reject null hypothesis.

Pair-wise Granger Causality Tests Results (Lag-4)

Null Hypothesis	Obs.	F-Stat.	P-Value	Hypothesis Decision	Causality Direction
NIFTY does not Granger Cause GOLD_PRICE	2498	0.38	0.82	Accept H_0	No Causality
GOLD_PRICE does not Granger Cause NIFTY		4.70	0.0009	Reject H_0	Bi-directional
SENSEX does not Granger Cause GOLD_PRICE	2612	0.73	0.57	Accept H_0	No Causality
GOLD_PRICE does not Granger Cause SENSEX		7.16	0.00001	Reject H_0	Bi-directional
SENSEX does not Granger Cause NIFTY	2539	51.96	4.E-42	Accept H_0	No Causality
NIFTY does not Granger Cause SENSEX		6.63	3.E-05	Accept H_0	No Causality

P value is more than 5%- Cannot reject null hypothesis, otherwise accept null hypothesis
P value is less than 5%-reject null hypothesis.

Table-8 indicates that the F-statistic (0.48) and P value (0.62) is more than 5%, for that reason, do not reject the null hypothesis or Nifty does not Granger cause of Gold price and no causality for the selection of lag 2. But the variables between Gold price and Nifty, P value is less than 5% meaning that reject the null hypothesis and it is a bi-directional causality in lag 2. Again, the variables between Sensex and Gold price, one is no causality because the P value is more than 5% and other is bi-directional causality for the reason that the P value is less than 5% in the same lag selection criterion. For the same way, same results have been carried out for the selection of lag 4. Finally, the overall results are No causality exists between (i) Nifty and Gold_Price, (ii) Sensex and Gold_Price (iii) Sensex and Nifty, (iv) Nifty and Sensex and Bi-directional causality exists between (i) Gold_Price and Nifty, (ii) Gold_Price and Sensex.

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