The purpose of the present study is to examine whether there exists a causal link between BSE Sensex (SENSEX) and gold price (GOLD). Time series data (monthly) of BSE Sensex and gold price for the period from January 2004 to December 2013 are used. To provide evidence on the existence of causal relationship between the variables, the Granger Causality test has been employed. Johansen cointegration results show that there is a cointegration between the two variables chosen and which leads to prove the existence of causal relationship between them. The study found that there exists a causal relationship, which is running from SENSEX to GOLD however there is no such relationship exists from GOLD to SENSEX, and therefore the study concludes that there is a unidirectional relationship existed between stock price and gold price.

I. INTRODUCTION

Gold is considered as one of the most precious elements from ancient times. It is considered as the symbol of purity and good fortune. There are many investment areas such as stock markets (SM), mutual funds, fixed deposits and government bonds amongst others, but people still prefer to invest in gold. Gold is purchased continuously over the years, as money is saved and available, thus the acquisition is done over generations. Except for the last few decades, gold was the only form of savings that was practiced. But now-a-days people buy gold for a variety of reasons such as for its auspicious sentiment; as an investment, hedge against inflation; asset allocation, etc. A report from the Gem and Jewellery Export Promotion Council (GJEPC) showed that India exported $718.36 million worth of gold jewellery in February 2014, which was an increase of just one per cent over February 2013. India exported $6.35 billion worth of gold jewellery in the 11 months from April 2013, down from $11.67 billion a year earlier.

Indian stock price is influenced by number of factors, but it is greatly influenced particularly by exchange rates, crude oil price and gold price. Gold prices, by and large, rise when attitudes on the economy and the financial markets bearish or there is uncertainty over future trends. In the 70’s, the price of gold soared significantly, while SM remained stagnant. However, in the recent past two decades, gold price remained comparatively stagnant, and the SM gave exceptional returns. While there is no accurate theory that brings out a concrete correlation between the price of gold and the performance of the Indian SM, a brief look at the history of investing habits of Indian investors paints a complicated picture. There has been a drastic change in the gold price over a century from now. Table I followed by figure 1, show the trend of gold price for the last 40 years.

In the past decade, the increase in gold prices has been notable. However, a sudden jump in the price from ₹18,500 in 2010 to ₹26,400 in 2011 is an astonishing increase. The price of 10 gm of gold in the year 1964 was just ₹63.25 whereas in the year 2012 it was ₹31,050; in December 2013 it was ₹29,600. Initially the increase in gold price was less from year to year but there is a drastic increase in the recent years.

Gold prices tumbled from ₹32,500 per 10 gm in November 2012 to ₹29,600 in December. If this trend continues, a common man will see gold not as an investment but as an unreachable asset. Many researches have done the long-run and short-run relationships of stock price index and gold price in developed and developing countries. Gold continues to offer good returns continually till recently, while SM remains volatile; this indicates that there is a correlation between these two. Hence, the present study examines the relationship between gold price (GOLD) and SM index of India.

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg. GP</th>
<th>Year</th>
<th>Avg. GP</th>
<th>Year</th>
<th>Avg. GP</th>
<th>Year</th>
<th>Avg. GP</th>
</tr>
</thead>
</table>

**TABLE I**

GOLD PRICE TREND IN INDIA (INR) FROM 1971-72 TO 2011-12
II. REVIEW OF LITERATURE

A number of previous studies made attempt to link the \textit{SM} with that of the economic indicators viz., GDP, inflation, and government deficits / surpluses etc. Numerous foreign and Indian studies ([7], [9], [12], [14], [16] and [17]) examined the relationship between the stock returns and the macro-economic variables.

Previous studies have also analysed the relationship between commodity market indicator and the \textit{SM} in various countries. A sizeable number of studies on the relationship between crude oil price, gold price, exchange rate and stock price index have been undertaken. For instance, [1], [2], [11] and [18] reported strong evidence for oil price risk impact on stock price returns in emerging markets.

On the other hand, relationship between stock price and gold price is documented in several studies. Reference [10] examined the relationship between gold price and stock index and proved that \textit{SM} is not ground for rising gold price. The empirical results of [18] showed that gold price can greatly affect the \textit{SM}. Reference [3] measured the relationship between the commodity market indicators and Indian stock price indices and found the existence of long-run relationship between the variables. Reference [15] pointed out that uni-directional causality runs from gold price to stock price. Contrary to that, [13] provided evidence of no relationship between gold price and stock price.

Although many researches have been done on the impact of gold price on the \textit{SM} indices, few studies only have devoted to the \textit{SM} of developing countries such as India. Hence, the present study made an attempt to explore the relationship between Indian stock index (BSE Sensex) and the gold price. The present study makes use of Granger causality test to assess the direction of relationship between \textit{SENSEX} and \textit{GOLD}.

III. OBJECTIVES OF THE STUDY

The main objectives of the study are:

1. To determine the existence of cointegrating vectors between BSE Sensex (\textit{SENSEX}) and gold price (\textit{GOLD}).
2. To check whether there exists causality between the selected two variables (\textit{SENSEX} and \textit{GOLD}).
IV. HYPOTHESES DEVELOPED FOR THE STUDY
To set out the results of the stated objectives, the following hypotheses are developed for the study and tested using appropriate statistical models.

- $H_0^1$: There is no cointegration relationship between SENSEX and GOLD.
- $H_0^2$: There is no causal relationship between SENSEX and GOLD.

V. RESEARCH METHODOLOGY
A. Data source
The study is fully based on secondary data collected from various data sources. To analyse the causal relationship between the variables, the study considered the monthly SM index (closing price) of Bombay Stock Exchange (BSE) BSE Sensex (SENSEX) and the monthly Indian gold price (GOLD) for the period of 10 years from January 2004 to December 2013, which were collected from the official website. (www.bseindia.com; www.mcxindia.com). The analysis has been done using econometric software called Eviews 7.

B. Research Methods
To test the stated hypotheses, the following research methods have been used for the study:

1) Descriptive Statistics: Descriptive statistics are used to evaluate the mean, median, standard deviation and kurtosis of the selected variables.

- $H_0$: Series is normally distributed ($JB=0$)
- $H_1$: Series is not normally distributed ($JB\neq0$)

Jarque-Bera ($JB$) is a statistics for testing whether the series is normally distributed. If the residuals are normally distributed, the histogram will be bell-shaped and the $JB$ statistics should not be significant. The $JB$ statistics strongly rejects the hypothesis of normal distribution.

2) Unit Root Test (Augmented Dickey Fuller Test): Prior to testing causality test, there is a need for checking whether the data are stationary or not. In this study, the Augmented Dickey-Fuller Test ($ADF$) proposed by [4] is applied to find out the presence of stationarity in the time series data.

- $H_0$: Series is non-stationary (There is unit root)
- $H_1$: Series is stationary (There is no unit root)

$ADF$ test critical values are more negative than the test statistics of all other variables in level, thus the null hypothesis of a unit root cannot be rejected. In other words, if the test statistics value is more than the critical values, the $H_0$ cannot be rejected.

3) Test of Cointegration (Johansen Co-integration Test): Co-integration theory was developed by Granger to examine the long-run relationship [6]. The purpose of cointegration test is to determine whether a group of non-stationary series are cointegrated or not and also explores the long-run equilibrium relationship among the variables. The Johansen [8] approach determines the number of cointegrated vectors for any given number of non-stationary variables of same order. The two types of Johansen test is employed, first, the $\lambda_{race}$ statistics test whether the number of cointegrating vector is zero or one, then the $\lambda_{max}$ statistic tests whether a single cointegration equation is sufficient. Both the test statistics are given as follows:

$$\lambda_{trace(r)} = -T \sum_{i=r+1}^{\infty} \log (1 - \lambda)$$

(1)

$$\lambda_{trace(r,r+1)} = T \log (1 - \lambda_{r+1})$$

(2)

Where,
- $r =$ number of separate series
- $T =$ number of usable observations
- $\lambda =$ estimated eigen values

In this framework, it is desirable to obtain at least one co-integrating vector, $r = 1$ to establish the model. The Trace test is a joint test that tests the null hypothesis of no cointegration ($H_0$: $r = 0$) against the alternative hypothesis of cointegration ($H_1$: $r > 0$). The Maximum Eigenvalue test conducts tests on each eigenvalue separately. It tests the null hypothesis that the number of cointegrating vectors is equal to $r$ against the alternative of $r+1$ cointegrating vectors. A significantly non-zero eigenvalue indicates a significant cointegrating vector.

4) Test of Causality (Granger Causality Test): Cointegration between the two variables indicates that causality exists between them, but it fails to show the direction of the causal relationship. After exploring the existence of cointegration between SENSEX and GOLD, it is imperative to test the causality to assess the direction of relationship. Granger Causality test seeks to determine whether the past values of variable helps to predict changes in another variable. Granger Causality test [5] has been used in order to find out the existence of unidirectional or bidirectional relationship between SENSEX and GOLD. Granger Causality between the two variables is tested using the formula:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_1 y_{t-1} + \beta_1 x_{t-1} + \ldots + \beta_1 x_{t-1} + \mu_1 t \quad (3)$$

$$x_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \beta_1 y_{t-1} + \beta_1 y_{t-1} + \mu_2 t \quad (4)$$

where it is assumed that the disturbances $\mu_{1t}$ and $\mu_{2t}$ are uncorrelated. Equation (3) represents that variable $x$ is decided by lagged variable $y$ and $x$. Granger causality means the lagged $y$ influence $x$ significantly in equation (3) and the lagged $x$ influence $y$ significantly in equation...
(4). In other words, it can be jointly tested if the estimated lagged coefficient \( \alpha_i \) and \( \lambda_i \) are different from zero with F-statistic. When the joint test rejects both the null hypotheses that \( \alpha_i \) and \( \lambda_i \) are not different from zero, causal relationship between \( x \) and \( y \) is confirmed.

VI. RESULTS AND DISCUSSION

According to the previous literature reviewed, the relationship between the two selected variables could be one-way as well as two-way. Therefore, our purpose of the study is to confirm if the causal relationship between SENSEX and GOLD exist. Using the monthly prices for ten years from 2004 to 2013, the analysis has been done using the above mentioned research methods and the results are tabulated as under.

The descriptive statistics viz., mean, median, standard deviation, skewness and kurtosis for BSE Sensex and gold price are presented in the table II. It is inferred from the table that the mean return is positive for two series. Regarding the normality, the value of skewness, kurtosis and Jarque-Bera statistics are considered. The kurtosis value is greater than three, hence implying that the series is sharp.

### TABLE II

**DESCRIPTIVE STATISTICS OF SELECTED VARIABLES**

<table>
<thead>
<tr>
<th>METHOD</th>
<th>BSE</th>
<th>GOLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>14205.92</td>
<td>13635199</td>
</tr>
</tbody>
</table>

Source: Computed results based on secondary data compiled from BSE and MCX websites.

The kurtosis value is less than three for BSE, which indicates that the series are flattened or depressed. The null hypothesis is rejected for the normality for two series, indicating that the series are not normally distributed, which is confirmed by Jarque-Bera statistics. The variables are not distributed normally in full, but are distributed very close to normal distribution as the median values of variables are very close to average values.

To test the stationarity of the daily price of market index SENSEX and gold price (GOLD), the Augmented Dickey Fuller test (ADF) proposed by [4] is applied and the result is presented in table III. The \( H_0 \) of unit root cannot be rejected (at level) for the two variables, as the ADF statistics values are not significant for both SENSEX and GOLD. Hence, \( H_0 \) is accepted, which implies that the series are non-stationary and has unit root, i.e. integrated of order zero.

### TABLE III

**RESULTS OF UNIT ROOT TEST**

<table>
<thead>
<tr>
<th>Variables at Level</th>
<th>Variable</th>
<th>ADF Statistics</th>
<th>Critical value</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SENSEX</td>
<td>-1.37(0.59)</td>
<td>1% -3.48</td>
<td>I(0)</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>-1.64(0.45)</td>
<td>1% -3.48</td>
<td>I(0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables in their first differences</th>
<th>Variable</th>
<th>ADF Statistics</th>
<th>Critical value</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SENSEX</td>
<td>-10.74*(0.00)</td>
<td>1% -3.48</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>GOLD</td>
<td>-5.92*(0.00)</td>
<td>1% -3.48</td>
<td>I(1)</td>
</tr>
</tbody>
</table>

Source: Computed results based on secondary data compiled from BSE and MCX websites. Figures in parentheses indicate p values. *Significant at 1% level.

However, \( H_0 \) of unit root is rejected at first difference for both the variables, as the ADF statistics are significant at 1% level, which implies that the two series are stationary and are integrated of order one. Hence, the result of ADF test for SENSEX and GOLD is not stationary I(0) ‘at level’ but the same become stationary at the position I(1) ‘at first difference’.

### TABLE IV

**RESULTS OF JOHANSEN COINTEGRATION TESTS**

<table>
<thead>
<tr>
<th>Median</th>
<th>15668.47</th>
<th>12986917</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. Dev.</td>
<td>4858.233</td>
<td>10689134</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.540449</td>
<td>1.095982</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>1.960377</td>
<td>5.403762</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>11.24579</td>
<td>52.91391</td>
</tr>
<tr>
<td>Probability</td>
<td>0.003614</td>
<td>0.000000</td>
</tr>
</tbody>
</table>

Johansen method is used in order to determine the number of cointegrating vectors; it provides two different likelihood ratio tests viz., the trace test and the maximum eigenvalue test and the results are shown in table IV.
From the table IV, it is inferred that the trace statistics is greater than the critical value (None), which established a long-run cointegration relationship in the model, whereas the Max-Eigen value does not show the same, since the p value is not significant at 5% level. Therefore, as per trace statistics, \( H_0 \) ‘there is no cointegration’ between the variables is rejected at 5% level of significance, which implies that there is one cointegration equation (since p value is less than 0.05) between the two variables viz., SENSEX and GOLD. Since the SENSEX and GOLD are cointegrated, the study proves for the presence of long-run relationship between them and hence \( H_0 \) ‘there is no cointegration relationship between SENSEX and GOLD’ is rejected.

### TABLE V
RESULTS OF GRANGER CAUSALITY TESTS

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F Statistics</th>
<th>Probability</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENSEX does not Granger Cause GOLD</td>
<td>4.1667</td>
<td>0.0179</td>
<td>Reject</td>
</tr>
<tr>
<td>GOLD does not Granger Cause SENSEX</td>
<td>0.2847</td>
<td>0.7527</td>
<td>Accept</td>
</tr>
</tbody>
</table>

Since cointegration tests indicate only the existence of long-run relationship between SENSEX and GOLD, the Granger Causality tests is used to analyse the direction of relationship between BSE Sensex (SENSEX) and gold price (GOLD).

Granger Causality test has been employed in search of the direction of causation between the selected variables, and the result is presented in table V. It is inferred from the table that the \( H_0 \), ‘SENSEX does not Granger cause GOLD’ is rejected, whereas the \( H_0 \) ‘GOLD does not Granger cause SENSEX’ is accepted, since the p value is more than 0.05. In other words, it reveals that there is no causality running from GOLD to SENSEX, therefore \( H_0 \) is accepted and concludes that ‘GOLD does not Granger Cause SENSEX’.

But for \( H_0 \) ‘SENSEX does not Granger Cause GOLD’ it is rejected since the p value is less than 0.05 and hence concludes that ‘SENSEX does Granger Cause GOLD’. Therefore, \( H_0 \) ‘there is no causal relationship between SENSEX and GOLD’ is rejected, indicating that SENSEX affects gold price (GOLD) in India and it is also found that the direction of causality between SENSEX and GOLD in India is generally unidirectional. Hence, from the results it is concluded that the Granger Causality runs one-way from SENSEX to GOLD and not the reverse.

### VII. CONCLUSION

The present study tries to empirically access the causality between SENSEX and gold price (GOLD) in India with the help of the monthly data over the period of 10 years from January 2004 to December 2013. First, the study finds the distributional properties of daily series of BSE Sensex and gold price during the study period using descriptive statistics, secondly, the unit root property of the data is examined using ADF test. Thirdly, the cointegration and causality tests are conducted for the study period. The results of ADF test reveals that the series are stationary (first difference) and also integrated.

SENSEX and GOLD are cointegrated implying the existence of long-run relationship between the two as confirmed by Johansen cointegration tests. The result of Granger Causality test reveals that there exists a causal relationship between SENSEX and GOLD and the study also confirmed the presence of uni-directional causality which runs from SENSEX to GOLD for the study period.

### VIII. SCOPE FOR FURTHER STUDIES

The study can also be extended using other commodities and macro-economic variables viz., gross domestic product...
(GDP), inflation, foreign direct investment, exchange rates etc. The present study also provides an opportunity for the further researchers to explore the causality relationship between different variables in other Asian countries as well. The study can also be done using other econometric tools using daily, weekly or annual data to empirically test whether the results are sensitive to the frequency of the data.

REFERENCES