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Long run relationship and short term causal dynamic linkages between Indian stock market and gold prices

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Abstract

This paper investigates the long run relationship and short term causal dynamic linkages between gold prices and Indian stock market index (BSE SENSEX). The daily time series data for gold prices and Mumbai stock market index BSE SENSEX are used for the period August, 2006 to May, 2014. By applying Augmented Dickey-Fuller unit root test, Johansen cointegration test and Granger causality test, the study concludes that all series are integrated of first order i.e. $I(1)$ and there is no long run relationship between gold prices and BSE SENSEX stock market index. However, the results of Granger Causality provide evidence of short term bidirectional dynamic linkages between gold prices and BSE SENSEX. Hence, for long term Indian equity market investors there exists portfolio diversification opportunity in gold investment, particularly in stock market slump periods.

Keywords: Cointegration, Diversification, Portfolio, Stock market, Return.

1. Introduction

Over the past decades, the global financial markets have witnessed a string of financial crises, among them including the Mexican peso crisis in 1994, the Asian financial flu in 1997/1998, the Russian crisis in 1998, the Brazilian crisis in 1999, the Argentine financial crisis in 2001/2002 and, most recently, the US subprime crisis in 2007 and the Greece financial crisis in 2009. The mentioning of these crises is likely to conjure up in the mind of many the images of excessive risk in stock market investment and to bring back interest in gold as an alternative investment asset. This interest is well-placed, as gold used to be a standard of value; it is still considered as a store of value and is universally accepted. Moreover, there seems to be a strong belief that gold can provide protection, as a hedge or a safe haven, against this heightened risk in the financial markets. As noted by Baur and Mc Dermott (2010), gold differs from other assets in that it reacts positively to adverse market shocks. As they mention, real gold value reached its historic high roughly in 1980, when the global economy faced the threat of stagflation due to oil crises in 1970s. Likewise, at the time the US subprime crisis intensified in September 2008, gold has responded with a surge in its value (Mansor, 2011).

Historical experiences show that the trend of gold prices is always higher during period of stock market slump. In India stocks do not seem to be perceived as an alternative to gold. The reason for holding gold is, to a large extent, guided by the individual sentiments. The gold investing habits of Indians strongly ingrained in the Indian Social Psyche. In India gold has been held by individuals for years and have passed hands of many generations. This tendencies offer positive returns during a crisis of such a magnitude has renewed the interest in gold. It has also reactivated the old common knowledge of gold being a safe haven, inherited from its monetary role throughout history (Bhunia and Das, 2012).

2. Literature Review

Against a backdrop of recurring financial crises and contagion as well as emerging interest in gold, several studies have attempted empirical investigation of gold hedging property. Notable among these studies are recent works by Smith, (2001), Capie *et al.* (2005), Hillier *et al.* (2006), Gilmore *et al.* (2009) Baur Lucey (2010), Baur and Mc Dermott (2010) and Wang et al (2010) Mansor (2011) and Bhunia and Das (2012).

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Smith (2001) examined the short-term and long-term relationships between four gold price series and six different US stock price indices over the 1991-2001 time periods. Smith reported that gold prices and US stock index levels were nonstationary, but were stationary in first differences. He found no bilateral long-term relationship, or co-integration, between a gold price series and a stock market index. There was, however, some evidences of a negative short-term Granger causality running from US stock index returns to gold returns, but not the reverse.

Capie *et al.* (2005) investigate an exchange rate hedge of gold using weekly data of gold price and sterling-dollar and yen-dollar exchange rates from January 1971 to February 2004. They find supportive evidence for exchange rate hedging property of gold, although the strength of hedging tends to vary over time.

Hillier *et al.* (2006) assesses the investment role of precious metals, namely gold, platinum and silver for the US market. They note low correlations between these three metals and stock market returns, which suggests diversification benefits of gold investment.

Gilmore *et al.* (2009) examined the dynamic relationships between gold prices, stock price indices of gold mining companies and broad stock market indices. Evidence of cointegration between these variables is found. A vector error-correction model reveals that both gold and large-cap stock prices adjust to disturbances to restore the long-term relationship between the variables. Short-term unidirectional causal relationships are running from large-cap stock prices to gold mining company stock prices and from gold mining company stock prices to gold prices.

Baur and Lucey (2010) examines whether gold is a safe haven, i.e. maintaining its value in times of market stress or turmoil, for the US, the UK and German markets. They document evidence suggesting the ability of gold to hedge against financial risks and to serve as a safe haven in extreme market conditions for these markets.

Baur and Mc Dermott (2010) extend the work of Baur and Lucey (2010) to a larger number of markets, which include both major developed and emerging markets. They analyze the relations between gold return and returns of world and emerging market indexes, various regional market indexes, and 13 individual market indexes. Their results demonstrate the ability of gold to provide a hedge and a strong safe haven for the European and US markets. Thus, for the developed markets, gold provides protection against losses during extreme market conditions. As they explain, investors in these markets sell stocks and buy gold when faced with heightened financial risk. By contrast, the emerging markets seem to lack these properties, indicating that investors tend to react differently to adverse shocks in the emerging markets. Namely, they shift the composition of their portfolios by selling shares of emerging markets and seeking shelter in the developed markets, which are viewed to be relatively safe. Wang *et al.* (2010) explored the impacts of fluctuations in crude oil price, gold price, and exchange rates of the US dollar vs. various currencies on the stock price indices of the United States, Germany, Japan, Taiwan, and China respectively, as well as the long and short-term correlations among these variables. Empirical results show that there exist cointegrations among fluctuations in oil price, gold price and exchange rates of the dollar vs. various currencies, and the stock markets in Germany, Japan, Taiwan and China. This indicates that there exist long-term stable

relationships among these variables. Whereas there is no co-integration relationship among these variables and the U.S. stock market indices which indicates that there is no long-term stable relationship among the oil price, gold price and exchange rate and the US stock market index.

Mansor (2011) examined the relation between gold return and stock market return and whether its relation changes in times of consecutive negative market returns for an emerging market, Malaysia. He finds a significant positive but low correlation between gold and once-lagged stock returns. Moreover, consecutive negative market returns do not seem to intensify the co-movement between the gold and stock markets as normally documented among national stock markets in times of financial turbulences. Indeed, there is some evidence that the gold market surges when faced with consecutive market declines. Based on these results, there are potential benefits of gold investment during periods of stock market slumps.

Bhunja and Das (2012) examined the gold price volatility and the causal relationship between gold prices and stock market returns in India. Taking into consideration the domestic gold prices and stock market returns based on NSE, the study investigates the Granger causality in the Vector Error Correction Model for the period from April 2001 to March 2011. Empirical results provide the support of feedback causality between the selected variables and indicate that the Gold prices Granger-causes stock market returns and stock market returns also Granger-causes the gold prices in India during the study period. The results indicate that the co-movement of gold prices and stock prices even during the period global financial crisis and thereafter. Indians have started considering gold not only as jewellery but also an important mode of investment like investment in bonds and equities.

In this paper we find whether there exists a diversification opportunity in gold, particularly in stock market slump periods by investigating long run relationship and short term causality dynamics linkages between gold prices and stock market index BSESENSEX of India. The rest of the paper is organized as follows: Section II explains the data and methodology, Section III includes the analysis, and Section IV concludes.

3. Data Description and Methodology

This empirical study is based on daily closing values of the Mumbai Stock Exchange index (BSE SENSEX) and 10 gm gold price in Indian Rupees. Daily closing price for the period from Aug, 2006 to May, 2014 has been taken from the website www.yahoofinance.com. The continuously compounded rate of return is calculated by using the following formula:

$$R_t = \ln (P_t/P_{t-1}) * 100$$

Where:

R_t = Return on day 't';

P_t = Index closing value on week 't'

P_{t-1} = Index closing value on week 't-1'

ln = Natural log.

There are several methods for testing the co-movement of prices across the different financial markets. In this study the emphasis is given to test the long run relationship and short term dynamics between the Indian Mumbai Stock Exchange

index (BSE SENSEX) and Gold price, via; (i). Descriptive Statistics; (ii) Correlation Matrix, (iii) Co integration Tests, and (iv) Granger Causality Test

3.1 Unit Root Test

Cointegration analysis requires that time series should be integrated of same order. Stationarity of time series has been examined by using unit root tests. Augmented Dickey-Fuller Test has been employed for said purpose. The Augmented Dickey Fuller test examines the presence of unit root in an autoregressive model. A simple AR (1) model is

$$y_t = \rho y_{t-1} + u_t,$$

Where, y_t is the variable of interest, t is the time index, ρ is a coefficient and u_t is the disturbance term. The regression model can be written as

$$\Delta y_t = (\rho - 1) y_{t-1} + u_t = \delta y_{t-1} + u_t,$$

Where, Δ is the first difference operator. This model can be estimated and testing for a unit root is equivalent to testing $\delta = 0$.

A financial time series is said to be integrated of one order i.e., I (1), if it becomes stationary after differencing once. If two series are integrated of order one, there may have a linear combination that may be stationary without differencing. If said condition fulfills then these are called cointegrated.

3.2 Johansen Cointegration Test

The Johansen (1988) and Johansen and Juselius (1990) procedure test the presence of long run relationship between the variables. Johansen and Juselius propose two likelihood ratio tests for the determination of the number of cointegrated vectors. One is the maximal eigenvalue test which evaluates the null hypothesis that there are at most r cointegrating vectors against the alternative of $r + 1$ cointegrating vectors. The maximum eigenvalue statistic is given by,

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

Where $\lambda_{r+1}, \dots, \lambda_n$ are the $n-r$ smallest squared canonical correlations and T = the number of observations.

The second test is based on the trace statistic which tests the null hypothesis of r cointegrating vectors against the alternative of r or more cointegrating vectors. This statistic is given by:

$$\lambda_{trace} = -T \sum \ln (1 - \lambda_i)$$

In order to apply the Johansen procedure, a lag length must be selected for the VAR. A lag length of is selected on the basis of the Akaike Information Criterion (AIC).

3.3 Granger Causality Test

According to representation of Granger theorem, if two variables are co-integrated, then there will be at least one direction or unidirectional granger causality must exist which tend to the consequences to find the relationship by error correction model (ECM). Granger causality test is used to determine causality relation among variables and direction.

So by employing pair-wise Granger causality test technique is helpful to identify each factor causal relationship. Lag is selected to get appropriate results which are user specified. The time series variables are not stationary at I (0) and no co-integration exist among variables then it would be converted by taking first difference I (1) and applied as follows (Akash *et al.*, 2011):

$$Q_{\text{prob}}(W_{t+n} | \Theta_t) = Q_{\text{prob}}(W_{t+n} | \mathcal{G}_t)$$

Q_{prob} is conditional probability, Θ_t information set at time t , on past values of W_{t+n} and ω_t information set containing values for both w_t and U_t for the t period. This is a unrestricted regression equation after while by running this will help to find out the unrestricted residual sum of square (RSSUR) and also eliminate the lagged values of particular macroeconomic variables (MV) at first difference to find the restricted regression to obtain the restricted sum of square (RSSR), then I (1) should be the zero for all values of I.F test is considerable to testify the null hypothesis as follows:

$$F = \frac{RSSR - RSSUR / k - k0}{RSS / N - k}$$

If the F-Statistic exceeds the critical value at the selected level of significance or the p-value associated to F Statistic is < 0.5 then null hypothesis is rejected.

4. Empirical Analysis

The empirical analysis has been done in three parts. In first part descriptive statistics and simple correlations between the stock market index (BSE SENSEX) and gold price series are analysed. In second part Bivariate Johansen Cointegration technique is applied to answer the question regarding the long run comovement between the two series. In third part we use Granger Causality test to analyse the short term dynamic return linkages between the two investment instruments.

4.1 Combine Graph of Daily close price of Gold and Sensex

Figure 3.10, Figure 3.11 and Figure 3.12 shows the graphs of daily close price of NIFTY, STI and KOSPI indices for the whole sample period i.e. from Aug, 2006 to May, 2014. It appears that both the series in the graph follow a random walk movement and no particular trend was found. The graphical analysis gives a first indication that the two series are seem to be non-stationary.

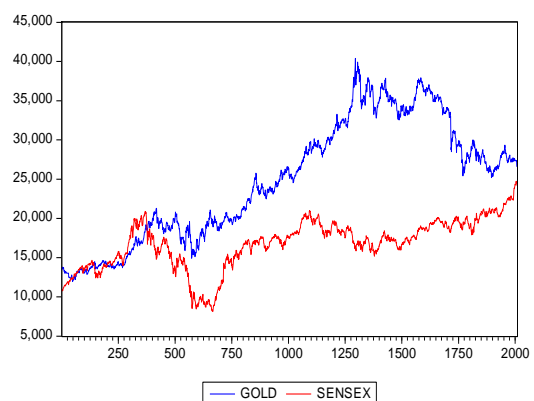


Fig 1: Daily Close Price Movement of Gold and Sensex

4.2 Gold and BSE SENSEX Return Graph

Figure 5.1, 5.2 and 5.3 display the dynamics of sample returns. Both return series exhibit volatile movement or volatility clustering, i.e. large changes tend to be followed by large changes of either sign and small changes tend to be followed by small changes. The period from the mid of 2007 to 2010 presents strong fluctuations compared with the other years. It shows that the volatility of stock market return and return of gold are fluctuated more intensely during financial crisis than before and after crisis.

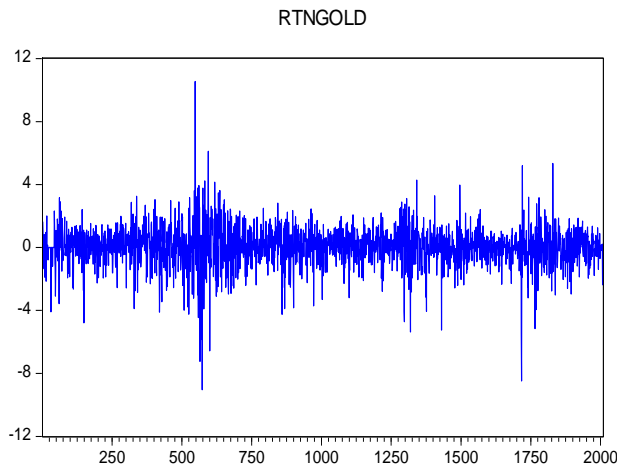


Fig 2: Daily Return Movement of Gold

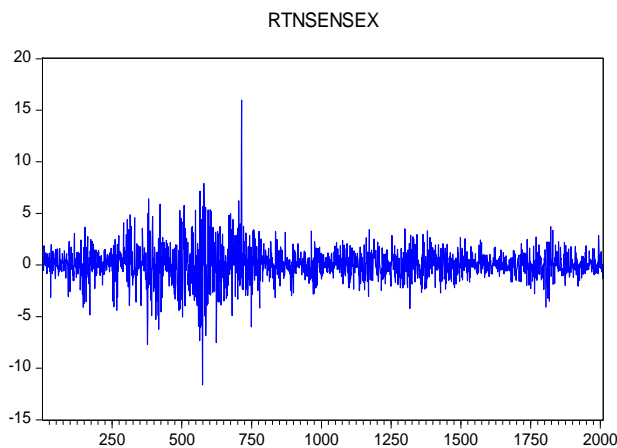


Fig 3: Daily Return Movement of Sensex

4.3 Descriptive Statistics

Descriptive statistics for the gold price and BSE SENSEX are given in Table 1. These include the distribution of mean, standard deviation, skewness and kurtosis etc. A careful examination reveals that Mumbai stock market offers higher return i.e. 0.04% per day at high risk level, as compare to daily gold return which is 0.033%. Return of BSE SENSEX is positively skewed while return of gold is negatively skewed. The negative value for skewness indicates that the series' distributions are skewed to the left and positive value for the skewness indicates that the series' distributions are skewed to the right. Both series exhibit a relatively high kurtosis (>3) means the two series are not normally distributed. Moreover, the jarque-bera test, an asymptotic test

of normality, indicates that none of the series is normally distributed at 5% level of significance, as probability is (<0.05).

Table 1: Descriptive Statistics

	RTNGOLD	RTNSENSEX
Mean	0.033932	0.040439
Median	0.059561	0.030836
Maximum	10.53733	15.98998
Minimum	-9.03981	-11.6044
Std. Dev.	1.305589	1.602611
Skewness	-0.45073	0.1816
Kurtosis	9.180909	11.69497
Jarque-Bera	3264.36	6336.442
Probability	0	0
Sum	68.1353	81.20087
Sum Sq. Dev.	3421.06	5154.704
Observations	2008	2008

4.4 Correlation Analysis

The correlation analysis is a basic and simple step to detect the direct relationship among the sample stock markets. It provides a preliminary verification for the presence of integration before other tests are conducted. It is a measure how two random variables move in relation to each other. The table below presents correlation coefficients for the index returns and close price indices of India, Singapore and Korea stock market.

Table 2: Return Correlation Matrix

	GOLD	SENSEX
GOLD	1	0.577954
SENSEX	0.577954	1

Table 4.4 correlation matrix shows positively large correlation between returns Mumbai stock market index (BSESENSEX) with returns of gold indicating the two series tend to move in the same direction in short term. (Cohen (1988) has suggested $0.1 < \rho < 0.29$ to be a small correlation, $0.30 < \rho < 0.49$ to be a medium correlation and $0.5 < \rho < 1$ to be a large correlation. The same benchmark is taken for negative values of ρ (Pallant 2005, 126Bosnian and Croatian stock markets). However, this correlation is relatively small.

4.5 ADF Unit Root Test

Table 4.7 shows the results of the Augmented Dickey-Fuller (ADF) test. It shows that the log series of BSE SENSEX and gold price are non-stationary at the level form as the absolute T statistic values are less than the absolute critical values at 1% level of significance. Moreover, p-values associated to their corresponding T-values are greater than 0.05. Hence the null hypothesis of presence of a unit root in the series cannot be rejected. However, they become stationary series in their first difference, as the absolute T statistic values are greater than the absolute critical values at 1% level of significance, rejecting the null hypothesis of a unit root. Thus, all of our data is integrated of order one i.e. $I(1)$ as discussed in the Methodology section.

Table 3: Augmented Dickey-Fuller Unit Root Test

Variables	Augmented Dickey-Fuller Test Intercept			
	T Statistic		T Statistic	
	Level	Probability	1 st Difference	Probability
LGOLD	-1.68193	0.4404	-45.4075	0.0001
LSENSEX	-1.81032	0.3758	-42.3677	0

Critical values of ADF & PP test statistics for 1%, 5% and 10% level of significance are -3.4385, -2.86503, and -2.56868 respectively.

4.6 VAR Lag Order Selection Criteria for Bivariate Johansen Cointegration Test

Having satisfied with the results of ADF stationarity test, we proceed to conduct the Bivariate Johansen’s Cointegration test for that, the order of the Vector Autoregressive Model

(VAR) should be determined by either the Akaike Information Criteria (AIC) or the Schwarz Information Criteria (SIC). The AIC is selected in this paper. The result in Table 4.13 shows that 2 lag lengths are chosen for the two series.

Table 4: VAR Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	124.4201	NA	0.003034	-0.12218	-0.11658	-0.12012
1	11294.21	22306.13	4.39E-08	-11.2657	-11.24890*	-11.2595
2	11302.53	16.60142*	4.37e-08*	-11.26999*	-11.242	-11.25972*
3	11303.38	1.702369	4.38E-08	-11.2669	-11.2277	-11.2525
4	11305.91	5.032832	4.39E-08	-11.2654	-11.2151	-11.2469
5	11309.49	7.128065	4.39E-08	-11.265	-11.2035	-11.2424

* indicates lag order selected by the criterion

4.7 Bivariate Johansen Cointegration Test (T-Statistic)

Table 4.17 reports the result of Bivariate Johansen Cointegration T-Statistic test. It shows that the T-Statistic values are less than there Critical value at 5% level of

significance. Moreover, p-values associated to their corresponding T-values are greater than 0.05. Hence the Mumbai stock exchange index series (BSE SENSEX) is not cointegrated with the gold price series.

Table 5: Multivariate Cointegration Analysis (Trace Statistics)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigen Value	Statistic	Critical Value	Prob.**
None	0.002029	6.966205	15.49471	0.5816
At most 1	0.001441	2.892124	3.841466	0.089
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				

Table 4.18 reports the result of Max-Eigen value test. It also confirms the presence of no cointegrating eqn(s) as Maximum Eigen values are less than the critical values at 5%

level of significance. Hence, there is no long run relationship between BSE SENSEX and gold price series

Table 6: Multivariate Cointegration Analysis (Eigen Value Statistics)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigen Value	Statistic	Critical Value	Prob.**
None	0.002029	4.074081	14.2646	0.8514
At most 1	0.001441	2.892124	3.841466	0.089

Max- Eigen value indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

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

4.8 Granger Causality Test

Johansen cointegration analysis is able to determine whether the long-run relationship exists between two variables, whereas the Granger causality test helps in determining the

short term causation, although causation can run in both directions. According to representation theorem, if two variables are cointegrated then Granger-causality must exist in at least one direction.

Table 7: Granger Causality Test

Lags: 1		
Null Hypothesis:	F-Statistic	Prob.
RTNSENSEX does not Granger Cause RTNGOLD	5.63668	0.0177
RTNGOLD does not Granger Cause RTNSENSEX	4.71871	0.03

Table 4.49 indicates the result of Pair wise Granger Causality Tests for the RTN series of BSE SENSEX and gold. We find that there is bidirectional causality running between Mumbai stock market index (BSESENSEX) and gold price series as their corresponding p values are less than 0.05 which means that any change in BSE SENSEX affects the gold price and any change in gold price affects the BSE SENSEX in the short run.

5. Conclusion

This study empirically investigates the long run relationship and short term dynamic linkages between Mumbai stock market index (BSE SENSEX) and gold prices. Based on the results of Descriptive Statistics we conclude that Mumbai stock market offers higher return at slightly high risk level as compare to gold return. We conclude from correlation matrix that the two series tend to move in the same direction in the short term. By applying Augmented Dickey-Fuller unit root test and Johansen cointegration test, the study concludes that all series are integrated of first order i.e. I(1) and there is no long run relationship between Mumbai stock market and gold prices. Hence, for long term Indian equity market investors there exists portfolio diversification opportunity in gold investment, particularly in stock market slump periods. However, the results of Granger Causality provide evidence of short term bidirectional dynamic linkages between the two series means that any change in BSE SENSEX affects the gold price and any change in gold price affects the BSE SENSEX in the short run.

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