

# A Scrutiny on Volatility and Leverage Effect in Indian Stock Market with Reference to 'Gold, Oil, Dollar Rates'

Aravind. M\*

## ABSTRACT

*The uncertainty in financial market compels the investors to reallocate their capital from stock market to other complementary alternatives like Gold, Oil and Dollar. This research aims to explore the leverage effect of Gold-Oil-Dollar rates on Indian stock market. The work extensively covers daily price observations of gold, crude oil, US Dollar and Nifty from 1st January 2012 to 31st December 2016. In terms of returns the stock market outperformed over Gold, Oil and Dollar throughout the study period. GARCH (1, 1) model confirmed the long-term persistency of Gold-Oil-Dollar rates over stock market volatility. Interestingly an inverse leverage effect was examined from EGARCH model and it signals that any increase in Gold-Oil-Dollar rates will enhance the stock market volatility. Further the diagnostic test results shows that the crude oil price fluctuations reported to have more significant influence on stock market volatility. The study can successfully serve the interest of investors, financial planners, policy makers and researchers by addressing some key macroeconomic issues related to financial markets.*

**Keywords:** *Gold-Oil-Dollar Effects, Unit Root Test, Stock Market Volatility, GARCH (1, 1), Leverage Effect, and EGARCH*

## INTRODUCTION

This is an era where commodities are overwhelming in financial assets. The investors tend to diversify their portfolio with stocks, currencies, bullion and other commodities. Among these a direct linkage can be observed in stock market return with Gold, Oil prices and Dollar rates. Numerous theories can be examined in order to ascertain the linkage of stock market with Gold-Oil-Dollar factors. Faugere and Erlach (1995) construct a gold valuation theory by viewing gold as a real store of wealth. According to

\* Assistant Professor (Finance), TKM Institute of Management (Accredited by NBA), Kerala, India. Email: aravind.1551@gmail.com; aravind.m@tkmim.ac.in

them the price of gold varies inversely to the real stock markets yield. This theory can be enlarged in another context as the investors will go for gold once they drop their faith in stock market. Because gold is the de facto commodity as there is limited supply and, at one point global currencies were backed by gold.

Another theory proposed by Hotelling (1931) can be related very much to the association between oil prices and stock market. In this theory they suggest that owners of nonrenewable resources will only produce that resource if it will yield more value than other financial instruments available on the market. In other words better yield from stock market will leads to falling the price of crude oil. In turn the producers of crude oil will restrict its supply. This results in increasing the demand and price for crude oil; and as a result more investors can be attracted to crude oil dealings.

Frankel (1976) proposed portfolio balance approach theory for currency market. He argues that a flourishing stock market would attract capital flows from foreign investors, which may cause an increase in the demand for domestic currency. The reverse would happen in case of falling stock market where the investors would try to sell their stocks to avoid further losses and would convert their money into foreign currency. As a result, rising stock prices would lead to an appreciation in exchange rates and fall in stock price leads to exchange rate depreciation.

In the light of the above theories this association can be reiterated as stock market index is considered as the major barometer for the performance of economy. Poor performance of stock market forces the investors to transfer capital from stock market to other near investment alternatives like Gold or US dollar. Huge flow of capital to US dollar may leads to depreciation of Indian Rupee. The depreciation in Rupee can adversely affect its purchasing power and consequently affects the economy by increasing purchase cost of crude oil. On the other hand on favorable market conditions the investors channelizes their capital from near alternatives to stock market. In this context the investors may convert US Dollar to Indian Rupee. As a result demand for Indian rupee increases and value of currency get appreciated. Appreciation in currency enhances the purchasing power of Indian rupee and reduces the cost of procuring crude oil.

The above relation can also be allied with gold. On unfavorable market conditions investors considers gold as the best investment alternative. Increase in gold price tends to strengthen the currencies which are issued on the backing of gold reserves. Better return from gold and currency

market reduces investor's attraction towards other commodities like crude oil. This situation may force the crude oil producers to control its production for creating transitory shortage in its supply. As a result oil price shoot up and capital tend to flow from gold to crude oil. At times such price level disparity in gold and oil market may also direct investor's capital towards stock market.

## **AIM AND SCOPE**

This research was carried out with the following intentions:

- To test how the Gold-Oil-Dollar rates fluctuations can impact the return and volatility of Indian stock market.
- To inspect the evidence of leverage effect in Indian stock market in connection with Gold-Oil-Dollar rates.

This study extensively considers the daily price observations of four major benchmarking factors used by market participants viz, Nifty Index, Gold Crude oil and US Dollar rates. The results of this study can potentially help the policy makers and govt. agencies in identifying the direction of price movements of Nifty and commodities; and later on they can control the price level through proper market intervention. The present model is developed on the basis of observing the daily price level variation for a period of five years. Considering this study as a prototype more research works can carried to spot out Gold-Oil-Dollar relation for an extensive period, thereby this work open ample scope for future researchers. The outcomes of the study also gives clear cut direction regarding the point in which price levels are going to change. Thereby results of this study can enable the market participants to diversify their portfolio by reallocating the capital among Gold, Oil, Dollar, and Stock.

## **REVIEW OF LITERATURE**

A survey on existing literature was carried out to examine the established relation among Gold-Oil-Dollar rates and stock market returns.

Sujit and Kumar (2011) made an attempt to test the dynamic relationship among gold price, stock returns, exchange rate and oil price. The results show that exchange rate is highly affected by changes in other variables. However, stock market has fewer roles in affecting the exchange rate. After examining different macro-economic variables and its impact on India stock market; Patel (2012) identified the causality run

from exchange rate to stock market indices to IIP and Oil Price. Kumar (2014) in his study observed the impact of oil price shocks on Indian stock and FOREX markets. The results suggest that oil price affects the stock market and exchange rates. Ingalhalli (2016) identified a unidirectional relationship between Oil, Gold, Forex and Stock Markets in Indian Context. The paper also emphasized that effect of one market on another market is not a new thing, but the variations in the degree of impact and co-movements between the markets need to be examined. Tripathi (2013) spot out that various external factors i.e. USD, LIBOR & Gold price can significantly influence the performance of Nifty.

Samadi (2012) revealed that the gold price, inflation and exchange rate variables influencing on the stock return and oil price and liquidity had no impact on the stock returns in Tehran Stock exchange. Sadri and Sani (2012) observed the volatility of crude oil and gold price on selected stock market indices of OPEC members with GARCH model. The results suggest that crude oil prices have a significant positive effect on stock exchange index of studied countries meanwhile this effect is negative for gold price.

Ewing and Malik (2013) found strong evidence of direct significant transmission of volatility between the gold and oil markets. Chiang (2013) applies a multivariate GARCH model to analyze the interdependence among gold, stocks, oil prices and bonds price. This work identify that Gold is a good diversification instrument for stock investment. Gencer and Kilic (2014) studied conditional correlations and volatility links among gold, oil and Istanbul stock exchange sector returns. After considering 28 different portfolio investments consisting equal investments in oil, gold and each sector index by turn. It is observed that oil GARCH effects are significant and close to unity in each model, positioning oil prices as a major source of portfolio volatility.

Azar (2015) employed GARCH (1, 1) model to explore the relation of US stocks, gold, and oil with the US dollar foreign exchange rate. It is found that the law of one price applies to US stocks, gold, and oil, not only in the short run but also in the long run. Basher and Sadorsky (2016) uses DCC, ADCC and GO-GARCH to model volatilities and conditional correlations between emerging market stock prices, oil prices, VIX, gold prices and bond prices. In most of the situations of study, it found that oil is the best asset to hedge emerging market stock prices. Balwinder and Kriti (2016) used GARCH model to estimate impact of Gold and Crude oil on stock market volatility in India. The study reveals that Crude oil;

Gold and Crude oil futures have a significant impact on stock market volatility in India.

Hussin (2013) observed that there was a bi-directional causality relationship between Islamic stock returns with oil prices. Jubinski and Lipton (2013) found that Gold and silver have a positive relationship with implied volatility, supporting the idea that investors perceive precious metals as safe havens, to be purchased in anticipation of rising equity market volatility. Oil has a negative relationship with implied volatility, indicating a decrease in demand as a reaction to equity market volatility. Gyasi (2016) produced evidence of a strong bi-directional linkage between the Ghana equity market, gold and crude oil prices both in regards of returns and volatility. Raza (2016) observed the asymmetric impact of gold prices, oil prices and their associated volatilities on stock markets of emerging economies. The empirical results indicate that gold prices have a positive impact on stock market prices of large emerging BRICS economies and oil prices have a negative impact on stock markets of all emerging economies.

Omag (2012) observes the relationship between gold prices and selected financial indicators in Turkey and the results reveal that there is a positive relationship between national gold prices, Istanbul Stock Exchange 100 Index and the exchange rate between Turkish Lira and the Dollar.

In another study Zhang (2013) concludes that although there is a stable relationship between the price of crude oil and the value of the US dollar in real terms, the relationship is subject to structural breaks over time. After investigating French and US stock market returns, Guesmi (2016) identified strong evidence of fractional co-integration between oil and stock market indices, suggesting the presence of a relationship that governs their long-run joint movements.

Baig (2013) examine the relationship between gold prices, oil prices and KSE100 return. The study concludes that Gold prices growth, Oil prices growth and KSE100 return have no significant relationship in the long run. These findings were subsequently agreed by Irshad (2014) as they found no significant long run relationship exists among Pakistan Equity, Oil, and Gold Market. On contrary to the above studies Siddiqui (2014) examined the oil price fluctuation and stock market fluctuation in Pakistan. The results revealed that the oil prices, exchange rate and foreign private portfolio investment have positive correlation with stock market performance. A study by Najaf (2016) produced an extremely

different result by inspecting the impact of gold, oil rates on Karachi stock exchange. The results show that Karachi stock exchange and GDP have inverse relationship with gold market. But it is observed that oil growth has a significant relationship with KSE100.

The above literature review look in to the effect of Gold-Oil-Dollar rates on international economies. In majority of studies this relationship was examined by means of causality or co-integration. A modeling on Gold-Oil-Dollar rates on stock market volatility has still remained as an untapped area of research in Indian context. This gap really motivated to carry out a study on the Gold-Oil-Dollar affect on the volatility of Indian stock Market and to examine the leverage effect.

## RESEARCH METHODOLOGY

The research is empirical in nature and the samples were collected on a judgmental basis. The daily price observations of the samples viz. Nifty, Gold, Crude oil and US Dollar from 1st January 2012 to 31st December 2016 were collected. The above study period was fixed on the ground as these years are considered to be the most recent normal periods when this research starts. For data collection multiple sources were relied. The historical daily trend on Nifty obtained from [www.nseindia.com](http://www.nseindia.com). The daily price observation of gold price per troy ounce (31.1 grams) accessed from the web portal of World Gold Council ([www.gold.org](http://www.gold.org)). The average daily traded price of crude oil per BBL for the study period was taken from the price chart of Multi Commodity Exchange of India Ltd. ([www.mcxindia.com](http://www.mcxindia.com)). The daily exchange rate variations of US Dollar to Indian rupee for were collected from [www.investing.com](http://www.investing.com). Eviews.9 statistical package was used for analyzing the time series data.

Initially log returns of the sampled data was computed in Microsoft excel by using the following formula;

$$R = \ln(P1/ P0)*100 \quad (1)$$

In the above equation; R denotes return, P1 stands for current day's price and P0 stands for price of the previous day. Through Ln we assume that the returns are log normally distributed.

In order to test the presence of unit root the well-established measures like Augmented Dickey Fuller Test and Phillips-Perron Test were performed. In order to satisfy the objective of examining Gold-Oil-Dollar influence on stock returns; further GARCH (1,1) and EGARCH Modeling were employed.

## Augmented Dickey Fuller (ADF) Test

Testing unit root has become a concern for econometric modeling and forecasting. This research followed the statistical model suggested by Dickey and Fuller (1979, 1981) and by Dickey (1984) for checking stationarity of the collected time series data. The test is usually carried out on the assumption that “the time series data is not stationary”. If the test statistics is found to be with in critical value the chance for rejection of null hypotheses is higher.

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \dots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t \quad (2)$$

Where  $Y_t$  represents time series to be tested,  $\alpha$  is a constant,  $\beta$  the coefficient on a time trend and  $p$  the lag order of the autoregressive process and  $\varepsilon_t$  is the white noise error term. Imposing the constraints  $\alpha = 0$  and  $\beta = 0$  corresponds to modeling a random walk and using the constraint  $\beta = 0$  corresponds to modeling a random walk with a drift.

## Phillip - Perron Test

Phillip Perron test is a unit root test in statistics developed by Phillip and Perron (1988). The major advantage of Philips-Perron test is that it is non-parametric, i.e. it does not require selecting the level of serial correlation as in ADF. PP test also takes the same estimation scheme as in ADF test, but corrects the test statistic to conduct for autocorrelations and heteroscedasticity.

$$f_\alpha = t_\alpha \left( \frac{\gamma_0}{f_0} \right)^{1/2} - \frac{T(f_0 - \gamma_0) (\text{se}(\hat{\alpha}))}{2 f_0^{1/2} s} \quad (3)$$

Where  $\hat{\alpha}$  is the estimate, and  $t_\alpha$  ratio of  $\alpha$ ,  $\text{se}(\hat{\alpha})$  is coefficient standard error, and ‘s’ is the standard error of the test regression. In addition,  $\gamma_0$  is a consistent estimate of the error variance;  $k$  is the number of regressors. The remaining term,  $f_0$ , is an estimator of the residual spectrum at frequency zero. The PP test is carried out with null hypothesis that the variable contains a unit root, and the alternative is that the variable was generated by a stationary process.

## GARCH (1, 1) Model

Generalized Auto Regressive Conditional Heteroskedasticity Model is an extension of ARCH Model and first developed by Bollerslev (1986). GARCH (1,1) is a time series model that are becoming widely used in

econometrics and finance to check the randomly varying volatility effect. The (1,1) in parentheses is a standard notation in which the first number refers to how many autoregressive lags, or ARCH terms, appear in the equation, while the second number refers to how many moving average lags are specified, which here is often called the number of GARCH terms.

$$Y_t = X_t' \theta + \epsilon_t \quad (4)$$

$$\sigma_t^2 = \omega + \alpha \epsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (5)$$

In which the mean equation given  $Y_t$  is written as a function of exogenous variables with an error term. Since  $\sigma_t^2$  is the one-period ahead forecast variance based on past information, it is called the conditional variance.

The conditional variance equation specified is a function of three terms viz. a constant term:  $\omega$ , news about volatility from the previous period, measured as the lag of the squared residual from the mean equation:  $\epsilon_{t-1}^2$  (the ARCH term). And last period's forecast variance:  $\sigma_{t-1}^2$  (the GARCH term).

### EGARCH Model

Exponential Generalized Auto Regressive Conditional Heteroskedasticity (EGARCH) models are appropriate when positive and negative shocks of equal magnitude might not contribute equally to volatility. This model was developed by Nelson (1991). EGARCH models provide an explanation for the so called leverage effect. It refers unexpected price drop increases volatility more than an analogous unexpected price increase.

$$x_t = \mu + a_t \quad (6)$$

$$\ln \sigma_t^2 = \alpha_0 + \sum_{i=1}^p \alpha_i (|\epsilon_{t-1}| + \gamma_i \epsilon_{t-1}) + \sum_{j=1}^q \beta_j \ln s_{t-j}^2 \quad (7)$$

$$a_t = \sigma_t \times \epsilon_t \quad (8)$$

$$\epsilon_t \sim P_v \quad (9)$$

Where  $x_t$  the time series value at time  $t$ ;  $\mu$  is the mean of GARCH model;  $a_t$  is the model's residual at time  $t$ ;  $\sigma_t$  is the conditional standard deviation (i.e. volatility) at time  $t$ ;  $p$  is the order of the ARCH component model;  $\alpha_0, \alpha_1, \alpha_2, \dots, \alpha_p$  are the parameters of the the ARCH component model;  $q$  is the order of the GARCH component model and  $\beta_1, \beta_2, \dots, \beta_q$  are the parameters of the the GARCH component model. The presence of leverage effects can be tested by the hypothesis that  $\gamma < 0$  and the impact is asymmetric if  $\gamma \neq 0$ .

## DATA ANALYSIS AND DISCUSSIONS

Table 1 exhibits the descriptive statistics regarding time series data of Gold, Oil and Dollar on its daily returns, standard deviation, skewness, Kurtosis, Jarque-Bera test results with its significance.

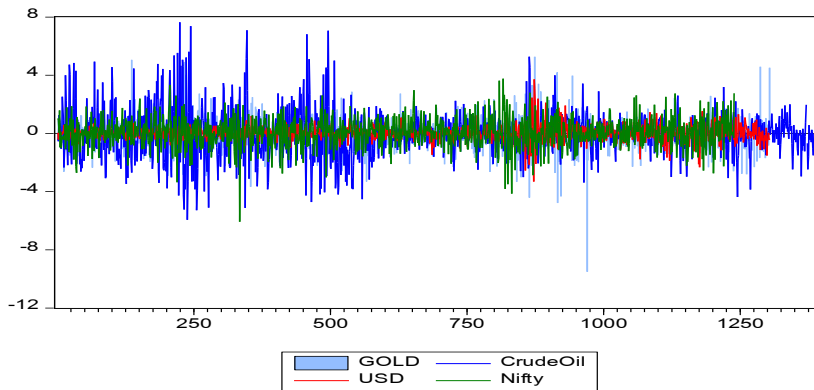
**Table 1: Descriptive Statistics**

Statistics	Gold	Crude oil	USD	NIFTY
Mean	-0.0034	-0.0346	0.01862	0.0458
Median	0.0000	-0.0323	0.0000	0.0479
Std. Dev.	1.0538	1.5924	0.5059	0.9819
Skewness	-0.3160	0.4309	0.1512	-0.2942
Kurtosis	10.6470	5.5375	10.0170	5.1459
Maximum	5.2550	7.6276	3.6935	3.7379
Minimum	-9.4954	-5.5949	-3.3248	-6.0972
Jarque-Bera *	3199.071	418.3605	2680.251	255.611
Probability *	0.00000	0.00000	0.00000	0.00000

Source: Data Analysis

While observing the mean scores it is clear that Nifty has generated the maximum average daily return of 0.0458 percent throughout the study period with a standard deviation of 0.98 percent. Nifty has obtained a maximum return of 3.74 percent during the study period and a minimum return of -6.09 percentages was reported. Among Gold-Oil-Dollar factors US Dollar alone provided a positive average daily return of 0.0186 percent all over the study period. Interestingly negative mean scores of -0.003 percent and -0.034 percent reported respectively for gold and crude oil. In terms of risk US Dollar is found to be the safest mode of investment among the selected variables with the lowest standard deviation of 0.505 percent. During the study period crude oil returns exhibited the greater variability with the highest standard deviation of 1.59 percent. The return series for gold and Nifty reported to have a negative skewness of -0.316 percent and -0.294 percents respectively suggesting that these distributions have long left tail. The return distribution of crude oil and USD exhibited a positive skewness with values of 0.430 and 0.151 percentages respectively. The obtained positive kurtosis values for the time series data indicate that the distributions have heavier tails and a sharper peak than the normal distribution.

To examine the normality of the time series distributions, Jarque-Bera test was employed. The test was carried on the assumption that the return series data is normally distributed. Table 1 gives clear evidence that the probability values obtained for all return series in Jarque-Bera test is statistically significant at 5 percentage level of significant ( $p$ -values  $0.00 < 0.05$ ). This leads to rejection of null hypotheses by accepting the fact that the return series are not normally distributed (Null hypothesis is rejected). These facts are supporting to the findings that the sample data do not have the skewness and kurtosis matching to a normal distribution. This is a tendency towards volatility clustering. Volatility clustering refers a trend where large changes tend to be followed by large changes, of either sign, and small changes tend to be followed by small changes (Mandelbrot, 1963).



Source: Data Analysis

**Fig. 1: Volatility Pattern**

Fig. 1 certifies volatility clustering as it can observe that small fluctuations are followed by small fluctuations and large changes are tending to follow large changes for a prolonged period.

ARCH test was also performed statistically to prove that heteroskedasticity does not exist. ARCH LM values of 17.67, 17.70, and 17.69 obtained respectively for Gold, Oil and Dollar returns. Further the probability values found to be statistically significant at five percent level of significance ( $p$  values  $< 0.05$ ).

The Augmented Dickey Fuller test and Phillips Perron test were used to test whether the time series data is stationary or not. The test results were presented in Table 2.

**Table 2: Unit Root Tests**

Return Data	Augmented Dickey Fuller Test		Phillips-Perron Test		Critical Values*		
	Test Statistics*	p. value	Test Statistics*	p. value	1%	5%	10%
Gold	-36.454	0.000	-36.544	0.000	-3.44	-2.86	-2.57
Crude oil	-29.850	0.000	-29.746	0.000			
USD	-28.653	0.000	-35.155	0.000			
Nifty	-32.673	0.000	-32.672	0.000			

Source: Data analysis

These tests were conducted with a null hypothesis that the time series data is not stationary. The Augmented Dickey Fuller Test produced t-values of -36.45, -29.85, -28.65 and -32.67 respectively for gold, crude oil US Dollar and Nifty respectively. These values are found to be much below the critical values of -3.44, -2.86 and -2.57 at corresponding significance level of one percent, five percent and ten percent. If the result of test statistics is falling within critical values lead to rejection of null hypotheses. In the above case null hypotheses is rejected; in other words it points that the time series data is stationary. Moreover, the probability values obtained (p-value =0.000) for the test statistics are much below the critical values of 0.01, 0.05 and 0.1.

The Phillip-Perron test results also agree with the findings of ADF test. The obtained t- values -36.54, -29.74,-35.15 and -32.67 of gold, crude oil, US Dollar and Nifty falling within the corresponding critical values of -3.44,-2.86,-2.57 at one percent, five percent and ten percent level of significance. This spot towards rejection of null hypotheses. The above test results confirmed that the time series distribution is stationary and it can be used for further econometric modeling.

The effect of Gold-Oil-Dollar factors on stock market volatility was examined by developing a GARCH (1, 1) Model with student's t distribution. Table 3 shows the result of GARCH (1, 1) Model.

**Table 3: GARCH 1,1 Model**

	Gold			Crude oil			USD		
	Co-ef- ficient	Z- Value	* p. value	Co-ef- ficient	Z- Value	* p. value	Co-ef- ficient	Z- Value	*p. value
Mean Equa- tion									
C (inter- cept)	0.059	0.03	0.019	0.057	-2.27	0.023	0.059	2.37	0.018
AR(1) ( $\rho$ )	0.019	0.03	0.462	-0.025	-1.63	0.102	-0.043	-0.81	0.419
Variance Equa- tion									
C	0.024	1.74	0.081	0.024	1.75	0.080	0.024	1.76	0.079
$\alpha$	0.039	2.98	0.003	0.040	3.01	0.002	0.040	2.99	0.003
$\beta$	0.937	39.4	0.000	0.937	40.2	0.000	0.937	39.7	0.000
$\alpha + \beta$	0.976			0.977			0.977		
<b>Log Likeli- hood</b>	-1681.0070			-1680.0500			-1680.9700		
<b>Durbin Watson sat.</b>	1.8525			1.8519			1.8531		
Schwarz criterion	2.7479			2.7464			2.7470		
Akaike Info Cir.	2.7239			2.7216			2.7320		

Source: Data Analysis ; \*p. values at 5% level of significance

In table 3 mean equations generates co-efficient of 0.019, -0.025 and -0.043 respectively for gold, crude oil and USD respectively. Further it is observed that the above mean scores are not found to be significant at five percent level of significance (as p.values > 0.05).

The constraint  $\alpha$  usually considered as active return on investment; which gauges the performance of an investment to certain benchmarks. The GARCH(1, 1) model generates  $\alpha$  coefficient of 0.039, 0.040 and 0.040 respectively for Gold, crude oil and USD. This refers that nifty generated an abnormal return over Gold-Oil-Dollar factors during the study period. These abnormal returns further signified by the Z- test statistics as the obtained probability values of 0.003, 0.002 and 0.003 respectively for

gold, crude oil and USD falling very much within five percent level of significance.

In variance equation the obtained conditional variances ( $\beta$ ) found to be very close to one. Additionally it is observed that the obtained  $\beta$  is statistically significant at five percent level of significance (as obtained p. values  $0.00 < 0.05$ ), signaling towards the existence of GARCH effect. The GARCH effect confirms that the past fluctuations in Gold, Oil and USD rates can influence present stock market volatility. These findings also signals that the investors are very keen in observing the historical rates of Gold, Oil and USD rates before allocating their capital towards stock market. The  $\alpha + \beta$  measures the degree of persistence of volatility shocks. It is also observed that the sum of  $\alpha$  and  $\beta$  coefficients ( $\alpha + \beta < 1$ ) is very close to one, indicating that volatility alarms are quite stable. The obtained summated values of  $\alpha$  and  $\beta$  coefficients for Gold, Oil and USD were 0.976, 0.977 and 0.97 respectively, as these rates are very much close to 'one'. These results strongly signals that volatility impacts are quite relentless and the historical information on Gold-Oil-Dollar rates are presumed to be significant than new information. To wrap up findings of estimated GARCH (I,1) model; it can be inferred that the stock market returns are greatly influenced by Gold-Oil-Dollar rates and this trend will continue for a sizeable period of time.

Numerical statistical measures were employed in order to validate the above relations. Akaike Information Criterion (AIC) and Schwarz criterion (SIC) is used for selecting the finest model from the set of established relations. Here the model with lowest AIC and SIC values will be deeply preferred. For the present GARCH (1, 1) model AIC of 2.723, 2.721 and 2.732 attained respectively for Gold, Oil and USD. In which lowest value of 2.721 was reported for crude oil - nifty relation. So it can be surmised that crude oil rates have a profound influence on stock market fluctuations. Schwarz criterion (SIC) also produced a same line of result. A lowest SIC value of 2.746 obtained for crude oil - nifty dealings. This relation further certifies the prominence of crude oil rates over Indian stock market. Durbin-Watson statistic is a test statistic used to detect the presence of autocorrelation in the residuals from a regression analysis. Durbin-Watson statistic is substantially less than two; there is evidence of positive serial correlation. Durbin-Watson statistic is near to 'two' in all cases, so it strongly signaling that error terms are not auto correlated. Through the above measures we can finalize the statistical strength of the model.

EGARCH method was employed for monitoring the existence of leverage effect in the present model (Refer Table 4). Leverage effect is a phenomenon of negative correlation between past returns and future volatility of returns. The leverage effect indicates that volatility increases with decrease in prices. The concept of leverage effect was originally explained by Black (1976); as ‘the volatility increases with decrease in price trend and the volatility tend to decline with increase in price’.

**Table 4: EGARCH Model**

	Gold			Crude oil			USD		
	Co-efficient	Z-Value	*p-value	Co-efficient	Z-Value	*p-value	Co-efficient	Z-Value	*p-value
<b>Mean Equation</b>									
C (intercept)	0.075	2.99	0.003	0.072	2.89	0.004	0.075	2.98	0.003
AR(1) ( $\rho$ )	0.020	0.81	0.416	-0.024	-1.66	0.096	-0.020	-0.37	0.708
<b>Variance Equation</b>									
$\alpha_0$	-0.068	-3.88	0.000	-0.068	-3.92	0.000	-0.068	-3.88	0.000
$\alpha_1$	0.090	4.02	0.000	0.090	4.04	0.000	0.090	4.02	0.000
$\gamma$ (Asymmetry)	0.084	4.92	0.000	0.085	4.92	0.000	0.084	4.84	0.000
$\beta$	0.985	109	0.000	0.985	109	0.000	0.985	108	0.000
<b>Log Likelihood</b>	-1669.6900			-1668.7700			-1670.0200		
<b>Durbin Watson sat.</b>	1.8512			1.8508			1.8516		
<b>Schwarz criterion</b>	2.7354			2.7339			2.7359		
<b>Akaike Info Cir.</b>	2.7065			2.7050			2.7070		

From Table 4 it is evident that the coefficient  $\gamma$  (Asymmetry) obtained for Gold, Oil and Dollar are 0.084, 0.085 and 0.084. These coefficients are positive and significant as the obtained probability values falling within five percent significant level. So we may arrive at a conclusion that ‘inverse leverage effect’ existing in this model. Inverse leverage effect implied as volatilities rise when price level increase. Any increase in

Gold-Oil-Dollar rates will enhance the stock market volatility. The strong positive interconnection among stock –commodity-currency markets can also be observed in line with this inverse leverage effect.

To confirm the above relations numerous statistical techniques were used. The relation between crude oil rates and stock market volatility is found to be deep-rooted among Gold-Oil-Dollar factors. While observing Table IV lowest Akaike Information Criterion (AIC) and Schwarz criterion (SIC) of 2.705 and 2.733 were obtained for crude oil-nifty relation. This signals that increase in oil rates can intensely affect nifty volatility. The obtained Durbin- Watson statistics of 1.851, 1.850, and 1.852 among Gold-Oil-Dollar rates certifies that the error terms are not auto correlated. The significant results in the above tests lead to the statistical validation of EGARCH model.

## ENDNOTES

Gold-Oil- Dollar are considered by Indian investors as a perfect alternative for hedging their investment portfolio. From the analysis interestingly it is observed that stock market generated a better return than Gold, Oil and Dollar for the study period. But during the period of inconsistency the investors wish prefer ‘Gold-Oil-Dollar’ investment over stock market. It is also observed that the stock market volatility is greatly influenced by Gold-Oil-Dollar rates; because Gold-Oil-Dollar rates fluctuation carried by the investors in their long memory. So volatility alarms attributed to nifty due to Gold-Oil-Dollar rates are persistent and this trend will continue for a sizeable period of time.

Further it is observed that crude oil is the most powerful factor that influencing stock market volatility. This finding can be inferred as any fluctuation in crude oil rates can bring massive change in the price level of the stock market. This finding will contribute to the existing literature of Sadri and Sani (2012), Malik (2013), Kumar (2014), Siddiqui (2014), Gencer and Kilic (2014), Ingalhalli (2016), Sadorsky (2016), Balwinder and Kriti (2016), Najaf (2016) and Guesmi (2016) as these studies agrees that crude oil rates can make a significant influence on stock market volatility. From the above findings it can also be suggested the crude oil can be considered as a primary alternative for hedging the investment portfolio other than gold and dollar.

This study also observed an inverse leverage effect of Gold-Oil-Dollar rates over stock market volatility. Inverse leverage effect refers that volatility increases with increasing price levels. It refers that any increase

in Gold-Oil-Dollar rates tends the investors to revise their portfolio through asset reallocation, and results in transferring capital from stock market to commodity/currency market. Thereby volatility in stock returns gets enhanced. So it can be summarize that any raise in Gold- Oil- Dollar rates can greatly influence the volatility in Indian stock market. Further this inverse leverage effect is found to be very strong in crude oil to stock market volatility.

The findings of this study justified the theoretical contributions of Hotelling (1931), Frankel (1976) and Faugere and Erlach (1995). This study result can help the policy makers and government agencies to control the price level through proper market intervention. The excess raise in oil rates can be controlled by ensuring more subsidies, rebates on its imports. A close observation on stock market volatility will enable the policy makers to tap 'Gold-Oil-Dollar' price trends. The investors have abundant opportunity to hedge their portfolio through proper asset allocation. The positive aspect found in this study was that the volatility alarms are persistent. It refers temporary fluctuation in 'Gold-Oil-Dollar' rates won't get much affects in stock returns. Thereby the investors will get adequate time and can save transaction cost arising on account of frequent portfolio revision. This work is not examining the cross sectional effect among 'Gold, Oil and Dollar' rates. The above limitation opens an avenue for the future researchers to explore.

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