

Fluctuations in Crude, Gold & Forex Prices and its Impact on Stock Market: Evidence from Sensex and Nifty 50

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ABSTRACT

Stock markets particularly in developing economies like India play a vital role in overall development of the economy. However, volatility in stock market leads to uncertainty in the economy which in turn hampers the overall development of the economy. Most of the time, the stock market seems to respond irrationally to a new macro and micro economic information and making it too difficult to predict. Therefore, the current empirical paper tried to investigate three major macro-economic indicators such as crude, gold and forex (Dollar) on the performance of the stock market. In order to realise the stated objectives the researcher has collected the daily data from 2000 to 2017. The collected data has been tested for stationarity by running ADF statistics and the lag length for each variable is chosen by using the AIC. Later, a robust multiple regression model has been run to ascertain the impact of the chosen variables on Indian benchmark indices. The volatility of the Sensex has been measured by applying GARCH (1,1) model. Apart from that the study concludes that the Forex, Gold and Crude prices were significant in the transmission of volatility of the chosen indices and have the competency to transmit shock on Sensex and Nifty50. Finally, these results have been compared to the available evidence.

Keywords: GARCH (1,1), Granger's Casualty, Nifty 50, Brent Crude, ADF statistics, Normal Gaussian.

INTRODUCTION:

Indian stock market has saw remarkable change in the recent years. The stock market has experienced massive reforms in the past two decades. The stock market is one of the most important ways for companies to raise money, they offer a stage which diverts the funds from savings of individuals and institutions to those who need for productive investment. However, the stock market reacts irrationally for both macro-economic information such as fluctuations in commodity prices Burbidge and Harrison (1984), Hamilton (1983); forex reserves, exchange rate fluctuations (Aggarwal (1981); Akinnifesi (1987); Soenen and Hennigan (1988)), balance of payment, growth rate, interest rate (Schwert (1981); Asperm (1989); Graham and Harvey (2001)), policy announcement (Sathyanarayana & Garagesa (2016), (2017); Sathyanarayana & Pushpa B. V. (2016)), inflation (Kannan R (1999); Choi et al. (1996); Bruno, M & W Easterly(1998)), money supply (Cheng (1995)), quantitative easing, elections (Person, (2012); Zuwen Zainabu (2014); Peel, D. & Pope, P. (1983)), terrorist attacks (Suleman, M.T. (2012); Carter and Simkins (2004)), union budget (Kaur (2004), Divya et al. (2015)) and micro economic information such as stock split, bonus issues, earnings announcement, merger and acquisition, change in management etc. Most of the time, the stock market appears to respond irrationally to the new information making it too difficult to predict. The relation of stock market with macroeconomic variables has always been an area of research among economists, researchers and policy makers. The Indian stock market is prone to the macroeconomic uncertainty. Therefore, the macroeconomic factors are very vital to be considered in order to determine the probable fluctuations in the stock market.

Crude oil, just like any other commodity is controlled by the simple economics law of demand and supply. The demand for crude oil in an economy is highly related to the economic activities in that country. The crude has a history of booms and bursts and is currently witnessing a sharp fall in the prices. The recent fall in the crude prices can be connected to the following reasons; low demand in many countries due sluggish economic activities, particularly in China, has led to sharp decrease in prices. Further, shale boom in United States technological developments that improve drilling efficiency, surging the production of crude. Added to this, the major oil producing nations like Saudi Arabia, Iran, Russia etc. have failed to lower the production capacity of fear of losing the market share. Crude oil price volatility can also be attributed to supply issues, for example Iranian oil entering the world market after a prolonged prohibition period. Volatility in crude price cause negative impacts on inflation, real GDP growth rates and employment rate and which in turn affect the stock market (Hamilton, 1983; 2003, 2009; Gisser and Goodwin, 1986; Hooker, 1996; Jones and Kaul (1996); Sadorsky (1999); Davies and Haltiwanger, 2001; Finn, 2000; Basher and Sadorsky (2006); Vivek Sharma, 2012; Arouri and Rault (2012)). In the words of Ayhan Kapusuzoglu, (2011) increase in crude prices would increase the production cost which will affect cash flow of the firms and result in decrease in stock prices. Huang et al. (1996) also argued that crude prices might affect expected inflation rates and interest rates thereby affecting also the discount rates used in share price valuation. Therefore, majority of the economies of the globe are dependent on crude. So, crude prices are expected to affect the different fundamental of an economy and in turn stock market too.

Gold or bullion is considered as one of the most precious commodity in the world. In early age, it was used as currency substitute ((Kaliyamoorthy et al., 2012) but now-a-days it is used as an investment alternative, jewelry making, a tool of diversification diversifier etc. According to Yahyazadehfar and Babaie, 2012, Bhunia, 2013; Bhunia and Mukhuti, 2013; Shefali Tiwari & Barkha Gupta (2015) normally, gold price and stock market moves in an opposite direction. When the economy is in a recession, investors have a tendency to divert their investible funds in gold. Consequently, the gold price rises and less investment in stocks, causing stock market to fall. Gold is one of the most sought investment options in India. The fascination to hold gold as a physical asset is so high that it has India has become one of the largest importer of gold in the world. India's gold imports surged 67% in 2017 from the previous year to 855 tonnes. Therefore, the relation between the Indian stock markets with a variable of the gold is worth further discussion. Gold is known by its stability in price. However, the price starts to oscillate owing to volatility in exchange rate, political uncertainty, variability in interest rate, recession and speculation.

Foreign exchange or simply the forex is the currency of other countries such as US Dollar, Japanese Yen, British Pound etc. and Foreign Reserves mean deposits of international currencies held by a central bank. Foreign reserves allow governments to keep their currencies stable. In simple words, exchange rate means the value of one currency for the purpose of conversion to another. There are two types of exchange rate (i) Fixed, and (ii) Floating rates.

A fixed exchange rate, also known as pegged exchange rate regime where a currency's value is fixed against either the value of another single currency, to a basket of other currencies, or to another measure of value, such as gold. The fixed exchange rate doesn't fluctuate because of government intervention. However, under floating rate regime in which a currency's value is allowed to fluctuate in response to foreign-exchange market instruments. A currency that uses a floating exchange rate is known as a floating currency. In order to bring stability in exchange rate the central banks attempt to influence their countries' exchange rates by buying and selling currencies. There are certain factors that drive the demand for a currency, they are Interest rate, inflation rate, export and import status, speculative trading in forex market etc.

According to (Joseph, 2002) forex rate fluctuations directly influence the competitiveness of firms, given their impact on input and output price. In turn it impacts the value of the firm as the future cash flows of the firm changes with the fluctuations in the forex rates. Ma and Kao, (1990) argue that the currency appreciation has both a negative and a positive effect on the domestic stock market.

The purpose of the current study is to further investigate the relationship between Indian stock market and fluctuation in crude price, exchange (US Dollar) and gold prices as there is still no consensus on the relationship between the above mentioned variables even though the topic has been widely discussed in the literature. The reminder of this paper is organized as follows: Section two deals with the reviews the available literature, section three discusses the methodology employed for the purpose of the study, Section four of this paper contains the results and in the last section a brief discussion conclusion have been drawn.

LITERATURE REVIEW:

The literature is relatively rich with respect to studies that link the fluctuation in macroeconomic variables such as crude prices, forex and gold prices and the stock market performance. For example Darby, (1982); Hamilton, (1983), Evangelia P (2001); Akttam (2004); Cobo-Reyes and Quirós (2005); Irene H & Perry S (2007); Chen (2010); Basher, Haug and Sadorsky (2012); Ansar and Asghar (2013); Abdalla (2013) on oil prices with stock market. Toda and Yamamoto (1995); Bhattacharya et al. (2001); Dimitrova (2005); Doong et al (2005); Aydemir and Demirhan (2009); Jorion (1990); Chow, Lee & Solt (1995); Aggarwal (1981); Ajayi & Mougoue (1996); Abdalla (1997) between stock market and exchange rate Kaliyamoorthy and Parithi (2012) and Patel (2013) Omag (2012), Smith (2001) Garefalakis et al. (2011); Joshi (2012); Ray (2013); on gold prices and stock market.

However, empirical evidence with respect to the relationship between oil prices and stock markets are not consistent. A number of studies suggested an inverse relationship between oil price and stock returns for example, Filis, 2010; Cunado & Perez de Garcia, 2014. On the other hand, another stream of literature found a positive relationship between oil price and stock markets for example, Boyer and Filion (2004); Sadorsky (2001); Constantinou et al., 2010; Hasan & Mahbobi, (2013).

In an empirical study by Ramos and Veiga (2010) concluded that increase in oil price depress international stock markets return. However, decrease in crude prices do not necessarily increase in global stock market returns. Jungwook P. & Ronald R. (2008) explored the relationship between the fluctuations in crude price and developed stock markets such as US and 13 European countries and concluded that fluctuations in oil prices account for six percent volatility in developed market stock returns. Similar findings were documented by Jones and Kaul (1992; 1996), Sadorsky (1999); Huang, Masulis and Stoll (1996). In an empirical study by Maghyereh (2004), on emerging markets concluded that oil prices have no significant impact on stock index returns. Hommoudeh and Li, (2005) found evidence that the stock returns in the oil consuming industry respond negatively to oil price increases. Rong-Gang Cong, et al. (2008) try to investigated relationship between crude price shock and Chinese stock market, in which it was found that oil price fluctuations do not affect significant impact on the real stock return.

In a study by Nwosa (2014) tried to investigate the relationship between oil prices and stock market by using VECM and VAR models found a long run significant relationship with Nigerian stock market and oil prices. Similar findings were documented by Miller and Ratti (2009); Ciner (2001), Toraman, et al. (2011), Muritala, et al. (2012) and Sharma and Khanna (2012). In as empirical study by S. Sathyanarayana, S. N. Harish and Sudhindra Gargasha (2018) found that changes in crudes prices have an impact on stock market. Apart from that the study concludes that the Crude prices was significant in the transmission of volatility of the Indian stock market and have the competency to transmit shock on Sensex.

Empirical evidence with respect to the relationship between gold prices and stock markets are again mixed. For instance Smith (2001); Carter et al. (1982), Blose and Shieh (1995); S. P. Narang and R. P. Singh (2011); Kaliyamoorthy & Parithi (2012) concluded that there is no relationship between the stock market and gold prices. However, studies conducted by Aggarwal and Soenen (1988); Mishra et al. (2012); Le et al. (2011); K. S. Sujit and B. R. Kumar (2011); Yahyazadehfar et al. (2012) contradicted this view and found a significant relationship with the two variables.

In an empirical study by Sherman (1983) concluded that gold prices have a significant positive relationship with unexpected inflation. Moore (1990) in his study concluded that the momentum in gold price can be used as a predictor for forecasting inflation.

Levin and Wright (2006) investigated the relationship between US Dollar and gold prices by employing co-integration technique found a long term relationship between the two variables. Similar findings were documented by Capie and Wood (2005)

Baur and Lucey (2009) studied the relationship between negative market conditions and gold prices. They found a curvilinear relationship between the two variables.

In an empirical study by Moore (1990) found a negative relationship between the stock market and gold prices. Similar findings were documented by Teresiene, D. (2009) from the Lithuanian stock market perspective. A research study by Larson & McQueen (1995) found a significant relationship between unexpected inflation and gold price.

The existence of a relationship between stock market and exchange rate has received significant attention in literature. However, the empirical evidence are not consistent. For example, Ong and Izan (1999); Jorion (1990); Chow, Lee & Solt (1995); Abdalla (1997); Aggarwal (1981); Ajayi & Mougoue (1996); Aydemir and

Demirhan (2009); Dimitrova (2005) found a significant relationship. However, Robert G. (2008) Franck and Young (1972); Bhattacharya and Mukherjee (2003) found no relationship between forex and stock market. Doong et al (2005) tried to investigate the relationship between stocks and exchange rates for Indonesia, Malaysia, Philippines, South Korea, Thailand, and Taiwan. The findings from the study confirmed that the two variables are not cointegrated. However, Pan et al. (2001) found a significant correlation between the stock markets in seven Asian countries with foreign exchange. Maysami-Koh (2000), tried to investigate the impacts of the interest rate and exchange rate on the stock returns and concluded that the exchange rate and interest rate are the determinants in the stock prices. Ibrahim and Aziz explored the linkage between the stock market and exchange rate for Malaysia, the results showed that exchange rate is negatively associated with the stock prices. Adjasi et al. (2008) found a negative relationship between stock market and forex market in Ghana. In an empirical investigation by Bahani-Oskooee and Sohrabian (2006) found a short run and bi-directional relationship between the exchange rate and stock markets in the context of S&P500 Index. This findings were supported by Ibrahim (2000) and Qiao (1997). In another empirical study by Solnik (1987) showed that depreciation of currency has a positive, yet insignificant, impact on the U.S. stock prices. The aim of the current paper is to uncover the impact of forex, crude and gold price on Indian stock markets with special reference to Sensex and Nifty 50. The review of the literature on the proposed topic, thus throws light on facts relating to the gap in the study of the chosen subject: (i) though there are empirical studies in India investigating the impact of proposed variables on stock price, the findings may differ when it is repeated with different sample periods taken for the purpose of the study; (i) Majority of the studies on the proposed topic have examined the phenomenon in western and developed countries context, with very little focus on developing market environment such as Indian stock market. (ii) India, being a developing economy exhibits several peculiar characteristics such as high degree of inflation, fluctuations in forex prices, frequent revision in interest rates and import bill on crude. Therefore the current study has been taken up to understand the impact of the above listed prominent macro-economic variables and its impact on the two Indian bench mark indices. Further, in this research several hypotheses have been proposed to test the relationships between the chosen variables.

**RESEARCH DESIGN:
OBJECTIVES OF THE STUDY:**

- 1.To examine and detail the effect of crude, exchange rate (dollar) and god prices on the Indian Stock market bench mark indices (BSE Sensex and Nifty 50).
- 2.To investigate the cause and effect relationship between the effect of crude, exchange rate (dollar) and god prices with Indian Stock market bench mark indices (BSE Sensex and Nifty 50).
- 3.To offer suggestions based on this research.

HYPOTHESIS OF THE STUDY:

To find the impact of crude, exchange rate (dollar) and god prices on the Indian Stock market the following Hypothesis have been framed.

H0: There is no significant relationship between independent variables (Crude Oil, Gold and Forex prices) and dependent variable (Index Returns).

Specification of the Model - Regression:

$$Y (\text{Index Returns}) = a + b_1 X_1 (\text{Crude}) + b_2 X_2 (\text{Dollar}) + b_3 X_3 (\text{Gold}) + \epsilon \dots\dots\dots (1)$$

Where,

Y = (Dependent variable)

X is the vector of explanatory variables in the estimation model

a = constant intercept term of the model

b = coefficients of the estimated model

ε = error component

Garch (1, 1) Mean Equation:

$$\text{Sensex Returns} = C1 + C2*CR + e \text{ -----} \rightarrow (1.1)$$

$$\text{Nifty Fifty Returns} = C1 + C2*CR + e \text{ -----} \rightarrow (1.2)$$

VARIANCE EQUATION – THIS IS THE GARCH (1,1) MODEL

$$H_t = C3 + C4 H_{t-1} + C5 * e^2_{t-1} + C6 * CR \text{ -----} \rightarrow (1.3)$$

Here, H_t = variance of the residual (error term) derived from equation 1.1 and 1.2 (current day's variance or volatility of Index return)

RESEARCH METHODOLOGY:

Analytical, Historical & Quantitative Research. Systematic sampling technique. In order to do the research on movement of stock market & different sector stocks with the movement of crude oil price. For the purpose of the current study the last seventeen years from 1st January 2000 to 31st March 2017, daily closing data from the BSE Sensex and Nifty 50.

Tools for Data Collection:

Secondary data was used for data collection. For the purpose of analyzing on movement of stock market with the movement of crude oil price, data is taken over a period of seventeen years from 1st January 2000 to 31st March 2017, which has periods of both hot and cold market as well as periods of bullish and bearish phases of Indian Stock Market. The collected data has been collated using Microsoft Excel Package and E-views software. In the first phase the collected data has been tested for the existence of unit root by running ADF test. In the second phase, a descriptive statistics have been run to investigate the normality of the collected time series data. Later a person correlation test has been run to assess the relationship between the chosen variables. In the next phase, we run a robust multiple regression model to investigate the impact of macro-economic variables on the chosen stock indices (BSE Sensex and Nifty 50).

DATA ANALYSIS:

Table 4.1: Table Showing Unit Root Results

Crude Pride						
	t-Statistic	-69.58075	Prob.*	0.0001		
C values	1% level	-3.431624	5% level	-2.861988	10% level	-2.567051
Dollar						
	t-Statistic	-27.74926	Prob.*	0.0000		
C values	1% level	-3.431625	5% level	-2.861989	10% level	-2.567052
Gold						
	t-Statistic	-67.67661	Prob.*	0.0001		
C values	1% level	-3.431624	5% level	-2.861988	10% level	-2.567051
BSE Sensex						
C values	t-Statistic	-46.14277	Prob.*	0.0001		
	1% level	-3.431703	5% level	-2.862023	10% level	-2.567070
Nifty 50						
C values	t-Statistic	-63.06464	Prob.*	0.0001		
	1% level	-3.431624	5% level	-2.861988	10% level	-2.567051

In order to investigate the existence of unit root in the time series distribution ADF test has been conducted Dickey-Fuller (ADF) (1979, 1981). It is evident from the above table that for crude prices, Forex (dollar), Gold prices, Sensex and Nifty 50 as the p value is less than 0.05, we can reject the null hypothesis that there is no unit root in the time series data.

Table 4.2: Table Showing Descriptive Statistics of Independent Variables

	Crude price	Dollar	Gold
Mean	62.45006	50.41867	883.3403
Standard Error	0.42042	0.12005	7.072292
Standard Deviation	27.88752	8.079128	469.336
Sample Variance	777.7138	65.27231	220276.3
Kurtosis	-0.97714	-0.4641	-1.31101
Skewness	0.31612	0.932655	0.152368
Count	4400	4529	4404

Analysis:

It is evident from the above table 4.2 that the mean price for crude was 62.45006 with a standard deviation of 27.88752. However, the variance for the study period was 777.7138. However, Kurtosis value for the study period was -0.97714 and Skewness of 0.31612. Where the maximum price recorded for the study period was 145.29 \$ per barrel and the minimum price documented was 17.45 (Range being 127.84). This indicates there exists a high degree of volatility in the crude prices for the study period.

For dollar (foreign exchange) the mean exchange rate was 50.41867 with a standard deviation of 8.079128. However, the variance for the study period was 65.27231. Kurtosis value for the study period was -0.4641 and Skewness of 0.932655. Where the maximum exchange rate recorded for the study period was 68.805 and the minimum price recorded was 39.075 (Range being 29.73). This indicates there exists a high degree of volatility even in the exchange rate for the study period.

For Gold prices the mean price was 883.3403 with a standard deviation of 469.336. However, the variance for the study period was 220276.3. Kurtosis value for the study period was -1.31101 and Skewness of 0.152368. Where the maximum exchange rate recorded for the study period was 1888.7 and the minimum price recorded was 255.1 (Range being 1633.6). This indicates there exists a high degree of volatility even in the gold prices for the study period.

Table 4.3: Table Showing Correlation for BSE Sensex

	BSE Sensex	Crude	Gold	Dollar
BSE Sensex	1			
Crude	0.123674	1		
Gold	0.065346	0.22296	1	
Dollar	-0.34515	-0.14877	-0.20614	1
	Nifty	Crude	Gold	Dollar
Nifty 50	1			
Crude	0.124900987	1		
Gold	0.069627271	0.218544176	1	
Dollar	-0.34031394	-0.145082884	-0.1923059	1

In order to assess the relationship between the independent variables (Crude, Gold and dollar) and dependent variable (BSE Sensex) an inter correlation matrix has been constructed. It is evident from the above table that the correlation between the BSE Sensex and Crude was 0.123674, between BSE Sensex and Gold was 0.065346. However, Dollar was sharing a negative correlation with BSE Sensex of -0.34515. The correlation between the Nifty 50 and Crude was 0.124900987, between Nifty 50 and Gold was 0.069627271. However, dollar was sharing a negative correlation with Nifty 50 -0.34031394.

Table 4.4: Table Showing Regression Statistics for BSE Sensex

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.000515	0.000217	2.37168	0.017752
Crude	0.048248	0.009126	5.286599	1.31E-07
Gold	-0.02832	0.019455	-1.45574	0.145537
Dollar	-1.20525	0.052578	-22.9232	9.5E-110

Test of Hypothesis:

In order to assess the relationship between the independent variables (Crude, Gold and dollar) and dependent variable (BSE Sensex), the researcher has established the following hypothesis and to prove or disprove the hypothesis the researcher has employed multiple regression analysis.

H0: There is no significant relationship between independent variables (Crude, Gold and Dollar) and BSE Sensex returns.

Result shows that independent variables (Gold and Dollar) share negative coefficient with the dependent variables meaning that they share an inverse relationship with the dependent variable (Index return). However,

Crude price has a positive coefficient meaning that it shares direct relationship with the Index. Crude and Dollar are statistically significant at 0.01 level with a p value of 0.0000131 and 0.000095 respectively. However, gold prices are statistically not significant at 0.05 level with a p value of 0.145537.

Therefore the accepted hypothesis is:

H1: There is a significant relationship between independent variables (Crude and Dollar) and BSE Sensex returns. (ACCEPT)

H0: There is no significant relationship between independent variables Gold and BSE Sensex returns. (REJECT)

Table 4.5

Regression Statistics	
Multiple R	0.353435
R Square	0.124916
Adjusted R Square	0.124299
Standard Error	0.014146
Observations	4257
F	202.3689
Significance F	1.1E-122
Durbin-Watson results	1.9548

Analysis:

R square represents the percentage movement of the dependent variable which is captured by the intercept and the independent variables. Above obtained results explain (0.124916) i.e. 12.4916% of the variation in Index return was captured by independent variables (Crude, Gold and Dollar) with Standard Error of 1.4146%.

Inference:

From the above analysis one can infer that BSE Sensex is not dependent much on the independent variables (Crude, Gold and Dollar) which means that there is no significant influence of independent variables on the dependent variable.

As the p value is lesser than the set level 5% that is 0.000011 with an F value of 202.3689 the independent variables (Crude, Gold and Dollar) have a no impact on the dependent variable that is BSE Sensex returns.

Table 4.6: Table Showing Regression for Nifty 50

	Coefficients	Standard Error	t Stat	P-value
Intercept	0.000483833	0.000205226	2.357564021	0.018438
Crude	0.048742593	0.008859511	5.501725222	3.97E-08
Gold	-0.014707505	0.018816914	-0.781610879	0.434485
Dollar	-1.169040718	0.050664829	-23.074009	2.1E-111

Test of Hypothesis:

H0: There is no significant relationship between independent variable (Crude, Gold and Dollar) and Nifty 50 returns.

Result shows that independent variables (Gold and Dollar) share negative coefficient with the dependent variables meaning that they share an inverse relationship with the dependent variable (Index return). However, Crude price has a positive coefficient meaning that it shares direct relationship with Index.

Crude and Dollar are statistically significant at 0.01 level with a p value of 0.000039 and 0.000021 respectively. However, Gold prices are statistically not significant at 0.05 level with a p value of 0.434485.

Therefore the accepted hypothesis is:

H1: There is a significant relationship between independent variables (Crude and Dollar) and Nifty 50 returns. (ACCEPT)

H0: There is no significant relationship between independent variable Gold and Nifty 50 returns. (REJECT)

Table 4.7

Regression Statistics	
Multiple R	0.348941621
R Square	0.121760255
Adjusted R Square	0.121172673
Standard Error	0.013737702
Observations	4488
F	207.2225
Significance F	7.1E-126
Durbin-Watson stats	1.9873

Analysis:

R square represents the percentage movement of the dependent variable which is captured by the intercept and the independent variables. Above obtained results explain (0.121760255) i.e. 12.1760255 % of the variation in Index return was captured by independent variables (Crude, Gold and Dollar) with Standard Error of 1.373%.

Inference:

From the above analysis one can infer that Nifty 50 is not dependent much on the independent variables (Crude, Gold and Dollar) which means that there is no significant influence of independent variables on the dependent variable.

As the p value is lesser than the set level 5% that is 0.000071 with an F value of 207.2225 the independent variables (Crude, Gold and Dollar) have a no impact on the dependent variable that is Nifty 50 returns.

GARCH (1, 1):

In order to investigate the volatility transmission, the Generalized Autoregressive Conditional Heteroscedasticity (GARCH (1, 1)) test was conducted to understand the impact of forex, gold and crude prices on Sensex by taking Sensex as a dependent variable and crude prices has independent variable by using daily time series data covering the period between 2000 and 2017. The GARCH (1,1) was used to capture the main characteristics of time series data, such as stationary by using fat tails and volatility clustering. In addition, the ARCH effects which contradict the random walk concept. For the study purpose all the three GARCH (1,1) models viz., Normal GAUSSIAN, Student t Distribution and GED with fix parameters have been run. The results of the tests (Normal GAUSSIAN, Student t Distribution and GED with fix parameters) for the GARCH (1.1) test are presented in the following Table No.

Table 4.8

Method: ML - ARCH (Marquardt) - Normal distribution				
GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000763	0.000148	5.159418	0.0000
FOREX	-0.915029	0.034525	-26.50317	0.0000
GOLD	-0.042083	0.013641	-3.085089	0.0020
CRUDE	0.036903	0.006704	5.504449	0.0000
Variance Equation				
C	2.78E-06	3.46E-07	8.023372	0.0000
RESID(-1)^2	0.096796	0.005474	17.68253	0.0000
GARCH(-1)	0.889599	0.006109	145.6225	0.0000

GARCH = C (5) + C (6)*RESID (-1)^2 + C(7)*GARCH(-1)

In the above table No. 4.8 the GARCH (1, 1) Model shows that, at Normal GAUSSIAN distribution, the p value is 0.0000 for Forex (Dollar), 0.0020 for Gold and 0.000 for crude prices. Apart from this, the p value of ARCH 1 and GARCH 1 are also less than 0.0000. Hence the null hypothesis that the no volatility caused by crude prices has been rejected.

We can conclude that the Forex (Dollar), Gold and Crude prices were significant in the creation of volatility of the Sensex. Apart from that the ARCH 1 and GARCH1 are also significant at one percent level. ARCH and GARCH are both internal shock of the volatility of the Sensex (they are also known as family shock). Null

hypothesis rejection indicates that Forex (Dollar), Gold and crude oil prices are significant to affect and have the competency to transmit shock on Sensex.

RESIDUAL DIAGNOSTICS TESTS:

**Table 4.9.: Correlogram of Standardized Residuals – Q-Statistics
 (Normal Gaussian Distribution, Student T Distribution And Ged With Fix Parameters)**

	Normal Gaussian Distribution		Student's t distribution		GED	
	Q-Stat	Prob. values	Q-Stat	Prob. values	Q-Stat	Prob. Values
1	0.0456	0.831	0.0752	0.784	0.0569	0.811
2	4.0153	0.134	3.7878	0.150	3.7348	0.155
3	4.3552	0.226	4.1730	0.243	4.1195	0.249
4	5.2816	0.260	5.0660	0.281	5.0215	0.285
5	5.2822	0.382	5.0661	0.408	5.0221	0.413
6	7.5409	0.274	7.3013	0.294	7.2544	0.298
7	7.8446	0.346	7.6283	0.367	7.5852	0.371
8	8.2164	0.413	8.0402	0.430	7.9787	0.436
9	10.119	0.341	10.062	0.345	9.9844	0.352
10	14.752	0.141	14.772	0.141	14.673	0.144
11	17.554	0.093	17.595	0.091	17.461	0.095
12	17.708	0.125	17.711	0.125	17.584	0.129
13	19.443	0.110	19.393	0.111	19.298	0.114
14	19.451	0.148	19.399	0.150	19.304	0.154
15	19.756	0.182	19.691	0.184	19.604	0.188
16	20.979	0.179	20.972	0.180	20.896	0.183
17	23.399	0.137	23.332	0.139	23.299	0.140
18	24.137	0.151	24.117	0.151	24.054	0.153
19	24.908	0.164	24.795	0.167	24.764	0.168
20	25.246	0.192	25.048	0.200	25.040	0.200
21	28.012	0.140	27.851	0.144	27.849	0.144
22	28.262	0.167	28.093	0.173	28.090	0.173
23	30.489	0.136	30.227	0.143	30.241	0.143
24	31.441	0.141	31.177	0.149	31.179	0.149
25	32.278	0.150	31.907	0.161	31.937	0.160
26	33.028	0.161	32.523	0.176	32.586	0.174
27	33.252	0.189	32.697	0.207	32.775	0.205
28	34.074	0.198	33.537	0.217	33.601	0.214
29	34.559	0.219	34.056	0.237	34.110	0.235
30	34.634	0.256	34.136	0.275	34.190	0.273
31	36.671	0.222	36.275	0.236	36.302	0.235
32	36.771	0.257	36.381	0.272	36.407	0.271
33	37.321	0.277	36.932	0.292	36.971	0.291
34	38.481	0.274	38.124	0.287	38.166	0.286
35	39.677	0.269	39.292	0.284	39.349	0.281
36	39.691	0.309	39.298	0.324	39.356	0.322

To investigate the existence of autocorrelation in the residuals Q – statistic test was conducted. If there is no serial correlation in the residuals, the autocorrelations and partial autocorrelations at all lags should be almost zero, and all Q-statistics should be insignificant with hefty p-values meaning that if the variance equation is perfectly specified, all Q–statistics should not be statistically significant. The test accepts the null hypothesis of no auto correlation in the time series data. The above correlogram of squared residuals test results indicate that the residuals are not auto correlated as the p value is greater than five percent at all lags.

ARCH EFFECT TEST:

Table 4.10: Normal Gaussian Distribution, Student's T Distribution And Ged With Fix Parameters

Heteroskedasticity Test: ARCH			
F-statistic	3.230779	Prob. F(1,2481)	0.0723
Obs*R-squared	3.229893	Prob. Chi-Square(1)	0.0723
Student's t distribution			
F-statistic	3.453995	Prob. F(1,2481)	0.0880
Obs*R-squared	3.454314	Prob. Chi-Square(1)	0.0878
GED with fix parameters			
F-statistic	3.579903	Prob. F(1,2481)	0.0789
Obs*R-squared	3.580170	Prob. Chi-Square(1)	0.0787

To investigate the presence of heteroscedasticity in the distribution of the residuals, an ARCH effect test was conducted. Results from the ARCH test are depicted in the Table No. 4.10 for all the three parameters. The ARCH test results indicate that there are no ARCH effects in the residuals. In other words, there is no heteroscedasticity in the residuals; thus, the residuals can be said to be homoscedastic.

Table 4.11: Granger’s Casualty BSE Sensex and the Independent Variables

	Lags	Obs	F-Statistic	Prob.	
SENSEX does not Granger Cause \$	2	4255	5.14368	0.0059	↔
\$ does not Granger Cause SENSEX			7.27946	0.0007	
GOLD does not Granger Cause SENSEX	4	4255	3.87504	0.0038	↔
SENSEX does not Granger Cause GOLD			2.49734	0.0408	
CRUDE does not Granger Cause SENSEX		4255	0.36883	0.6916	
SENSEX does not Granger Cause CRUDE	2		2.11557	0.1207	

In order to find out the cause and effect relationship between the independent variables Crude, Gold, Dollar and dependent variable SENSEX, Granger Causality test was conducted and the results were shown in Table No. 4.11 we can infer that the p value between SENSEX and Dollar was less than 0.05 level of significance (0.0059). However, from Dollar to SENSEX it was less than 0.05 level (0.0007) therefore, there is a bi-directional cause and effect relationship between SENSEX and Dollar at lag 2.

The p value between Gold and SENSEX was less than 0.05 level of significance (0.0038). However, from SENSEX and Gold to it was less than 0.05 level (0.0408) therefore, there is a bi-directional cause and effect relationship between Gold and SENSEX at lag 4.

The p value between Crude and SENSEX was more than 0.05 level of significance (0.6916). However, from SENSEX and Crude it was more than 0.05 level (0.1207) therefore, there exist no cause and effect relationship between Crude and SENSEX.

Table 4.12: Granger’s Casualty Nifty 50 and the Independent Variables

	Lags	Obs	F-Statistic	Prob.	
NIFTY does not Granger Cause \$	2	4486	6.62218	0.0013	↔
\$ does not Granger Cause NIFTY			7.34052	0.0007	
NIFTY does not Granger Cause GOLD	4	4486	3.06918	0.0155	↔
GOLD does not Granger Cause NIFTY			3.05254	0.0159	
CRUDE does not Granger Cause NIFTY	2	4486	0.41490	0.6604	
NIFTY does not Granger Cause CRUDE			2.87669	0.0564	

In order to find out the cause and effect relationship between independent variables Crude, Gold, Dollar and dependent variable Nifty 50 Granger Causality test were conducted and the results were shown in Table No. 4.12 The p value between Nifty 50 and Dollar was less than 0.05 level of significance (0.0013). However, from

Dollar to Nifty 50 it was less than 0.05 level (0.0007) therefore, there is a bi-directional cause and effect relationship between Nifty 50 and Dollar at lag 2.

The p value between Nifty 50 and Gold was less than 0.05 level of significance (0.0155). However, from Gold to Nifty 50 it was less than 0.05 level (0.0159) therefore, there is a bi-directional cause and effect relationship between Nifty 50 and Gold at lag 4.

The p value between Crude and Nifty 50 was more than 0.05 level of significance (0.6604). However, from Nifty 50 to Crude it was more than 0.05 level (0.0564) therefore, there exist no relationship between Nifty 50 and Crude at lag 2.

DISCUSSION AND CONCLUSION:

The current study entitled “Volatility of Crude Oil, gold and Forex market and its impact on Indian Stock Market” has been undertaken to investigate the impact of volatility of Indian stock market. In order to realise the stated objectives the researcher has collected the data from 2000 to 2017. The collected data has been tested for the stationarity by ADF test. In the second stage Descriptive statistics has been run to understand the behaviour of both the variables and regression has been done to check the significance. In the last phase multiple regression has been done. Crude oil is one of the most basic global commodities. Fluctuation in the crude oil prices has both direct and indirect impact on the global economy. Therefore, the prices of crude oil are tracked very closely by investors the world over. The price variation in crude oil impacts the sentiments and hence the volatility in stock markets all over the world. The rise in crude oil prices is not good for the global economy. Price rise in crude oil virtually impacts industries and businesses across the board. Higher crude oil prices mean higher energy prices, which can cause a ripple effect on virtually all business aspects that are dependent on energy (directly or indirectly). Gold is also an important standard commodity traded across the global markets. Since gold is also a seasonal commodity, it is exposed to lot of volatility. Forex rate fluctuations directly influence the competitiveness of firms, given their impact on input and output price. It is also capable of transmission of volatility in global stock market. Result shows that independent variables (Gold and Dollar) share negative coefficient with the dependent variable (Sensex) meaning that they share an inverse relationship with the dependent variable. However, Crude price has a positive coefficient meaning that it shares direct relationship with the Index. Crude and Dollar are statistically significant at 0.01 level (our findings seem to agree with the findings of Ramos and Veiga (2010); Jones and Kaul (1992; 1996); Sadorsky (1999); Huang, Masulis and Stoll (1996); Sathyanarayana & Gargesa (2018)). However, gold prices are statistically not significant at 0.05 level with Sensex (seems to agree with the findings of Smith (2001); Carter et al. (1982), Blose and Shieh (1995); S. P. Narang and R. P. Singh (2011); Kaliyamoorthy & Parithi (2012)).

Regression results for Nifty 50 show that independent variables (Gold and Dollar) share negative coefficient with the dependent variables meaning that they share an inverse relationship with the dependent variable (Index return). However, Crude price has a positive coefficient meaning that it shares direct relationship with Index. Independent variables Crude and Dollar were statistically significant at 0.01 level. However, Gold price was not statistically significant at conventional level. GARCH (1,1) results indicate that Forex (Dollar), Gold and Crude prices were significant in the transmission of volatility to both Sensex and Nifty 50 Indices. Apart from that the ARCH 1 and GARCH 1 were also significant at one percent level. ARCH and GARCH are both internal shock of the volatility of the Sensex and Nifty 50. Evidence from the study shows that Sensex and Forex (Dollar), Gold share a bi-directional relationship. However, we did not find any cause and effect relationship between Crude and SENSEX. Similarly we found a bi directional relationship between Nifty 50 and Forex (Dollar), Gold. Further, we did not find any evidence in between Nifty 50 and Crude prices.

The implications of the current research is that, there exists a statistical relationship between Crude & Dollar with BSE Sensex and Nifty 50, while buying or selling any stocks or constructing a portfolio the market participants should take the momentum in forex and crude prices seriously. However, the impact of fluctuations in crude and forex prices on the economy, sectors, firm level differs. Further, the volatility of the crude price challenges for policy makers in oil-importing countries like India because crude price is a critical source of energy and input for many industrial applications and moment of goods for final consumption. The price variation in crude oil impacts the sentiments and hence the volatility in stock markets all over the world. The rise in crude oil prices is not a good sign for the global economy. Price rise in crude oil virtually impacts industries and businesses across the board. Higher crude oil prices mean higher energy prices, which can cause a ripple effect on virtually all business aspects that are dependent on energy (directly or indirectly). Therefore, maintaining macroeconomic stability has been of the main challenges for developing countries like India. Findings of this study provide significant insights for policy makers and firms engaged in foreign exchange

exposure such as IT, textiles, export and import houses etc. Forex is the currency of other nations and foreign reserves mean deposits of international currencies held by a central bank (Reserve Bank of India). Foreign exchange reserves allow RBI to keep their domestic currency stable. In turn the foreign exchange reserves are used as an instrument of exchange rate and monetary policy, it facilitate for the payment of external debt and other liabilities. Further, the fluctuation in foreign exchange has a direct bearing on interest rate, inflation, export-import etc. Therefore, the central bank has to keep the currency stable. Further, the variables chosen for the purpose of the study were interrelated for example, whenever there is any increase in the crude price, the INR depreciates against the US Dollar. Therefore, the government of India buys more US Dollar against Indian Rupee to honour the import bill of crude and gold, causing in considerable demand for US Dollar. Therefore, the policy makers have to pay attention to the above three factors that may influence overall risk on the economy. Apart from it fluctuations in foreign exchange and its impact on operating profits and share price is useful for market participants while making rational investment decisions. Further, the variability of operating profits of a Multi-National companies is very much essential for decision makers to identify the right financial instruments to hedge away the foreign exchange risk exposure.

Any research has its own limitations and in the same genre this research too has its limitations. The study was confined only to three macroeconomic variables such as gold, crude and foreign exchange and its impact on two benchmark indices such as Sensex and Nifty 50. However, it is suggested to incorporate more macro-economic variables such as interest rate, GDP, inflation, policy announcement, balance of payment, growth rate etc. an extended study of this kind encompassing more number of indices especially sectorial indices over a longer period of time may be taken up.

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