DYNAMIC RELATIONSHIP BETWEEN COMMODITIES AND INDIAN STOCK MARKET

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1. Introduction

Now-a-days, the interconnectedness between the economies of the world is enhancing significantly. All the markets around the globe are interlinked with each other especially after the globalization. The relationship among all the asset classes has gradually deepened. Any fluctuations in the price of an asset class have a direct or indirect impact on other asset classes like the prices of commodities trade over the world have an impact on all the asset classes around the world. As far as a country like India is concerned, the country is the largest importer of all the major commodities like gold, crude oil, copper, etc. So, when there are any fluctuations arising in the prices of these commodities, it leads to the fluctuations in the stock market which is also known as "Spillover Effect". Commodities and Stock Market are showing significant linkage over the number of years as the prices of the commodities have dual impact on the stock market.

First point of view, where these commodities are used as raw materials when the price of these commodities increases, the cost of production increases where these commodities are used as raw materials, and the amount of profit decreases, which leads to a reduction in the stock prices of the companies, and vice versa; it is also known as Mean or Return Spillover Concept.

Second point of view, when the fluctuations in the price of these commodities increases, investors move towards the stock market which leads to increase in the stock prices of the companies as the demand for it grows, and vice versa; it is also known as Volatility Spillover Concept.

When it comes to portfolio allocation, investors always use commodities and the stock market as hedges against each other. So, the present study is an attempt to understand the dynamic relationship between selected commodities and stock market index, which helps investors revise their portfolio so as to minimize their financial risk. The ADF and PP unit root tests are used to detect stationary properties, while the Johansen

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co-integration test is used to investigate the relationship between the variables. In addition, the Granger causality test is used to determine the direction of connection. At last, Multivariate Diagonal VECH GARCH (1, 1) Model is used to examine the spillover effect.

The rest of article is organized as :Section 2 gives a review of the literature; Section 3 examines the data and empirical methodology; Section 4 describes the empirical analysis; and Section 5 summarizes the study.

2. Literature Review

Soumya Saha and Gagari Chakrabarti (2011) studied the dynamic relationship between the stock market and the foreign exchange market and collected secondary data from 2006 to 2010. The study concluded that there is the presence of volatility spillover between the foreign exchange market and the stock market. MohdYahya Mohd Hussin et al, (2013)studied the relationship between selected macro economic variables and stock prices. Secondary data for the period ranging from 2007 to 2011 was used. Furthermore, the study concluded that there is no long-run relationship between oil prices, gold prices, and stock prices. However, there does exist a bidirectional causal relationship between oil and stock prices. Amalendu Bhunia and Somnath Mukhuti, (2013) assessed the relationship between gold prices and stock prices and collected secondary data for the period ranging from 1991 to 2012. The study revealed that there is no causality between stock prices and gold prices. Amalendu Bhunia, (2013) examined the relationship between selected financial variables and oil and gold prices. Secondary data for the period ranging from 1991 to 2012 was used and it was found that there existed a long run relationship between all the variables under study..Korhan K. Gokmenoglu And Negar Fazlollahi, (2015) analyzed the relationship between selected macro economic variables and stock prices and used secondary data for the period ranging from 2013 to 2014 for analysis. Results show that the impact of gold prices on stock prices is significant both in the long and short run, whereas oil has a short run impact on stock prices. Rabia Najaf And Khakan Najaf, (2016) focused on the relationship between selected macro economic variables and stock prices and collected secondary data for the period ranging from 2003 to 2011. The study concluded that stock prices are not affected by oil and gold prices, and there exists no long-run relationship among all the variables under consideration..Varsha Ingalhalli et al, (2016) evaluated the relationship between selected macro economic variables and stock prices. Secondary data for the period 2005 to 2015 was collected for analysis and concluded that crude oil is the main causal factor affecting all other variables. Furthermore, there exists a positive relationship among all the variables.

3. Research Methodology

3.1 Data

In the present study, Crude oil, Gold, Copper and Palm oil have been taken as the proxies of Commodity and BSE Sensex has been used as the proxy for the Indian stock market. Daily data has been collected from websites of MCX&BSE for the period of 2014-2019.

3.2. Methods of Study

The method of data analysis includes Descriptive tools and Econometric tools like Augmented dickey fuller test, Phillips Perron test, Johansen co integration test, Vector Autoregressive Model, Wald test, Granger causality test and Multivariate GARCH Model.

1. Descriptive Statistics: It explains the characteristics of the collected data and helps in comparing the variables selected for the data.

MEAN: It is a measure of central tendency to calculate the average value of variable.

? xi/N where ? xi represent total of all variable
N represents total number of frequency

STANDARD DEVIATION: It is used to measure the variance in the series.

v? (xi - ¯ x)²/N where ? xi represent total of all variable N represents sample size

2. Econometric models

These models are used to analyze the time series data. Firstly, Stationarity of the variables are checked through ADF and PP test, to know that the variables are I(1) or I(0). After checking the stationarity, if all the variables are I(1), then johansen test is applied to check is there any long run relationship exists between the variables or not. If the variables are found to be cointegerated then we can apply VECM Model to know the speed of adjustment to the equilibrium. After the Granger causality is applied to know the direction of causality between the variables. At last to check the spillover effect, Multivariate GARCH Model is used on the returns of all the time series data

AUGMENTED DICKEY FULLER TEST: It is used to check the stationarity of the series. The regression equation used by this test:

$$Y = \alpha + \beta t + \gamma Yt \quad 1 + \delta \; Yt \quad 1 + \ldots + \; \delta p \quad 1 \; Yt \quad p + 1 + \in t$$

Where α and β are parameters and $\in t$ is the error term.

- JOHANSEN COINTEGRATION TEST: It is used to check the long run relationship between two non-stationary series. It has 2 test :

  A. TRACE TEST

$$LRtr\left(\frac{r}{k}\right) = \quad T\sum_{i=r+1}^{k} \log(1 \quad \theta i)$$

  B. MAXIMUM EIGENVALUE TEST

$$LRmax\left(\frac{r}{r+1}\right) = \quad T\log(1 \quad \theta r+1)$$

Where r is the number of co integration g equations and θ is the eigen value.

- GRANGER CAUSALITY TEST: It is used to check the direction of the cause and effect relationship between the variables.

$$Xt = \alpha + \sum_{t=1}^{n} \alpha iYt \quad 1 + \sum_{j=1}^{n} \beta jXt \quad j + \mu 1t$$

$$Yt = \delta + \sum_{t=1}^{n} \delta iYt \quad i + \sum_{j=1}^{n} \theta jXt \quad j + \mu 2t$$

Where $,\beta,\ \delta\ ,\theta$ are the coefficients of respective variables and $\mu 1t$, $\mu 2t$ are the two error terms.

- MULTIVARIATE GARCH MODEL: A univariate GARCH formulation suffers from an omitted variable bias if the variance of one variable is affected by prior shocks to the variance of another variable. So, the present study used Multivariate Diagonal VECH GARCH (1,1) Model which explains variance-covariance as a function of past squared error terms, cross-product error terms, variances, and covariance.

  Diagonal VECH Model:Vech (Ht) = C + A*vech(εt-1 ε't-1) + B*vech(Ht-1)

  Where A and B are: N(N+1)/2 * N(N+1)/2

  And C is: N(N+1)/2 * 1

  The Diagonal elements of Matrix A (aij where i = j) measures Own Volatility Shocks.
  The Diagonal elements of Matrix A (aij where i □ j) measures Cross Volatility Shocks.
  The Diagonal elements of Matrix B (bij where i = j) measures Own Volatility Spillovers.
  The Diagonal elements of Matrix B (bij where i □ j) measures Cross Volatility Spillovers.

4. 4. Dynamic relationship between Commodities and Indian Stock Market

4.1 Descriptive Statistics

Table1: Descriptive Statistics

	LSENSEX	LGOLD	LCRUDEOIL	LCOPPER	LPALMOIL
Mean	10.31129	10.29391	8.236214	5.974411	6.255341
Median	10.26804	10.28892	8.216628	6.012247	6.278334
Maximum	10.63781	10.57326	8.778018	6.196953	6.706006
Minimum	9.913109	10.10896	7.486053	5.663828	5.874931
Std. Dev.	0.171792	0.096931	0.260274	0.129333	0.136259
Skewness	-0.009229	0.839666	0.217793	-0.670927	-0.318151
Kurtosis	2.128640	3.908624	2.705638	2.216157	3.020598
Jarque-Bera	46.30454	222.2391	16.84787	147.2132	24.70670
Probability	0.000000	0.000000	0.000220	0.000000	0.000004
Sum	15085.42	15059.99	12049.58	8740.564	9151.564
Sum Sq. Dev.	43.14708	13.73647	99.03970	24.45499	27.14415
Observations	1463	1463	1463	1463	1463

Source: Author's Compilation

Table 1 depicts the descriptive statistics of log prices of all the variables. Crude oil prices show high degree of variability as followed by Sensex prices. The values of Skewness show that the prices of Gold and Copper are moderately skewed. Further the values of Kurtosis show that the prices of Sensex, Crude oil and Copper are platykurtic while the prices of Gold AndPalmoil are leptokurtic. At last, the result of JarqueBera test shows that all the variables do not follow normal distribution.

4.2 Unit Root/ Stationarity Test

In order to carry out the analysis of time-series data, the properties of data should be considered firstly. Unit root testing is the first step in understanding the properties of the data. In order to test the presence of unit root, ADF and PP test are more popularly used. With the help of these tests, it can be understood that the time series is having unit root or not. The time series having unit root is non-stationary time series which is not good for further analysis as it leads to the spurious regression. Non-stationary time series can be make stationary after taking the first difference. Stationarity means constant mean and variation over the period of time, which makest he regression results reliable. So, for the reliable findings, series should be stationary.

Table 2: Augmented Dickey Fuller Test		
	t-statistics (At Level)	t-statistics (At 1st Difference)
LSENSEX	-2.7108	-35.375*
LGOLD	-1.7791	-36.931*
LCRUDEOIL	-2.0395	-43.085*
LCOPPER	-2.5450	-42.550*
LPALMOIL	-1.2893	-21.485*

*significance at 0.05

Table 3: Phillips Perron Test		
	t-statistics (At Level)	t-statistics (At 1st Difference)
LSENSEX	-2.5190	-35.375*
LGOLD	-2.1168	-37.195*
LCRUDEOIL	-2.1364	-42.836*
LCOPPER	-2.608	-42.447*
LPALMOIL	-1.7067	-33.138*

*significance at 0.05

Source: Author's Compilation

Table 2 & 3 depicts the results of Augmented dickey fuller test and Phillipsperron test, the prices of all the variables under study are non stationary or has a unit root at level and stationary at first difference.

4.3 Johansen cointegration test

In order to check the presence of long run relationship between the variables, Johansen cointegration is more popularly used when the variables under study are more than two. With the help of this test, it can be understood that if the difference between the non stationary time series is stationary or not. If the difference is stationary, then there is cointegrating relationship between the series and vice-versa.

Table 4: Johansen cointegration test

Table 4: Johansen cointegration test				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.026913	73.72064	69.81889	0.0236*
At most 1	0.011001	33.88862	47.85613	0.5080
At most 2	0.007233	17.73772	29.79707	0.5855
At most 3	0.004729	7.139760	15.49471	0.5615
At most 4	0.000150	0.218995	3.841466	0.6398

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.026913	39.83202	33.87687	0.0087*
At most 1	0.011001	16.15091	27.58434	0.6530
At most 2	0.007233	10.59796	21.13162	0.6872
At most 3	0.004729	6.920765	14.26460	0.4986
At most 4	0.000150	0.218995	3.841466	0.6398

*significance at 0.05

Source: Author's Compilation

Table 4 depicts the results of Johansen Cointegration test, the p value is less than the significance value of 0.05 in both the cases of trace test and maximum eigen value test, which results in the rejection of null hypothesis i.e.there is no relationship in the long run between the prices of selected commodities and BSE Sensex.

4.4 Vector Error Correction Model and Wald Test

After checking that there exists cointegrating relationship, next step is to know the speed of adjustment towards equilibrium, for that Vector error correction model is used. After that, Wald test is used on the VECM Equation to know about the short run relationship between the variables under study.

Table 5: Vector Autoregression Estimates				
Dependent Variable: D(SENSEX)				
Method: Least Squares (Gauss-Newton / Marquardt steps)				
D(LSENSEX) = C(1)*(LSENSEX(-1) - 1.33523486454*LGOLD(-1) - 0.0798662908257*LPALMOIL(-1) + 0.720361547115*LCRUDEOIL(-1) - 1.37756720092*LCOPPER(-1) + 6.22973611876) + C(2)*D(LSENSEX(-1)) + C(3)*D(LSENSEX(-2)) + C(4)*D(LGOLD(-1)) + C(5)*D(LGOLD(-2)) + C(6)*D(LPALMOIL(-1)) + C(7)*D(LPALMOIL(-2)) + C(8)*D(LCRUDEOIL(-1)) + C(9)*D(LCRUDEOIL(-2)) + C(10)*D(LCOPPER(-1)) + C(11)*D(LCOPPER(-2)) + C(12)				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.003234	0.001579	-2.048374	0.0407*
C(2)	0.071327	0.026971	2.644581	0.0083*
C(3)	-0.016480	0.027015	-0.610035	0.5419
C(4)	-0.044438	0.033520	-1.325722	0.1851
C(5)	-0.036515	0.033540	-1.088671	0.2765
C(6)	-0.010008	0.025207	-0.397047	0.6914
C(7)	0.020002	0.025251	0.792121	0.4284
C(8)	0.000454	0.009881	0.045951	0.9634
C(9)	-0.010763	0.009871	-1.090352	0.2757
C(10)	-0.018225	0.017704	-1.029422	0.3035
C(11)	0.004157	0.017688	0.234998	0.8142
C(12)	0.000451	0.000221	2.038324	0.0417*
R-squared	0.012685	Mean dependent var		0.000467
Adjusted R-squared	0.005185	S.D. dependent var		0.008438

S.E. of regression	0.008416	Akaike info criterion	-6.709070
Sum squared resid	0.102572	Schwarz criterion	-6.665622
Log likelihood	4909.621	Hannan-Quinn criter.	-6.692862
F-statistic	1.691271	Durbin-Watson stat	2.000384
Prob(F-statistic)	0.069810		

*significance at 0.05

Source: Author's Compilation

Table 5 depicts the results of Vector Error Correction Model, the p value is less than the significance value of 0.05 in case of C(1) which is the coefficient of cointegrating equation which shows 0.3% speed of adjustment towards the equilibrium.

Table 6: WALD Test

Null Hypothesis	Probability value
C(3)=C(4)=C(5)=C(6)=C(7)=C(8)=C(9)=C(10)=C(11)=0	0.6966

Source: Author's Compilation

Table 6 depicts the results of Wald Test,the p value is more than the significance value of 0.05 which shows that in the short run, no commodities are associated with the stock market.

4.5 Pairwise Granger Causality Test

To check the direction of causality, Granger causality test is used. In order to know which variable is grangerly causing other variable, this test is used. This test is having two possible outcomes i.e. Unidirectional Causality and Bidirectional Causality. If one variable causes other variable then it is known as unidirectional causality and if two variables are causing each other then it is Bidirectional causality.

Table 7: Pairwise Granger Causality Test

Null Hypothesis	F-Statistic	Prob.
LGOLD does not Granger Cause LSENSEX	4.44691	0.0119*
LSENSEX does not Granger Cause LGOLD	2.62827	0.0725
LCRUDEOIL does not Granger Cause LSENSEX	1.20965	0.2986
LSENSEX does not Granger Cause LCRUDEOIL	3.08252	0.0461*
LCOPPER does not Granger Cause LSENSEX	2.35561	0.0952
LSENSEX does not Granger Cause LCOPPER	3.67230	0.0257*
LPAMOIL does not Granger Cause LSENSEX	4.15662	0.0158*
LSENSEX does not Granger Cause LPALMOIL	0.44297	0.6422

*significance at 0.05Source: Author's Compilation

Table 7 depicts the results of granger causality test, 4 unidirectional relationship found. Gold and Palmoilgrangerly causes Sensex while on the other hand,Sensexgrangerly causes Crudeoil and Copper prices.

4.6 Multivariate Diagonal VECH GARCH (1, 1) Model

To, check the spillover effect, different multivariate GARCH model is used. Diagonal VECH is one of the most popular method to check: 1) Own & cross past shocks effect, 2) Own & cross past volatility effect, 3) Asymmetric effect. In order to apply this model, ARCH-LM test should be significant, so as to ensure the ARCH effects in the model which leads to the usage, implication and reliability of the test. In our study all the bivariate models shows the presence of ARCH effects.

Table 8: Diagonal VECH		
	SENSEX	GOLD
aij		
SENSEX	0.064*	
GOLD	0.071*	0.131*
bij		
SENSEX	0.903*	
GOLD	0.880*	0.858*
dij		
SENSEX	2.41E-06*	
GOLD	2.67E-06*	2.96E-06*

Table 9: Diagonal VECH		
	SENSEX	CRUDE
aij		
SENSEX	0.049*	
CRUDE	0.001	0.069*
bij		
SENSEX	0.914*	
CRUDE	0.91*	0.924*
dij		
SENSEX	2.66E-06*	
CRUDE	1.88E-07	4.32E-06*

Table 10: Diagonal VECH		
	SENSEX	COPPER
aij		
SENSEX	0.072*	
COPPER	-0.055	0.043*
bij		
SENSEX	0.896*	
COPPER	0.547	0.903*
dij		
SENSEX	2.45E-06*	
COPPER	3.20E-06	9.30E-06*

Table 11: Diagonal VECH		
	SENSEX	PALM
aij		
SENSEX	0.067*	
PALM	-3.47E-05	1.78E-08
bij		
SENSEX	0.899*	
PALM	-0.939*	0.980*
dij		
SENSEX	2.49E-06*	
PALM	-2.03E-06*	1.65E-06*

*significance at 0.05

Source: Author's Compilation

From Table 8 results of bivariate Diagonal VECH GARCH (1, 1) Model, it can be concluded that Sensex and Gold were significantly impacted by its own as well as cross past volatility shocks as the all coefficients of aij were significant. Further, own and cross volatility spillover impact was also found significant as all the coefficients of bij were significant.

From Table 9 results of bivariate Diagonal VECH GARCH (1, 1) Model, it can be concluded that Sensex and Crudeoil were significantly impacted by its own past volatility shocks as the coefficients of aij(where i=j only) were significant. Further, own and cross volatility spillover impact was also found significant as all the coefficients of bij were significant.

From Table 10 results of bivariate Diagonal VECH GARCH (1, 1) Model, it can be concluded that Sensex and Copper were significantly impacted by its ownpast volatility shocks as the coefficients of aij (where i=j only) were significant. Further, own volatility spillover impact was also found significant as the coefficients of bij(where i=j only) were significant.

From Table 11 results of bivariate Diagonal VECH GARCH (1, 1) Model, it can be concluded that Sensex and Palmoil were significantly impacted by its ownpast volatility shocks as the coefficients of aij(where i=j only) were significant. Further, own and cross volatility spillover impact was also found significant as all the coefficients of bij were significant.

5. Conclusion

The study focused on evaluating the dynamic relationship between Commodities and Indian Stock market and it can be concluded that the prices of all the variables were non

stationary at level and stationary at first difference. Also, with the help of Johansen cointegration test, it was found that there exists long term association between both the selected commodities and Indian stock index. Furthermore, Vector autoregressive model revealed that the speed of adjustment was 0.03% towards equilibrium and Wald test results concluded that no relationship between commodities and stock index the short run. It has also been found out through Granger causality test that both Gold and Palm oil granger causes Sensex while on the other hand, Sensex grangerly causes Crude oil and Copper prices. At last, Cross volatility spillover found between Gold and Sensex, Crude oil and Sensex, Palm oil and Sensex which revealed that there exists an impact of fluctuations in one market leads to the fluctuations in other market.

So, in order to take any investment decision, investors should take in to consideration all the factors affecting the prices of both Commodities as well as Indian stock market to make their portfolio efficient.

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