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Causality between Macroeconomic Variables andStock Market in India

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Abstract: *The present study tries to explore the time series relationship between the stock market and macroeconomic variables. Quarterly data of BSE Sensex, Exchange rate, Index of Industrial Production, Wholesale Price Index and Gross value Added over the period April 2012 to June 2017 has been used in this study. Descriptive analysis, Pearson correlation, Unit root test and Granger Causality test are used to test the relationship between macroeconomic variables. Thestudy finds strong correlation between BSE Sensex, Exchange Rate, Industrial productivity and Gross Value Added. Although no causality relationship exists between respective variables and BSE Sensex, this may be due to the influence of other factors on stock market returns, warranting further research.*

Keywords: *Macroeconomic variables, Stock market, Unit Root test, Granger Causality Test*

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I. Introduction

Indian capital market has experienced tremendous changes since 1991, when the government has implemented liberalization and globalization more seriously than ever before. As a result, there can be little uncertainty about the increasing significance of the stock market from the point of view of the aggregate economy. Everyday activities and news are reflected in the stock market, some of them may be important to the stock market as they specify the variations in the economic and financial basics while others may be irrelevant. Negative events affect Stock Market consistently faster than positive elements. The stock market is one of the important components of a free-market economy, as it helps to arrange long term capital for the listed companies from investors in exchange for shares in ownership.The stock market offers alternative investment opportunities to the investors so that they can invest their surplus funds judiciously. The investors observe the composite market index before investing their money.

The market index may be considered as abenchmark to compare the performance of individual portfolios and also helps in predicting future trends in the market. Especially the stock market of developing economies isexpected to be more sensitive to changes in economic policies and structure than the stock markets of developed countries. Several studies show conflicting results regarding the relationship between macroeconomic variables and stock market returnssuch as Agrawalla (2006) stated that rising indices in the stock markets cannot be taken to be a leading indicator of the revival of the economy in India and vice-versa. However, Shah and Thomas (1997) held the idea that stock prices act as a mirror which reflect the real economy. Similarly, Kanakaraj et al. (2008) examined the trend of stock prices and various macroeconomic variables between the time periods 1997-2007 and tried to find out if the rise in the stock market can be explained in the terms of macroeconomic fundamentals and concluded by recommending a strong relationship between the two. From the perspective of investors, policy makers and researchers, it has become important to study the interaction of stock market returns and the macroeconomic variables because both investors and policy makers are concerned about the changes in stock prices due to any change in the economy.Thus the present study tries to investigate whether there is any causal relationship persisting in India between macroeconomic variables, namely, Gross Value Added (GVA), Wholesale Price index (WPI), Index of Industrial Production (IIP), Exchange rate (Rs./US$), and Indian stock market in the form of BSE SENSEX by using quarterly data from April, 2012 to June, 2017. In this study relationship between the selected macroeconomic variables and BSE Sensex is tested by using descriptive analysis, correlation analysis, and Granger Causality test. The results would be advantageous for the traders, investors,policy makers and academicians concerned with future research.

II. Literature Review

Abdalla and Murinde (1997) studied the interaction between stock prices and exchange rates in India, Korea, Pakistan and Philippines. The study found unidirectional causality from exchange rates to stock prices in all sample countries except Philippines.Ibrahim (2000) examined the causal relationship between stock prices and exchange rates and found no long run relationship between exchange rates and stock prices. Gay (2008) studied the relationship between stock market with exchange rate and oil prices among Brazil, China, India and Russia by using Box - Jenkins ARIMA model. The study found no significant relationship between respective variables and stock market. The study concluded that the markets of Brazil, Russia, India, and China (BRIC) showed the weak-form of market efficiency.Rahman and Uddin (2009) examined the relationship between stock market and exchange rate of three emerging countries of South Asia named as Bangladesh, India and Pakistan for the period 2003 to 2008. The study found no co-integrating relationship between stock prices and exchange rates. The Granger causality test showed there was no causal relationship between stock prices and exchange rates in selected countries for the study period.Noman, Kabir and Bashar (2012) conducted Granger Causality test between foreign exchange market and stock market in Bangladesh and found no relationship between stock market and foreign exchange market.Vashistha, Singh and Kumar (2013) studied the relationship between economic growth and capital market for the study period 2006 to 2011. The study concluded that there was moderate relationship between IIP and S&P BSE Sensex during the study period. However, Wholesale Price Index and Sensex showed high correlation in 2009-10, low in 2008-09 and moderate 2006-07, 2007-08 and 2010-11. Parmar (2013) analysed the inter relationship amongReverse Repo rate, Cash Reserve Ratio, Statutory Liquidity Ratio, Repo rate, Inflation rate, Consumer Price Index, Index of Industrial Production, Gold rate, Oil rate, Exchange rate and their impact on stock market during the study period 2004 to 2012. The study concluded that domestic macroeconomic variables had more impact on the stock market as compared to global variables.Somasundaram and Muthukumaran (2014) analysed the association between exchange rate and stock returns for the period 1997 to 2014. Granger Causality testfound that there was no causal relationship between stock returns and exchange rate.Mohanamani and Sivagnanasithi(2014) investigated the impact of macroeconomic variables on the behaviour of Indian Stock market and found positive relationship between stock market and WPI, Industrial productivity and money supply. FIIs and exchange rate showed insignificant relationship. Granger causality revealed that WPI and IIP influence the stock market to a great extent.Ahmad and Sinha (2016) examined the dependency of Sensex on GDP and Exchange rates from 2012 to 2014. The study showed that significant relationship was between GDP and BSE Sensex, while Exchange rate showed insignificant relationship with Sensex.Upadhyay (2016) studied the casual relationship between Interest rates and stock returns using monthly data. The Granger test found that no causality runs between interest rates and Stock returns.

Previous studies have shown mixed results. Vashistha, Singh and Kumar (2013), Mohanamani and Sivagnanasithi(2014),Ahmad and Sinha (2016) found significant relationship between macroeconomic variables and stock market.Noman, Kabir and Bashar (2012)Rahman and Uddin (2009), Somasundaram and Muthukumaran (2014),Ibrahim (2000) found no causal relationship between stock market and exchange rate. Most of the studies had examined thecausal relationship between stock market and exchange rate. In this study the effort has been made to observethe correlation and casual relationship between stock market and macroeconomic variables such as Gross Value Added, Index of Industrial Production, Wholesale Price Index and Exchange rate.

III. Objectives Of The Study

- To examine the correlation between BSE Sensex and macroeconomic variables.
- To investigate the causal nexus between BSE Sensex and macroeconomic variables.

IV. Data And Methodology

Data: In this study the quarterly data from April 2012 to June 2017is taken to examine the relationship between BSE Sensex and macroeconomic variables namely, Gross Value Added (GVA), Wholesale Price Index (WPI), Index of Industrial Production (IIP) and Exchange rate. The data is collected from the official source of Reserve Bank of India (RBI) and Bombay Stock Exchange (BSE). The study is empirical in nature.

Tools Used: Statistical and econometric tools have been used to test and verify the results of the study for their accuracy. Following tools are used in the present study:

Unit Root Test

Unit root test is used to check the stationarity in a time series. A time series has a stationarity if a shift in time does not cause a change in the shape of the distribution. Non stationary data cannot be used for empirical study as it can lead to spurious results. In this study Augmented Dickey Fuller (ADF) test has been used to investigate whether the time series is stationary or not. ADF test is an augmented version of Dickey Fuller test

for larger and more complicated sets of model. Augmented Dickey-Fuller (1979) test is obtained by the following regression:

$$\Delta Y_t = \beta_1 + \beta_2 + \delta Y_{t-1} + \alpha i \sum_{t=1}^{m} \Delta Y_{t-1} + \varepsilon_t$$

Where Δ is the difference operator, β, δ and α are the coefficients to be estimated, Y is the variable whose time series properties are examined and ε is the error term.It tests the null hypothesis that a unit root is present in a time series. If the absolute test statistics is more than absolute critical value then null hypothesis is rejected.

Pearson coefficient of correlation

Correlation coefficient is used to measure how strong a relationship is between two variables. Pearson's correlation coefficient is a linear correlation coefficient that returns a value between -1 and +1.

Granger causality test

The Granger Causality tests are proposed by Granger (1969) and popularized by Sims (1972). It is designed to find whether the past values of variable X helps to predict change in Y variable or vice versa. The Granger Causality method has been applied to identify the direction of causality that runs between the selected variables in our model, namely BSE Sensex, Wholesale Price Index(WPI), Industrial productivity (IIP), Exchange rate and Gross Value Added (GVA). The Granger Causality test involve estimation of following two equation to see if Y variable granger cause X variable and X variable granger cause Y variable.

$$X_t = \sum_{i=1}^{p} \alpha_i X_{t-i} + \sum_{j=1}^{q} \beta_j Y_{t-j} + u_t$$

$$Y_t = \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=1}^{q} \beta_j X_{t-j} + u_t$$

Where X_t and Y_t are the logarithm of X variable and Y variable respectively.u_t is the noise series, p and q are optimal number of lags of X and Y variable. The tests are conducted within the framework of F- test. If the computed F-value exceeds the critical F-value at the chosen level of significance, the null hypothesis is rejected. This would imply that one variable granger cause another variable.

V. Empirical Results And Discussion

This section presents the summarized results of descriptive statistics, Augmented Dickey Fuller Test, Pearson Correlation and Granger Causality Test. Table 1represents thequarter wise data of the selected parameters under the study which ranges from April 2012 to June 2017

Table 1: Indian Macroeconomic variables

YEAR	Quarter	BSE	IIP	GVA	INR/US$ Rate	WPI
2012-13	Q_1	16989.11	102.20	20745.89	54.22	105.10
	Q_2	17809.49	100.13	20479.09	55.24	106.90
	Q_3	19090.66	103.03	21775.28	54.14	107.27
	Q_4	19197.43	107.93	22462.51	54.17	108.33
2013-14	Q_1	19553.43	103.30	22062.30	56.01	109.10
	Q_2	19115.06	104.90	21938.97	62.13	112.80
	Q_3	21042.38	106.17	23149.41	62.03	114.10
	Q_4	21340.08	112.50	23485.79	61.79	113.83
2014-15	Q_1	24016.31	109.10	23774.18	59.77	114.70
	Q_2	26387.86	109.53	23809.06	60.59	116.77
	Q_3	28019.75	110.23	24595.10	62.00	113.93
	Q_4	28833.98	115.17	25011.90	62.25	110.10
2015-16	Q_1	27540.19	110.37	25579.49	63.48	111.13
	Q_2	26850.83	112.13	25760.44	64.88	110.33
	Q_3	26306.68	114.90	26389.05	65.95	109.80
	Q_4	24404.85	121.43	27176.16	67.50	107.60
2016-17	Q_1	26424.77	118.23	27514.07	66.93	110.37
	Q_2	28123.33	117.17	27505.60	66.96	111.47
	Q_3	27069.83	119.30	28144.40	67.46	111.70
	Q_4	28673.26	125.17	28690.32	67.01	107.60
2017-18	Q_1	30661.94	120.63	29041.28	64.46	112.93

Source: Compiled from Handbook on Indian Economy

The value of BSE index has increased during the study period except for the year 2015-16. The value of index experienced maximum value 30661.94 during Q_1 of 2017-18. Index of Industrial Production(IIP), Gross Value Added(GVA), INR/US$ rate and Wholesale Price Index has shown mixed trend of upward and downward movements during the study period. The value of INR/US$ rate ranges from Rs.54/USD to Rs.68/USD during the study period. The INR/US$ rate experienced the maximum value Rs.67.50/USD during the 4th quarter of 2015-16. The Gross Value Added (GVA) has continuously increased from Q_3 of 2013-14 and reached to the maximum value 29041.28 during Q_1 of 2017-18. IIP and WPI experienced maximum percentage 125.17 and 116.77 during Q_4 of 2016-17 and Q_2 of 2014-15 respectively.The descriptive information about the selected parameters has been presented in table 2.

Table 2: Descriptive Statistics

Statistics	**Parameters**				
	BSE	**INR/US$ RATE**	**GVA**	**IIP**	**WPI**
Mean	24164.34	61.86	24718.59	111.60	110.76
Median	26306.68	62.13	24595.10	110.37	110.37
Maximum	30661.94	67.50	29041.28	125.17	116.77
Minimum	16989.11	54.14	20479.09	100.13	105.10
Std. Dev.	4262.81	4.68	2650.74	7.02	3.02
Skewness	-0.30	-0.49	0.07	0.17	0.06
Kurtosis	1.63	1.97	1.80	2.05	2.24
Jarque-Bera	1.95	1.77	1.27	0.88	0.52
Probability	0.38	0.41	0.53	0.64	0.77
Observations	21.00	21.00	21.00	21.00	21.00

Source: Compiled from Handbook on Indian Economy, RBI

The average index of BSE Sensex is 24164.34 during the study period with a high Standard Deviation (i.e.4262.81) implying a volatile stock market. The average industrial productivity represented by Index of Industrial Production is 111.60 per cent with a maximum of 125.17 per cent and minimum of 100.13percent. The analysis of INR/US$ rate shows a minimum of Rs.54.14/USD and maximum of Rs.67.50/USD while the average accounts at Rs.61.86 with a standard deviation of 4.68. BSE Sensex and Exchange rate is negatively skewed meaning that the mean of the observation is less than median, while other variables are positively skewed. It shows the deviation from normal distribution of the data. The values of Kurtosis indicate that all the variables are platykurtic(i.e. < 3) explaining that values are less concentrated around the mean. JarqueBera test is a goodness of fit test to check whether the data series has Skewness and Kurtosis matching the normal distribution. The value of JarqueBera test shows that the underlying series does not fit normal distribution. Hence, it may be concluded that the distribution of observation does not satisfy the requirement of normal distribution.

Thedata series used in the study are time series data. So the data must consistof the properties of a time series in terms of stationarity of data.Non stationary data cannot be used for empirical analysis. The Unit Root Test has been applied to ascertain the stationarity of data.Augmented Dickey Fuller (ADF) test has also used to investigate whether the time series data is stationary or not. The null hypothesis indicates that data has a unit root or is non- stationary.Following table shows the results of Augmented Dickey Fuller (ADF) test

Table 3: Augmented Dickey Fuller Test

Variable	**ADF t – value**	**Alpha (5% level)**	**p value**	**H_0**
At Level				
BSE Sensex	-1.589	-3.658	0.760	Accepted
Gross Value Added	-2.886	-3.710	0.190	Accepted
Index of Industrial Production	-2.349	-3.733	0.388	Accepted
INR/US$ Rate	-2.068	-3.674	0.529	Accepted
Wholesale Price Index	-4.617	-3.733	0.011	**Rejected**
Ist Difference				
BSE Sensex	-4.444	-3.760	0.016	**Rejected**
Gross Value Added	-7.487	-3.710	0.001	**Rejected**

Index of Industrial Production	-1.989	-3.733	0.563	Accepted
INR/US$ Rate	-3.238	-3.674	0.107	Accepted
IInd Difference				
Index of Industrial Production	-14.40	-3.733	0.001	**Rejected**
INR/US$ Rate	-5.331	-3.691	0.003	**Rejected**

***H_0:** Data has a unit root

In the above table the stationarity of the time series has been tested at 5 per cent level of significance with trend and intercept. Table 3 shows that only Wholesale Price Index (WPI) is stationary at Level because p-valueof WPI (0.011) is less than 5 per cent and value of absolute test statistic (4.617) is more than absolute critical value (3.733). Therefore, the null hypothesis is rejected. However the nullhypothesis of other variables is accepted at Levelbecause their p-value is more than 5 per cent.At 1st difference the null hypothesis of BSE Sensex and GVA is rejected as their p-value (0.016 and 0.001) is less than 5 per cent. Results indicate that null hypothesis of a unit root in case of IIP and INR/US$ rate is rejected at 2nd difference. So they are stationary at 2nd difference. Thus the variables BSE Sensex and Gross Value Added are individually integrated of the order I(1), Wholesale Price Index is integrated of the order I(0), whereas Index of Industrial Production and Exchange Rate is integrated of the order I(2).

Table 4: Pairwise Pearson Coefficient Of Correlation

		BSE Sensex	IIP	GVA	INR/US$ Rate	WPI
BSE Sensex	R Sig. (2- tailed)	1				
IIP	R Sig. (2- tailed)	0.805** 0.000	1			
GVA	R Sig. (2- tailed)	0.878** 0.000	0.955** 0.000	1		
INR/US$ Rate	R Sig. (2- tailed)	0.780** 0.000	0.858** 0.000	0.890** 0.000	1	
WPI	R Sig. (2- tailed)	0.377 0.092	0.100 0.666	0.162 0.482	0.295 0.195	1

** Correlation is significant at the 0.01 level (2- tailed)

The above correlation matrix shows that all the variables are positively correlated with each other explaining that when one variable increases other variable increase in the same direction. Gross Value Added (GVA) and Industrial productivityexperienced maximum correlation 0.955 during the study period. BSE Sensex, Gross Value Added (GVA), Index of Industrial Production (IIP) and INR/US$ Rate haveshown strong correlation with each other. However, Wholesale Price Index (WPI) shows weakcorrelation with GVA, IIP and Exchange rate and moderate correlation with BSE Sensex. The correlation is statistically significant at 0.01 level in the case of BSE Sensex, IIP, GVA and INR/US$ rate. The p-value of WPI has been more than 1 percent in all cases explaining that the correlation is not statistically significant.

Correlation analysis indicates only the positive or negative linear relationship between two variables. It does not explain the casual nexus between variables. The Econometric model, Granger Causality test has been used to ascertain the short run casual interdependence among the macroeconomics variables and BSE Sensex. The Granger Causality Test has been used to bring more precision to the analysis. The data has been transformed into stationary for causality test. The following table shows the results of Granger Causality test:

Table 5: Pairwise Granger Causality Tests

Null Hypothesis:	**F-Statistic**	**P. value Results**
BSE does not Granger Cause WPI	1.944	0.182 **Accepted**
WPI does not Granger Cause BSE	0.628	0.549 **Accepted**
INR/US$ Rate does not Granger Cause WPI	0.295	0.749**Accepted**
WPI does not Granger Cause INR/US$ Rate	0.110	0.896**Accepted**

GVA does not Granger Cause WPI	1.307	0.304**Accepted**
WPI does not Granger Cause GVA	0.863	0.445**Accepted**
IIP does not Granger Cause WPI	0.599	0.565**Accepted**
WPI does not Granger Cause IIP	1.390	0.286**Accepted**
INR/US$ Rate does not Granger Cause BSE	0.504	0.616 **Accepted**
BSE does not Granger Cause INR/US$ Rate	0.402	0.678**Accepted**
GVA does not Granger Cause BSE	0.035	0.965**Accepted**
BSE does not Granger Cause GVA	0.644	0.541**Accepted**
IIP does not Granger Cause BSE	0.109	0.897**Accepted**
BSE does not Granger Cause IIP	0.062	0.940**Accepted**
GVA does not Granger Cause INR/US$ Rate	2.468	0.126**Accepted**
INR/US$ Rate does not Granger Cause GVA	1.242	0.323**Accepted**
IIP does not Granger Cause INR/US$ Rate	3.473	0.064**Accepted**
INR/US$ Rate does not Granger Cause IIP	2.332	0.139**Accepted**
IIP does not Granger Cause GVA	12.48	0.001 Rejected
GVA does not Granger Cause IIP	9.560	0.003 Rejected

According to existing literature the granger causality results are sensitive to the selection of lag length. As per, Akaike Information Criteria (AIC), the optimum lag is one which minimizes the value of AIC. In this study lag 2 is the appropriate lag order chosen in terms of AIC.Thep-value shows bi directional relationship between Index of Industrial Production (IIP) and Gross Value Added (GVA). It implies that IIP affects GVA and GVA also affects IIP. In other cases the null hypothesis cannot be rejected because the p–value has been more than 5 per cent explaining that the data does not indicate significant evidence of causality among the rest of the variables. In other words, there is no causality between BSE and WPI, BSE and exchange rate, BSE and IIP, WPI and IIP, INR/US$ Rate and WPI, GVA and WPI, GVA and BSE, GVA and INR/US$ Rate, IIP and Exchange rate during the study period.

VI. Conclusion

Thispaper attempts to examine the relationship between stock market as represented by BSE Sensex and a set of macroeconomic variables by using quarterly data from April 2012 to June 2017. By employing correlation analysis, the study establish positive strong relationship between BSE Sensex, Exchange rate, GVA and IIP. However Wholesale Price Index shows weak to moderate correlation with these variables. The Granger Causality test does not find any evidence of causality running from macroeconomic variables to BSE Sensex and vice-versa. Index of Industrial Production (IIP) and Gross Value Added (GVA) have shown bi-directionalcausality relationship during the study period.The results would help traders, policy makers and investors in Indian stock market in decision making. However the study can be more refined by analysing the relationship for longer period of time.

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