CAUSALITY BETWEEN STOCK MARKET AND MACRO-ECONOMIC INDICATORS IN INDIA – AN EMPIRICAL ANALYSIS

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Abstract

The stock market index of any country has got unprecedented importance in recent days as it is highly sensitive and responsive to the internal and external macroeconomic factors. The present study evaluates the relationship between the stock market index and the various macroeconomic indicators viz., inflation, exchange rate, foreign institutional investments (FII), index of industrial production and money supply and how they impacts the stock market in India over the period April 2005 to December 2015. The Vector Error Correction Model (VECM) is used to evaluate the results. The major findings of the study are; there exists long run bi-directional causality between the inflation (CPI), money supply (MS) and exchange rate (ER) in India, unidirectional causality between BSE SENSEX (BS), index of industrial production (IIP) and net foreign institutional investments (FII) with inflation (CPI), money supply (MS) and exchange rate (ER) in the long run. In the short run, there exists bidirectional causality between the inflation (CPI), index of industrial production (IIP) and money supply (MS), a unidirectional causality between the BSE SENSEX (BS) and exchange rate (ER) from BS to ER, money supply (MS) and exchange rate (ER) from MS to ER, money supply (MS) and net foreign institutional investments (FII) from MS to FII and between the index of industrial production (IIP) and net foreign institutional investments (FII) from IIP to FII. The macroeconomic indicators effect transmission mechanism impacting stock market is also presented in the study.

Key Words: *Cointegration,VECM, Stock Market Index, Macroeconomic variables.*
JEL Classification: *C32, G1, E1.*

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I. INTRODUCTION

India is progressing at a relatively faster pace for achieving high growth rate by adopting series of initiatives like economic reforms, digital India initiative, Make in India, etc. The primary focus of these initiatives is to give boost to the manufacturing industries in India due to lackluster performance in recent past. The scarcity of funds to boost the manufacturing sector has compelled the government of India to explore the opportunities outside for attracting the investors who are keen to invest in India. Any investor who wishes to invest in any country prima facea evaluates the investment opportunity by analysing the performance of the existing stock market as it is the index of market performance. There are several indices, but the stock market index of any country has got unprecedented importance for the foreign investors as it is highly sensitive and responsive to the internal and external macroeconomic factors. It is an essential element of any economy for attracting funding for companies and governments directly from the investors to support investment projects or expansion of institution. As pointed out by Kshitij Anand (2014), if GDP growth hits 8%, Sensex may touch 35,000. Thus, the stock market has taken the place of de facto 'Leading Economic Indicator' as it is appropriately accommodating the fluctuations in the market or economy. In India, the stock market index BSE SENSEX comprising of stock prices of 30 commodities of major companies of different sectors (like ICICI bank, Infosys, TCS, SBI, Reliance, ONGC, Maruti Suzuki, etc.) representing India's market is considered as one of the important indicator, as it reflects the fluctuations taking place in major sectors of Indian market.

The volatility of stock market is the outcome of various economic and non-economic factors, but when the market is volatile, market sentiments are more important than the facts. The market sentiments are influenced by the various economic factors like inflation, monetary policy of Central Bank, money supply in the market by banks, growth of manufacturing or industrial sector, foreign institutional investments, exchange rate fluctuations, etc. Any changes caused in these variables make direct impact on the sentiments of the investors reflected by the stock market index volatility. In context of India, the underperformance of manufacturing sector leads to high cost and low production, raising the prices in the market and causing cost-push inflation in the economy. The high inflation result in loss of international competitiveness of manufacturing goods for exports and on the other hand increases the imports of the country. This puts pressure on exchange rate and thus increases the exchange rate volatility. The exchange rate volatility impacts the sentiments of foreign institutional investors resulting in increased inflow or outflow of investments causing stock market volatility. Thus, there exists an intricacy of relationship between the stock market index and the various macroeconomic variables.

Hence, the present study is intended to study the empirical relationship and causality between the stock market index BSE SENSEX and various economic factors like inflation, money supply, index of industrial production, exchange rate and foreign institutional investments and evaluate the transmission mechanism between the variables. The rest of the paper is organized as below: Section II reviews the existing literature, Section III: discusses the methodology, Section IV: deals with empirical analysis, Section V: discusses the empirical findings, Section VI: concludes with policy implications and Section VII: discusses limitations and further scope of research.

II. LITERATURE REVIEW

Pooja Singh (2014) studied the relationship between macroeconomic variables and Indian stock market from Jan 2011 to Dec 2012 by taking the monthly data of Stock Indices BSE Sensex and S&P CNX Nifty and various macroeconomic indices namely; Index of Industrial Production, Wholesale Price Index,Money Supply, InterestRates, Trade Deficit, Foreign Institutional Investment, Exchange rate, Crude Oil Price and GoldPrice. The study shows that exchange rate Granger cause stock market and there exists unidirectional causal relationship from exchange rate to stock market and from money supply to S&P CNX Nifty.

Patel Samveg (2012) investigated the effect of macroeconomic determinants on the performance of the Indian Stock market using monthly data over the period January 1991 to December 2011 usingeightmacroeconomic variables, viz., Interest Rate,Inflation, Exchange Rate, Index of IndustrialProduction, Money Supply, Gold Price, Silver Price &Oil Price, and two stock market indices namelySensex and S&P CNX Nifty. The study found that Interest Rate is I(0); Sensex, Nifty, Exchange Rate, Index of Industrial Production, Gold Price, Silver Price and Oil Price are I(1); and Inflation and MoneySupply are I (2). The study also revealed thecausality run from exchange rate to stock marketindices to IIP and Oil Price.

Kantesha et. al. (2014) studied the empirical relation between Indian stock market and macro-economic factors namely; GDP, exchange rate, inflation rate, gross domestic savings, capital formation/investment and Indian stock market for the period April 1998 to March 2014. They found that the depreciation in the rupee against the dollar has led to decrease in the share prices and increase in the inflation rate has led to decrease in the share prices, but the effect of changes in inflation rate on BSE Sensex is very less. The study concludes that other than the exchange rate and inflation rate, the factors like interest rate, market sentiments, global factors, performance of company, etc., affect the Indian stock market.

Aurangzeb (2012) conducted study to identify the factors affecting the performance of stock market in South Asia for the period 1997 to 2010 comprising South Asian countries, namely, Pakistan, India and Sri Lanka. The study indicates that foreign direct investment and exchange rate have significant positive impact while interest rate has negative and significant impact on performance of stock market in South Asia. The inflation has negative but insignificant impact on stock market performance in South Asia.

Jareno & Negrut (2016) analyzed the relationship between the US stock market and some relevant US macroeconomic factors such as gross domestic product, the consumer price index, the industrial production index, the unemployment rate and long-term interest rate for the quarterly data for the period 2008-2014. The study concludes that the US stock market exhibits a positive and significant relationship with the gross domestic product and the industrial production index and a negative and statistically significant relationship with the unemployment and interest rate variables.

Gay R. D (2008) studied the relationship between the macroeconomic factors such as foreign exchange rate and oil prices and the stock market return between 1999:03 to 2006:06 for Brazil, Russia, India and China. He concludes that the exchange rate and oil price did not reveal any significant relationship with stock prices in Bazil, Russia, India and China.

Acikalin et. al. (2008) examined the relationships between returns in Istanbul Stock Exchange (ISE) and four macroeconomic variables, viz., GDP, exchange rate, interest rate and current account balance in Turkish economy by employing cointegration tests and vector error correction model on a quarterly data set from last quarter of 1991 to last quarter of 2006. The study concludes that there exists unidirectional relationship between macroeconomic indicators and Istanbul stock exchange index.

Also, the changes in GDP, foreign exchange rate and current account balance have an effect on ISE index, but on the contrary, changes in stock market index do affect interest rate.

Naik & Padhi (2012) investigated the relationships between the Indian stock market index (BSE Sensex) and five macroeconomic variables, namely, industrial production index, wholesale price index, money supply, treasury bills rates and exchange rates over the period April 1994 to June 2011. The study concludes that the macroeconomic variables and stock market index are co-integrated and long run relationship exists between them. The stock prices are positively related to the money supply and industrial production but negatively related to inflation. The exchange rate and the short-term interest rate are found to be insignificant in determining stock prices. There is bidirectional causality between industrial production and stock prices, whereas, unidirectional causality from money supply to stock price, stock price to inflation and interest rate to stock price.

Joshi & Saxena (2011) studied the impact of FII on Stock market with reference to BSE Sensex for the last quarter of 2011 and analyzed the monthly and overall impact. The study concludes that FII has significant impact on BSE Sensex.

Olowe (2007) investigated the relationship between the Nigerian Stock Exchange Index and the various macroeconomic variables namely, industrial production index, the consumer price index, money supply, oil prices and treasury bill rates. The study concludes that there exists a cointegrating relation among the macroeconomic variables.

Thus, from the various literatures, the nature of causality between the various macroeconomic variables and stock market index is still unresolved as many researchers came out with different causalities. Also the different countries have different directions of causality, especially the developing county like India where there is a wave of industrialization, the sector is gaining more importance in terms of policy focus of the government like 'make in India' and attracting the investors to invest in India. In such occasions, stock market of any country plays significant role as it is the index of not only the stock market, but the index of the economy as a whole as it is being treated as the leading economic indicator. Thus, there is a need for more empirical research on the subject matter as the stock market index must be appropriately regulated by the authorities by controlling various other macroeconomic variables as they affect the sentiments of the market as reflected by the stock market of any country, hence the present study is proposed.

III. METHODOLOGY & DATA

The objective of the paper is to evaluate the causality between the stock market index and the various macroeconomic indicators viz., inflation, exchange rate, foreign institutional investments (FII), index of industrial production and money supply and how theyimpacts the stock market in India.The macroeconomic variables are selected based on the literature review and relative importance of these variables in influencing stock market. The basic model employed in this study is given as:

$$BS = \alpha_0 + \alpha_1 CPI_t + \alpha_2 ER_t + \alpha_3 IIP_t + \alpha_4 MS_t + \alpha_5 FII_t + \varepsilon_t \quad \text{------- \{1\}}$$

Where, IIP is the index of industrial production (base 2004-05), ER is the real exchange rate, CPI is used as proxy for inflation represents consumer price index (base 2004-05), and MS is the broad money supply (MS) (base 2004-05). The monthly data is used for the study from April 2005 to December 2015. The data of exchange rate and broad money supply (MS) is taken from the Annual Reports, RBI Handbook of Statistics on Indian Economy and the data of index of industrial production and consumer price index (CPI) is taken from Ministry of Statistics and Programme Implementation, Government of India and the data for stock indices is taken for Bombay Stock Exchange, Market Indices for SENSEX (S&P) (BS). The reason for selecting this period is the common base year 2004-05 for two series IIP and

CPI. Secondly, the period covered for the study is last 10 years is also considered appropriate sample data to analyze the impact. The five variables, CPI, ER, IIP, MS and FII are selected as they are found to be critical variables for estimation of the model. Also the coefficient of correlation between these variables is found to be strong. The descriptive statistics of the variables is shown below in table 1:

Table 1: Descriptive Statistics

	BS	CPI	ER	IIP	MS	FII
Mean	17411.42	220.0354	50.53306	154.5591	62053.46	7423.694
Median	17429.98	218.8030	47.06132	161.4000	58544.53	5447.300
Maximum	29220.12	238.6540	66.55245	198.1000	113004.4	36046.00
Minimum	6154.440	194.4000	39.36519	99.08380	23299.37	-44162.00
Std. Dev.	5567.738	13.21415	7.768722	23.89374	27338.22	13194.78
Skewness	0.220804	-0.252716	0.558478	-0.615112	0.254201	-0.138489
Kurtosis	2.625661	1.877449	2.024250	2.558510	1.813480	3.853434
Jarque-Bera	1.801412	8.146264	11.82327	9.182458	8.956372	4.327231
Probability	0.406283	0.017024	0.002708	0.010140	0.011354	0.114909
Sum	2246074.	28384.57	6518.765	19938.13	8004896.	957656.5
Sum Sq. Dev.	3.97E+09	22350.57	7725.190	73076.57	9.57E+10	2.23E+10
Observations	129	129	129	129	129	129

For model estimation, the Augmented Dickey-Fuller (1979) test is employed to infer about the stationarity of the series by employing unit root test. If there exists a non-stationarity in levels and stationarity in differences, then there exists a chance of cointegration relationship, which reveals the long-run relationship between the variable series.

Johansen's (1988) cointegration approach and Vector Error Correction Model (VECM) have been employed to investigate the causal nexus between the six variables (BS, CPI, ER, IIP, MS and FII). Johansen's cointegration test has been employed to investigate the long-run relationship between the four variables. Also, the causal relationship between these variables is investigated by estimating the following Vector Error Correction Model (VECM) (Johansen, 1988):

$$\Delta X_t = \sum \Gamma_i \Delta X_{p-1} X_{t-1} \; ; \quad \varepsilon_t \mid \Omega_{t-1} \sim \text{distr}(0, H_t)$$

---------- {2}

Whe $i = 1$ the 6 x 1 vector of BS, CPI, ER, IIP, MS and FII, respectively, Δ denotes the first difference operator, $\varepsilon_t$is a 6 x 1 vector of residuals ($\varepsilon_{BS,t}$, $\varepsilon_{CPI,t}$, $\varepsilon_{ER,t}$, $\varepsilon_{IIP,t}$, $\varepsilon_{MS,t}$, $\varepsilon_{FII,t}$,) that follow an as-yet-unspecified conditional distribution with mean zero and time-varying covariance matrix, H_t. The VECM specification contains information on both the short and long-run adjustment to changes in X_t, via the estimated parameters $\Gamma_i$and $\prod$, respectively.

To identify the cointegration between the above six series, Johansen's cointegration test comprising of two likelihood ratio tests is employed. The variables are cointegrated if and only if a single cointegrating equation exists. The first statistic λ_{trace} tests the number of cointegrating vectors if zero or one, and the other λ_{max} tests whether a single cointegrating equation issufficient or if two are required. In general, if r cointegrating vector is correct, the following test statistics can be constructed as:

$$\lambda_{trace}(r) = -T \sum \ln(1 - \hat{\lambda}) \quad \text{-----} \quad (3)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+i}) \quad \text{-----} \quad (4)$$

where $\hat{\lambda}_i$ are the eigen values obtained from the estimate of the Π matrix and *T* is the number of usable observations. The λ_{trace}tests the null that there are at most r cointegrating vectors, against the alternative that the number of cointegrating vectors is greater than r and the λ_{max}tests the null that the number of cointegrating vectors is r, against the alternative of r + 1. Critical values for the $\lambda_{trace}$and λ_{max}statistics are provided by Osterwald-Lenum (1992).

If the six variables BSE SENSEX (BS), Consumer Price Index (CPI), Exchange rate (ER), Index of industrial production (IIP), Money supply (MS) and net Foreign Institutional Investments (FII) are cointegrated, then causality must exist in at least one direction (Granger, 1988). Granger causality can identify whether two variables move one after the other or contemporaneously. When they move contemporaneously, one provides no information for characterising the other. If "X causes Y", then changes in X should precede changes in Y. Consider the VECM specification of Equation (2), which can be written as follows:

$$\Delta BS_t = \sum a_{BS,i}\,\Delta BS_{t-i} + \sum b_{BS,i}\,\Delta CPI_{t-i} + \sum c_{BS,i}\,\Delta ER_{t-i} + \sum d_{BS,i}\,\Delta IIP_{t-i} + \sum e_{BS,i}\,\Delta MS_{t-i} + \sum f_{BS,i}\,\Delta FII_{t-i} + a_{BS} z_{t-1} + \varepsilon_{BS,t} \quad (5)$$

$$\varepsilon_{i,t} \mid \Omega_{t-1} \sim \text{distr}\,(0, H_t)$$

$$\Delta CPI_t = \sum a_{CPI,i}\,\Delta BS_{t-i} + \sum b_{CPI,i}\,\Delta CPI_{t-i} + \sum c_{CPI,i}\,\Delta ER_{t-i} + \sum d_{CPI,i}\,\Delta IIP_{t-i} + \sum e_{CPI,i}\,\Delta MS_{t-i} + \sum f_{CPI,i}\,\Delta FII_{t-i} + a_{CPI} z_{t-1} + \varepsilon_{CPI,t} \quad (6)$$

$$\Delta ER_t = \sum a_{ER,i}\,\Delta BS_{t-i} + \sum b_{ER,i}\,\Delta CPI_{t-i} + \sum c_{ER,i}\,\Delta ER_{t-i} + \sum d_{ER,i}\,\Delta IIP_{t-i} + \sum e_{ER,i}\,\Delta MS_{t-i} + \sum f_{ER,i}\,\Delta FII_{t-i} + a_{ER} z_{t-1} + \varepsilon_{ER,t} \quad (7)$$

$$\Delta IIP_t = \sum a_{IIP,i}\,\Delta BS_{t-i} + \sum b_{IIP,i}\,\Delta CPI_{t-i} + \sum c_{IIP,i}\,\Delta ER_{t-i} + \sum d_{IIP,i}\,\Delta IIP_{t-i} + \sum e_{IIP,i}\,\Delta MS_{t-i} + \sum f_{IIP,i}\,\Delta FII_{t-i} + a_{IIP} z_{t-1} + \varepsilon_{IIP,t} \quad (8)$$

$$\Delta MS_t = \sum a_{MS,i}\,\Delta BS_{t-i} + \sum b_{MS,i}\,\Delta CPI_{t-i} + \sum c_{MS,i}\,\Delta ER_{t-i} + \sum d_{MS,i}\,\Delta IIP_{t-i} + \sum e_{MS,i}\,\Delta MS_{t-i} + \sum f_{MS,i}\,\Delta FII_{t-i} + a_{MS} z_{t-1} + \varepsilon_{MS,t} \quad (9)$$

$$\Delta FII_t = \sum a_{FII,i}\,\Delta BS_{t-i} + \sum b_{FII,i}\,\Delta CPI_{t-i} + \sum c_{FII,i}\,\Delta ER_{t-i} + \sum d_{FII,i}\,\Delta IIP_{t-i} + \sum e_{FII,i}\,\Delta MS_{t-i} + \sum f_{FII,i}\,\Delta FII_{t-i} + a_{FII} z_{t-1} + \varepsilon_{FII,t} \quad (10)$$

where a's, b's, c's, d's, e's and f's are the short-run coefficients, $z_{t-1} = \beta' X_{t-1}$ is the error- correction term which measures how the dependent variable adjusts to the previous period's deviation from long-run equilibrium from equation (2), and ε's are residuals. The hypothesis of short term causality is tested by applying Wald tests on the joint significance of the lagged estimated coefficients of ΔBS_{t-i}, ΔCPI_{t-i}, ΔER_{t-i}, ΔIIP_{t-i}, ΔMS_{t-i} and ΔFII_{t-i}.

Finally, the Impulse Response Function (IRF) and variance decomposition analysis has been employed to investigate the time paths of one variable in response to one-unit shock to the other variables and vice versa. The impulse response function analysis is a practical way to visualize the behaviour of a time series in response to various shocks in the system (Enders, 1995). The plot of the IRF shows the effect of a one standard deviation shock to one of the innovations on current and future values of the endogenous variables. This study includes six variables, viz. BS, CPI, ER, IIP, MS and FII, for the Impulse Response Function technique.

IV. EMPIRICAL RESULTS

1. Variables Estimation

The table 2 below presents the correlation between the variables under consideration:

Table 2: Correlation Matrix

	BS	CPI	ER	IIP	MS	FII
BS	1.000000	0.855843	0.707921	0.808995	0.883426	0.312689
CPI	0.855843	1.000000	0.822163	0.908345	0.967578	0.209183
ER	0.707921	0.822163	1.000000	0.650494	0.907497	0.135915
IIP	0.808995	0.908345	0.650494	1.000000	0.865425	0.280304
MS	0.883426	0.967578	0.907497	0.865425	1.000000	0.225812
FII	0.312689	0.209183	0.135915	0.280304	0.225812	1.000000

In the correlation matrix above, it can be seen that the BSE SENSEX (BS) is strongly correlated with the various indices like CPI, ER, IIP and MS but weakly correlated with Net FII. The other variables are also positively correlated with one another. The coefficient of correlation between CPI and Exchange rate, IIP and MS is very high and very low with FII. The coefficient of correlation between exchange rate and IIP and MS is very high and very low with Net FII. Also the coefficient of correlation between IIP and MS is high and low with FII and the coefficient of correlation between MS and FII is positive but low.

2. Unit Root Test

The Augmented Dickey-Fuller test (ADF) is employed to test the stationarity of the series BS, CPI, ER, IIP, MS and FII. The results are presented in Table 3 below:

Table 3: Unit Root Test

Series	Augmented Dickey-Fuller test statistic					
	Level	p-value	1st Difference	p-value	2nd Difference	p-value
BS (constant)	-1.467229	0.5471	-11.17455	0.0000	---	---
CPI (constant)	-1.685638	0.4361	-6.665952	0.0000	---	---
ER (constant)	-0.174164	0.9376	-8.887168	0.0000	---	---
IIP (constant)	-2.911174	0.0471	---	---	---	---
MS (constant)	2.218363	.9999	-1.814314	0.3720	-10.84919	0.0000
FII	-7.418943	0.0000	---	---	---	---

The test results reveals that the series BS, CPI and ER becomes stationary when their first difference is used and the series MS becomes stationary when their second difference is used. The series IIP and FII are stationary series. Hence, it can be inferred that except the series IIP and FII, all the series viz., BS, CPI, ER and MS have unit root, and possible cointegration amongst them. Thus, it can be assumed that some or all the variables are integrated in order of one or two, i.e., I(1) or I(2).

Having established that the variables are cointegrated, the Johansen's cointegration test is applied to determine the order of cointegration. The results of trace and λ_{max} are presented below in Table 4:

Table 4: Johansen Co-integration Test – r is the number of Cointegrating Vectors

Null	Alternative r	Trace Statistics	Critical value at 0.05	λ – max Statistics	Critical value at 0.05
None *	1	145.6911	95.75366	56.15179	40.07757
At most 1*	2	89.53935	69.81889	45.25239	33.87687
At most 2	3	44.28696	47.85613	22.25190	27.58434
At most 3	4	22.03506	29.79707	13.81464	21.13162
At most 4	5	8.220421	15.49471	8.076280	14.26460
* denotes rejection of the hypothesis at the 0.05 level					

As seen in table 4, the null hypothesis of no cointegration (none, 0) and at most one (r = 1) can be rejected using the trace or maximum eigen statistics. But the null hypothesis of cointegration (r = 2) cannot be rejected as the critical value is greater than the trace or maximum eigen statistics. Thus, it can be concluded that the six variables are cointegrated of order 2. The existence of cointegration implies the existence of long term causality. Also, the existence of cointegration indicates that any one variable can be targeted as a policy variable to bring about the desired changes in other variables in the system.

3. Results of Vector Error Correction Model

According to Granger Representation Theorem, if there is evidence of cointegration between two or more variables, then a valid error correction model exists between the six variables. The results of the estimated Vector Error Correction Model (VECM) are presented below in table 5.

Table 5: Vector Error Correction Estimates

Equation	D(BS)	D(CPI)	D(ER)	D(IIP)	D(MS)	D(FII)
ECC1	0.006744	2.50E-05*	-4.21E-05*	4.85E-05	0.020369*	-0.051881
	(0.01201)	(8.1E-06)	(1.1E-05)	(8.0E-05)	(0.00578)	(0.13197)
	[0.56169]	[3.08808]	[-3.96646]	[0.60844]	[3.52437]	[-0.39311]
ECC2	-19.46100	-0.064870*	0.110613*	-0.131701	-52.45105*	159.9194
	(31.3978)	(0.02118)	(0.02777)	(0.20825)	(15.1126)	(345.096)
	[-0.61982]	[-3.06229]	[3.98295]	[-0.63243]	[-3.47069]	[0.46340]
D(BS(-1))	-0.084479	0.000123	-0.000281*	4.93E-05	-0.055084	2.043026

	(0.11325)	(7.6E-05)	(0.00010)	(0.00075)	(0.05451)	(1.24479)
	[-0.74592]	[1.61130]	[-2.80498]	[0.06559]	[-1.01048]	[1.64126]
D(BS(-2))	-0.146732	-7.31E-05	0.000176**	-7.96E-05	0.004808	-0.575531
	(0.11749)	(7.9E-05)	(0.00010)	(0.00078)	(0.05655)	(1.29138)
	[-1.24886]	[-0.92181]	[1.69804]	[-0.10217]	[0.08502]	[-0.44567]
D(CPI(-1))	45.71473	0.637925*	-0.062437	-1.59452**	-6.066625	-802.3107
	(135.294)	(0.09128)	(0.11967)	(0.89733)	(65.1205)	(1487.03)
	[0.33789]	[6.98857]	[-0.52175]	[-1.77695]	[-0.09316]	[-0.53954]
D(CPI(-2))	26.24129	-0.178543**	-0.074108	-1.050673	38.19886	-582.4628
	(139.483)	(0.09411)	(0.12337)	(0.92512)	(67.1368)	(1533.07)
	[0.18813]	[-1.89722]	[-0.60068]	[-1.13572]	[0.56897]	[-0.37993]
D(ER(-1))	-54.31544	-0.065689	-0.039058	0.453137	-32.88659	1500.574
	(121.166)	(0.08175)	(0.10717)	(0.80363)	(58.3206)	(1331.75)
	[-0.44827]	[-0.80354]	[-0.36444]	[0.56386]	[-0.56389]	[1.12677]
D(ER(-2))	115.1005	-0.070756	-0.079592	-1.214509	-14.21040	981.0091
	(116.836)	(0.07883)	(0.10334)	(0.77491)	(56.2364)	(1284.16)
	[0.98514]	[-0.89760]	[-0.77018]	[-1.56728]	[-0.25269]	[0.76393]
D(IIP(-1))	-4.311213	-0.035187*	0.014159	-0.743497*	-26.50540*	98.87746
	(20.9944)	(0.01416)	(0.01857)	(0.13925)	(10.1052)	(230.752)
	[-0.20535]	[-2.48413]	[0.76247]	[-5.33948]	[-2.62295]	[0.42850]
D(IIP(-2))	-2.687707	-0.011837	-0.011758	-0.256066*	-15.50516*	370.1678*
	(15.3221)	(0.01034)	(0.01355)	(0.10162)	(7.37492)	(168.407)
	[-0.17541]	[-1.14504]	[-0.86759]	[-2.51975]	[-2.10242]	[2.19806]
D(MS(-1))	-0.043991	-0.000161	0.000424*	-0.004525*	-0.137797	-5.62678*
	(0.19886)	(0.00013)	(0.00018)	(0.00132)	(0.09571)	(2.18566)
	[-0.22122]	[-1.20134]	[2.41190]	[-3.43080]	[-1.43966]	[-2.57441]
D(MS(-2))	0.092037	-0.000104	0.000109	-0.001032	-0.078033	-0.934194

	(0.21175) [0.43465]	(0.00014) [-0.73091]	(0.00019) [0.58394]	(0.00140) [-0.73456]	(0.10192) [-0.76562]	(2.32738) [-0.40139]
D(FII(-1))	-0.016512 (0.01158) [-1.42640]	4.36E-06 (7.8E-06) [0.55771]	6.86E-06 (1.0E-05) [0.66954]	-4.87E-05 (7.7E-05) [-0.63436]	0.005141 (0.00557) [0.92260]	-0.42175* (0.12723) [-3.31475]
D(FII(-2))	0.002368 (0.00892) [0.26551]	1.19E-06 (6.0E-06) [0.19706]	-1.03E-05 (7.9E-06) [-1.30688]	-6.17E-05 (5.9E-05) [-1.04351]	-0.001469 (0.00429) [-0.34234]	-0.128762 (0.09802) [-1.31365]
C	121.2957 (240.560) [0.50422]	0.406799 (0.16230) [2.50641]	-0.109634 (0.21278) [-0.51525]	6.131425 (1.59551) [3.84292]	891.8406 (115.788) [7.70236]	4038.785 (2644.03) [1.52751]
R^2	0.061516	0.479251	0.347078	0.501177	0.178346	0.415075
F-statistic	0.519703	7.296747	4.214652	7.965997	1.720950	5.626288
Prob (F-statistic)	0.917223	0.000000	0.000007	0.000000	0.061085	0.000000
Model Specification Test Criteria:						
Normality Test	Not fulfilled*	Not fulfilled*	Fulfilled**	Fulfilled*	Not fulfilled*	Fulfilled*
Serial Correlation Test	No serial correlation*	No serial correlation*	No serial correlation*	No serial correlation*	No serial correlation*	No serial correlation *
Test for Heteroscedasticity (ARCH)	No ARCH effect*	No ARCH effect*	No ARCH effect*	No ARCH effect*	No ARCH effect*	No ARCH effect*

* signifies 5 % level of significance. ** signifies 10 % level of significance.

As can be seen in table 5, there are two error correction terms ECC1 and ECC2. The error correction terms corresponding to equation 6, equation 7 and equation 9 are of correct sign and are significant at 5% level of significance. But the error correction terms corresponding to equation 5, equation 8 and equation 10 are not significance even though they are of correct sign. The equation 6 indicates that BSE SENSEX (BS), exchange rate (ER), index of industrial production (IIP), money supply (MS) and net FII cause inflation (CPI) in the long run. The equation 7 indicates that BSE SENSEX (BS), inflation (CPI), index of industrial production (IIP), money supply (MS) and net FII cause exchange rate volatility in the long run. Also, equation 9 indicates that BSE SENSEX (BS), inflation (CPI), exchange rate

(ER), index of industrial production (IIP), and net FII cause money supply in the long run. Thus, there exists a channel of causation among the variables in the long run as shown below.

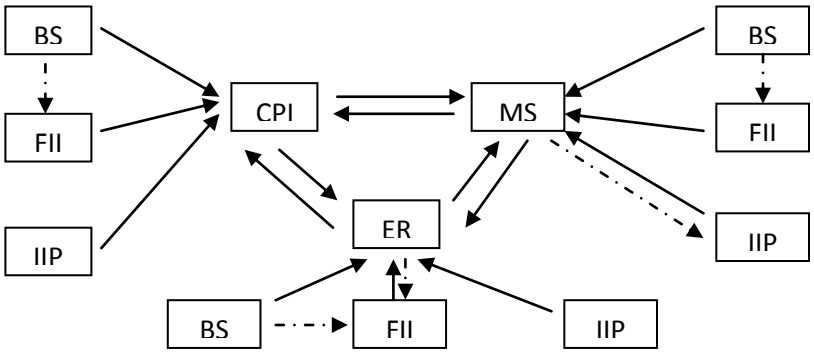


Fig 1: Long run Causality

From Fig 1, it can be seen that BSE SENSEX (BS), index of industrial production (IIP) and net foreign institutional investments (FII) has unidirectional causality with inflation (CPI), money supply (MS) and exchange rate (ER), but there exists bidirectional causality between inflation (CPI), money supply (MS) and exchange rate (ER) in the long run. The summary of the direction of causality in the short run is evaluated using Wald Chi-square test as shown below for equations 5 to 10 in table 6 below:

Table 6: Wald Test

Variable	**D(BS)**	**D(CPI)**	**D(ER)**	**D(IIP)**	**D(MS)**	**D(FII)**
D(BS) →	--	0.308437 (0.8571)	1.120295 (0.5711)	0.044131 (0.9782)	0.254460 (0.8805)	3.186329 (0.2033)
D(CPI) →	4.043684 (0.1324)	--	1.548302 (0.4611)	6.864015* (0.0323)	1.851363 (0.3963)	0.317061 (0.8534)
D(ER) →	12.65947* (0.0018)	1.373235 (0.5033)	--	4.434930 (0.1089)	5.974396* (0.0504)	3.862578 (0.1450)
D(IIP) →	0.017415 (0.9913)	9.366946* (0.0092)	2.673645 (0.2627)	--	11.98895* (0.0025)	1.113532 (0.5731)
D(MS) →	1.085903 (0.5810)	0.388693 (0.8234)	0.401357 (0.8182)	7.018484* (0.0299)	--	1.639900 (0.4405)
D(FII) →	3.219874 (0.1999)	0.928417 (0.6286)	1.969356 (0.3736)	7.251398* (0.0266)	6.667819* (0.0357)	--

( ) – indicates p – value.

* - significant at 5 % level of significance.

From the table 6, it is seen that in equation 5, inflation, exchange rate, index of industrial production, money supply and net FII does not cause BSE SENSEX in the short run. From equation 6, it can be inferred that index of industrial production causes inflation in the short run, but BSE SENSEX, exchange rate, money supply and net FII does not cause inflation in short period. The equation 7 shows that BSE SENSEX and money supply cause exchange rate in the short run, but inflation, index of industrial production and net FII does not cause exchange rate in the short run. In the equation 8, it can be seen that inflation and money supply cause index of industrial production in the short run, but BSE SENSEX, exchange rate and net FII does not cause index of industrial production in the short run. As seen in equation 9, only index of industrial production cause money supply in the short run and others are not causing money supply in the short run. Lastly, in equation 10, it is seen that index of industrial production and money supply cause net FII in the short run, but other variables, viz., BSE SENSEX, inflation and exchange rate does not cause FII in the short run. The summary of causality in short run is presented in fig. 2 below.

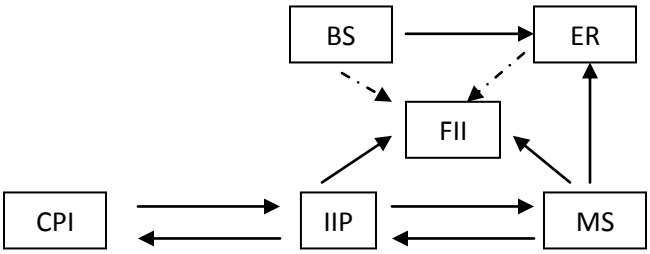
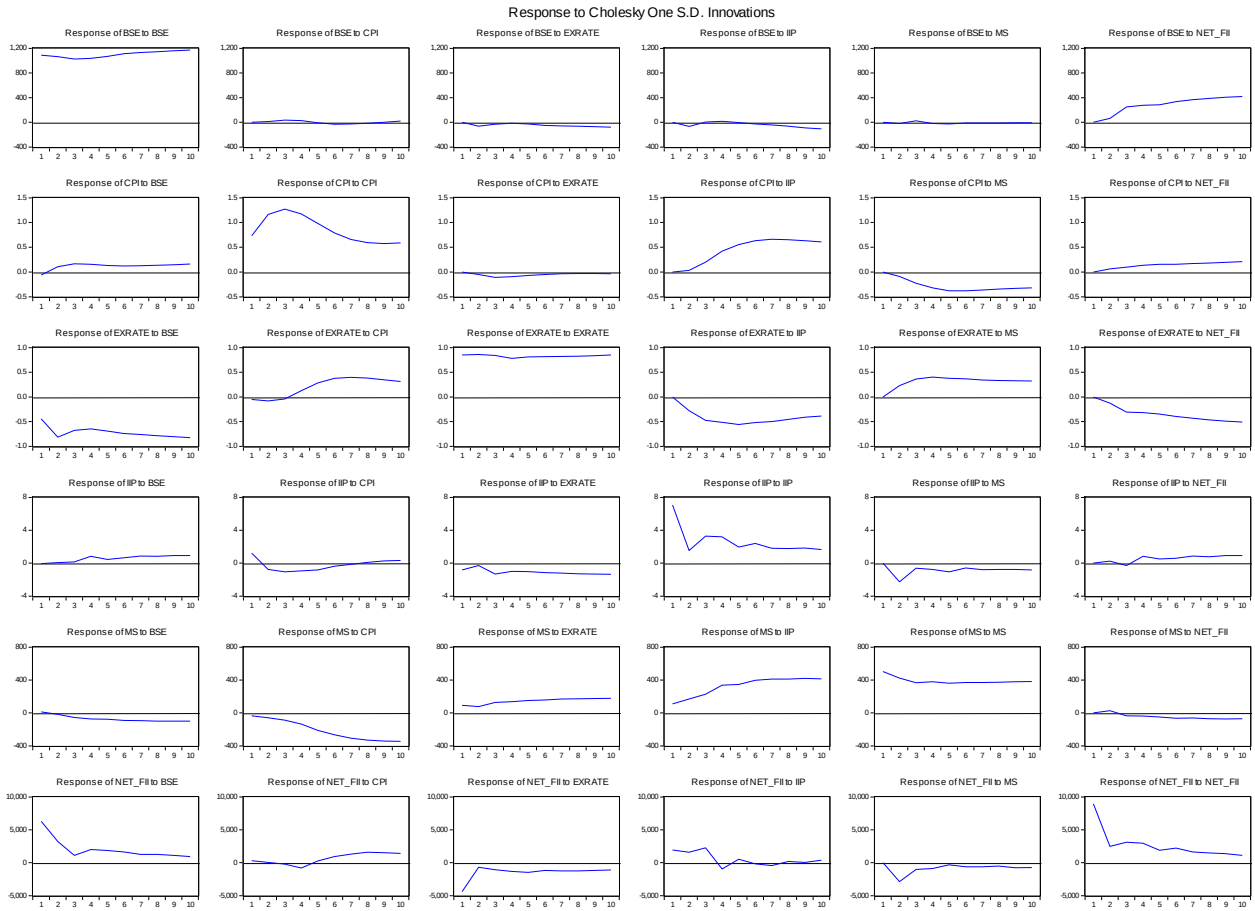


Fig. 2: Short run Causality

Thus, there exists a bi-directional causality between the inflation (CPI), index of industrial production (IIP) and money supply (MS) in the short run. But there exists a unidirectional causality between the BSE SENSEX (BS) and exchange rate (ER), money supply (MS) and exchange rate (ER), money supply (MS) and net foreign institutional investments (FII) and between the index of industrial production (IIP) and net foreign institutional investments (FII) in the short run.

The dynamic properties of the model are examined by the impulse response functions which capture the dynamic responses to the effect of shock in one variable upon itself and on all other variables. These impulse response functions are presented in fig. 3 below:

Fig. 3: Impulse Response Functions



As seen in figure 3, a one standard deviation shock applied to each variable to see the possible impact on other variables in the short and long run. As can be seen from the variables graphs, there is an evidence of the various results obtained as above in table 5 and 6 about the causality in short and long run. The variance decomposition test is performed to test and verify the causality in short and long run as shown below in table 7.

Table 7: Variance Decomposition

Variance Decomposition of BS:							
Period	S.E.	BS	CPI	ER	IIP	MS	FII
1	1087.060	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	1526.741	99.43817	0.005882	0.172965	0.188599	0.016611	0.177771
3	1855.279	97.72674	0.041913	0.143696	0.127920	0.029917	1.929816
4	2142.623	96.59237	0.048825	0.113695	0.102124	0.030364	3.112619
5	2411.441	95.88714	0.039533	0.103343	0.080986	0.037266	3.851731
6	2676.407	95.02904	0.044938	0.122875	0.075669	0.032798	4.694676

7	2929.998	94.22192	0.046677	0.142882	0.084817	0.029134	5.474570
8	3170.187	93.49162	0.041849	0.161064	0.111028	0.026223	6.168218
9	3401.254	92.81239	0.036363	0.183259	0.164734	0.023537	6.779722
10	3624.480	92.19479	0.034495	0.209481	0.229469	0.021118	7.310644

Variance Decomposition of CPI:

Period	S.E.	BS	CPI	ER	IIP	MS	FII
1	0.733426	0.656478	99.34352	0.000000	0.000000	0.000000	0.000000
2	1.386907	0.789470	98.37847	0.124463	0.063992	0.432978	0.210627
3	1.917517	1.176104	95.34480	0.381071	1.106332	1.637563	0.354133
4	2.321802	1.267786	90.60140	0.431141	4.084774	3.029265	0.585639
5	2.616741	1.242854	85.36033	0.407289	7.714662	4.468359	0.806509
6	2.839281	1.233801	80.26980	0.375563	11.54786	5.593320	0.979653
7	3.018776	1.270481	75.77409	0.347798	15.02257	6.404403	1.180659
8	3.171975	1.337044	72.11395	0.324605	17.82966	6.993682	1.401060
9	3.311180	1.426161	69.20083	0.306148	20.02334	7.407199	1.636326
10	3.442347	1.535671	66.92802	0.292676	21.64146	7.717633	1.884538

Variance Decomposition of ER:

Period	S.E.	BS	CPI	ER	IIP	MS	FII
1	0.961514	21.57426	0.266220	78.15952	0.000000	0.000000	0.000000
2	1.572843	34.77283	0.352327	59.03536	3.140269	2.080092	0.619118
3	2.022599	32.27005	0.255431	52.84791	7.422810	4.504270	2.699532
4	2.377828	30.72242	0.471475	48.98450	10.02183	6.078302	3.721477
5	2.727616	29.78139	1.436536	46.00176	11.83304	6.514267	4.433003
6	3.059758	29.57646	2.677569	43.65545	12.26642	6.605909	5.218192
7	3.365860	29.57858	3.606354	42.02240	12.32458	6.505993	5.962092
8	3.647726	29.81500	4.155926	40.88342	12.05860	6.374106	6.712954
9	3.910615	30.19298	4.414143	40.15109	11.59378	6.246570	7.401440

10	4.160386	30.62996	4.467640	39.64149	11.10320	6.120594	8.037118
Variance Decomposition of IIP:							
Period	S.E.	BS	CPI	ER	IIP	MS	FII
1	7.209903	0.004646	2.894844	1.332016	95.76849	0.000000	0.000000
2	7.767012	0.010338	3.498622	1.285816	86.51244	8.595143	0.097642
3	8.628624	0.037839	4.312528	3.429462	84.58140	7.453848	0.184924
4	9.408116	0.803985	4.616679	4.021126	82.72323	6.923752	0.911228
5	9.778550	0.949067	4.964899	4.817449	80.57590	7.584646	1.108044
6	10.20089	1.286459	4.697006	5.724239	79.62892	7.300193	1.363186
7	10.53472	1.863968	4.423638	6.711041	77.62910	7.401299	1.970955
8	10.84844	2.354923	4.180176	7.751219	75.86881	7.475201	2.369676
9	11.18436	2.881290	3.995693	8.683530	74.04650	7.486649	2.906342
10	11.49540	3.370475	3.866222	9.578755	72.15869	7.613219	3.412640
Variance Decomposition of MS:							
Period	S.E.	BS	CPI	ER	IIP	MS	FII
1	523.2302	0.048555	0.438673	3.034464	4.303753	92.17455	0.000000
2	701.7482	0.084958	0.972526	2.878762	8.200209	87.70514	0.158409
3	841.1215	0.488891	1.773541	4.315948	13.04487	80.09774	0.279009
4	1004.785	0.860703	3.067425	4.852079	20.47629	70.39772	0.345790
5	1155.471	1.103006	5.715663	5.364236	24.43132	62.94966	0.436116
6	1317.510	1.321050	8.492210	5.540820	27.82161	56.24244	0.581869
7	1475.553	1.464753	11.06758	5.717795	29.97115	51.13543	0.643302
8	1624.880	1.594653	13.27387	5.850968	31.12756	47.43482	0.718130
9	1767.259	1.675170	14.94660	5.932390	31.94564	44.72560	0.774596
10	1898.939	1.732939	16.24924	6.007466	32.43775	42.75929	0.813320
Variance Decomposition of FII:							
Period	S.E.	BS	CPI	ER	IIP	MS	FII

1	11948.00	27.72912	0.063294	13.50665	2.586212	0.000237	56.11449
2	13056.60	29.27952	0.053614	11.59113	3.664415	4.816748	50.59457
3	13742.59	27.09524	0.076668	11.06048	6.038909	4.926391	50.80231
4	14344.05	26.81407	0.385955	11.00868	5.991097	4.902682	50.89752
5	14676.40	27.19923	0.399383	11.53926	5.853952	4.728797	50.27938
6	15022.07	27.11699	0.766382	11.62836	5.602410	4.682961	50.20290
7	15291.68	26.84579	1.477442	11.89108	5.495043	4.687163	49.60348
8	15554.57	26.59510	2.458813	12.12052	5.325603	4.645493	48.85447
9	15787.54	26.30041	3.292785	12.30651	5.170178	4.744331	48.18579
10	15976.75	26.01778	3.981491	12.50826	5.104849	4.838208	47.54941
Cholesky Ordering: BS CPI ER IIP MS FII							

The variance decomposition analysis of BSE Sensex shows that over a period of 10 years, 7.8% of the variation in BSE Sensex is explained by inflation, exchange rate, index of industrial production, money supply and net FII. It is important to note that out of this; around 7.31% variation is explained by net foreign institutional investments. In case of inflation, 21.64% variation is explained by index of industrial production and 7.71% variation is explained by money supply over a period of 10 years; whereas, BSE Sensex and foreign institution investments explains only 3.4% of the variation. Thus, it is inferred that high index of industrial production and money supply may lead to a higher inflation in the long run. The variance decomposition of exchange rate shows that BSE Sensex cause 34.77% variation over a period of 2 years and remains at 30.62% over a period of 10 years. Hence it seems that the BSE Sensex cause exchange rate in the short and long run. In case of exchange rate, inflation, index of industrial production, money supply and foreign institution investments cause 4.46%, 11.10%, 6.12% and 8.04% variation respectively over a period of 10 years. Thus, it can be inferred that inflation, index of industrial production, money supply and foreign institutional investments cause exchange rate in the long run. In case of index of industrial production, the variance decomposition analysis shows that money supply cause 8.59 % variation and inflation cause 3.49% variation respectively in a period of 2 years, which implies that money supply and inflation cause index of industrial production in short run. Similarly, exchange rate and money supply shows 9.57% and 7.61% variation respectively over a period of 10 years. Thus, exchange rate and money supply cause index of industrial production in the long run. The variance decomposition analysis of money supply shows that index of industrial production cause 8.20% variation over a period of 2 years whereas other variables shows negligible impact in short run. Thus, only index of industrial production cause money supply in the short period. But over a period of 10 years inflation and index of industrial production cause 16.24% and 32.43% variation respectively. Hence, inflation and index of industrial production cause money supply in the long run. Finally, the variance decomposition of net foreign institution investments shows that BSE Sensex and exchange rate cause 29.27% and 11.59% variation respectively over a period of 2 years, whereas they cause 26.01% and 12.50% variation respectively over a period of 10 years. Thus, BSE Sensex and exchange rate cause foreign institutional investments in the short and long run. Thus variance decomposition analysis confirms the results obtained from vector error correction models with little exception given by dotted

lines in fig 1 and fig 2, respectively. Based on variance decomposition analysis, the transmission mechanism of effects of these variables is given as below in Fig 4 for long run as the short run effects are not prominent. Fig 4 is self explanatory and is arrived on based on variance decomposition analysis.

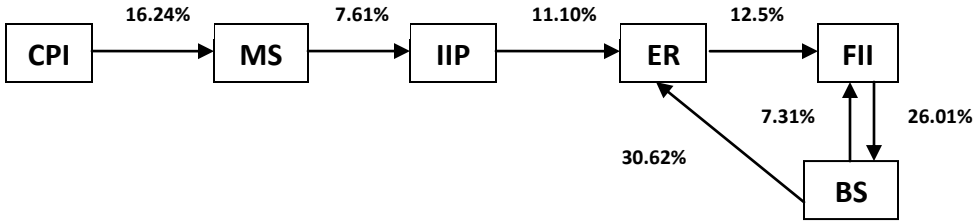


Fig 4: Variable Effect Transmission Mechanism – Variance Decomposition Analysis

The equations 5, 6, 7, 8, 9 and 10 are tested for robustness of the model. It is found that equations 7, 8 and 10 fulfills all the conditions of robustness i.e., normality test, test for serial correlation and test of heteroscedasticity (existence of ARCH effect). Also the equation 6 and 9 fulfills all the conditions of robustness except the normality test but F-statistics is significant. But the equation 5 fulfills the conditions of robustness except the normality test but F-statistics is not significant, hence furious in nature. Hence the models can be considered as robust except equation 5.

V. EMPIRICAL FINDINGS

The paper examined the empirical relationship between the stock market and the macro economic indicators in India April 2005 to December 2015. The main findings of the paper are as follows:

- There exists long run bi-directional causality between the inflation (CPI), money supply (MS) and exchange rate (ER) in India.
- There exists unidirectional causality between BSE SENSEX (BS), index of industrial production (IIP) and net foreign institutional investments (FII) with inflation (CPI), money supply (MS) and exchange rate (ER) in the long run.
- In the short run, there exists bidirectional causality between the inflation (CPI), index of industrial production (IIP) and money supply (MS) in the short run.
- There exists a unidirectional causality between the BSE SENSEX (BS) and exchange rate (ER) from BS to ER, money supply (MS) and exchange rate (ER) from MS to ER, money supply (MS) and net foreign institutional investments (FII) from MS to FII and between the index of industrial production (IIP) and net foreign institutional investments (FII) from IIP to FII in the short run.
- There is no evidence of short run causality between BSE SENSEX (BS) and inflation (CPI), BS and index of industrial production (IIP), BS and money supply (MS) and BS and net foreign institutional investments (FII) in India.
- The above results are confirmed by variance decomposition analysis.
- Moreover, the variance decomposition analysis shows that there exists unidirectional causality between BSE SENSEX (BS) and foreign institutional investments (FII) from BS to FII; and money supply (MS) to index of industrial production (IIP) in the long run.
- The variance decomposition analysis also confirms the unidirectional causality between BSE SENSEX (BS) and foreign institutional investments (FII) from BS to FII; and between exchange rate (ER) and foreign institutional investments (FII) from ER to FII in the short run.

VI. CONCLUSION& POLICY IMPLICATIONS

To conclude, it is worth mentioning that the empirical findings have certain policy implications. As can be seen in Fig 4, CPI is the first variable in the chain. Thus, the monetary policy must have significant focus on regulating inflation and is what India's RBI is doing with inflation-targeting monetary policy. But when industrial growth is slow, the Central bank has to choose amongst the following two alternatives; either increasing the money supply by reducing the bank rate or to rely on the open market operations of quantitative easing to inject money into the industrial sector or economy. If the bank lowers the rate, it may further aggravate the already persisting inflation. In the context of India, the second alternative is more advantageous as the inflation in India is already high and witnessing anincreasing trend. Under such circumstances the money cannot be infused directly in the economy by adopting bank rate policy, but the central bank can buy assets in the form of government bonds, equities or corporate bonds from commercial banks or other financing companies to inject money in the system. Also, there exists an ample liquidity with the investors in developed countries, and are unable to find the investment opportunities due to weak economic condition in their countries and are keen to invest in India due to higher growth rate and better investment prospects. In such circumstances, Indian government should promote green masala bonds which are issued to offshore investors, but denominated in Indian rupees rather than the foreign currency. Such move may help India to increase the international status of rupee and will be a step forward towards full currency convertibility. This will help the Indian business to raise debt-free finances for their business.Also, as recommended by Adeniran et. al. (2014), the government should encourage export promotion strategies; create conducive environment and infrastructure facilities to attract foreign investors to invest in India. There is a need to effectively manage the money supply to boost the industrial production on one hand and regulate the inflation on the other hand. As there exists bi-directional causality between MS, CPI and ER in the long run, and MS and IIP cause FII in the short run, the monetary and fiscal policy needs to be focused on money supply management and control. This will help Indian economy not only in the short run by infusing the investment in the industrial sector but also in the long run bymaintaining inflation and exchange rate at moderate levels. The aggregate effect of all these will be positive on Indian stock market which can be used by the foreign investors as the most significant leading economic indicator for evaluating the market performance of India.

VII. LIMITATIONS AND FURTHER SCOPE

The present study has excluded foreign direct investment as it is a long term investment and its impact is visible through index of industrial production which is taken as a proxy for GDP and FDI flows. Also there are various non-economic factors influences the sentiments of the investors and create over-expectation or pessimism due to asymmetry of information amongst the investors. Thus, asymmetry of information is one important dimension which needs to be addressed to evaluate the stock market performances. Also how the investors rate various developments in the market and government initiatives becomes another area of study. There are some exogenous factors which are beyond the control of the government can also be analyzed which makes the impact on the stock market even if the endogenous factors are well regulated.

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