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A Study of Linkage Between Indian Stock Market and Macroeconomic Indicators

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Abstract

Fama (1970) supported the Efficient Market Hypothesis and argued that all pertinent information about the changes in the macroeconomic factors is totally replicated in the current stock prices in an efficient market. The present study has focused in obtaining the evidences of linkages between Indian stock market performance and macro-economic variables. The present study has considered S&P BSE Sensex index to represent Indian stock market and five macroeconomic variables representing Indian economy. The empirical evidences of linkage between stock market performance and macro-economic variables are worth noting.

Keywords: *Johansen Co-integration, Indian Stock Market, Macroeconomic Variables, Granger Causality, Impulse Response Function.*

Introduction

Fama (1970) supported the Efficient Market Hypothesis and argued that all pertinent information about the changes in the macroeconomic factors is totally replicated in the current stock prices in an efficient market. The researchers have always taken keen interest in identifying the linkage between stock market behavior and macro-economic fundamentals of a country. Many relevant evidences have been identified indicating the association between stock market returns and one or more macro-economic variables during various time frames. Mukherjee and Naka (1995) studied this relationship for Japan having six macroeconomic variables and found that the Japanese Stock Market was co-integrated with these variables which indicated a long run equilibrium relationship between the stock market returns and the selected macroeconomic variables. Mookerjee and Yu (1997) studied relationship between monthly data on Singapore stock returns and four major microeconomic variables (narrow money supply, broad money supply, exchange rates and foreign exchange reserves) from October 1984 to April 1993. Their study concluded that the narrow as well as broad money supply and foreign exchange had a long run relationship with stock markets while foreign exchange did not have such relationship.

Pethe and Karnik (2000) investigated the inter-relationship between Indian stock market and macroeconomic variables using monthly data from April 1992 to December 1997. Their analysis discovered that the state of economy and the prices on the stock market did not reveal a long run relationship. A stable and efficient stock market is really essential for the development of an economy. Therefore it is always important to understand the performance of stock market as a response to the performance of macroeconomic indicators. India is one of the fastest growing

and an emerging economy with rising performance of its two major bourses, i.e., Bombay Stock Exchange & National Stock Exchange. After liberalization reforms the Indian economy and specifically Indian capital markets have gone through tremendous changes and size of capital market has become huge now. Many other Asian economies have also given cues of association between their macroeconomic variables and stock market performance. One of such research conducted by Wongbampo and Sharma (2002) examined the relationship in five Asian countries viz. Malaysia, Philippines, Thailand, Indonesia and Singapore by taking five macroeconomic variables such as exchange rate, inflation, money supply, GNP and interest rate. They discovered that in the long run all the five stock price indexes were positively related to increase in output and negatively related to the aggregate price level. Conversely they also found that stock prices and interest rate were negatively related for Singapore, Thailand and Philippines but positively related for Indonesia and Malaysia. Related research has also been conducted in India also. Ray and Vani (2003) examined linkage between the stock market movements and real economic factors in the Indian stock market by using monthly data from April 1994 to March 2003 and concluded that exchange rate, interest rate, money supply, industrial production and inflation rate had a significant influence on the equity prices. Nath and Samanta (2004) examined the degree of integration between foreign exchange and stock markets in India during the Liberalization era. Agarwalla and Tuteja (2008) examined the relationship between share price index and economic growth for India and applied multivariate Granger causality test within an error correction framework and concluded that stock markets in India were demand determined and industry directed. Narayan (2009) concluded that there was a positive relationship between exchange rate and stock returns. Pal and Mittal (2011) examined the relationship between the Indian stock markets and macroeconomic variables using quarterly data from January 1995 to December 2008. They applied Johansen's co-integration framework and reveled that long-run relationship was found between the stock market indexes and sampled macroeconomic variables. They also concluded that inflation and exchange rate had significant impact on BSE Sensex but interest rate and gross domestic saving were insignificant. Singh (2010) made an effort to explore the causal relation between stock market index (BSE Sensex) and macroeconomic variables of Indian economy by applying Granger causality test. He found that the IIP was the only variable having bilateral causal relationship with BSE Sensex. WPI was having strong correlation with Sensex, but it was having unilateral causality with BSE Sensex. Hence it can be understood that a continuous research on identifying the empirical evidences of linkage between stock market performance and macro-economic variables is important. Any linkage or association identified through such studies will help the individual and institutional investors or understand the future trend of the stock market which further helps them to make wise investment strategies for a superior rate of return.

Objective of Study

The present study has focused in obtaining the evidences of linkages between Indian stock market performance and macro-economic variables.

Data Inputs

The present study has considered S&P BSE Sensex index to represent Indian stock market and five macroeconomic variables representing Indian economy. The macroeconomic variables are finalized after thorough study of literature. Most of the studies in the past have considered one or more of above mentioned macro variables to study association, causality or impact of macroeconomic variables on the performance of stock index return series. The present study

has considered secondary data for more than ten years, i.e., April 2004 to February 2015 and monthly observations were used for all time series. The five macroeconomic factors are IIP (Index of Industrial Production), Money Supply, Exchange Rate (value of Rupee in terms of one US Dollar), rate of 91 days Treasury Bills and Wholesale Price Index. Therefore the present study has considered 130 monthly observations for all empirical tests.

For the present study the raw data of different macro variables have been converted into natural logarithm series to avoid the problem of non-stationarity in order to run OLS regression equations. The following is the description of the data used in present study.

Table I Description of Variables

Acronym	*Construction of Variables*
Sensex	Natural Logarithm of monthly closing value of S&P BSE Sensex Index
IIP	Natural Logarithm of month end values of Index of Industrial Production
Money Supply	Natural Logarithm of month end value of broad money supply (M3)
Exchange Rate	Natural Logarithm of monthly average of exchange rate of Indian rupee in terms of US dollar
91-days Treasury Bills	Monthly average of the 91-days Treasury Bills rates of Government of India
WPI	Natural Logarithm of monthly average of Wholesale Price Index

Methodological Framework

The present study has taken various analytical tools into consideration in order to identify the association between Indian stock market performance and its macroeconomic variables. The present study has obtained empirical results by using Descriptive statistics, Correlation analysis, Unit root test, Johansen Co-integration test, Granger causality and Impulse Response Function.

- *Unit Root Test*: Further in order to obtain the status of association between stock index return and macroeconomic variables, the present study has used OLS regression tool. But in order to use OLS regression, the time series data must be stationary otherwise it may provide some spurious results. In a stationary time series, the mean and variance remain constant over time and the value of covariance between two time periods depends only on the distance between the two time periods. And it is not the actual time at which the covariance is computed. In order to check whether time series data is stationary or non-stationary, the present study has used two most popular methods of testing *unit root*. These are Phillips-Perron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests which have examined the unit root in time series.
- The findings obtained from unit root tests suggested that the variables considered in the present study are non stationary and found co-integrated of same order. Therefore a test of co-integration is applied to further examine the association in the variables of the study. But before that lag length criteria has been examined to identify the lag length for testing the co-integration and further analysis.
- *Johansen Co integration Test:* The results of unit root test supported the application of Johansen co-integration test (discussed in following sections). When two or more variables are non stationary but are found co-integrated of same order then there is always a possibility to identify a trend in the movement of time series variables despite a drift in their movement.

A co-integration test also permits the existence of non-stationarity in the time series and the evidences of existence of co-integration in the time series indicate the long run linkage between the time series. There are several models developed by experts to study the existence of co-integration but Johansen test of co-integration also tells the number of co-integrated equations. There can be even more than one co-integrated movement in the variables and Johansen test of co-integration helps to identify such co-integrating movements.

- Granger Causality Test: *Granger test* is used, which identify that whether one series has significant explanatory power for another series. The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. Y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant. It is important to note that two-way causation is frequently the case; x Granger causes y and y Granger causes x.

Analysis of Results and Interpretation

Table 1 has reported the results of descriptive statistics of all six variables. As shown in Table, the standard deviation coefficient explains that interest rate on t-bills has shown highest volatility in last decade followed by money supply and Sensex. The coefficients of skewness and kurtosis also indicate less asymmetric distribution of majority of variables. The Jarque-Bera statistics has also indicated non-normal distribution in monthly observations of S&P BSE Sensex and macro economic variables except t-bills.

Table 1 Descriptive Statistics

	Sensex	*IIP*	*Money Supply*	*Exchange Rate*	*91-days Treasury Bills*	*WPI*
Mean	9.576523	4.977221	10.78420	3.876414	6.701533	4.898134
Std. Dev.	0.421973	0.194742	0.503689	0.132549	1.826463	0.203209
Skewness	-0.9079	-0.7132	-0.1922	0.676474	-0.2677	0.102447
Kurtosis	3.116191	2.298631	1.742292	2.458388	2.279185	1.662128
Jarque-Bera	17.79447	13.57883	9.296690	11.41550	4.333630	9.846366
Probability	0.000137	0.001126	0.009577	0.003320	0.114542	0.007276

Source: Calculations done by Authors

For studying the association between various variable, the time series must not have a problem of multi co-linearity otherwise the results may be very spurious. In order to obtain more reliable results, the paired correlation between different variables have been studied and it is good to identify that there is very low degree of correlation between the variables of the current study hence the problem of multi co-linearity will not create problem in further analysis of data.

Table 2 Correlation Matrix

	Sensex	*IIP*	*Money Supply*	*Exchange Rate*	*91-days Treasury Bills*	*WPI*
Sensex	1	0.0220	-0.0184	-0.5803	-0.0170	-0.0389
IIP	0.0220	1	-0.3981	-0.0416	0.0038	-0.1025
Money Supply	-0.0184	-0.3981	1	-0.1325	-0.1446	-0.1066
Exchange Rate	-0.5803	-0.0416	-0.1325	1	0.0249	0.1340
91-days Treasury Bills	-0.0170	0.0038	-0.1446	0.0249	1	0.1683
WPI	-0.0389	-0.1025	-0.1066	0.1340	0.1683	1

Source: Calculations done by Authors

In the next step stationarity of the time series variables has been tested. As mentioned earlier, the present study has considered two tests to examine whether a unit root exists in long term series of stock index return and macro economic variables or not. Both PP test and KPSS test have shown an I (1) process and showed that the time series variables are non-stationary at level but at first order these have become staionary. These results indicate that despite drift in the time series of all variables, in the long run these variables tend to follow an integrated movement. To further understand the co-integration of variables, Johansen test of co-integration has been studied.

Table 3 Unit Root Test for Stationary

	PP Test *t-Statistic*	*KPSS Test* *LM-stat.*
Sensex	-1.53341*	1.111831*
Δ (1)	-10.6138	0.086196
IIP	-1.48779*	1.26592*
Δ (1)	-28.7773	0.224626
Money Supply	-1.39462*	1.397980*
Δ (1)	-11.3243	0.441559
Exchange Rate	-0.46808*	1.006243*
Δ (1)	-10.0728	0.149619
91-days Treasury Bills	-2.22974*	0.624465*
Δ (1)	-13.6627	0.055577
WPI	-0.69938*	1.394942*
Δ (1)	-7.23992	0.103003
Oder of Integration	**I(1)**	**I(1)**

*significant at 5% level, Ä (1) first order difference to examine unit root.
Source: Calculations done by Authors

Before running the Johansen test of co-integration, the lag length criterion was used to decide lag length order for the present time series variables. After analyzing different criterion a lag

length order of 3 (FPE and AIC) has been decided for present study. Table 4 has shown the results of Johansen test of co-integration with the help of Trace statistic and Max-Eigen statistic. As shown in Table 4, the Johansen test of co-integration examines the null hypothesis that there are none, at the most 1, 2, 3, 4 & 5 co-integrated equations. The Trace statistic and Max-Eigen values are used to test the null hypothesis at 5 percent level of significance. The Trace statistic has shown that there is at the most one co-integrated equation.

Table 4 Multivariate (Johansen) Cointegration test results
Unrestricted Cointegration Rank Test (Trace & Max-Eigen Values)

Hypothesized No. of CE(s)	*Eigenvalue*	*Trace Statistic*	*0.05 Critical Value*	*Prob.***
None *	0.287	112.140	95.754	0.002
At most 1 *	0.231	71.173	69.819	0.039
At most 2	0.135	39.325	47.856	0.248
At most 3	0.104	21.758	29.797	0.312
At most 4	0.058	8.538	15.495	0.410
At most 5	0.011	1.321	3.841	0.250
Hypothesized No. of CE(s)	*Eigenvalue*	*Max-Eigen Statistic*	*0.05 Critical Value*	*Prob.***
None *	0.287	40.967	40.078	0.040
At most 1	0.231	31.848	33.877	0.086
At most 2	0.135	17.567	27.584	0.532
At most 3	0.104	13.220	21.132	0.432
At most 4	0.058	7.217	14.265	0.464
At most 5	0.011	1.321	3.842	0.250

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level, Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

*denotes rejection of hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The estimated co-integrating coefficients for S&P BSE Sensex based on first normalized eigenvector are as under.

$$\mathbf{Xt = (Sensex_t, IIP_t, MS_t, Exchange\ Rate_t, 91\text{-}days\ Treasury\ Bills_t, WPI_t)}$$

$$\mathbf{B1 = (1.00, 9.39, -12.79, -0.48, -0.35, 23.48)}$$

The co-integration relationship can be re-expressed as under because the variables are converted into log transformation which measures the long term elasticity.

LnSensex = 29.18 - 9.39LnIIP + 12.79 MS + 0.48 Exchange Rate + 0.35 91-days Treasury Bills - 23.48 WPI

(-4.33) (5.74) (0.36) (4.88) (-5.03)

The positive and negative signs of equation tell the direction of relationship and t-coefficients tell the significance of relationship. As given above, except Exchange Rate rest all macro variables

have shown significant relationship with S&P BSE Sensex returns. It indicates that the returns of Sensex are related to IIP, Money Supply, Treasury Bills Rate and Wholesale price Index.

Further, the Granger pair-wise causality test indicated that there is significant one way causality from Sensex to IIP, IIP to Exchange Rate, IIP to WPI, and WPI to Exchange Rate. In addition to this the evidences were also obtain for two-way causality in Money Supply &IIP and Money Supply &WPI.

Table 5 Pair wise Granger Causality Test

	Sensex	*IIP*	*Money Supply*	*Exchange Rate*	*91-days Treasury Bills*	*WPI*
Sensex	-	→	No	←	No	No
IIP	←	-	→	→	No	→
Money Supply	No	←	-	No	No	↔
Exchange Rate	→	←	No	-	No	←
91-days Treasury Bills	No	No	No	No	-	No
WPI	No	←	↔	→	No	-

*The highlighted cells indicate the significant evidences of causality at 5 percent level of significance.

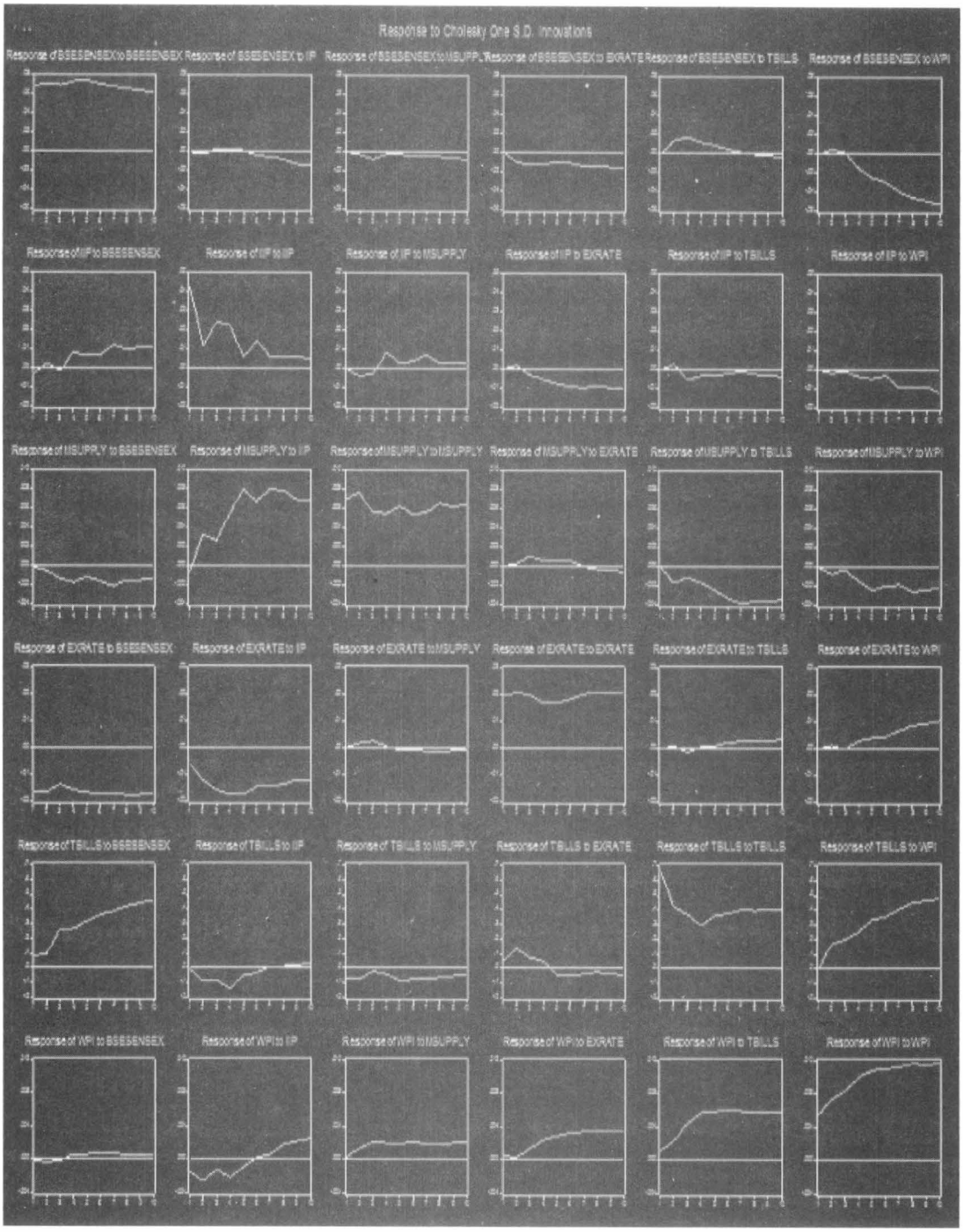
Impulse Response Function (IRF)

The impulse response function helps to understand that if one standard deviation shock is given to time series then what will be its predicted behavior for a given number of periods. The present study has made an analysis of 10 months forecast of all time series variables if one shock is given. As shown in charts, it will take around five months to BSE Sensex to reach at equilibrium point after giving a shock of one standard deviation of IIP and 4-5 months after giving a shock of Money Supply. It will be close to equilibrium state in next 10 months if one shock of Exchange Rate is given. And it will take seven months to reach at stable point after one shock of 91 days T-bills rate and for WPI it shows reaching equilibrium after two months but after that it has gone far from the stability line. In a similar way, the impact on other variables can be observed by giving one shock of related variable.

Conclusion and Implication

The following are the major findings and implications of the above results.

- The evidences obtained from Johansen test of co-integration gave an indication of existence of two long run relationships between S&P BSE Sensex and macroeconomic variables considered in present study.
- The evidences of causality through Granger Causality test also indicate drift in the movement of stock market return from an equilibrium or balanced state.
- As a result if t-coefficients are analyzed then it can be said that the index of industrial production is significant but have shown a negative relationship with stock index returns.
- A positive and significant linkage is identified with money supply. The increase in money supply is expected to cause positive impact on stock index returns.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- No significant linkage has been indentified in exchange rate and stock market returns in India.
- The return on Treasury Bills has shown a positive linkage with Sensex returns. The t-coefficient for this is also found significant giving further evidence of this linkage.
- There is a significant negative impact of Wholesale Price Index on stock market returns. The rise in inflation rate is found inversely related with stock market returns.

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