

## **Causal Relationship Between Macro-Economic Variables and Stock Market: A Case Study for India**

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### **Abstract**

*In this research paper, attempt has been made to explore the relation especially the causal relation between stock market index i.e. BSE Sensex and three key macro economic variables of Indian economy by using correlation, unit root stationarity tests and Granger causality test. Monthly data has been used from April, 1995 to March, 2009 for all the variables, like, BSE Sensex, wholesale price index (WPI), index of industrial production(IIP) and exchange rate(Rs/\$). Results showed that the stock market index, the industrial production index, exchange rate, and wholesale price index contained a unit root and were integrated of order one. Granger causality test was then employed. The Granger causality test indicated that IIP is the only variable having bilateral causal relationship with BSE Sensex. WPI is having strong correlation with Sensex but it is having unilateral causality with BSE Sensex. Therefore, it is concluded that, Indian stock market is approaching towards informational efficiency at least with respect to two macroeconomic variables, viz. exchange rate and inflation (WPI).*

**Keywords:** Granger Causality; Stationarity Test; Macroeconomic variables; Stock Market Index; Efficient Market Hypothesis; Indian Economy

### **I. Introduction:**

Security prices are influenced by number of factors some are company specific, sector specific while some belong to the environment in which the company is operating. Movements of stock prices are seen to depend on macroeconomic factors; domestic and international economic, social or political events; market sentiments / expectations about future economic growth trajectory, monetary and fiscal policy announcements etc. The stock market capitalizes the present and future values of growth opportunities while evaluating the growth of all sectors in the economy. In a sense stock markets can really be regarded as the pulse of the economy as they reflect every action taken by the economic and political agents almost instantly.

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An efficient capital market is one in which security prices adjust rapidly to the arrival of new information and, therefore, the current prices of securities reflect all information about the security. Moreover, economic theory suggests that stock prices should reflect expectations about future corporate performance, and corporate profits generally reflect the level of economic activities. If stock prices accurately reflect the underlying fundamentals, then the stock prices should be employed as leading indicators of future economic activities, and not the other way around. Therefore, the causal relations among macroeconomic variables and stock prices are important in the formulation of the nation's macroeconomic policy.

The relationship between macro economic factors and stock market movements has dominated the academic and practitioners' literature since long. The attack on the conclusions drawn from the Efficient Market Hypothesis (EMH) includes early studies by Fama and Schwert (1977) affirming that macroeconomic variables influence stock returns.

The analysis on stock markets has come to the fore since this is the most sensitive segment of the economy and it is through this segment that the country's exposure to the outer world is most readily felt. The present study is an endeavor in this direction. It analyses the relationship between stock prices and macroeconomic variables in India with implications on efficiency of Indian stock market.

The informational efficiency of major stock markets has been extensively examined through the study of causal relations between stock price indices and macroeconomic variables. If lagged changes in some macro economic variables cause variations in stock prices and past fluctuations in stock prices cause variations in the economic variable, then bi-directional causality is implied between the two series. This behavior indicates stock market inefficiency. In contrast, if changes in the economic variable neither influence nor are influenced by stock price fluctuations, then the two series are independent of each other and the market is informationally efficient.

The purpose of the present study is to investigate the causal relationship persisting in India between macroeconomic variables, namely exchange rate(Rs/\$), index of Industrial Production(IIP), Wholesale Price index(WPI), and stock prices in the Bombay Stock Exchange (SENSEX) using monthly data that span from 1994-95 to 2008-09. Specifically, in this study we test for market informational efficiency in BSE, by testing the existence of a long – run causal relationship between macroeconomic variables and stock prices using Granger causality test. The rest of the paper is organized as follows. A survey of the existing literature including empirical evidences on the nature of the causal relationship between macroeconomic variables and stock prices is conducted in Section II. Section III discusses the methodology to be employed and presents the variables and data descriptions. Section IV reports the trend analysis, correlation matrix, ADF test results and causality test results followed by conclusion in Section V.

## **II. Literature Review**

Numbers of studies have been conducted to examine the effects of macroeconomic variables on stock market of industrialized economies. An illustrative list of studies for developed economies includes Fama (1981, 1990), Fama and French (1989), Chen et al. (1986), Chen (1991), Thornton (1993), Kaneko and Lee (1995), Abdalla and Murinde

(1997). The few notable studies for developing economies include Mookerjee and Yu (1997) and Maysami and Koh (2000) for Singapore, Kwon and Shin (1999) for South Korea, and Habibullah and Baharumshah (1996) and Ibrahim (1999) for Malaysia. Using bi-variate co-integration and causality tests, Mookerjee and Yu (1997) note significant interactions between M2 money supply and foreign exchange reserves and stock prices for the case of Singapore. However, Maysami and Koh (2000) document significant contribution of interest rate and exchange rate in the long-run relationship between Singapore's stock prices and various macroeconomic variables.

Chen et al. (1986) examined equity returns relative to a set of macroeconomic variables and found that the set of macroeconomic variables which can significantly explain stock returns includes growth in industrial production, changes in the risk premium, twists in the yield curve, measures of unanticipated inflation and changes in expected inflation during periods of volatile inflation. More recent examples of studies involving a number of macroeconomic variables include Chen (1991), and Flanery and Protopapadakis (2002). Some studies also find that the predictive ability of certain macroeconomic variables with respect to stock returns is quite uneven over time. On the other hand, there is no dearth of studies, which fail to support the ability of macro variables to predict stock returns.

Chowhan et al. (2000) have tried to fetch reasons for turbulence in stock market in the short run in India taking into account SENSEX as the main index. They have tried to find that how SENSEX which stood at 2761 on 21st of October 1998 rose to 6000 in February 2000, i.e., 117% increment in just 15 months, which is not at all strongly supported by fundamental economic factors in these years as Indian economy grew by just 5.9% in 1999-2000. As per the results of this paper, even long run economic factors don't support such a spike in stock prices. Such a trend was noted not just in Indian stock markets but world wide.

Pethe and Karnik (2000), using Indian data for April 1992 to December 1997, attempts to find the way in which stock price indices are affected by and affect other crucial macroeconomic variables in India. But this study runs causality tests in an error correction framework on non-cointegrated variables, which is inappropriate and not econometrically sound and correct. The study of course avers that in the absence of cointegration it is not legitimate to test for causality between a pair of variables and it does so in view of the importance attached to the relation between the state of economy and stock markets. The study reports weak causality running from IIP to share price index (Sensex and Nifty) but not the other way round. In other words, it holds the view that the state of economy affects stock prices.

Another study conducted by Sarkar, P. (2005) has examined that if any meaningful relation between growth and capital accumulation exists in case of India. They have used annual data on various variables like nominal and real share price, share market turnover ratio, number of listed firms in the stock market, fixed capital formation and growth of real GDP and industrial output. But all tell the same story that no positive relationship exists between real and stock market variables either in short run or long run during 1950-51 to 2005.

Kanakaraj et al. (2008) have examined the trend of stock prices and various macro economic variables between the time periods 1997-2007. They have tried to explore upon and answer that if the recent stock market boom can be explained in the terms of macroeconomic fundamentals and have concluded by recommending a strong relationship between the two. The GDP growth in India has grown consistently at high levels touching the highest average from 2003-04 to 2006-07 since Independence, and is strongly backed by manufacturing sector growth and services sector growth. Gross Domestic Investment and Gross Domestic Saving as percentage of GDP have also grown enormously with inflation remaining under control most of the time.

Muhammad and Rasheed (2002) examine the exchange rates and stock price relationships for Pakistan, India, Bangladesh and Sri Lanka using monthly data from 1994 to 2000. The empirical results show that there is a bi-directional long-run causality between these variables for only Bangladesh and Sri Lanka. No associations between exchange rates and stock prices are found for Pakistan and India.

Husain (2006) has examined the causal relationship between stock price and real sector variables of Pakistan economy, using annual data from 1959-60 to 2004-05. It has divided the data into two halves- pre and post liberalization and has studied the causal relationship between them using various econometric techniques like ECM, Engle-Granger co integrating regressions and Augmented Dickey Fuller (ADF) Unit Root tests. By using this data set and methodology, this analysis has indicated the presence of a long run relationship between the stock prices and real sector variables.

Abdalla and Murinde (1997) found out that the results for India, Korea and Pakistan suggest that exchange rates Granger cause stock prices, which is consistent with earlier study by Aggarwal (1981). But, for the Philippines, Abdalla and Murinde found out that the stock prices lead the exchange rates. This is consistent with Smith's (1992) finding that stock returns have a significant influence on exchange rate in Germany, Japan and the United States.

### **III. Objectives of the study**

In this study the major objective is to find out the correlation and causal relationship, if any, between the stock market and real economic variables. The specific sets of objectives of the study are as follows:

- (1) To calculate correlation and causality, if any, between the stock market index SENSEX and macro economic variables.
- (2) To shed light on the nature of causal relationship that exists between the stock market and macro economic variables, i.e., is it unilateral or bilateral.
- (3) To explore that to what degree the two, stock market and macro economic variables cause each other.

### **IV. Research Methodology and Data Source**

The empirical analysis in the present study is based on unit root test and Granger-Causality tests. The first step in the analysis is to subject the macroeconomic series to unit root tests or tests the series for stationarity. The present study uses Granger Causality test for causality tests among the macro economic variables and stock market prices (SENSEX).

The present study uses relatively longer time series of monthly data for the period 1995:04 (April 1995) to 2009:03 March 2009) for India on the following macroeconomic variables, namely, share price index(SENSEX), Index of industrial production(IIP), wholesale price index(WPI), and exchange rate(RS/\$). The data for the macroeconomic variables were extracted from the handbook of statistics on Indian Economy. In the empirical analysis, the variables are used in their logarithm.

With a view to accomplish the stipulated set of objectives of our study, different methods have been adopted. First of all, to fulfill the research objectives, trend analysis is done to get a pictorial view of the movement in the variables under consideration. Correlation is the next step to move towards the objectives of this study and finding any relation between the stock market and macro economic variables. Then the formal investigation is carried out by examining the stochastic properties of the variables by using Unit Root Test to test the stationarity of the variables. In this context, the widely used technique is Augmented Dickey Fuller (ADF) test (1979). If the variables don't have unit root problem then Granger causality can be estimated. To test the causal relationship Granger causality test was used.

## V. Trend Analysis

In the box (1) given below, the monthly observations of all the four variables are plotted on the graph with time on X-axis and values on Y-axis. It is evident from the graph that movement of Sensex after 133th observation is not in line with other three macroeconomic variables. Although they are also increasing but the rate of increase is not in that proportion. It was a period from 2005 to 2007.

If we observe the behavior of three macroeconomic variables from April, 1995 to March, 2009 the IIP and WPI are consistently showing the upward trend but exchange rate is showing wide fluctuations. The graph, thus suggests that movement of stock market after 2005 was more influenced by external factors rather than macroeconomic variables of the economy.

Next step is to check out the correlation between the variables in consideration in this study. This correlation is very important as it helps to know that the variables on which we wish to apply Granger causality are even related to each other. Hence a correlation matrix is worked out between them and presented in table (1). In the following correlation matrix almost all the variables are highly correlated to each other apart from Sensex and exchange rate which are less correlated to each other. Since remarkable correlations have been found between the variables under consideration so further econometric tools would be applied to them. But one point is worth enough to bring into consideration that a high or low degree of correlation certainly doesn't signify or rules out causality. It simply points towards the positive or negative linear relationship that exists between the two variables.

## VI. Augmented Dickey-Fuller (ADF) Test

Consider here two variables such as X and Y for methodological discussion relating to the study. If the calculated Augmented Dickey-Fuller (ADF) statistics is less than its critical value, then X is said to be stationary or integrated to order zero, i.e.,  $I(0)$ . If this is not the case, then the ADF test is performed on the first difference of X (i.e.,  $\Delta X$ ). If  $\Delta X$  is found to stationary then X is integrated order one i.e.,  $I(1)$ .

Augmented Dickey Fuller test has been applied to test the stationary status of the data using E-views software. In the ADF test that has been conducted on all the variables in the table 1 and 2 to check their stationarity in order to fulfill the precondition of Granger causality, all the variables were found stationary. The lag values were chosen on the basis of E-views software i.e. defaults values using SIC criteria. We have tested on both the levels and the first differences of the series. The results are tabulated in Table (2) and Table (3).

Since the computed ADF test-statistics is greater than the critical at (1%, 5% and 10% significant level, respectively), we cannot conclude to reject  $H_0$ . This means that LEXR, LIIP, LSPI and LWPI series has a unit root problem and these series are non-stationary series. Only LWPI was not significant at 5% level of significance.

Now the absolute computed ADF test-statistic is smaller than the critical values at (1%, 5% and 10% significant level, respectively), thus we can reject the  $H_0$ . That means the 1st-difference of LEXR, LIIP, LSPI and LWPI series becomes stationary.

From the above unit root test, it is apparent that all the variables have no unit root problem. Now, to test causality between stock market and macro economic variables, we have estimated Granger causality. The estimated results are presented in the table (4).

## VII. Granger Causality Test:

Finally, Engle-Granger (1969) causality model is used to test the causality between the stock market and macro economic variables. The following is the model adopted in the study to empirically examine the above said hypothesis. Let's start by defining Granger's concept of causality. X is said to be Granger cause Y if Y can be predicted with greater accuracy by using past values of X.

Consider the following equation:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \beta_1 X_{t-1} + u_t$$

If  $\beta_1 = 0$ , X does not Granger cause Y. If, on the other hand, any of the  $\beta$  coefficients is non-zero, then X does Granger cause Y. The null hypothesis that  $\beta_1 = 0$  can be tested by using the standard F-test of joint significance. Note that it has been taken one period lag in the above equation. In practice, the choice of the lag is arbitrary.

From the analysis of the above table (4), it specifies that SENSEX is Granger causing IIP and IIP is Granger causing SENSEX i.e., there is a bilateral directional relationship between them at 10% level of significance. The positive relation between industrial production and stock prices is quite apparent. Higher industrial production numbers indicate a healthy economy and induce "feel good" sentiments among stock market investors. Current period's positive data also increases expectations of better future performance by the industry as well and drives up stock prices in general and prices of stocks of the particular industrial sectors that have performed or are expected to perform better than the average.

Fama (1990) shows that monthly, quarterly and annual stock returns are highly correlated with future production growth rates. He argues that the relation between

current stock returns and future production growth reflects information about future cash flows that is impounded in stock prices. The same results are also found by Schwert (1990) who uses a larger data period for his study. In a study of Indian stock markets, Agrawalla and Tuteja (2008) examine the causal relationships between the share price index and industrial production. The study reports causality running from economic growth proxied by industrial production to share price index and not the other way round.

Exchange rate as an indicator of a currency movement is a monetary variable that affects prices of stock in a way similar to the inflation variable. Depreciation of the local currency makes import expensive compared to export. Thus, production costs of import companies increase and since all the cost cannot be passed on to the consumers because of the competitiveness of the market, this reduces corporate earning and hence the stock prices. From the analysis of the above table it specifies that SENSEX is Granger causing WPI, i.e., there is a unilateral directional relationship between them. SENSEX is basically nothing but showing future expected occurrences of the real economy. With the rise in SENSEX then masses' expectations of a further rise in their profits is there and also due to this monetary gain in terms of their investments in stock markets, their demand for goods and services rises but there being a time-lag between the demand and supply, prices or WPI also increases.

The null hypothesis related to SENSEX and exchange rate has confirmed that neither SENSEX nor exchange rate cause each other, which denotes that SENSEX does not have an effect on exchange rate in India. The results are consistent with the results of trend analysis and correlation matrix in table (1).

### **VIII. Concluding Remarks**

The aim of this research is to find out and study the causality, if any, between stock market and three key macro economic variables in Indian economy. The results that have been found are mixed and ambiguous as there is undoubtedly strong correlation between BSE Sensex and IIP, Sensex and WPI but not between exchange rate and Sensex. Although there is strong correlation between the Sensex and macroeconomic variables even then the causality that has come out is just amongst a one macroeconomic variable (IIP) and stock market variable which further strengthens the issue that stock markets in India are in their nascent phase as their impact on macro economic variables is less as that in developed countries and moreover effect of macroeconomic variables is weak on stock market index in case of causality.

The results of correlation are not supported by causality test. In correlation matrix, correlation between almost all the variables was high, i.e., they are all moving in the same direction, but such a sequence was not followed by the causality analysis thus were not fundamentally supported by each other. Granger Causality test pointed towards a different story where SENSEX undoubtedly Granger causes IIP and WPI. But only IIP Granger causes SENSEX, thus implying that apart from IIP, WPI and exchange rate are not responsible for causing the vibes in stock market and even the volatility in it is due to some other external factors and not these real economic factors. The reason behind this may be that stock market is in nascent stage in India and only a meager percent of people invest in stock market which makes it not so good representative of the Indian financial health.

The second part of the conclusion is related to informational efficiency of the Indian stock market. The efficient market hypothesis (EMH) was formalized by Fama (1970). The hypothesis suggests that changes in the macroeconomic variables cannot be used as a trading rule by investors to earn consistently abnormal profits in the stock market. In an efficient market, current as well as past information on the growth of these variables are fully reflected in asset prices so that investors are unable to formulate some profitable trading rule using the available information.

As mentioned above bilateral causal relationship is observed only in case of SENSEX and IIP. This means that IIP results can be used to predict the stock market movement. Whereas, other two variables i.e. WPI and exchange rate, they can't be used to predict the movement of stock market. Therefore, we can say that Indian stock market is showing the weak form of market efficiency. This concludes that Indian stock market is approaching towards informational efficiency at least with respect to two macroeconomic variables, viz. exchange rate and inflation (WPI).

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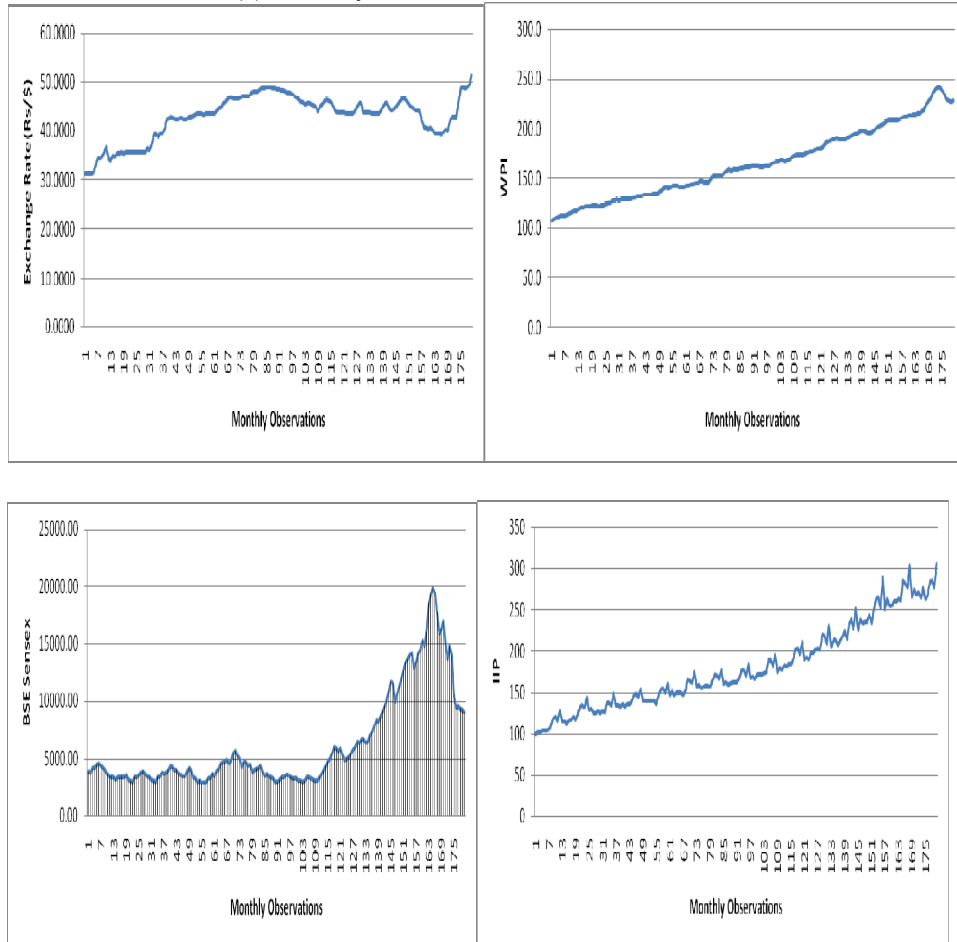


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## Appendix

**Box (1) Monthly observations of all the four variables**



**Table (1) Correlations Matrix**

		IIP	SENSEX	WPI	EXRATE
IIP	Pearson Correlation	1.000	.851**	.976**	.435**
	Sig. (2-tailed)		.000	.000	.000
	N	180.000	180	180	180
SENSEX	Pearson Correlation	.851**	1.000	.801**	.046
	Sig. (2-tailed)	.000		.000	.538
	N	180	180.000	180	180
WPI	Pearson Correlation	.976**	.801**	1.000	.504**
	Sig. (2-tailed)	.000	.000		.000
	N	180	180	180.000	180
EXRATE	Pearson Correlation	.435**	.046	.504**	1.000
	Sig. (2-tailed)	.000	.538	.000	
	N	180	180	180	180.000

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

**Table (2) Results for the ADF unit root test in levels**

Variable	Intercept ,with no trend	Intercept, with trend
LEXR	-2.263456*	-2.283095*
LIIP	-0.240721*	-2.256238*
LSPI	-0.893617*	-1.870758*
LWPI	-1.058178*	-4.661100**

\* Significant at all the levels, \*\* significant at 10% level

**Table (3) Results for the ADF unit root test in first differences**

Variable	Intercept ,with no trend	Intercept, with trend
LEXR	-9.208708*	-9.212738*
LIIP	-2.629879*	-2.620912*
LSPI	-10.48720*	-10.46399*
LWPI	-8.667313*	-8.687142*

\* Significant at all the levels

**Table (4) Results of Granger causality test.**

Null Hypothesis	F Statistics	Probability
LIIP does not Granger Cause LSPI	2.97375	0.08638
LSPI does not Granger Cause LIIP	3.25103	0.07309
LEXR does not Granger Cause LSPI	0.03025	0.86213
LSPI does not Granger Cause LEXR	0.32335	0.57033
LWPI does not Granger Cause LSPI	1.25370	0.26437
LSPI does not Granger Cause LWPI	10.9576	0.00113