THE NATURE OF THE CAUSAL RELATIONSHIP BETWEEN STOCK MARKET AND MACROECONOMIC AGGREGATES IN INDIA: AN EMPIRICAL ANALYSIS

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Abstract

This paper investigates the nature of the causal relationship between stock prices and macroeconomic aggregates in India. By applying the techniques of unit–root tests, cointegration and the long–run Granger non–causality test recently proposed by Toda and Yamamoto (1995), we test the causal relationships between the BSE Sensitive Index and the five macroeconomic variables, viz., money supply, index of industrial production, national income, interest rate and rate of inflation using monthly data for the period 1992-93 to 2000-01. The major findings are (i) there is no causal linkage between stock prices and money supply, stock prices and national income and stock prices and interest rate, (ii) index of industrial production lead the stock price, and (iii) there exists a two – way causation between stock price and rate of inflation.

JEL classification: G1, E4

Keywords: Macroeconomic Aggregates, Stock Price Index, Granger Causality and Efficient Market Hypothesis.

Introduction:

Globalisation and financial sector reforms in India have ushered in a sea change in the financial architecture of the economy. In the contemporary scenario, the activities in the financial markets and their relationships with the real sector have assumed significant importance. Since the inception of the financial sector reforms in the beginning of 1990's, the implementation of various reform measures including a number of structural and institutional changes in the different segments of the financial markets, particularly since 1997, have brought about a dramatic change in the financial architecture of the economy. Altogether, the whole gamut of institutional reforms, introduction of new instruments, change in procedures, widening of network of participants call for a reexamination of the relationship between the financial sector and the real sector in India. Correspondingly, researches are also being conducted to understand the current working of the economic and the financial system in the new scenario. Interesting results are emerging particularly for the developing countries where the markets are experiencing new relationships which are not perceived earlier. The analysis on stock markets has come to the fore since this is the most sensitive segment of the economy. The present study is an endeavour in this direction. It analyses the relationship between stock prices and macroeconomic variables with implications on efficiency of stock markets. Along with this, newer econometric techniques are also being introduced and applied. This paper makes use of the latest available econometric techniques and examines efficiency of Indian stock market in terms of the relationships mentioned above.

The informational efficiency of major stock markets has been extensively examined through the study of causal relations between stock price indices and macroeconomic aggregates. The findings of these studies are important since informational inefficiency in stock market implies on the one hand, that market participants are able to develop profitable trading rules and thereby can consistently earn more than average market returns, and on the other hand, that the stock market is not likely to play an effective role in channeling financial resources to the most productive sectors of the economy.

The Efficient Markets Hypothesis (EMH) assumes that everyone has perfect knowledge of all information available in the market. Therefore, the current price of an individual stock (and the market as a whole) portrays all information available at time t. Accordingly, if real economic activity affects stock prices, then an efficient stock market instantaneously digests and incorporates all available information about economic variables. The rational behaviour of market participants ensures that past and current information is fully reflected in current stock prices. As such, investors are not able to develop trading rules and, thus may not consistently earn higher than normal returns. Therefore, it can be concluded that, in an informationally efficient market, past (current) levels of economic activity are not useful in predicting current (future) stock prices. Stated in Granger jargon, informational efficiency exists if a uni-directional lagged causal relationship from a macroeconomic variable to stock prices could not be detected.

While finding causality from lagged values of stock prices to an economic aggregate does not violate informational efficiency, this finding is equivalent to the existence of causality from current values of stock prices to future levels of the economic variable. This would suggest that stock prices lead the economic variable and that the stock market makes rational forecasts of the real sector.

If, however, lagged changes in some 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 behaviour 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 empirical relationship between macroeconomic aggregates and stock prices in the Bombay Stock Exchange (BSE) using monthly data that span from 1992-93 to 2000-01. Specifically, in this study we test for market informational efficiency in BSE, by testing the existence of a long – run causal relationship between macroeconomic aggregates and stock prices using Granger non – causality test recently proposed by Toda and Yamamoto (1995). 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 aggregates 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 empirical results followed by conclusion in Section V.

I. A Survey of the Existing Literature and Objective of The Study:

In recent times, studies on the relationship between macroeconomic variables and national stock market have been the cornerstone of most economic literature. Among the many macroeconomic variables, the relationship between money supply and stock prices has been widely studied because of the belief that money supply changes have important direct effects through portfolio changes, and indirect effects through their effect on real economic activity, which in turn postulated to be the fundamental determinants of stock prices. Despite extensive investigations, the precise nature of the relationship between money supply and the stock market remains ambiguous. Early studies by Palmer (1970) and Sprinkel (1971) have indicated that money supply leads stock prices. This was further supported, in recent studies, by Malliaris and Urrutia (1991), who arrived at the same conclusion for the United States. On the other hand, the evidence that stock market leads money supply was found by Cooper (1974) and Rozeff (1974) and, more recently, by Thornton (1993) who claims that stock price leads the money supply in the United Kingdom. For the developing countries, Fung and Lie (1990) showed that Taiwan's stock market is closely related with money supply, which is further supported by Lin (1993) who found that the growth in money supply can be used to predict the Taiwanese stock market. Lin's work also pointed out that both the Korean and Singaporean markets are closely related with money supply, but with a different result. In the former, money supply leads the stock market, but for the latter, stock market leads the money supply. In another study, Ho (1983) found that money supply is a useful information in predicting stock markets in Hong Kong, Japan, the Philippines, Australia and Thailand.

The importance of other macroeconomic variables apart from money supply has been pointed out by Fama (1981). Fama asserts that there is a strong relationship between stock returns with other macroeconomic variables, notably, inflation and national output as well as industrial production. The inflation rate is an important element in determining stock returns due to the fact that during the times of high inflation, people recognize that the market is in a state of economic difficulty. People are laid off work, which could cause production to decrease. When people are laid off, they tend to buy only the essential items. Thus production is cut even further. This eats into corporate profits, which in turn makes dividends diminish. When dividends decrease, the expected return of stocks decrease, causing stocks to depreciate in value. Fama (1981), Geske and Roll (1983), James et. al. (1985), and Stulz (1986) all attempt to explain the negative association between stock returns and inflation.

Malliaris and Urrutia (1991) observed that the performance of the stock market might be used as a leading indicator for real economic activities in the United States. For the United Kingdom, Thornton (1993) also found that stock returns tend to lead real income. In related work, Chang and Pinegar (1989) and Chen et. al. (1986) also concluded that there is a close relationship between stock market and the domestic economic activity. However, for Hong Kong, Mok (1993) found out that interest rates and stock returns are independent.

In the context of the Indian Economy, work in this area has not progressed much. Abhay Pethe and Ajit Karnik (2000) has investigated the inter – relationships between stock prices and important macroeconomic variables, viz., exchange rate of rupee vis - a - vis the dollar, prime lending rate, narrow money supply, and index of industrial production. The analysis and discussion are situated in the context of macroeconomic changes, especially in the financial sector, that have been taking place in India since the early 1990s. Chakradhara Panda and B. Kamaiah (2001) investigated the causal relations and dynamic interactions among monetary policy, expected inflation, real activity and stock returns in the post liberalization period, using a vector – autoregression (VAR) approach. The major findings are (i) expected inflation and real activity do affect stock returns, (ii) monetary policy loses its explanatory power for stock returns when expected inflation and real activity are present in the system, (iii) the relationships of monetary policy, expected inflation and real activity with stock returns lack consistency, (iv) there is no causal linkage between expected inflation and real activity. There are some other related studies though not specifically focused to this aspect.

The main purpose of the present study is to complement the existing literature on the stock market – macroeconomic nexus in two respects. First, is to determine whether stock returns are a leading indicator for future real economic activity. In India, certain quarters of the population believe that the improvement in the performance of the stock markets will result in an improvement in the economy measured by the positive growth in the gross national product. However, whether stock markets lead or lag real economic activity is an empirical question. The empirical evidence provided by the studies mentioned above showed that macroeconomic variables have strong effects on the stock market. In other words, national stock markets are said to informationally inefficient with respect to most macroeconomic variables. If market is inefficient with respect to information, then it has important implications both at micro and macro levels. At the micro level, this implies that the individual investor can earn considerably higher normal rate of returns from the stock market. At the macro level, it raises serious doubts on the ability of the market to perform its fundamental role of channeling funds to the most productive sectors of the economy.

Secondly, the more recent developments in econometrics on the properties of time series has enabled researchers to investigate the relationship between integrated economic variables with ease and can provide precise estimates, in the sense that spurious regression problems can be avoided. It has been noted that the traditional Granger (1969) causality test for inferring leads and lags among integrated variables will end up in spurious regression results, and the F – test is not valid unless the variables in levels are cointegrated. Several tests for a unit – root(s) in a single time – series have been proposed (for example, Dickey and Fuller, 1979; Phillips and Perron, 1988). Unfortunately, however, the power of these tests is known to be very low against the alternative hypothesis of (trend) stationarity. Tests for cointegration and cointegrating ranks have also been developed, viz., error correction model due to Engle and Granger (1987) and the vector autoregression error correction model due to Johansen and Jesulius (1990). Unfortunately, these tests are cumbersome and sensitive to the values of the nuisance parameters in finite samples and therefore their results are unreliable, as pointed out by Toda and Yamamoto, (1995) and Zapata and Rambaldi, (1997).

Toda and Yamamoto (1995) proposed a simple procedure requiring the estimation of an “augmented” VAR, even when there is cointegration, which guarantees the asymptotic distribution of the MWALD statistic. This method is applicable “whether the

VAR's may be stationary (around a deterministic trend), integrated of an arbitrary order, or cointegrated of an arbitrary order" (Toda and Yamamoto: *Journal of Econometrics 66, 1995*, pp. 227). The methodology that we have applied to examine the nature of the causal relationship between macroeconomic aggregates and stock prices is discussed in the next section.

II. Methodology and Data Sources:

Traditionally to test for the causal relationship between two variables, the standard Granger (1969) test has been employed in the relevant literature. This test states that, if past values of a variable Y significantly contribute to forecast the value of another variable X_{t+1} then Y is said to Granger cause X and vice versa. The test is based on the following regressions:

$$Y_t = b_0 + \sum_{k=1}^{M} b_k Y_{t-k} + \sum_{l=1}^{N} a_l X_{t-l} + u_t \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$X_t = g_0 + \sum_{k=1}^{M} g_k X_{t-k} + \sum_{l=1}^{N} d_l Y_{t-l} + v_t \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where Y_t and X_t are the variables to be tested, and U_t and V_t are mutually uncorrelated white noise errors, and t denotes the time period and *'k'* an 'l' are the number of lags. The null hypothesis is $\alpha_i = \delta_i = 0$ for all i's versus the alternative hypothesis that $\alpha_i \neq 0$ and $\delta_i \neq 0$ for at least some i's. If the coefficient α_i's are statistically significant but δ_i's are not, then X causes Y. In the reverse case, Y causes X. But if both α_i and δ_i are significant, then causality runs both ways.

Recent developments in the time series analysis have suggested some improvements in the standard Granger test. The first step is to check for the stationarity of the original variables and then test cointegration between them. According to Granger (1986), the test is valid if the variables are not cointegrated. Second, the results of Granger causality are very sensitive to the selection of lag length. If the chosen lag length is less than the true lag length, the omission of relevant lags can cause bias. If the chosen lag length is more, the irrelevant lags in the equation cause the estimates to be inefficient. To deal with this problem Hsiao (1981) has developed a systematic autoregressive method for choosing optimal lag length for each variable in an equation. This method combines Granger causality and Akaike's Final Prediction Error (FPE), defined as the (asymptotic) mean square prediction error.

Unit Root Test and Cointegration:

Empirical studies (for example, Engle and Granger, 1987) have shown that many time series variables are non-stationary or integrated of order 1 (i.e., their changes are stationary). The time series variables considered in this paper are the stock prices and five macroeconomic variables, namely, money supply, index of industrial production, real GDP, interest rate and rate of inflation. In order to avoid a spurious regression situation the variables in a regression model must be stationary or cointegrated. Therefore, in the first step, we perform unit root tests on these six time series to investigate whether they are stationary or not. The Augmented Dickey-Fuller (ADF) unit root test is used for this purpose. The ADF regression equations are:

$$\Delta Y_t = a_1 Y_{t-1} + \sum_{j=1}^{P} g_j \Delta Y_{t-j} + e_t \text{ ……………………………….. (3)}$$

$$\Delta Y_t = a_0 + a_1 Y_{t-1} + \sum_{j=1}^{P} g_j \Delta Y_{t-j} + e_t \text{ ……………………….. (4)}$$

$$\Delta Y_t = a_0 + a_1 Y_{t-1} + a_2 t + \sum_{j=1}^{P} g_j \Delta Y_{t-j} + e_t \text{ …………………. (5)}$$

where ε_τ is white noise. The additional lagged terms are included to ensure that the errors are uncorrelated. The tests are based on the null hypothesis (H_0): Y_t is not I (0). If the calculated DF and ADF statistics are less than their critical values from Fuller's table, then the null hypothesis (H_0) is accepted and the series are non-stationary or not integrated of order zero.

In the second step we estimate cointegration regression using variables having the same order of integration. The cointegration equation estimated by the OLS method is given as:

$$Y_t = a_0 + a_1 X_t + Z_t \text{ …………………………………….. (6)}$$

In the third step residuals (Z_t) from the cointegration regression are subject to the stationarity test based on the following equations:

(DF) $\Delta Z_t = \alpha + \beta_0 Z_{t-1} + V_t$ ………………………………. (7)

(ADF) $\Delta Z_t = \alpha + \beta_0 Z_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Z_{t-i} + V_t$ ...…………….(8)

where, Z_t is the residual from equation (6). The null hypothesis of non-stationarity is rejected if β is negative and the calculated DF or ADF statistics is less than the critical value from Fuller's table. That means there is a long run stable relationship between the two variables and causality between them is tested by the error correlation model.

Hsiao's Optimum Lag Length:

More recently many studies like Thornton and Batten (1985), Hwang et. al. (1991) and Chang and Lai (1997) have found Hsiao's Granger Causality test provides more robust results over both arbitrary lag length selection and other systematic methods for determining lag length. Hsiao's procedure involves two steps. The first step follows a series of autoregressive regressions on the dependent variables. In the first regression, the dependent variable is lagged once. In each succeeding regression, one more lag on the dependent variable is added. The m regressions we estimated are of the form:

$Y_t = \alpha + \sum_{i=1}^{m} \beta_i Y_{t-i} + \varepsilon_{1t}$ ………………………………. (9)

where, the choice of lag length is based on the sample size and underlying economic process. It is better to select m as large as possible (for example, we may set m=10). Then we computed the FPE for each regression in the following way:

$$FPE(m) = \frac{T+m+1}{T-m-1} RSS(m) / T \quad \text{………………………………. (10)}$$

where T is sample size and FPE and RSS are the final prediction error and the residual sum of squares respectively. The optimal lag length, m*, is the lag length which produces the lowest FPE. In the second step, once m* has been determined, regressions are estimated with the lags on the other variables, with lags added sequentially in the same manner used to determine m*. Thus we estimate ten regressions of the form:

$$Y_t = \alpha + \sum_{i=1}^{m*} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j} + \varepsilon_{2t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

We then compute FPE for each regression as:

$$FPE\,(m^*, n) = \frac{T + m^* + 1}{T - m^* - 1}\; RSS\,(m^*, n)\,/T \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

We choose the optimal lag length for X, n* as the lag length which produces the lowest FPE.

Toda and Yamamoto Version of Granger Causality:

It has been noted that the traditional Granger (1969) causality test for inferring leads and lags among integrated variables will end up in spurious regression results, and the *F*-test is not valid unless the variables in levels are cointegrated. New developments in econometric offers the error correction model (due to Engle and Granger (1987)) and the vector auto regression error-correction model (due to Johansen and Jesulius, 1990) as alternatives for the testing of non-causality between economic time series. Unfortunately, these tests are cumbersome and sensitive to the values of the nuisance parameters in finite samples and therefore their results are unreliable (see Toda and Yamamoto, 1995; Zapata and Rambaldi, 1997).

Toda and Yamamoto (1995) proposed a simple procedure requiring the estimation of an 'augmented' VAR, even when there is cointegration, which guarantees the asymptotic distribution of the MWald statistic. Therefore, the Toda-Yamamoto causality procedure has been labeled as the long-run causality tests. All one needs to do is to determine the maximal order of integration d_{max}, which we expect to occur in the model and construct a VAR in their levels with a total of ($k + d_{max}$) lags. Toda and Yamamoto point out that, for d=1, the lag selection procedure is always valid since k=1=d. If d=2, then the procedure is valid unless k=1. Moreover, according to Toda and Yamamoto, the MWald statistic is valid regardless whether a series is I (0), I (1) or I (2), non-cointegrated or cointegrated of an arbitrary order.

In order to clarify the principle, let us consider the simple example of a bivariate model, with one lag (k=1). That is,

$$x_t = A_0 + A_1 x_{t-1} + e_t \text{ -- } (13)$$

or more fully,

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(1)} & \alpha_{12}^{(1)} \\ \alpha_{21}^{(1)} & \alpha_{22}^{(1)} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \text{ ------------------ } (14)$$

where $E(e_t) = E\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = 0$ and $\mathrm{E}(e_t e_t^{/}) = \Sigma$

To test that x_2 does not Granger cause x_1, we will test the parameter restriction $\alpha_{12}^{(1)}$=0. If now we assume that x_{1t} and x_{2t} are I (1), a standard t-test is not valid. Following Dolado and Lutkepohl (1996), we test $\alpha_{12}^{(1)}$=0 by constructing the usual Wald test based on least squares estimates in the augmented model:

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(1)} & \alpha_{12}^{(1)} \\ \alpha_{21}^{(1)} & \alpha_{22}^{(1)} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(2)} & \alpha_{12}^{(2)} \\ \alpha_{21}^{(2)} & \alpha_{22}^{(2)} \end{bmatrix} \begin{bmatrix} x_{1,t-2} \\ x_{2,t-2} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \text{ ------------------ } (15)$$

The Wald statistic will be asymptotically distributed as a Chi Square, with degrees of freedom equal to the number of "zero restrictions", irrespective of whether x_{1t} and x_{2t} are I (0), I (1) or I (2), non-cointegrated or cointegrated of an arbitrary order.

In this study, we used monthly data series for six variables for the period April 1992 to March 2001. For stock price we use the monthly averages of BSE Sensitive Index (base: 1978-79=100). 364-day Treasury bill rate has been used as a proxy for interest rate; and the average rate of inflation based on wholesale price index (base: 1993-94=100) has been used as a proxy for the price level. As for income variable, since GNP series is available only annually, the Gandolfo’s (1981) technique has been used to interpolate monthly data series from annual observations. The other macroeconomic variables that we have included in our study are the money supply (M3) and the index of industrial production. The data has been compiled from Handbook of Statistics on Indian Economy (2001) published by Reserve Bank of India and various issues of RBI Bulletin.

III. Empirical Results:

As our first step, we have determined the order of integration for each of the six macroeconomic variables used in the analysis. Using the standard Augmented Dickey Fuller unit root test analysed in the earlier section, we have tested on both the levels and the first differences of the series. The results are tabulated in Table 1 and Table2.

Table 1: Results for the Dickey Fuller unit root test for the stock price index and five macroeconomic variables in levels

Variables	**Constant, No trend**	**Constant, With trend**
Stock Price	-2.0562	-2.9462
Money Supply	4.8467***	1.1482***
Index of Industrial Production	0.035003***	-3.3110***
National Income (GNP)	0.30488***	-3.7070***
Interest Rate	-1.6443	-1.9724
Rate of Inflation	-8.2659	-11.470

Note: Asterisk (***) denotes statistically significant at 10% level

Table 2: Results for the Dickey Fuller unit root test for the stock price index and three macroeconomic variables in first differences

Variables	**Constant, No trend**	**Constant, With trend**
Stock Price	-3.7766***	-3.7553***
Interest Rate	-4.1759***	-4.1598***
Rate of Inflation	-4.7586***	-4.7189***

Note: Asterisk (***) denotes statistically significant at 10% level

Clearly the results suggest that macroeconomic variables such as money supply, index of industrial production and national income are stationary, that is, integrated of order 0. On the other hand, stock price and the remaining macroeconomic variables viz. interest rate and rate of inflation are characterised as integrated of order 1, that is, first differencing will render the series stationary.

Having determined that d_{max}=1, we then proceed in estimating the lag structure of a system of VAR in levels and our results indicate that the optimal lag length based on Akaike's FPE (using Hsiao's optimal lag technique discussed in the previous section) is

2, that is, k=2. We then estimate a system of VAR in levels with a total of (d_{max}+k=3) lags.

$$\begin{bmatrix} SP_t \\ MS_t \\ IIP_t \\ NI_t \\ IR_t \\ INF_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} SP_{t-1} \\ MS_{t-1} \\ IIP_{t-1} \\ NI_{t-1} \\ IR_{t-1} \\ INF_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} SP_{t-2} \\ MS_{t-2} \\ IIP_{t-2} \\ NI_{t-2} \\ IR_{t-2} \\ INF_{t-2} \end{bmatrix} + A_3 \begin{bmatrix} SP_{t-3} \\ MS_{t-3} \\ IIP_{t-3} \\ NI_{t-3} \\ IR_{t-3} \\ INF_{t-3} \end{bmatrix} + \begin{bmatrix} e_{sp} \\ e_{ms} \\ e_{iip} \\ e_{ni} \\ e_{ir} \\ e_{\inf} \end{bmatrix} \text{---------------------- (16)}$$

where, SP = Stock price,
MS = Money supply,
IIP = Index of industrial production,
NI = National income,
IR = Interest rate, and
INF = Rate of inflation

The system of equations is jointly estimated as a "Seemingly Unrelated Regression Equations" (SURE) model by Maximum Likelihood and computes the MWALD test statistic. The MWALD statistic will be asymptotically distributed as a Chi Square, with degrees of freedom equal to the number of "zero restrictions", irrespective of whether x_{1t} and x_{2t} are I (0), I (1) or I (2), non-cointegrated or cointegrated of an arbitrary order. The results of the MWALD test statistic as well as its *p*-values are presented in table 3.

Table 3: Results of long run Causality due to Toda-Yamamoto (1995)

Null Hypothesis	MWALD statistics	*p*-values
Stock price versus money supply		
Stock price does not *Granger cause* money supply	1.0681472	0.58621
Money supply does not *Granger cause* stock price	1.2232359	0.54247
Stock price versus index of industrial production (IIP)		
Stock price does not *Granger cause* IIP	1.0359442	0.59573
IIP does not *Granger cause* stock price	11.596856*	0.00303
Stock price versus national income		
Stock price does not *Granger cause* national income	1.2232359	0.54247
National income does not *Granger cause* stock price	0.81643502	0.66483
Stock price versus interest rate		
Stock price does not *Granger cause* interest rate	2.5727095	0.27628
Interest rate does not *Granger cause* stock price	0.69672186	0.70584
Stock price versus rate of inflation		
Stock price does not *Granger cause* rate of inflation	10.918141*	0.00426
Rate of inflation does not *Granger cause* stock price	133.49749*	0.00000

Note: Asterisk (*) denotes statistically significant at 1% level

The test results in table 3 suggest that we fail to reject the null hypothesis of *Granger non-causality* from stock price to money supply, national income and interest rate as well as the null hypothesis of *Granger non-causality* from money supply, national income and interest rate to stock price even at 10% level of significance. The results suggest that the BSE Sensitive Index neither leads these three macroeconomic variables nor they lead the BSE Sensitive Index. This implies that the stock market cannot be used as a leading indicator for future growth in money supply, national income and interest rate in India. The null hypothesis of *Granger non-causality* from stock price to index of industrial production cannot be rejected even at 10% level of significance. On the other hand, the null hypothesis of *Granger non-causality* from index of industrial production to stock price can be rejected at 1% level of significance. This implies that index of industrial production leads the BSE Sensitive Index. Finally our result suggests a bi-directional causality between stock price and the rate of inflation, thus implying that the market informational efficiency hypothesis can be rejected for BSE Sensitive Index with respect to the rate of inflation.

IV. Conclusion:

The efficient market hypothesis (EMH), as formalized by Fama (1970), suggests that changes in the money supply or national output 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 important macro-variables are fully reflected in asset prices so that investors are unable to formulate some profitable trading rule using the available information.

The main objective of the present paper is to determine the lead and lag relationships between the Indian stock market and five key macroeconomic variables. We endeavor to investigate the question: Can the Indian stock market act as a barometer for the Indian economy? This is of course an empirical question. To test this hypothesis, we employ the methodology of *Granger non-causality* recently proposed by Toda and Yamamoto (1995) for the sample period April 1992 to March 2001. In this study, the BSE Sensitive Index was used as a proxy for the Indian stock market. The five important macroeconomic variables included in the study are broad money supply M3, national income (gross national product at constant prices), index of industrial production, interest rate (364 - day Treasury bill rate) and the rate of inflation.

The results are summarised as follows (i) there is no causal linkage between money supply and stock prices, (ii) index of industrial production leads the BSE Sensitive Index, (iii) there is no causal linkage between national income and stock prices, (iv) a bi-directional causality exists between stock price and the rate of inflation, (v) there is no causal linkage between interest rate and stock prices.

The results suggest that the Sensitive Index of the Bombay Stock Exchange has already incorporated all past information on money supply (M3), national income and interest rate. However the stock market is informationally inefficient with respect to the index of industrial production and the rate of inflation. If India's stock market is informationally inefficient with respect to both the index of industrial production and the rate of inflation, abnormal profit may be obtained consistently by using information on the changes in these variables. Rejecting the hypothesis will suggest that certain policies need to be formulated and implemented to improve the performance of the market.

The analysis reveals interesting results in the context of the Indian stock market, particularly with respect to key macroeconomic aggregates, viz., broad money supply, national income, index of industrial production, interest rate and the rate of inflation. These results must be explained in the light of the following developments. First, most of the earlier studies that analysed the nature of the nature of the causal relationship between macroeconomic aggregates and stock prices have employed the traditional Granger – causality test. Since it is now recognized that the conventional procedure may be inadequate, conclusions based on such an approach may yield misleading inferences. So we have employed the recently developed long–run Granger non–causality test proposed by Toda and Yamamoto (1995) in our study. Secondly, although our data set is from April 1992, the full–fledged financial sector reforms in India have come to operate only after 1995. Further, for a sufficient period of time the financial sector in India has remained dominated by the banking sector through which the changes in money supply primarily operate. In this context, the relationship between money supply and stock prices that we obtained in our result is not very surprising. Last but not the least, stock market in India is still in a transitory phase. If this result is also arrived at for subsequent periods, then it may be concluded that Indian stock market is approaching towards informational efficiency at least with respect to three macroeconomic variables, viz. money supply, national income and interest rate.

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