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Does Stock Market Respond to Economic Fundamentals? Time-series Analysis from Indian Data

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This study investigates the impact of Macroeconomic factors on stock market behavior considering the Indian data. Monthly data of five macroeconomic variables, namely, industrial production index, inflation, money supply, short term interest rate exchange rates and stock market index over the period 1994:04–2011:04 have been used for the analysis. Johansen's co-integration and vector error correction model have been applied to explore the long-run equilibrium relationship between stock market index and abovementioned macroeconomic variables. The analysis reveals that macroeconomic variables and the stock market index are co-integrated and, hence, a long-run equilibrium relationship exists between them. It is evident that the stock prices positively relate to the money supply and industrial production but negatively relate to inflation. The exchange rate and the short-term interest rate are found to be insignificant in determining stock prices. In the Granger causality sense, macroeconomic variable causes the stock prices in the long-run as well as in the short-run.

Keywords: *Stock market index, macroeconomic variables, co-integration test, causality test*

1. Introduction

As it is well known that the stock market avail long-term capital to the listed firms by pooling funds from different investors and allow them to expand in business and also offers investors alternative investment avenues to put their surplus funds in, investors carefully watch the performance of stock markets by observing the composite market index, before investing funds. The market index acts as the yardstick to compare the performance of individual portfolios and also provides investors for forecasting future trends in the market. However, as far as the developing country is concern, there have been numerous attempts to develop and stabilize the stock markets. Notwithstanding the emerging economies are characterized as the most volatile stock markets (Engel and Rangel, 2005). Moreover, the stock markets of emerging economies are likely to be sensitive to factors such as changes in the level of economic activities, changes in the political and international economic environment and also related to the changes in other factors. Investors evaluate the potential economic fundamentals and other firm specific factors/characteristics to formulate expectations about the stock markets.

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The Efficient Market Hypothesis championed by Fama (1970), promulgates that all relevant information about the changes in macroeconomic factors are fully reflected in the current stock prices in the efficient market. However, conclusions drawn from the Efficient Market Hypothesis has been critically examined by subsequent studies by Fama and Schwert (1977), Nelson (1976) and many scholars and affirm that macroeconomic variables do influence the stock returns by affecting stock prices. The Arbitrage Pricing Theory (APT) also provides theoretical framework of the linkage between stock prices and macroeconomic fundamentals (Ross, 1976; Chen et al., 1986).

The Study by Chen et al. (1986) is one of the earliest to empirically examine the link between stock prices and macroeconomic variables in the line of APT and provides the basis to believe for the existence of a long-run relationship between them. Subsequently, an increasing amount of empirical studies have been focusing attention to relate the stock prices and macroeconomic factors for both developed and emerging economies (see. Mukherjee and Naka, 1995; Wongbampo and Sharma, 2002; Maysami et al., 2004; Ratanapakorn and Sharma, 2007; Rahman et al., 2009; Asaolu and Ognumuyiwa, 2011 to name few). However, until recently, a negligible amount of research has been conducted for Indian stock market and economic factors and thus the conclusion might be inadequate (e.g. Pethe and Karnik, 2000; Bhattacharya and Mukherjee, 2006; Ahmed, 2008; Pal and Mittal, 2011).

The relationship of some macro factors could vary from market to market; may change in different sample periods and also in different frequency of the data. Thus, more in-depth studies are needed to understand the macroeconomic variables that might influence the stock market in an emerging economy like India since it is one among the fastest growing economies. The Indian capital market has undergone tremendous changes after the adoption of liberalization policy and it became more open to international investors. The reforming market and the significant economic potential have been attracting a large number of foreign institutional investors into the Indian stock market. This led India to become one of the most widely tracked emerging market with nearly 1,000 foreign institutional investors registered with Securities and Exchange Board of India (SEBI). In this end, how does and at what extent the Indian stock market responds to the changes in macroeconomic factors remains an open empirical question. Understanding the macroeconomic variables that could impact the stock market index, with the recent data can be useful for investors, traders as well as the policy makers. The goal of the present study is to investigate whether the changes of economic factors in India explain the stock prices in aggregate. It is believed that the findings of this study would extend the existing literature by providing some meaningful insight to the policy makers and the practitioners as far as the developing country like India is concerned.

The rest of the paper is organized as follows. Section 2 reviews some selected empirical literature pertaining to the study. Section 3 provides the theoretical justification and selection of variables and hence the model. The data sources, sample, and econometric methodology used in the study are discussed in section 4. The empirical results are reported and interpreted in section 5 and 6. Finally, section 7 summarizes the findings of the study and concludes.

2. Review of Literature

The previous empirical works on the link between macroeconomic factors and stock markets can be divided into two broad categories. The first category is such studies which investigated the impact of macroeconomic factors on stock prices. The second category of studies focused on the relationship between the stock market volatility and volatility in the

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macroeconomic fundamentals. Since the present study is based on the first category, some of the relevant literatures on the macroeconomic determinants of stock prices have been reviewed as follows.

Chen et al. (1986) explored a set of macroeconomic variables as systematic influence on stock market returns by modeling equity return as a function of macro variables and non-equity assets returns for US. They found that the macroeconomic variables such as industrial production anticipated and unanticipated inflation, yield spread between the long and short term government bond were significantly explained the stock returns. Similar results were found by Ratanapakorn and Sharma (2007) who examined the short-run and long run relationship between the US stock price index and macroeconomic variables using quarterly data for the period of 1975 to 1999. Their results revealed that the stock prices positively relates to industrial production, inflation, money supply, short term interest rate and also with the exchange rate, but, negatively related to long term interest rate. Mukherjee and Naka (1995) examined this relationship for Japan with a set of six macroeconomic variables. They found that the Japanese stock market was co-integrated with these set of variables indicating a long-run equilibrium relationship between the stock market return and the selected macroeconomic variables.

Mookerjee and Yu (1997) examined the nexus between Singapore stock returns and four macroeconomic variables such as narrow money supply, broad money supply, exchange rates and foreign exchange reserves using monthly data from October 1984 to April 1993. Their analysis revealed that both narrow and broad money supply and foreign exchange reserves exhibited a long run relationship with stock prices whereas exchange rates did not. Wongbampo and Sharma (2002) explored this relationship in 5-Asian countries viz. Malaysia, Indonesia, Philippines, Singapore and Thailand with the help of five macroeconomic variables such as GNP, inflation, money supply, interest rate, and exchange rate. Their analysis revealed that in the long run all the five stock price indexes were positively related to growth in output and negatively related to the aggregate price level. However, they found a negative relationship between stock prices and interest rate for Philippines, Singapore and Thailand, but positive relationship for Indonesia and Malaysia. Maysami et al. (2004) examined the relationship among the macroeconomic variables and sector wise stock indices for Singapore using monthly data from January 1989 to December 2001 and found a significant long-run equilibrium relationship between the Singapore stock market and the macroeconomic variable tested. Rahman et al. (2009) examined the macroeconomic determinants of stock market returns for the Malaysian stock market by employing co-integration technique and vector error correction mechanism (VECM). Using monthly data ranged from January 1986 to March 2008, they found that interest rates, reserves and industrial production index were positively related while money supply and exchange rate were inversely related to Malaysian stock market return in the long run. Their causality test indicates a bi-directional relationship between stock market return and interest rates. Akbar et al. (2012) examined the relationship between the Karachi stock exchange index and macroeconomic variables for the period of January 1999 to June 2008. Employing a co-integration and VECM, they found that there is a long-run equilibrium relationship exists between the stock market index and the set of macroeconomic variables. Their results indicated that stock prices were positively related with money supply and short-term interest rates and negatively related with inflation and foreign exchange reserve.

Gan et al. (2006) investigated the relationships between New Zealand stock market index and a set of seven macroeconomic variables from January 1990 to January 2003 using co-integration and Granger causality test. The analysis revealed a long run relationship between New Zealand's stock market index and the macroeconomic variables tested. However, the Granger causality test results showed that the New Zealand's stock index was not a leading indicator for changes in macroeconomic variables. On the other hand, Robert (2008) examined the effect exchange rate and oil prices on stock market returns for four emerging economies, namely; Brazil, Russia, India and China using monthly data from March 1999 to June 2006. He concluded that there was no significant relationship between present and past market returns with macroeconomic variables, suggesting that the markets of Brazil, Russia, India and China exhibit weak form of market efficiency. Furthermore, no significant relationship was found between respective exchange rate and oil price on the stock market index of the four countries studied. Asaolu and Ognumuyiwa (2011) investigated the impact of macroeconomic variables on Average Share Price for Nigeria for the period of 1986 to 2007. The results from their causality test indicated that average share price does not Granger cause any of the nine macroeconomic variables in Nigeria in the sample period. Only exchange rate Granger caused average share price. However, the Johansen Co-integration test affirmed that a long run relationship exists between average share price and the macroeconomic variables.

Abugri (2008) investigated the link between macroeconomic variables and the stock return for Argentina, Brazil, Chile, and Maxico using monthly dataset from January 1986 to August 2001. His estimated results showed that the MSCI world index and the U.S. T-bills were consistently significant for all the four markets he examined. Interest rates and exchange rates were significant three out of the four markets in explaining stock returns. However, it can be observed from his analysis that, the relationship between the macroeconomic variables and the stock return varied from country to country. For example from his analysis it is evident that, for Brazil, exchange rate and interest rate were found to be negative and significant while the IIP was positive and significantly influenced the stock return. For Maxico, the exchange rate was negative and significantly related to stock return but interest rates, money supply, IIP were insignificant. For Argentina, interest rate and money supply were negatively and significantly influenced on stock return but exchange rate and IIP were insignificant. But for Chile, IIP was positively and significantly influence stock return but exchange rate and money supply were insignificant. These results implies that the response of market return to shock in macroeconomic variables cannot be determine a priori, since it tends to vary from country to country.

In the Indian context, Pethe and Karnik (2000) employed co-integration and error correction model to examine the inter-relationship between stock price and macroeconomic variables using monthly data from April 1992 to December 1997. Their analysis revealed that the state of economy and the prices on the stock market do not exhibit a long run relationship. Bhattacharya and Mukherjee (2006) examined the relationship between the Indian stock market and seven macroeconomic variables by employing the VAR framework and Toda and Yamamoto non-Granger causality technique for the sample period of April 1992 to March 2001. Their findings also indicated that there was no causal linkage between stock returns and money supply, index of industrial production, GNP, real effective exchange rate, foreign exchange reserve and trade balance. However, they found a bi-directional causality between stock return and rate of inflation.

Ray and Vani (2003) employed a VAR model and an artificial neural network (ANN) to examine the linkage between the stock market movements and real economic factors in the Indian stock market using the monthly data ranging from April 1994 to March 2003. The

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results revealed that, interest rate, industrial production, money supply, inflation rate and exchange rate have a significant influence on equity prices, while no significant results were discovered for fiscal deficit and foreign investment in explaining stock market movement. Ahmed (2008) employed the Johansen's approach of co-integration and Toda – Yamamoto Granger causality test to investigate the relationship between stock prices and the macroeconomic variables using quarterly data for the period of March, 1995 to March 2007. The results indicated a long-run relationship between stock price and FDI, money supply, index of industrial production. His study also revealed that movement in stock price caused movement in industrial production. Pal and Mittal (2011) investigated the relationship between the Indian stock markets and macroeconomic variables using quarterly data for the period January 1995 to December 2008 with the Johansen's co-integration framework. Their analysis revealed that there was a long-run relationship exists between the stock market index and set of macroeconomic variables. The results also showed that inflation and exchange rate have a significant impact on BSE Sensex but interest rate and gross domestic saving (GDS) were insignificant.

3. Theoretical Background and Selection of Variables

The theoretical linkage between the macroeconomic factors and the stock market movement can directly be drawn from the present value model or the dividend discount model (DDM) and the arbitrage pricing theory (APT). The present value model focused on the long-run relationship whereas the arbitrage pricing theory focused on short-run relationship between the stock market movement and the macroeconomic fundamentals. According to these models, any new information about the fundamental macroeconomic factors such as, real output, inflation, money supply, interest rate and so on, may influence the stock price/return through the impact of expected dividends, the discount rate or both (Chen *et al.*, 1986; Rahman *et al.*, 2009). A simple discount model shows that the fundamental value of corporate stock equals the present value of expected future dividends. The future dividends must ultimately reflect real economic activity. If all currently available information is taken into account, there could be a close relationship between stock prices and expected future economic activity.

Amongst many macroeconomic variables, five variables are selected based on their theoretical importance, performance measures of the economy, and also their uses and findings in the previous empirical literature. The level of real economic activity is regarded as the crucial determinants of stock market returns. The traditional measure for real economic activity is the gross domestic product (GDP) or the gross national product (GNP). However, the data unavailability for these variables on a monthly basis restricts many researchers to use IIP as an alternative to incorporate the real output. The rise in industrial production signals the economic growth (Maysami *et al*., 2004). Moreover, it may explain more return variation than GNP or GDP (Ratanapakorn and Sharma, 2007). Increase in industrial production increase the corporate earnings enhancing the present value of the firm and hence it leads to increase the investment in stock market which ultimately enhances the stock prices. The opposite will cause a fall in the stock market. The previous studies such as, Chen *et al.* (1986), Maysami *et al.* (2004), Rahman *et al.* (2009), Ratanapakorn and Sharma, (2007) found a positive relationship between IIP and stock prices.

Another variable that extensively used in the literature is inflation. The impact of inflation on stock price is empirically mixed. Fama (1981), Chen *et al.* (1986), Mukherjee and Naka (1995), Pal and Mittal (2011) found negative correlation between inflation and stock price. Their explanation for the negative coefficient is based on Fama's proxy effect.

According to Fama (1981), the real activity is positively associated with the stock return but negatively associated with inflation through the money demand theory; therefore, stock return will negatively influenced by inflation. The negative relationship between inflation and stock return can also be explained through the dividend discount model. Since, stock price can be viewed as the discounted value of expected dividend, an increase in inflation may enhance the nominal risk free rate and thus the discount rate leading to declining stock price. However, the previous empirical studies also found a positive relationship between inflation and stock return (e.g. Ratanapakorn and Sharma, 2007) suggesting that equity act as a hedge against inflation.

Money supply is another fundamental macroeconomic variable which widely used in the literature to determine the stock prices. Beside the extensive empirical investigation, the relationship between money supply and stock price is still ambiguous. According to the portfolio theory, an increase in the money supply may results in a portfolio change from non-interest bearing money assets to financial assets like stock. Moreover, as explained by Mukherjee and Naka (1995) if money supply brings the economic stimulus then the resulting corporate earnings in turn increase the stock prices. On the other hand, when the increased money supply cause the inflation to be increased, then an increase in money supply raise the discount rate and therefore reduce the stock prices. Mukherjee and Naka (1995), Maysami *et al.* (2004), Ratanapakorn and Sharma, (2007) found positive relationship between money supply and stock prices, whereas, Rahman *et al.* (2009) found negative relationship.

Other than IIP, inflation and money supply, two more variables such as interest rate and exchange rate are the most used macro-economic factors to determine the stock returns. When the companies finance their capital equipment and inventories through borrowings, a reduction of interest rate means the cost of borrowing is decreased. This may serve as an incentive for expansion via the increased investment capacity of the companies which in turn increase their stock prices. Alternatively, as Maysami *et al.* (2004) explains, when a substantial amount of stocks are purchased with borrowed money, an increase in interest rate would make stock transaction more costly. Investors will expect a higher rate of return before investing which results the demand to fall and hence leads to price depreciation.

The impact of exchange rate on stock price depends on the importance of a nation's international trade in its economy as well as the degree of the trade balance. Depreciation of a domestic currency against a foreign currency increase return on foreign currency and induce investor to shift fund from domestic assets (stocks) toward foreign currency assets, depressing stock price in home country. An appreciation of a domestic currency lowers the competitiveness (firm value) of exporting firms and may negatively affects the stock prices. On the other hand if the country is import dominant, the exchange rate appreciation reduces import costs and generates a positive impact on domestic stock price.

Based on the above discussion, the present study tries to investigate the long run and short run relationship between the stock price indices and five macroeconomics variables, by considering the following model:

$$X_t = (SPI_t, IIP_t, WPI_t, MS_t, TBR_t, EXR_t)' \qquad (1)$$

where SPI is the stock market indices, IIP is industrial production index, WPI is the wholesale price index, MS is the broad money supply, TBR is the short term treasury bills rate, EXR is the real effective exchange rate and X is a 6×1 vector of variables.

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4. Data and Methodology

4.1. Data Description

The present study uses the time series data obtained from two main sources i.e. Bombay Stock Exchange official website and Handbook of Statistics on Indian Economy provided by Reserve Bank of India. The BSE Sensex is employed as a proxy for Indian stock market indices[2]. Since it would be almost impossible to incorporate every potential aspect to explain the stock market behavior we limit to select five macroeconomic variables namely industrial production index (IIP), wholesale price index (WPI), money supply, exchange rate, and short run interest rate. The selection of variables for the present study is based on the existing theoretical propositions and the empirical evidences. The base period for Sensex is 1978-79 = 100, whereas, the other index series are rebased as 2004-05 = 100. IIP is used as a proxy for real output, WPI is used in order to incorporate the inflation rate, broad money supply (M3), the rupee vs dollar exchange rate, and three month treasury bills rate is used to incorporate the short run risk free interest rate. As already discussed, these variables are extensively used in the previous literature to capture the macroeconomic activities. To accomplish the research objective monthly data ranging from April-1994 to April-2011 are obtained which comprises 205 data points for the analysis. The choice of study period is based on the availability of data series. Descriptions of variables and data sources are presented in Table 1. All variables except the treasury bills rate are converted into natural logarithmic form.

4.2. Statistical methods for data analysis

The present study employs the time series data analysis technique to study the relationship between the stock market index and the selected macroeconomic variables. In a time series analysis, the ordinary least squares regression results might provide a spurious regression if the data series are non-stationary. Thus, the data series must obey the time series properties, i.e. the time series data should be stationary, meaning that, the mean and variance should be constant over time and the value of covariance between two time periods depends only on the distance between the two time periods and not the actual time at which the covariance is computed. The most popular and widely used test for stationary is the *unit root test*. The presence of unit root indicates that the data series is non-stationary. Three standard procedures of unit root test namely the Augmented Dickey Fuller (ADF), Phillips-Perron (PP), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are performed to check the stationary nature of the series.

Table 1. Description of Variables

Acronym	Construction of Variables	Data Source
SPI	Natural logarithm of the index of market value weighted average of the month-end closing prices listed in the Bombay Stock Exchange	BSE
IIP	Natural logarithm of the month-end Index of Industrial Production	RBI
WPI	Natural logarithm of the monthly average wholesale price index	RBI
MS	Natural logarithm of month-end broad money supply (M3)	RBI
EXR	Natural logarithm of the exchange rate (monthly average) of the Indian rupee vs US dollar	RBI
TBR	Monthly average of the 91-day Government of India treasury bills	RBI

[2] The BSE sensitive index or Sensex is a market capitalization-weighted index of 30 stocks that represents large and well established financially sound companies in India, and widely used in measuring the performance of Indian Stock market.

Assuming that the series follows an AR (p) process the ADF test makes a parametric correction and controls for the higher order correlation by adding the lagged difference terms of the dependent variable to the right hand side of the regression equation. However, since the ADF test is often criticized for low power, the unit root test has been complement with PP test which adopts a non parametric method for controlling higher order serial correlation in the series. In both ADF test and PP test the null hypothesis is that data set being tested has unit root. One more criticism of the ADF test is that it cannot distinguish between unit root and near unit root process. Thus, we performed the KPSS test where the null hypothesis is that the data series is stationary against the alternative of a unit root. This provides a robustness check for stationary. The unit root tests also provide the order of integration of the time series variables.

In a multivariate context if the variable under consideration are found to be I(1) (i.e. they are non-stationary at level but stationary at first difference), but the linear combination of the integrated variables is I(0), then the variables are said to be co-integrated (Enders, 2004). With the non-stationary series, co-integration analysis has been used to examine whether there is any long run relationship exists. However, a necessary condition for the use of co-integration technique is that the variable under consideration must be integrated in the same order and the linear combinations of the integrated variables are free from unit root. According to Engel and Granger (1987), if the variables are found to be co-integrated, they would not drift apart over time and the long run combination amongst the non-stationary variables can be established. To conduct the co-integration test, the Engel and Granger (1987) or the Johansen and Juselius (1990) or the Johansen (1991) approach can be used. The Engel-Granger two step approaches can only deal with one linear combination of variables that is stationary. In a multivariate practice, however, more than one stable linear combination may exist. The Johansen's co-integration method is regarded as full information maximum likelihood method that allows for testing co-integration in a whole system of equations.

The Johansen methods of co-integration can be written as the following vector autoregressive framework of order *p*.

$$X_t = A_0 + \sum_{j=1}^{p} B_j X_{t-j} + e_t \qquad (2)$$

where, X_t is an $n\times 1$ vector of non stationary I(1) variables, A_0 is an $n\times 1$ vector of constants, p is the maximum lag length, B_j is an $n\times n$ matrix of coefficient and e_t is a $n\times 1$ vector of white noise terms.

To use the Johansen's method, equation (2) needs to be turned into a vector error correction model (VECM) which can be written as

$$\Delta X_t = A_0 + \sum_{j=1}^{p-1} \Gamma_j \Delta X_{t-j} + \Pi X_{t-p} + e_t \qquad (3)$$

where, Δ is the first difference operator, $\Gamma_j = -\sum_{i=j+1}^{p} B_j$ and $\Pi = -I + \sum_{i=j+1}^{p} B_j$, and I is an n×n identity matrix.

The test for co-integration between the X's is calculated by observing the rank of the Π matrix via its eigenvalues. The rank of a matrix is equal to the number of its characteristic roots that are different from zero. The hypothesis is H_0: $\Pi = \alpha\beta'$ where α and β are $n\times r$ loading matrices of eigenvectors. The matrix β gives the co-integration vectors, while α is known as the adjustment parameters that gives the amount of each co-integration entering each equation of the VECM. The aim is to test the number of *r* co-integrating vectors such as

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$\beta_1, \beta_2, \ldots\ldots \beta_r$. The number of characteristic roots can be tested by considering the following *trace* statistic and the maximum eigenvalue test.

$$\lambda_{trace}(r) = -T\ \sum_{i=j+1}^{p} \ln(1-\hat{\lambda}_j) \quad \text{and} \quad \lambda_{max}(r,\ r+1) = -T\ln(1-\hat{\lambda}_{r+1})$$

where, r is the number of co-integrating vectors under the null hypothesis, T is the number of usable observations and $\hat{\lambda}_j$ is the estimated value for the j^{th} ordered characteristic roots or the eigenvalue from the Π matrix.

A significantly non-zero eigenvalue indicates a significant co-integrating vector. The trace statistics is a joint test where the null hypothesis is that the number of co-integration vectors is less than or equal to r against an unspecified general alternative that there are more than r. Whereas, the maximum eigenvalue statistics test the null hypothesis that the number of co-integrating vectors is less than or equal to r against the alternative of $r+1$ (Enders, 2004; Brooks, 2008). The presence of co-integrating vectors supports the application of a dynamic VECM that depicts the feedback process and speed of adjustment for short run deviation towards the long run equilibrium and reveals short run dynamics in any variables relative to others.

5. Estimation Results and Interpretations

The descriptive statistics for all six variables under study, namely, BSE sensitive index proxied for stock price index (SPI), industrial production index (IIP), wholesale price index (WPI), broad money supply (MS), the exchange rate (EXR) and treasury bills rate (TBR) are presented in Table 2. The value of skewness and kurtosis indicate the lack of symmetric in the distribution. Generally, if the value of skewness and kurtosis are 0 and 3 respectively, the observed distribution is said to be normally distributed. Furthermore, if the skewness coefficient is in excess of unity it is considered fairly extreme and the low (high) kurtosis value indicates extreme platykurtic (extreme leptokurtic). From the table it is observed that the frequency distributions of underlying variables are not normal. The significant coefficient of Jarque-Bera statistics also indicates that the frequency distributions of considered series are not normal. The value of standard deviation indicates that the treasury bills rate, BSE sensitive index and money supply are relatively more volatile as compare to exchange rate, wholesale price index and the index of industrial production. Table 3 presents the correlation coefficient of the underlying variables. It is evident that all the coefficients are less than 0.5 suggesting less multicolinear problems.

Table 2. Descriptive Statistics

	LnSPI	LnIIP	LnWPI	LnMS	LnEXR	TBR
Mean	8.703	4.397	4.502	14.321	3.744	7.255
Std. Dev.	0.645	0.374	0.254	0.775	0.1308	2.324
Maximum	9.915	5.328	5.024	15.709	3.936	12.967
Minimum	7.960	3.722	4.038	13.009	3.445	3.226
Skewness	0.630	0.366	0.145	0.062	-1.035	0.639
Kurtosis	1.821	2.335	2.011	1.876	2.957	3.111
Jarque-Bera	25.469	8.357	9.058	10.911	36.640	14.084
Probability	0.000	0.015	0.010	0.004	0.0000	0.0008
Observations	205	205	205	205	205	205

Table 3. Correlation Matrix

	LnSPI	LnIIP	LnWPI	LnMS	LnEXR	TBR
LnSPI	1					
LnIIP	0.053	1				
LnWPI	-0.154	0.049	1			
LnMS	-0.067	0.097	-0.018	1		
LnEXR	-0.311	-0.051	0.064	0.007	1	
TBR	-0.034	0.150	0.024	-0.038	0.040	1

The stationarity of the data series has been established by the standard procedure of unit root testing by employing the Augmented Dickey Fuller (ADF) test. However, the ADF test is often criticized for low power. Thus we complement this test with the Phillips-Perron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The results are presented in Table 4. On the basis of these three tests, all the series are found to be non-stationary at level with intercept. However, after taking the first difference these series are found to be stationary at 1and 5 percent level. Thus all the three stationary tests indicate that all series are individually integrated of the order I(1) and the linear combination of these variables or the error term is integrated of order I(0). These results also indicate that the underlying variables are cointegrated. The analysis has been done under a vector autoregressive (VAR) framework.

Table 4. Unit Root Test for Stationary

Variables	ADF Test *H_0: Variable is non-stationary*	PP Test *H_0: Variable is non-stationary*	KPSS Test *H_0: Variable is stationary*	Order of Integration
LnSPI	-0.234	-0.178	1.474***	
ΔLnSPI	-10.905***	-10.925***	0.167	I(1)
LnIIP	1.257	0.053	1.778***	
ΔLnIIP	-3.852***	-30.702***	0.109	I(1)
LnWPI	0.677	0.625	1.808 ***	
ΔLnWPI	-9.672***	-9.654***	0.148	I(1)
LnMS	1.027	1.197	1.804***	
ΔLnMS	-2.934**	-14.892***	0.201	I(1)
LnEXR	-2.321	-2.272	1.039***	
ΔLnEXR	-10.505***	-15.434 ***	0.296	I(1)
TBR	-1.578	-1.976	0.946***	
ΔTBR	-12.629***	-12.827***	0.067	I(1)
U (error term)	-3.283**	-3.549***	0.070	I(0)

Notes: *** implies significant at 1% level, and ** implies significant at 5% level. Δ represents first difference

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Table 5. VAR Lag Order Selection Criteria

Endogenous variables: LnSPI LnIIP LnWPI LnMS LnEXR TBR

Lag	LogL	LR	FPE	AIC	SC	HQ
0	467.5441	NA	3.37e-10	-4.782840	-4.681410	-4.741764
1	2328.046	3586.045	2.07e-18	-23.68960	-22.97958*	-23.40206
2	2396.717	128.0908	1.48e-18*	-24.02816	-22.70956	-23.49416*
3	2423.271	47.87988	1.64e-18	-23.93027	-22.00309	-23.14982
4	2465.828	74.08832	1.54e-18	-23.99821	-21.46245	-22.97131
5	2503.779	63.71113	1.52e-18	-24.01844	-20.87408	-22.74507
6	2524.084	32.82375	1.81e-18	-23.85579	-20.10285	-22.33597
7	2556.784	50.82906	1.90e-18	-23.82159	-19.46007	-22.05531
8	2592.430	53.19322	1.95e-18	-23.81793	-18.84782	-21.80520
9	2634.887	60.71579	1.88e-18	-23.88484	-18.30615	-21.62565
10	2689.399	74.56542	1.61e-18	-24.07668	-17.88940	-21.57103
11	2721.406	41.79113	1.76e-18	-24.03530	-17.23943	-21.28319
12	2774.399	65.89834*	1.56e-18	-24.21139*	-16.80694	-21.21283

Notes: * indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

It is important to note that in time series the lag order in the analysis is quite sensitive to the results and therefore selection of lag length in an appropriate criterion is quite essential. Table 5 depicts the lag order selection criteria. The Akaike Information Criterion (AIC) suggests a lag order of 12. However, the Schwarz Information Criterion (SIC) suggests that one lag is enough for the analysis. Hence, the selection of lag order for the analysis is based on the SIC.

The presence of and the number of co-integrating relationships among the underlying variables are tested through a vector error correction model (VECM) applying the Johansen procedure i.e., Johansen and Juselius (1990) and Johansen (1991). Accordingly, trace statistic and the maximum eigenvalue are used to test for the number of co-integrating vectors. The results of both trace statics and the maximum eigenvalue test statistics are presented in Table 5. Both the trace statistic and the maximum eigenvalue statistics identify one co-integrating vector.

Table 6. Multivariate (Johansen) Cointegatrion Test results

Hypothesized No. of CE(s)	Trace Statistics	0.05 Critical Value	Probability**	Max-eigen Statistics	0.05 Critical Value	Probability**
None*	105.949	95.753	0.008	52.800	40.077	0.001
At most 1	**53.148**	**69.818**	**0.498**	**22.668**	**33.876**	**0.555**
At most 2	30.480	47.856	0.694	14.568	27.584	0.781
At most 3	15.912	29.797	0.718	8.451	21.131	0.874
At most 4	7.461	15.494	0.524	5.823	14.264	0.636
At most 5	1.637	3.841	0.200	1.637	3.841	0.200

Notes: * denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values

Assuming one co-integrating vector, the short run and long run interaction of the underlying variables the VECM has been estimated based on the Johansen co-integration methodology. The results show that a long-run equilibrium relationship exists between the stock market indices and the macroeconomic variables. The estimated co-integrating coefficients for the BSE sensitive index based on the first normalized eigenvector are as follows.

$$X_t = (SPI_t,\ IIP_t,\ WPI_t,\ MS_t,\ EXR_t,\ TBR_t,)$$
$$B_1 = (1.00, -19.93, 57.18, -10.18, 1.48, 0.13)$$

The variables are converted into log transformation and hence these values represent long term elasticity measures. Thus the co-integration relationship can be re-expressed as:

$$LnSPI = 39.14 + 19.93LnIIP - 57.18LnWPI + 10.18LnMS - 1.48LnEXR - 0.13TBR$$

(6.78) (-6.19) (3.76) (-0.83) (-1.36)

The t-statistics are given in brackets. The coefficients for LnIIP, and LnMS are positive while the coefficients for LnWPI is negative and statistically significant. On the other hand the coefficients for LnEXR and TBR are negative but statistically insignificant. The intercept term is positive. In general the signs of all variables are in line with theoretical predictions. The co-integration results reveal that stock returns are positively and significantly related to the level of real economic activity as proxied by the index of industrial production. A positive relationship between stock price and real output is consistent with Maysami *et al.* (2004), Ratanapakorn and Sharma, (2007), Rahman *et al.* (2009), Akbar *et al.* (2012), who found similar results for Singapore, US, Malaysia, and Pakistan respectively. The positive relationship indicates that, with the presence of cointegration, increase in industrial production index increase the corporate earning which enhances the present value of the firm and hence the stock prices increase. It may also increase the national disposable income and therefore more retail investment in the stock market. The negative relationship between stock price and inflation support the proxy effect of Fama (1981) which explains that higher inflation raise the production cost which adversely affects the profitability and the level of real economic activity; since the real activity is positively associated with stock return, an increase in inflation reduces the stock price. Pal and Mittal (2011), Akbar (2012) also found a negative relationship for India and Pakistan respectively. However, this finding is contrary to Maysami *et al.* (2004) and Ratanapakorn and Sharma, (2007) who finds a

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positive relationship between inflation and stock price suggesting that equities serve as a hedge against inflation.

The relationship between money supply and stock prices is found to be positive which indicates that money supply brings the economic stimulus enabling the aggregate stock price to increase. The positive relationship between money supply and the stock price has been consistent with Mukherjee and Naka (1995), Maysami *et al.* (2004), Ratanapakorn and Sharma, (2007). The result of co-integration test indicates that interest rate and exchange rate are insignificant in determining the stock price although the sign of the coefficient for LnEXR and TBR are negative.

The sign of the error correction coefficient in determination of LnSPI is negative (-0.0089) and the t-value (-2.14) is statistically significant. This indicates that stock price do respond significantly to re-establish the equilibrium relationship once deviation occurs. However, the speed at which the LnSPI adjusts in the absence of any shocks is approximately 0.09% per month which is less (see. Table 7). The R^2 shows that only 13 percent of the variation in the stock price index is explained by industrial production, money supply, inflation, exchange rate and interest rate. However, the highly significant F statistics suggests the overall significance of the model. The robustness of these results is confirmed by the insignificant probability value of LM test and ARCH test for residual diagnostic.

Table 7. Results of Vector Error Correction Model

Normalized Co-integrating Coefficients						
LnSPI (-1)	LnIIP (-1)	LnWPI (-1)	LnMS (-1)	LnEXR (-1)	TBR (-1)	Constant
1.0000	-19.938	57.189	-10.187	1.489	0.130	-39.143
	(2.93)	(9.23)	(2.77)	(1.79)	(0.09)	
	[-6.78]	[6.19]	[-3.67]	[0.83]	[1.36]	

Coefficient of Error Correction terms = -0.0089 (0.0041) [-2.14]
$R^2 = 0.13$
$F= 4.37^{***}$
DW = 1.97
Probability value of LM test = 0.65
Probability value of ARCH test = 0.80
Notes: Standard errors in ( ) and t-statistics in [ ]

6. Causality Analyses

The co-integration results indicate that causality exists between the co-integrated variables, however, it fails to show us the direction of the causal relationship. According to Engel and Granger (1987), if the variables are found to be co-integrated then there always exists an error correction representation in which the short run dynamics of the variables can be tested that are influenced by the deviation from equilibrium. Engel and Granger suggest that if co-integration exist between the variables in the long run, then, there must be either unidirectional or bidirectional relationship between variables. The short run and long run causal relationship between the variables should be examined in a vector error correction (VECM) framework.

The system of short run dynamics of the stock price, corresponding to model (1) with log transformation can be written in the following VECM framework.

$$\Delta LnSPI_t = \mu_1 + \gamma_1 Z_{t-1} + \sum_{i=1}^{p} \theta_{1i}\,\Delta LnSPI_{t-i} + \sum_{i=1}^{p} \delta_{1i}\,\Delta LnIIP_{t-i} + \sum_{i=1}^{p} \tau_{1i}\,\Delta LnWPI_{t-i} + \sum_{i=1}^{p} \rho_{1i}\,\Delta LnMS_{t-i} + \sum_{i=1}^{p} \omega_{1i}\,\Delta LnEXR_{t-i} + \sum_{i=1}^{p} \xi_{1i}\,\Delta TBR_{t-i} + \varepsilon_t^{SPI} \quad (4)$$

where, Z_{t-1} is the error correction term obtained from the co-integrating vector; γ, θ, δ, τ, ρ, ω and ξ are the parameter to be estimated; *p* is the lag length; *μ* is a constant term and ε^{SPI} is assumed to be stationary random process with mean zero and constant variance. The VECM for other variables can be written similarly.

The VECM can capture the short run dynamics as well as the long run equilibrium relations between time series variables and therefore can distinguish between short run and long run Granger causality. The significant coefficient for lagged error correction term (i.e. by testing H_0: $\gamma_1 = 0$) provides the long run Granger causality which can be observed through the t-statistics. On the other hand, the short run Granger causality is tested by the joint significance of the coefficients of the differenced explanatory variables. For example, in (4), real output Granger cause stock market indices if either δ_{1i} are jointly significant (i.e. by testing H_0: $\delta_{11} = \delta_{12} = \ldots\ldots = \delta_{1p} = 0$) by computing the Wald F-statistics. Similarly, inflation Granger causes stock market indices in the short run if either τ_{1i} are jointly significant. The short run causality for other variables can be tested in similar way.

The Granger causality analyses based on the VECM with 1 lag are conducted between the stock price index and five macroeconomic variables. The test statistics results are reported in Table 8. Considering the stock price index equation, it can be observed that only t-statistics of the error correction term is statistically significant and also negative. The significant and negative error correction term supports the presence of co-integration in the long run and variables adjust towards long run equilibrium.

Table 8. Results of VECM

Dependent Variable	F-statistics						t-statistics
	ΔlnSPI	ΔlnMS	ΔlnIIP	ΔlnWPI	ΔlnEXR	ΔTBR	ECT_{t-1}
ΔlnSPI	-	0.57	0.49	3.74*	3.20*	3.04*	-2.14**
ΔlnMS	3.23*	-	3.29*	5.40**	0.01	0.81	3.78***
ΔlnIIP	0.60	14.64***	-	7.22***	0.31	0.027	-2.56**
ΔlnWPI	2.64	4.09**	0.033	-	1.27	8.79***	-4.09***
ΔlnEXR	0.32	0.11	0.09	0.026	-	1.48	2.40**
ΔTBR	0.30	3.30*	0.01	4.86**	0.13	-	-0.33

Notes: All variables are in first difference except the lagged error correction term (ECT_{t-1}). The error correction term is generated from Johansen cointegration with the first cointegrating equation which is normalized with the stock price index. The VECM is based on 1 lag with a constant term. ***, ** and * indicates 1%, 5% and 10% level of significant respectively.

The results indicate that, in the long-run, there is bidirectional causality exists between stock market index and industrial production index; stock price index and wholesale price index. Thus, in the long-run, stock market index do have a feedback effect on two macroeconomic variables selected. The VECM causality result also reveals that, in the short-run, three variables such as wholesale price index, exchange rate and risk free interest rate do Granger cause stock price index at least at 10 percent significance level. No significant results found for money supply and industrial production index. This might be the fact that, in the short-run, the stock price may follow a random walk. However, in the long-run, the evolution of the economy may lead to such causality. From Table 8, it is also observed that,

in the short-run, the wholesale price index has a feedback relationship with money supply and short term interest rate. The wholesale price index also shows a one-way causality with industrial production and exchange rate from wholesale price index to industrial production and exchange rate. It is also evident that, in the short-run, money supply and industrial production have a feedback effect; also, stock price granger cause industrial production.
From the result it can be interpreted that, increase in the industrial production stimulates the state of economy, the corporate profits and that in turn lead to increase the stock prices. At the same time, the health of the stock market, in the sense of rising share prices, translates into health of the economy both in short run and long run.

7. Summarization and Conclusion

This study revisited the inter-linkage between the stock prices and macroeconomic fundamentals by examining the Indian stock market index and five macroeconomic variables, namely, the industrial production index representing the real output, the wholesale price index to represent inflation, broad money supply, the risk free interest rate, and the rupee vs dollar exchange rate using Johansen's co-integration and VECM techniques. The analysis used the monthly data for the period of April 1994 to April 2011 which are obtained from Bombay Stock exchange official website and the Hand Book of Statistics on Indian Economy provided by RBI. The BSE Sensex is used to represent the Indian stock market index. It is believed that, the selected macroeconomic variables, among others, represent the state of the economy.

To conclude, the analysis revealed that all variables are non-stationary at log level but stationary at their first difference. The Indian stock market index as proxied by BSE Sensex formed significant long-run relationship with three out of five macroeconomic variables tested. The Johansen's co-integration test suggests that the stock market index has co-integrated with the macroeconomic variables. It is observed that in the long-run, the stock prices are positively related to money supply and real economic activity represented by index of industrial production. The wholesale price index that proxied for inflation has found to be negatively related to stock price index. The short term interest rate, as proxied by three month government of India treasury bills, and the real effective exchange rate are not turning out to be the significant determinant of stock prices.

The findings from Granger causality based on the VECM indicate a bi-directional causality between two macroeconomic variables and stock market index in the long-run. This finding clearly indicates that real economic activity leads stock prices and vice-versa in the long run. It may be concluded that the higher demand of stocks created by positive growth expectation in the economy. Furthermore, the wholesale price index proxied for inflation is observed to be most important factor since it causes stock price, money supply and industrial production both in short run and in long run.

The present study confirms the beliefs that macroeconomic factors continue to affect the Indian stock market. The implication of this study for the policy makers and the government, as they may concentrate on controlling inflation and promoting equity share as leading financial instruments which can boost the economy. The limitations of the study, however, should not be over looked. The present study is limited to only five selected macroeconomic variables. Inclusion of more variables with a longer time period may improve the results. A logical extension of the study can be done by including more variables and analyzing sector wise stock index.

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