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Long-Run and Short-Run Relationships between BSE SENSEX and Macroeconomic Variables

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Abstract

This study has attempted to explore the long-run and short-run relationships between BSE SENSEX and four key macroeconomic variables of Indian economy by using descriptive statistics, ADF tests, Johansen and Juselius's cointegration test and Granger causality test. Monthly data has been used from April, 2007 to March, 2012 for all the variables, i.e., BSE SENSEX, wholesale price index, index of industrial production, exchange rate and call money rate. Results showed that all the variables has contained a unit root and are integrated of order one. Johansen and Juselius's cointegration test pointed out at least one cointegration vector and long-run relationships between BSE SENSEX with index of industrial production and call money rate. Granger causality test was then employed. The Granger causality test has found no short-run unilateral or bilateral causal relationships between BSE SENSEX with the macroeconomic variables. Therefore, it is concluded that, Indian stock markets had no informational efficiency.

Keywords: BSE SENSEX, Macroeconomic variables, ADF Tests, JJ Cointegration test, Granger Causality test, Long-run and short-run relationships

1. Introduction

Nowadays stock markets have become a key driver of modern market based economy like India. They transfer the long term funds from savers to borrowers and then from the capital borrowers to capital investors, i.e., corporate houses, which is indispensable for economic development of a country. In fact, commercial banking and stock markets both contribute in a major way to the transformation of savings into investment, thereby enabling financial development and economic growth (Billmeier and Massa, 2009). However, economic growth and prosperity is possible only when stock markets are informationally efficient. This is, in fact, very true in the emerging markets like India.

The major benefits that India had received during the globalization of 1990s are financial sector development and its link with economic stability and growth. The smoothening process of developments in the Indian stock markets continues to be breath taking. From 3739.69 points on March 31st, 1999, within nine years, Bombay Stock Exchange (BSE) Sensitivity Index (SENSEX) had reached an overwhelming level of 21,000 points in January, 2008. But the lasting impact had been slightly affected by the recent global financial crisis, which hit the world economy in the middle of 2008 and the very recently emerging euro-crisis.

In the context of this doldrums in Indian stock markets, the critical question is whether the decades-old developments or recent degradation in the markets are in any way influenced by the domestic and international macroeconomic fundamentals.

It may be stated that the stock markets in India are demand-driven and industry-led which means that demand for greater equity finance is led by higher and improved corporate financial performance. Thus, the state of the Indian economy has a bearing on the share prices, but, the sound health of the stock markets in the sense of a rising share price index is not reflective of an improvement in the health of the economy. In other words, a Bull Run or rising indices in the stock markets cannot be taken to be a leading indicator of the revival of the economy in India and vice versa (Agrawalla, 2006).

However, Shah and Thomas (1997) supported the idea that stock prices are a mirror which reflect the real economy, and are relatively insensitive to factors internal to the financial system, such as, market mechanisms. Kanakaraj et al. (2008) had also examined the trend of stock prices and various macroeconomic variables between the time periods 1997-2007. They tried to explore upon and answer that if the stock market boom can be explained in the terms of macroeconomic fundamentals and concluded by recommending a strong relationship between the two. The study of Ahmed (2008) also reveals that the movement of stock prices is not only the outcome of the behaviour of key macroeconomic variables but it is also one of the causes of movement in other macro dimensions in the economy.

Thus, in the last few decades, stock markets (including BSE), have received a great deal of attention, both as a source of financial development and ultimately economic growth, and in the context of large swings in stock market valuation (Bose, 2005). The interaction of stock market indices returns and the macroeconomic variables has been a subject of intense study among researchers and practitioners. It is generally argued that stock market prices are determined by some fundamental macroeconomic variables such as the GDP, interest rate, exchange rate, inflation, crude oil prices, etc.

Results of this study may help in exploring whether the movement of Indian stock markets (represented by BSE SENSEX) is the result of some selected macroeconomic variables or it is one of the causes of movement in those variables of the Indian economy. The study also expects to explore whether the short-run movement of Indian stock markets is anyway associated with the economy or not. Thus, the purpose of the present study is to investigate whether there is any causal relationship persisting in India between macroeconomic variables, namely, Wholesale Price index (WPI), Index of Industrial Production (IIP), exchange rate (Rs./US$), Call Money Rate (CMR) and Indian stock markets in the form of BSE SENSEX (B-SENSEX) by using monthly data that span from April, 2007 to March, 2012.

More specifically, in this study I test the long-run relationships between those macroeconomic variables and BSE SENSEX by Johansen and Juselius's (JJ) cointegration technique, and the market informational efficiency in BSE by testing the existence of short-run (causal) relationships by using Granger causality test. The results would be very useful for the policy makers, traders, investors and others concerned along with the future researchers.

The rest of the paper is organized as follows. A survey of the existing literature including empirical evidences on the nature of the long-run and short-run causal relationships between macroeconomic variables and stock prices is conducted in Section 2. Section 3 presents the data descriptions, variables undertaken for this study and discusses the research methodology to be employed for investigation and analysis purposes. Section 4 reports the empirical results and discussions including descriptive statistics, ADF tests, JJ cointegration test and Granger causality test followed by conclusion in Section 5.

2. Literature Survey

The relationship between macroeconomic variables and stock market movements has dominated the academic and practitioners' literature since long. Numerous studies have been conducted to examine

the effects of macroeconomic variables on stock markets of developed (e.g., Flannery and Protopapadakis [2002]; Kaneko and Lee [1995]; Mukherjee and Naka [1995]; Thornton [1993]; etc.) and developing (e.g., Abdalla and Murinde [1997]; Gay [2008]; Ibrahim [1999]; Kwon and Shin [1999]; Mookerjee and Yu [1997]; Wongbangpo and Sharma [2002]; etc.) countries during the last few decades. The results of all those studies have provided different conclusions according to the combination of macroeconomic variables used.

Mukherjee and Naka (1995) employed the Johansen cointegration test in the Vector Error Correction Model (VECM) and found that the Japanese stock market was cointegrated with six macroeconomic variables, namely, exchange rate, money supply, inflation rate, industrial production, long term government bond rate and the short term call money rate. The results of the long-term coefficients of the macroeconomic variables were consistent with the hypothesized equilibrium relationships.

Abdalla and Murinde (1997) investigated interactions between exchange rates and stock prices in the emerging financial markets of India, Korea, Pakistan and the Philippines. They found out that the results for India, Korea and Pakistan suggest that exchange rates Granger cause stock prices. But, for the Philippines, they found that the stock prices lead the exchange rates.

Gay (2008) evaluated the association among stock prices and macroeconomic variables in cases of China, India, Brazil and Russia which are emerging economies of the world using oil price, exchange rate, and moving average lags values as explanatory variables employing MA (Moving Average) method with OLS (Ordinary Least Square) and found insignificant results which postulate inefficiency in market. Finally they concluded that in emerging economies the domestic factors influence more than external factors, i.e., exchange rate and oil prices.

Kwon and Shin (1999) applied Engle-Granger cointegration and the Granger causality tests from the VECM and found that the Korean stock market was cointegrated with a set of macroeconomic variables. However, using the Granger-causality test on macroeconomic variables and the Korean stock index, the authors found that the Korean stock index was not a leading indicator for economic variables.

Mookerjee and Yu (1997) studied the Singapore stock market pricing mechanism by investigating whether there were long-term relationships between macroeconomic variables and stock market pricing. They found that three out of four macroeconomic variables were cointegrated with stock market prices. Using bi-variate cointegration and causality tests, they noted significant interactions between M2 money supply and foreign exchange reserves and stock prices for the case of Singapore.

In Indian context, the following studies had examined the short and long run relationships between Indian stock markets and different macroeconomic variables during the last few decades by applying different research methodologies and tests.

Darat and Mukherjee (1987) applied a Vector Auto Regression (VAR) model over 1948-1984 and found that a significant causal relationship exists between stock returns and selected macroeconomic variables.

Naka, Mukherjee and Tufte (1999) employed a VECM [i.e., of **Johansen (1991)**] in a system of five equations to investigate the presence of cointegration among these factors, analysed a negative relationship between interest rates or inflation and stock prices, and a positive relation between output growth and stock prices. They also found that domestic inflation and domestic output were the two most prominent factors influencing stock prices.

Chowhan et al. (2000) tried to fetch reasons for turbulence in stock market in the short-run in India taking into account BSE SENSEX as the main Index. They tried to find that how BSE SENSEX which stood at 2761 on 21st October, 1998 rose to 6000 in February, 2000, i.e., 117% increment in just 15 months, which was 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 didn't support such a spike in stock prices. Such a trend was noted not just in Indian stock markets but word wide.

Pethe and Karnik (2000), using Indian data for April, 1992 to December, 1997, attempted to find the way in which stock price indices were affected by and had affected other crucial macroeconomic variables in India. But, this study had run causality tests in an error correction framework on non-cointegrated variables, which is inappropriate and not econometrically sound and correct. The study reported weak causality running from IIP to share price indices (i.e., SENSEX and S&P CNX NIFTY) but not the other way round. In other words, it hold the view that the state of economy had affected stock prices.

Naka, Mukherjee and Tufte (2001) analysed long-term equilibrium relationships among selected macroeconomic variables and the BSE SENSEX. The study used data for the period 1960:1 to 1995:4 for India on the following macroeconomic variables; namely, the Industrial production index, the consumer price index, a narrow measure of money supply, and the money market rate in the Bombay inter bank market. It employed a VECM to avoid potential misspecification biases that might result from the use of a more conventional VAR modeling technique. The study found that the five variables were cointegrated and there exists three long-term equilibrium relationships among these variables. The results of the study also suggested that domestic inflation was the most severe deterrent to Indian stock markets performance, and domestic output growth as its predominant driving force.

Bhattacharya and Mukherjee (2001) investigated the nature of the causal relationship between stock prices and macroeconomic aggregates in the foreign sector in India. By applying the techniques of unit–root tests, cointegration and the long–run Granger non–causality test as proposed by Toda and Yamamoto (1995), they tested the causal relationships between the BSE Sensitive Index and the three macroeconomic variables, viz., exchange rate, foreign exchange reserves and value of trade balance using monthly data for the period 1990-91 to 2000-01. The results suggested that there is no causal linkage between stock prices and the three variables under consideration.

Bhattacharya and Mukherjee (2002) examined the causal relationships between the BSE SENSEX and five macroeconomic variables applying the techniques of unit-root tests, cointegration and long-run Granger non-causality test as proposed by Toda and Yamamoto (1995) using monthly data for the period 1992-93 to 2000-01. Their major findings are that there were no causal linkage between the stock prices and money supply, national income and interest rate while the index of industrial production (i.e., IIP) leads the stock price and there existed a two-way causation between stock prices and rate of inflation.

Vina and Ray (2003) examined the relative influence of macroeconomic variables like national output proxied by IIP, money supply, inflation, exchange rate, fiscal deficit and foreign institutional investment (FII) on BSE SENSEX using monthly data over 1994-2003 using VAR and Artificial Neural Networks (ANNs). The results showed that certain variables like the interest rate, output, money supply, inflation rate and the exchange rate had considerable influence on BSE SENSEX in the considered period, while the other variables had very negligible impact on the Indian stock markets.

Mishra (2004) by using monthly data for the period 1992 to 2002, examined the relationship between stock markets and foreign exchange markets (FEMs) using Granger causality test and VAR technique study, suggested that there was no Granger causality between the exchange rate return and stock return.

Agrawalla (2005) by using VECM had estimated that the share price index and the macroeconomic variables were cointegrated.

Agrawalla (2006) attempted to investigate whether share price index can be considered as a mirror or reflection of economic activities in India. He examined the causal relationships between the share price index and industrial production in a multivariate VECM which involved certain other crucial macroeconomic variables, namely, money supply, credit to the private sector, exchange rate, wholesale price index, and money market rate for the reason of right and robust model specification.

Sharma and Singh (2007) used interest rate, exchange rate and reserve, industrial production index, monetary growth and inflation as independent variables with AR and MA to nullify the effects of non-stationary in the variables. The results showed that lag values were highly connected with current share prices which recommend the speculation in market. Exchange rate and reserve, industrial production index and monetary growth were significantly associated. The study took data set from 1986 to 2004.

Agrawalla and Tuteja (2008) examined the causal relationships between the share price index and industrial production. The study reported causality running from economic growth proxied by industrial production to share price index and not the other way round.

Ahmed (2008) investigated the nature of the causal relationships between stock prices and the key macro economic variables (i.e., IIP, exports, foreign direct investment [FDI], money supply, exchange rate, interest rate) representing real and financial sector of the Indian economy. Using quarterly data, Johansen's approach of cointegration and Toda and Yamamoto's (1995) Granger causality test they studied the long-run relationships while BVAR modeling for variance decomposition and impulse response functions were applied to examine short-run relationships. The study indicated that stock prices in India lead economic activity except movement in interest rate which seems to lead the stock prices. Cointegration regressions indicated the presence of a long-run relationship between stock prices and the IIP. In National Stock Exchange (NSE), movement in NSE did not have effect on exchange rate and IIP while movement in BSE SENSEX seemed to cause these variables. In case of short-run, the results revealed that NSE S&P CNX Nifty caused exchange rate, exports, IIP and money supply while interest rate and FDI caused NSE S&P CNX Nifty Index. Broadly, these patterns were valid also in the case of BSE SENSEX Index.

Nair (2008) showed that the macroeconomic variables, real income and its growth rate and financial intermediary development were significantly and positively affecting stock market development in India for the period of analysis (i.e., 1996-97 – 2006-07). Interest rate was negatively and significantly affecting stock market development which is proved by the results in the study. Variables like FII, exchange rate and macroeconomic instability proxied by inflation did not have a significant impact on stock market development, though there was a long-run relationship between all the macroeconomic variables used in the analysis and stock market development in India.

The study of **Sharma and Mahendru (2010)** focused on four major macroeconomic variables vis-à-vis Gold price, foreign exchange reserves, exchange rate and inflation and their impact on the stock prices. Empirical results revealed that exchange rate and gold price to affect the entire BSE stock prices. However, inflation rate was significant for only three of the twelve portfolios. Thus, inflation rate and foreign exchange reserves didn't influence the stock prices.

The study of **Manish and Agarwal (2011)** analysed the relationships between stock prices and macroeconomic variables in India and US with implications on efficiency of Indian stock markets. Economic variables like FII, exchange rate, gold price (per 10 gm.), fiscal deficit, industrial production index (IIP) and inflation measured with WPI are the important factors which affect the Indian capital market. In addition to the Indian economic variables, the US economic variables like interest rate, inflation and gross domestic product (GDP) also affect the Indian capital market. There is also a linkage between US capital markets (i.e., S&P Index) movement and their effects on the Indian capital market. The monthly data between 1994 to 2010 had been taken to find the effect of these variables on Nifty-50 Index. The results showed that Exchange rate, US GDP, S&P Index, US interest rate, Gold Price, WPI, Fiscal Deficit, IIP had highly affected the Indian stock prices. It had also been observed that since the liberalization, from 1994 to 2010, stock markets in India has largely affected by microeconomic variables.

Kumar (2011) aimed at studying the nature of the causal relationships between stock prices and macroeconomic variables in India, if any such relationship exists. For this purpose the techniques of unit-root tests, cointegration and the Granger causality test had been applied between the NSE Index 'Nifty' and the macroeconomic variables, viz., Real effective economic rate (REER), Foreign

Exchange Reserves (FER), and Balance of Trade (BoT), FDI, IIP, WPI by using monthly data for the period from 1st April, 2006 to 31st March, 2010. The major findings of the study are that there was no cointegration between Nifty and all other variables except WPI as per Johansen's cointegration test. Therefore, causal relationships between such macroeconomic variables having no cointegration with Nifty was not established. Also, Nifty did not Granger Cause WPI and WPI also did not Granger Cause Nifty.

Yadav and Lagesh (2011) estimated the dynamic interrelations among the macroeconomic variables viz., real output, money, price, interest rate and exchange rate using monthly data for India covering the period from 1991:1 to 2007:12 using ARDL approach to cointegration. The bounds test revealed that there existed a long-run relation between real output, money supply, interest rate and exchange rate when the price variable was the dependent variable. Also, a long-run relationship between real output, money supply, price and interest rate was found when exchange rate was the dependent variable. However, reverse cointegration relationships were not noticed when the real output, money supply and interest rate were the dependent variables. The short-run causality found no evidence of causality between real output and money and a unidirectional causality running from price and interest rate to real output was found. The exchange rate was found independent to the changes in real output. The exchange rate and price were found to be independent to changes in money. Further, it was noticed that the price is caused by output, money, interest rate and exchange rate. The causality was found to be neutral from output, money, price, and exchange rate on interest rate. Finally, it was found that output, money, price and interest rate had no effect on exchange rate in the short-run.

As discussed above, existing literature reveals differential causal patterns and relationships (both short and long-runs) between key macroeconomic variables and Indian stock markets and stock prices. These relationships vary in a number of different stock markets and time horizons in the literature throughout the world as well as in Indian context.

3. Data, Variables and Research Methodology

3.1. Data

I have used monthly data from April, 2007 to March, 2012 to examine the relationships between the selected macroeconomic variables and BSE SENSEX (i.e., B-SENSEX) (used as a proxy to Indian stock markets) Index. The macroeconomic variables, i.e., the WPI (i.e., WPI) (used as a proxy to domestic inflation), the IIP (i.e., IIP) (used as a proxy to Indian GDP), Indian Rupee to US Dollar (US$) (i.e., INRUS$) (used as a proxy to India's foreign exchange position/health), and Call Money Rate (i.e., CMR) (used as a proxy to domestic interest rate) were used in this study. The data were obtained from Annual Reports of BSE, monthly bulletins of Securities and Exchange Board of India (SEBI) and Reserve Bank of India (RBI), and 'Economy Observer' Issues of Dun & Bradstreet, India.

3.2. Variables

3.2.1. BSE SENSEX Index (B-SENSEX)

Though the BSE was established in 1875, till the decade of 1980s there was no scale to measure the ups and downs in the Indian stock markets. In 1986, the BSE came out with a stock index (i.e., the SENSEX) that subsequently became the barometer of the Indian stock markets. Also, due to its wide acceptance amongst the Indian investors and the Foreign Institutional Investors (FIIs), today, the SENSEX is regarded to be the pulse of Indian stock markets. As the oldest Index in the country, it provides the time series data over a fairly long period of time (from 1979 onwards). One can identify the booms and busts of Indian stock markets through BSE SENSEX. It is a value weighted stock average, using the free float market capitalization methodology, of 30 largest and most actively traded stocks of Indian stock markets from varied sectors being the most quoted Index. So, B-SENSEX has been selected for this study as the representative of Indian stock markets.

Among the many macroeconomic variables which have strong influence and impact on BSE SENSEX, I have selected the following four representing both domestic and international situations and important parameters.

3.2.2. Wholesale Price Index (WPI)

Inflation is an increase in the general level of prices, or, alternatively, it is a decrease in the value of money. Inflation is one of those macroeconomic variables that affect every Indian citizen, irrespective of an investor, borrower or lender, almost everyday. Inflation is seen as negative news by the stock markets, because it tends to curb consumer spending and therefore corporate profits. It also affects the value of the domestic currency adversely in the FEMs.

The two frequently used measures of inflation in India are based on the WPI and the Consumer Price Index (CPI). Unfortunately, in India we do not have an aggregate CPI appropriate for use as an indicator of aggregate prices and demand pressures.

So, in this study I have selected the WPI as a proxy to Indian domestic inflation. The WPI is also the main measure of the rate of inflation often used in India. The WPI is available for all commodities, and for major groups, sub-groups and individual commodities. The basic advantage of this measure of inflation is its availability at high frequency, i.e., on weekly basis with a gap of about two weeks, thereby enabling continuous monitoring of the price situation for policy purposes.

3.2.3. Index of Industrial Production (IIP)

Binswanger (2000) found that markets move with economic output. A measure of real output or real economic activity often used is Gross domestic Product (GDP) or Index of Industrial Production (IIP) (Birajdar et al., 2007). Since, this study is based on monthly data and due to the availability of only quarterly, half yearly and yearly GDP data, IIP is chosen as a measure of real output and a proxy to GDP. This IIP is the general IIP computed as the weighted average of all use based IIP, by the Ministry of Statistics and Programme Implementation, Government of India (GOI).

As IIP numbers present a measure of overall economic activity in the economy and affect stock prices through its influence on expected future cash flows (Fama, 1990), we would expect a positive relationship between stock prices and IIP. Fama (1981) also found that such variables are able to help explain fluctuations in aggregate corporate cash flows and thus stock market returns.

3.2.4. Exchange Rate (i.e., INRUS$)

The third macroeconomic variable used in this study has been the exchange rate, which represents the bilateral nominal rate of exchange of the Indian Rupee (Rs.) against one unit of a foreign currency. US Dollar ($) has been taken to be the foreign currency against which the Indian Rupee exchange rate is considered. This is because the US Dollar has remained to be the most dominating foreign currency used for trading and investment throughout the period of this study.

Generally, a depreciating currency causes a decline in stock prices because of expectations of inflation (Ajayi and Mougoue, 1996). On an average, export-oriented companies are adversely affected by a stronger domestic currency while import-oriented firms benefit from it. Though these arguments suggest a linkage between exchange rates and stock prices, the empirical evidence supporting such a linkage was weak at best (Pritamani, Shome and Singal, 2002).

Also, at the micro level, exchange rate changes influence the value of a portfolio of domestic and multinational firms and it is predicted that a negative relationship exists between the strength of the home currency and the aggregate stock prices index (Murinde and Poshakwale, 2004).

3.2.5. Call Money Rate (CMR)

The observations in regard to the relationship between interest rates and stock prices generally suggests that an increase in interest rates increases the opportunity cost of holding money and thereby causing substitution of stocks with interest bearing securities, and hence would result in falling stock prices. It

is mention worthy here that the expected exchange rate (Rs./US$) and inflation rate do play roles in the determination of the domestic interest rates along with the domestic money supply.

The CMR has been selected in this study as a proxy to interest rate. It is selected because the Reserve Bank of India (RBI) has no control on it unlike the Repo Rate, Cash Reserve Ratio (CRR), Prime Lending Rate (PLR), etc. This rate is fully market-driven and dependent on the demand-supply equilibrium relationships. Changes in the CMR affect the Indian stock markets by affecting the corporate profits, general demand for goods and services in the economy, relative attractiveness of competing financial assets like shares, bonds, and other fixed-interest investments, the way companies finance their operations and cost of borrowing money for the purchase of shares.

3.3. Research Methodology

3.3.1. Stationary Tests

Empirical research in stock markets is based on time series data. The two central properties of many such time series data are non-stationarity and time-volatility (Wei, 2006). We know that stationarity of a data series is a prerequisite for drawing meaningful inferences in a time series analysis and to enhance the accuracy and reliability of the models constructed. Generally a data series is called a stationary series if its mean and variance are constant over a given period of time and the covariance between the two extreme time periods does not depend on the actual time at which it is computed but it depends only on lag amidst the two extreme time periods. Nelson and Plosser (1982) indicated that most macroeconomic variables are non-stationary in nature.

In this paper the test of stationarity of the time series data of the above mentioned variables have been systematically done in order to rule out the likely spurious results. Since the testing of the unit roots of a data series is a precondition to the existence of cointegration relationship, originally, the Augmented Dickey-Fuller (ADF) (1979) tests are widely used to test for stationarity (Dickey and Fuller, 1979; 1981). Thus, I have employed the ADF tests to verify the stationarity issue.

In order to test for unit root through ADF tests, the following equation is used:

$$\Delta y_t = \alpha_0 + \lambda y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t$$

In the above equation, I have tested the null hypothesis of $\lambda = 0$ against the alternative hypothesis of $\lambda < 0$. So, the null hypothesis of non-stationarity would be rejected if λ is negative and significantly different from zero.

3.3.2.1. Johansen and Juselius's (JJ) Cointegration Test

Whether the data is stationary at levels or non-stationary at levels but stationary when differenced, i.e., I(1), determination of the proper multivariate time series analysis technique has to be done. The VAR method requires the variables to be stationary at levels to obtain proper estimates of the coefficients. If the series are non stationary at levels but stationary when differenced once, i.e., the series are integrated to the order 1 [i.e., I(1)], the use of cointegration analysis and the VECM is more appropriate (Goswami and Jung, 1997).

To explore long-run relationships between the macroeconomic variables and the BSE SENSEX Index, Johansen and Juselius's (1990) cointegration technique has been used. This technique resolved most of the problems attached with Engle and Granger technique. This technique gives maximum Eigen Value and Trace Value test statistics for determining the number of cointegrating vectors.

In order to fulfill the above objective, the following VECM-specific equation is used:

$$\Delta x_t = A_0 + \sum_{j=1}^{k-1} \Gamma_j \Delta x_{t-j} + \Pi x_{t-k} + \varepsilon_t$$

Where:

k k

$\Gamma_j = -\sum_{i=j+1} A_j$ and $\Pi = -I + \sum_{i=j+1} A_j$

(Sohail and Hussain, 2011)

The Trace and the Maximum Eigen Value test could be used to find the number of cointegrating vectors. As the Trace [Likelihood Ratio (LR)] statistic is more robust than the Maximum Eigenvalue statistic (Cheung and Lai, 1993), therefore, this study has used the former method in order to establish the long-run relationships among the variables.

Also, if the test statistic is greater than the critical value from the Johansens's tables, I would reject the null hypothesis that there are r cointegrating vectors in favour of the alternative hypothesis under the said test in line with Brooks (2002).

3.3.2.2. Model

To explore long run relationships between the selected macroeconomic variables and BSE SENSEX Index, I have employed the following econometric model:

$$\text{BSE SENSEX} = \beta_1 \text{WPI} + \beta_2 \text{IIP} + \beta_3 \text{INRUS\$} + \beta_4 \text{CMR} + \varepsilon_t$$

3.3.3. Granger Causality Test

The Granger causality test as proposed by C. J. Granger in 1969 only establishes short-run relationships between stock prices and macroeconomic variables. It enables us to identify leading, lagging and coincidence microeconomic and macroeconomic variables for the stock markets performance (Ahmed and Osman, 2007). It also measures the precedence and information content but does not itself has causality in the more common use of the term.

Under the Granger causality test, the null hypothesis is $\Sigma\alpha_i = 0$ for all values of i. To test this hypothesis, the F-test is applied, as shown below:

$$F = \frac{(\text{RSS}_R - \text{RSS}_{UR}) / m}{\text{RSS}_{\text{UR}} / (n - k)}$$

(Gujarati, 2004)

If the computed *F*-value exceeds the critical *F*-value at the chosen level of significance, the null hypothesis is rejected. This would imply that macroeconomic variable 'Granger cause' or improve the prediction in stock prices and vice versa.

4. Empirical Results and Discussions

4.1. Descriptive Statistics Results

Table 1: Descriptive Statistics

Mean	B-SENSEX	WPI	IIP	INRUS$	CMR
Median	16164.89	6.670500	6.095000	45.43517	6.327667
Maximum	16935.41	7.475000	5.980000	45.53000	6.515000
Minimum	20509.10	12.39000	17.60000	52.67000	18.59000
Standard	8891.61	–1.450000	–5.950000	39.37000	0.170000
Deviation	2949.858	3.585524	5.338870	3.526231	2.989119
Skewness	–1.001446	–0.645127	0.029710	–0.161757	1.168826
Kurtosis	3.464303	2.532724	2.729032	2.149846	6.836500
Jarque-Bera	10.56789	4.707759	0.192386	2.068560	50.45836
Probability	0.005072	0.095000	0.908289	0.355482	0.000000
Observations	60	60	60	60	60

Table 1 represents the summary statistics of the variables under this study. The average monthly index for BSE SENSEX is 16164.89 during the study period (April, 2007 – March, 2012)

with a high standard deviation (i.e., 2949.858) implying a volatile stock market. The average inflation (represented by the WPI) is 6.6705% with a maximum of 12.39% and minimum of –1.45%. This indicates pressure on purchasing power of the general public and less amount of liquidity as available to the investors to invest in the Indian stock markets (including BSE). The difference between maximum and minimum in the inflation front can also be one of the root causes for the stock market's enormous volatility. The average INR/US$ exchange rate is Rs.45.4352/US$ with a maximum of Rs.52.67/US$ and minimum of Rs.39.37/US$. Thus, the exchange rate is also quite volatile during the study period. The average interest rate (represented by the CMR) is 6.3277% during the study period with 2.98912% deviation. But recent trend is declining as the GOI has undertaken the necessary steps to reduce the interest rate in order to encourage the investors for investing in the Indian stock markets. Interest rate shows the investors' expectation of return if they wish to invest in money market and ensure the funds to be secured. Hence the variable represents opportunity costs of investors' funds when to invest in the capital market.

The value of skewness of the above variables has pointed out that except IIP and INRUS$, all the other variables had extreme values during the study period. It indicates a deviation from normal distribution of the data and volatility in those parameters. The value of kurtosis has pointed out that B-SENSEX and CMR had leptokurtic distribution (i.e., >3) with values concentrated around the mean and thicker tails. This means high probability for extreme values which is observed from the above table. The kurtosis value of all other variables indicated platykurtic distribution (i.e., <3) and the values are wider spread around the mean. Jarque-Bera test statistic measures the difference of the skewness and kurtosis of the data series with those from the normal distribution.

4.2. ADF Tests Results

In order to check the unit roots in the above data series, the ADF tests has been applied at levels and first difference. Table 2 has indicated the results of ADF tests, i.e., stationary level of all non-stationery variables with intercept and no trend. We know that, all non-stationary variables should have the same level of integrating factor for cointegration analysis. According to my results, all variables of this study have the same order [i.e., I(1)].

Table 2: Augmented Dickey-Fuller (ADF) Tests with Intercept and no Trend

Variables	Level	1st Difference	Conclusion
B-SENSEX	–1.7706 (–3.5457)	–5.3804 (–3.5478)	I(1)
WPI	–2.5573 (–3.5457)	–3.1432 (–2.9127)*	I(1)
IIP	–2.0638 (–3.5457)	–6.6220 (–3.5478)	I(1)
INRUS$	–1.5827 (–3.5457)	–5.3832 (–3.5478)	I(1)
CMR	–2.8816 (–3.5457)	–6.5820 (–3.5478)	I(1)

* Critical value at 5% significance level.

4.3.1. Johansen and Juselius's (JJ) Cointegration Test Results

The results of stationarity tests are exposed in Table 2. The results depicted that the variables involved in this study are integrated of order one, i.e., I(1), therefore the Johansen and Juselius's (1990) cointegration technique has been applied to examine the long-run relationships between the selected macroeconomic variables and BSE SENSEX Index. In multivariate cointegration analysis using JJ technique, the first step is the appropriate lag selection for the variables. The Akaike Information Criteria (AIC) has been widely used in the time series analysis to determine appreciative length of the

distributed lag (Maddala and Kim, 2000). One lag length has been selected equal in this study on the basis of AIC (see Table 3).

Table 3: Akaike Information Criteria (AIC)

AIC Value	Lag
–928.9233	(1 1)
–881.1667	(1 2)
–838.9856	(1 3)
–788.6299	(1 4)

Note: This criteria is used to determine the lag length - the smaller the value of the information criteria, the 'better' the model is.

Test statistics are calculated allowing for an intercept and trend term in the cointegrating equation (CE) and no trend term in the VAR.

Table 4: Results of JJ Cointegration Test

Likelihood Ratio (Trace) Test for Cointegrating Rank

Variable	Eigenvalue	Likelihood Ratio (LR)	5% Critical Value	1% Critical Value	Hypothesized No. of CE(s)
B-SENSEX	0.416752	90.85229	87.31	96.58	None*
WPI	0.326650	59.58200	62.99	70.05	At most 1
IIP	0.273525	36.64356	42.44	48.45	At most 2
INRUS$	0.194767	18.10960	25.32	30.45	At most 3
CMR	0.091183	5.545443	12.25	16.26	At most 4

*(**) denotes rejection of the hypothesis at 5% (1%) significance level.
LR test indicates 1 co-integrating equation(s) at 5% significance level.

The results of the Johansen and Juselius's Trace test are shown in Table 4. At the 5% significance level the Trace test suggests that the variables are cointegrated with $r \neq 0$. It implies that there is at least one cointegration vector, i.e., one CE in order to establish the long-run relationships among the variables.

4.3.2. Model (Long-run Relationships) Results

After the normalization of the first cointegrating vector on BSE SENSEX, normalized cointegrating coefficients are estimated as reported in Table 5.

Table 5: Normalized Cointegrating Coefficients

(statistically significant results at $\alpha = 0.05$)

B-SENSEX	WPI	IIP	INRUS$	CMR
1.000000	932.8284	–747.6101	818.3013	–1164.788
S.E.	(295.387)	(253.181)	(179.623)	(432.418)
t-value	1.025	1.747	–1.910	0.203

The first normalized equation is estimated as below:

BSE SENSEX = –932.8284 WPI + 747.6101 IIP – 818.3013 INRUS$ + 1164.788 CMR

According to the first normalized equation, stock prices (BSE SENSEX) has shown significantly negative relation with the WPI in the long-run which has suggested that Indian stock markets did not provide hedge against inflation. The negative relationship between stock prices and inflation was consistent with the results of Humpe and Macmillan (2009) for US data and Naka,

Mukherjee and Tufte (1999; 2001) for Indian stock markets. However, this findings are at variance with the findings of Abdullah and Hayworth (1993); Vina and Ray (2003); Ratanapakorn and Sharma (2007); Kumar (2011); etc. The above normalized equation has also shown that there was a significant positive relationship between stock prices and the IIP numbers. The result is consistent with the findings of many researchers (*inter alia* Fama, 1981; Chen *et al.*, 1986; Abdullah and Hayworth, 1993; Eva and Stenius, 1997; Naka, Mukherjee and Tufte, 1999, 2001; Ibrahim and Yusoff, 2001; Bhattacharya and Mukherjee (2002); Vina and Ray, 2003; Nishat and Shaheen, 2004; Ratanapakorn and Sharma, 2007; Cook, 2007; Ahmed, 2008; Shahbaz *et al.*, 2008; Liu and Sinclair, 2008; Humpe and Macmillan, 2009; Manish and Agarwal, 2011). BSE SENSEX Index was also influenced by the CMR positively. It implies that the domestic interest rate has also had positive influence on Indian stock markets. The same results were shown in the study of Humpe and Macmillan (2009) for Japan. However, Naka, Mukherjee and Tufte (2001) didn't find any long-run relationship between the above two variables for Indian stock markets. The above equation has also pointed out that BSE SENSEX Index was also influenced by the Rs./US$ exchange rate negatively. This implied that along with the increase in exchange rate or depreciation in domestic money, there was a negative effect on Indian import-oriented corporate houses (more in numbers than export-oriented firms) that led to decrease in financial profits of such corporate houses and ultimately resulting in decline in individual stock prices and thereby the overall BSE SENSEX Index. Soenen and Hennigar (1988) also reported similar findings between stock prices and exchange rate, but, Aggarwal (1981); Vina and Ray (2003); Ratanapakorn and Sharma (2007); Sharma and Mahendru (2010); Manish and Agarwal (2011); Yadav and Lagesh (2011); etc. had reported positive relationship between the two variables.

4.4. Granger Causality Test Results

Table 6: Granger Causality Test Results

Null Hypothesis:	Observations	F-statistic	Probability
WPI does not Granger Cause B-SENSEX	59	5.22479	0.02607
B-SENSEX does not Granger Cause WPI		16.6432	0.00014
IIP does not Granger Cause B-SENSEX	59	1.09403	0.30007
B-SENSEX does not Granger Cause IIP		0.21995	0.64090
INRUS$ does not Granger Cause B-SENSEX	59	0.65827	0.42061
B-SENSEX does not Granger Cause INRUS$		0.86851	0.35537
CMR does not Granger Cause B-SENSEX	59	5.05352	0.02853
B-SENSEX does not Granger Cause CMR		3.66057	0.06083
IIP does not Granger Cause WPI	59	9.35044	0.00342
WPI does not Granger Cause IIP		2.30057	0.13495
INRUS$ does not Granger Cause WPI	59	5.97096	0.01772
WPI does not Granger Cause INRUS$		7.47051	0.00838
CMR does not Granger Cause WPI	59	2.29746	0.13521
WPI does not Granger Cause CMR		6.79457	0.01170
INRUS$ does not Granger Cause IIP	59	0.00955	0.92252
IIP does not Granger Cause INRUS$		6.46856	0.01377
CMR does not Granger Cause IIP	59	3.24356	0.07709
IIP does not Granger Cause CMR		0.95745	0.33204
CMR does not Granger Cause INRUS$	59	4.05107	0.04896
INRUS$ does not Granger Cause CMR		1.30869	0.25750

This study has applied Granger causality test as proposed by C. J. Granger (1969) with 1 lag. Granger proposed that if causal relationship exists between variables, they can be used to predict each other. Results from Granger causality test are given in Table 6.

The results showed no Granger causality between BSE SENSEX Index prices (i.e., B-SENSEX) and the WPI in any direction, no Granger causality between B-SENSEX and the IIP numbers, no Granger causality between B-SENSEX and the exchange rate (i.e., INRUS$) and no

Granger causality between B-SENSEX and the CMR. Overall, this study has found no unidirectional or bi-directional Granger causality between the selected macroeconomic indicators and Indian stock markets.

Thus, the overall Granger causality test reveals no significant short-run causal relationships between Indian stock markets (i.e., BSE SENSEX Index) and selected macroeconomic variables which ultimately is the evidence of an informationally inefficient market.

5. Conclusion

To conclude, the analysis has revealed that the Indian stock markets as proxied by BSE SENSEX formed significant long-run relationships with two out of four macroeconomic variables tested. The Johansen and Juselius's co-integration test has suggested that the BSE SENSEX Index has been cointegrated with the macroeconomic variables. It is observed that in the long-run, the stock prices are positively related to interest rate as proxied by the CMR and real economic activity represented by the IIP. The WPI that proxied for inflation has found to be negatively related to Indian stock markets namely BSE SENSEX Index. The exchange rate (i.e., Rs./US$) is also turning out to be a negatively significant determinant of Indian stock markets.

However, this study has found no short-run relationships between the BSE SENSEX Index and the macroeconomic variables selected under this study by applying Granger causality test. This result itself pointed out to the limitations of this kind of study, because, some of the selected macroeconomic variables, such as, the exchange rate and the CMR at least would have some sort of influence and impact on Indian stock markets and its indices.

Not only that, selection of some of the above variables, such as, the WPI and CMR would not also be free from subjective biases. WPI's weakness lies in excluding prices of retail and other services that are part of the basket of the hypothetical average consumer. Similarly, domestic interest rate has many proxy representatives to be used in CMR's place.

Some of the above macroeconomic variables, such as, inflation, interest rate, exchange rate, etc. are also dependent on some global macroeconomic factors, situations and events. For example, capital inflows and outflows by the FIIs and others are not determined by domestic interest rate only, but, also by the changes in the interest rate by major economies in the world, e.g., the US. Not only that, the domestic inflation is strongly influenced by the crude oil prices as governed by some other countries of the world. Also, the exchange rate is dependent on the inflows in the route of FIIs and FDI and the export-import disparity which is also influenced by external factors and situations.

Thus, inclusion of more macroeconomic variables keeping in mind the domestic and international factors with a longer time-frame may improve the results of future studies.

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