Macroeconomic determinants of stock markets: Indian case

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Abstract:

The aim of this study is to investigate the relationships between the Indian stock market index (BSE Sensex) and three main macroeconomic determinants, namely, industrial production index, wholesale price index, and exchange rates to find out whether the economic fundamentals in India explain the stock prices behavior in the market and to what extent the Indian stock price responds to the changes in macroeconomic variables. The reason for this study is that an insignificant amount of research has been conducted for Indian stock market and economic factors since the economic reforms of 1991. Thus, in-depth studies are needed to understand the macroeconomic variables that might influence the Indian stock market due to the fact that India is among the fastest growing economies. Standard time series techniques such as, Johansen Co-integration and Vector Error Correction Model and Variance decompositions have been applied. The significance of this study is that it confirms the belief that macroeconomic factors continue to affect the Indian stock market, which is not always the case with other studies done in the same area. The analysis also reveals that macroeconomic variables and the stock market index are co-integrated and, hence, a long-run equilibrium relationship exists between them. It is observed that the stock prices positively relate to the industrial production and exchange rate but negatively relate to inflation. The results tend to indicate that the Indian stock market is driven by inflation rate and exchange rate (as evidenced by the variance decomposition analysis). This is an essential indicator to the policy makers, which will facilitate them to formulate policies.

Keywords: Stock Market Index, Macroeconomic Variables, VECM, VDC,
Granger-causality, India.

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Introduction: The Issue Motivating This Study

Indian capital market has undergone tremendous changes since 1991, when the government has adopted liberalization and globalization polices. As a result, there is a growing importance of the stock market from aggregate economy point of view. Nowadays stock market have become a key driver of modern market based economy and is one of the major sources of raising resources for Indian corporate, thereby enabling financial development and economic growth. In fact, Indian stock market is one the emerging market in the world.

Stock market is an important part of the economy of a country, which plays a pivotal role in the growth of the industry and commerce of the country that eventually affects the economy of the country to a great extent. That is the reason that the government, industry and even the central banks of each country keep a close watch on the happenings of the stock market. The stock market is important from both the industry's point of view as well as the investor's point of view. The stock market make available long-term capital to the listed firms by pooling funds from different investors and allowing them to expand their business and offers investors' alternative investment avenues to save their surplus funds. The investors carefully watch the performance of stock markets by observing the composite market index, before investing funds. The market index provides a historical stock market performance, the yardstick to compare the performance of individual portfolios and provides investors for forecasting future trends in the market.

However, unlike mature stock markets of advanced countries, the stock markets of emerging economies began to develop rapidly only in the last two and half decades. While there have been numerous attempts to develop and stabilize the stock markets, the emerging economies are characterized as the most volatile stock markets. 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 related to the changes in other macroeconomic factors. Investors evaluate the potential economic fundamentals and other firm specific factors/characteristics to formulate expectations about the stock markets.

The impact of economic fundamentals on stock prices or stock returns has been a long debated issue amongst the academicians and professionals. According to the Efficient Market Hypothesis

(Championed by Fama, 1970), in an efficient market, all the relevant information about the changes in macroeconomic factors are fully reflected in the current stock prices and hence, investors would not be earning abnormal profits in such markets. If the conclusion of Efficient Market Hypothesis is to be believed; then the changes of any macroeconomic variables should not affect the stock returns much. However, conclusion drawn from the Efficient Market Hypothesis has been critically examined by subsequent studies by many scholars, which affirm that macroeconomic variables do influence the stock returns by affecting stock prices. Be that as it may but it may not be true for the Indian stock prices because of the 1991 economic reforms and lack of literature to show that the macroeconomic variables impact stock prices.

In this connection, several empirical studies have shown that changes in stock prices are linked with macroeconomic fundamental. 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. More recently, an increasing amount of empirical studies have been focusing attention to relate the stock prices and macroeconomic factors for both developed and emerging Economies. These studies conclude that stock prices do respond to the changes in macroeconomic fundamentals but the sign and causal relationship might not hold equal for all the studies. Therefore, this issue remains unresolved.

Until recently, a negligible amount of research has been conducted for Indian stock market and economic factors and thus the conclusion might be inadequate (see; Pal and Mittal, 2011). The relationship of some macro factors could vary from market to market; may change in different sample periods and in different frequency of the data. Thus, more in-depth studies are needed to understand the macroeconomic variables that might influence the Indian stock market. Moreover, the country like India is particular importance to study such relationship since it is one among the fastest growing economies. Furthermore, the 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. 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 affect 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 test whether the economic fundamentals in India explain the stock prices behavior in the market. The study uses monthly data from 2000:01 to 2013:08 to investigate the relationship between stock prices and three macroeconomics variables such as industrial production index, inflation and exchange rates for India. It is believed that the finding 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 paper is organized in the following sections. Section 2 reviews some selected empirical literature. Section 3 provides the theoretical justification and selection of variables and hence the model. In section 4, the data sources, and econometric methodology used in the study are discussed. The empirical results are reported and discussed in section 5. Finally, the conclusion of the study is provided in Section 6.

2: Literature Review:

The previous empirical works done on the link between the various macroeconomic factors and stock returns can be divided into two broad categories. The first category is the studies, which investigated the impact of macroeconomic factors on stock prices, and the second category of studies focused on the relationship between the stock market volatility and volatility in the macroeconomic indicators. Since our present study is based on the first category, some of the relevant literature on the macroeconomic determinants of stock prices has been reviewed.

Mukherjee and Naka (1995) employed a vector error correction model (VECM) to study and examine the relationship between the stock market returns in Japan and a set of six macroeconomic variables such as exchange rate, inflation, money supply, industrial production index, the long-term government bond rate and call money rate. It was found that the Japanese stock market was integrated with these sets of variables indicating a long-run equilibrium relationship between the stock market return and the selected macroeconomic variables.

Wongbampo and Sharma (2002) examined the relationship between stock returns 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. Using monthly data for the period of 1985 to 1996, they found 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.

Abugri (2008) investigated the link between macroeconomic variables and the stock return for Argentina, Brazil, Chile, and Mexico 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 Index of Industrial Production (IIP) was positive and significantly influenced the stock return. For Mexico, 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. However, 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.

Ratanapakorn and Sharma (2007) 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. Employing Johansen's co-integration technique and vector error correction model (VECM) they found 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. Their causality analysis revealed that every macroeconomic variable considered caused the stock price in the long run but not in the short-run.

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 Foundation:

The aim of the present study is to empirically investigate the impact of fundamental macroeconomic factors on the Indian stock market.

The theoretical linkage between the macroeconomic factors and the stock market movement can be directly obtained 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. 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.

Among the many macroeconomic variables, three 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. Moreover, it may explain more return variation than GNP or GDP. 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.

Another variable that extensively used in the literature is inflation. The impact of inflation on stock price is empirically mixed. 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.

Besides inflation, another variable namely, exchange rate is the most used macro economic factors to determine the stock returns. 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 the macroeconomics variables of IIP, Inflation and exchange rate.

4. Data and Methodology:

4.1. Data Description

The present study uses the time series data obtained from DataStream. The BSE Sensex is employed as a proxy for Indian stock market indices. Since it would be almost impossible to incorporate every potential aspect to explain the stock market behavior, we limit to select three macroeconomic variables namely industrial production index (IIP), wholesale price index (WPI), and exchange rate. The selection of variables for the present study is based on the existing theoretical propositions and the empirical evidences. IIP is used as a proxy for real output, WPI is used in order to incorporate the inflation 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 for fourteen years starting from January-2000 are obtained which comprises 164 data points for the analysis.

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 period 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. Two standard procedures of unit root test namely the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) are performed to check the stationary nature of the series.

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 complemented 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. The unit root tests also provide the order of integration of the time series variables.

In a multivariate context, if the variables under consideration are found to be I (1) (i.e. they are non-stationary at level but stationary at first difference). 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 (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 cointegration method is regarded as full information maximum likelihood method that allows for testing co-integration in a whole system of equations. The fourth step is Long Run Structural Modeling (LRSM). This test confirms whether a variable is statistically significant and tests the long run coefficients of the variables against theoretically expected values. Vector Error Correction Model (VECM) is the fifth step, and it is used to test Granger causality. The VECM shows the leading and lagging variables but it is unable to show relative exogeneity and endogeneity. The sixth step (Variance Decompositions or VDCs) ranked the variables by determining the proportion of the variance explained by its own past shocks whereby the variable

That is explained mostly by its own shocks (and not by others) is deemed to be the most exogenous of all. Step seven, the Impulse Response Function (IRF) and step eight, Persistence Profiles (PP) is in graph form. IRF exposes relative exogeneity and endogeneity (similar to VDC) while PP estimates the speed with which the variables get back to equilibrium when there is a system-wide shock (unlike the IRF which traces out the effects of a variable-specific shock on the long-run relationship).

5: Empirical result:

This section will perform the eight steps of the time series technique.

5.1. Testing the non-stationarity/stationarity of each variable

ADF Test:

Before starting the process, the stationary of variable should be checked first. The variable is stationary if it always has a constant mean, a constant variance and a constant covariance throughout the time. In this step, the objective is to check whether the variables chosen were stationary or not. The checking can be done by using the Augmented Dickey-Fuller Unit Root Tests (ADF) and the Phillips-Perron Test (PP).

We begin our empirical testing by determining the stationarity of the variables used. In order to proceed with the testing of cointegration later, ideally, our Variables should be I (1), in that in their original level form, they are non-stationary and in their first differenced form, they are stationary. The differenced form for each variable used is created by taking the difference of their log forms. For example, DBSE = LBSE – LBSEt-1. We then conducted the Augmented Dickey-Fuller (ADF) test on each variable (in both level and differenced form).

the table below summarizes the results.

Variable	**Test Statistic**	**Critical Value**	**Implication**
Variable in Level form			
LIIP	-3.0407	-3.4389	Variable is non-stationary
LEXC	-3.0959	-3.4389	Variable is non-stationary
LWPI	-1.5963	-3.4389	Variable is non-stationary
LBSE	-2.4532	-3.4389	Variable is non-stationary
Variable in Differenced form			
DIIP	-8.0326	-2.8799	Variable is stationary
DEXC	-3.605	-2.8799	Variable is stationary
DWPI	-5.8256	-2.8799	Variable is stationary
DBSE	-5.3949	-2.8799	Variable is stationary

Relying primarily on the AIC and SBC criteria, the conclusion that can be made from the above results is that all the variables we are using for this analysis are I (1), and thus we may precede with testing of cointegration. The null hypothesis for the ADF test is that the variable is non-stationary. In all cases of the variable in level form, the test statistic is lower than the critical value and hence we cannot reject the null. Conversely, in all cases of the variable in differenced form, the test statistic is higher than the critical value and thus we can reject the null and conclude that the variable is stationary (in its differenced form). Note that in determining which test statistic to compare with the 95% critical value for the ADF statistic, we have selected the ADF regression order based on the highest computed value for AIC and SBC.

PP Test:

PP test also can be used to test whether the variables are stationary or not. The result is concluded based on the P-value. P-value shows the error we are making when we are rejecting the null. Moreover, the p-value will be determined based on which level of confidence that you are choosing

95% or 90%. Therefore, if the p- value is less than the confidence interval, you will reject the null. If p-value is higher than the confidence interval, the null cannot be rejected. As mentioned above, the null hypothesis for this test states that the variable is non- stationary.

PP results for 'Level' Form (Differenced Once)

Variable	Test Statistic (p-value)	Results
DIIP	**[.186}**	Non-stationary
DEXC	**[.088]**	Non-stationary
DWPI	**[.150]**	Non-stationary
DBSE	**[.722]**	Non-stationary

PP results for 'Differenced' Form (Differenced Twice)

Variable	Test Statistic (p-value)	Results
D2IIP	**[.000]**	**Stationary**
D2EXC	**[.000]**	**Stationary**
D2WPI	**[.000]**	**Stationary**
D2BSE	**[.000]**	**Stationary**

5.2. Determination of order or (lags) of the Var model

Before proceeding to the cointegration test, it is compulsory to determine the optimum order (or lags) of the vector autoregressive model. We put the variables in log-differenced form. Referring to Table below , it is found that there is a contradicting optimum order given by the highest value of AIC and SBC. As expected, SBC gives lower order (order 1) as compared to AIC (order 5). This difference is due to the AIC tries to solve for autocorrelation while SBC tries to avoid over-parameterization.

	CHOICE CRITERIA	
	AIC	SBC
OPTIMAL ORDER	**5**	**1**

Given this apparent conflict between recommendation of AIC and SBC, we address this in the following manner. First, we checked for serial correlation for each variable and obtained the following results.

VARIABLE	**CHI-Sq P-Value**	**Implication (at 5%)**
DIIP	**0.015**	**There is serial correlation**
DEXC	**0.246**	**There is no serial correlation**
DWPI	**0.828**	**There is no serial correlation**
DBSE	**0.325**	**There is no serial correlation**

Although the test shows these results we will move further in with the study using ***5 lags (According to the result we obtained from AIC)*** because using a lower order, we may encounter the effects of serial correlation. The disadvantage of taking a higher order is that we risk over-parameterization. However, with the amount of data point available taking into consideration we decided to go with VAR order of ***5.***

5.3. Testing cointegration

The cointegration test is very important in the sense that it will check whether all variables are theoretically related. If they are cointegrated, it means that there is a co-movement among these variables in the long term reaching the equilibrium, although they move differently in the short term. This test is very useful because it will prove the untested hypothesis or theory.

Johansen method:

Once we have established that the variables are I (1) and determined the optimal VAR order as 5, we are ready to test for Cointegration. We have performed two tests to identify cointegration between the variables; namely ***Johansen*** method and ***Engle-Granger*** method. The Johansen method uses maximum likelihood (i.e. eigenvalue and trace) and may identify more than one cointegrating vectors while the Engle-Granger method can only identify one cointegrating vector. According to the Johansen method (Table below), we have found that there is at least one cointegrating vectors between the variables which confirm cointegration. This test considers the available number of cointegrating vectors or r. In the case when the null hypothesis is r = 0, there is no cointegration when we fail to reject the null. On the other hand, there is cointegration if the null is rejected.

Criteria	**Number of cointegrating vectors**
Maximal Eigenvalue	1
Trace	1
AIC	4
SBC	1
HQC	1

From the above results, we select one cointegrating vector based on the Eigen value and trace test Statistics at 95% level. The underlying VAR model is of order 5. From the result shown above, we are inclined to believe that there is one cointegrating vector based on intuition as well as familiarity that, there is relationship between stock market and macroeconomics variables and that the movement in marcoeconomics variables are affecting the changes in the stock market prices in some way or other, to varying degrees. Based on the above statistical result as well as our insight, for the purpose of this study, we shall assume that there is one cointegrating vector, or relationship.

Statistically, the above results indicate that the variables we have chosen in some combination result in a stationary error term. The economic interpretation, in our view, is that the four variables are theoretically related, in that they tend to move together in the long run. In other words, the four variables are cointegrated. That is their relations to one another is not merely spurious or by chances. This conclusion has an important implication for investors' .Given that these series are cointegrated. Above is based on the Johansen method.

Engle-Granger method:

Alternatively, we have used the Engle-Granger method.

Variable	Test Statistic		Critical Value	Results
	AIC	SBC		
LBSE	**-3.6196**	**-3.6733**	**-4.1693**	**Non-stationary**
LWPI	**-1.5133**	**-1.9588**	**-4.1693**	**Non-stationary**
LIIP	**-5.6655**	**-5.2601**	**-4.1693**	**Stationary**
LEXC	**-2.5083**	**-2.9193**	**-4.1693**	**Non-stationary**

Here, it is found that of four variables at least one variable has the error term as stationary, which means that there is at least one cointegration between the variables. This result support earlier Johansen method test of cointegration.

5.4. Long run structural modeling (LRSM)

This step will estimate theoretically meaningful cointegrating relations. We impose on those long-run relations and then test the over-identifying restrictions according to theories and information of the economies under review. In other words, this step will test the coefficients of our variables in the cointegration equations against our theoretical expectation. This LRSM step also can test the coefficients of our variables whether they are statistically significant.

Earlier, we have mentioned that we want to see the impact of macroeconomics variables on stock prices. In other words, our focus variable in this paper is stock market index (BSE) price. Thus, we first normalized LBSE (i.e. normalizing restriction of unity) at the 'exactly identifying' stage (Panel A). Next, we imposed restriction of zero on one of the macroeconomic variable at the 'over identifying' stage (Panel B).

When we normalized LBSE, we found that all the coefficients of the cointegrating vector are significant. However, when we imposed restriction of zero on WPI we found that the over identifying restriction is rejected (with a p-value of (**.047**) error while rejecting the null) and as a result we proceed with 'Panel A' and continue to include WPI as one of our variable in the following tests.

Table. Exact and over identifying restrictions on the Cointegrating vector

	PANEL A	PANEL B
LIIP	7.0750*	6.5985
	(1.0949)	(1.0086)
LEXC	2.5600*	2.1076
	(.55945)	(.53417)
LWPI	-2.6228*	0.00
	(.4351)	(*NONE*)
LBSE	1.0000	1.0000
	(*NONE*)	(*NONE*)
TREND	.039975	.024480
	(.011439)	(.0058880)
Chi-Square	(None)	3.9403 (.047)

***Indicates significance.**

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 Ratanapakorn and Sharma, (2007), who found similar results on USA. The positive relationship indicates that 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), also found a negative relationship for India. However, this finding is contrary Ratanapakorn and Sharma, (2007) who finds a positive relationship between inflation and stock price suggesting that equities serve as a hedge against inflation.

5.5. Vector error correction model (VECM)

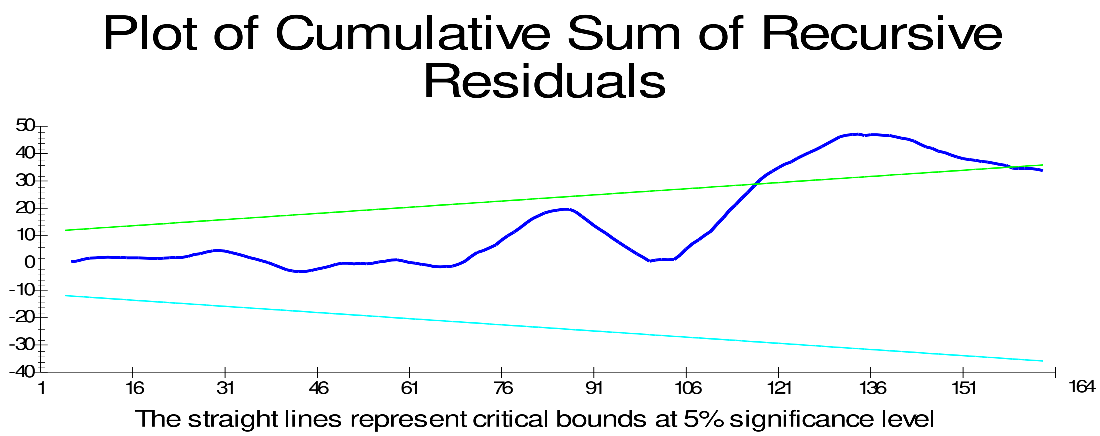
Error-correction term (ECT) is the stationary error term, in which this error term comes from a linear combination of our non-stationary variables that makes this error term to become stationary if they are cointegrated. It means that the ECT contains long-term information since it is the differences or deviations of those variables in their original level form. VECM uses the concept of Granger causality that the variable at present will be affected by another variable at past. Therefore, if the coefficient of the lagged ECT in any equation is insignificant, it means that the corresponding dependent variable of that equation is exogenous. This variable does not depend on the deviations of other variables. It also means that this variable is a leading variable and initially receives the exogenous shocks, which results in deviations from equilibrium and transmits the shocks to other variables. On the other hand, if the coefficient of the lagged ECT is significant, it implies that the corresponding dependent variable of that equation is endogenous. It depends on the deviations of other variables. This dependent variable also bears the brunt of short-run adjustment to bring about the long-term equilibrium among the cointegrating variables.

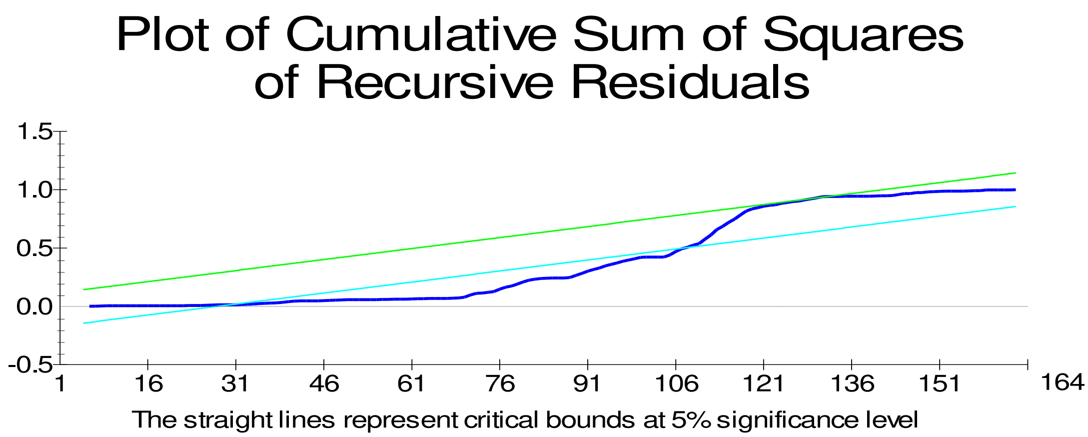
The previous four steps tested theories and confirm that there is cointegration between the variables but it did not show which the leader and the lagged variables. Step 5 onwards allows us to answer this shortcoming. The statistical results generated from these steps will be welcomed by policy makers. Policy makers want to know which variable is the leader to focus their policies on those variables to make the biggest impact. Thus, we have performed VECM and the results are summarized in Table below.

Variable	ECM (-1) t-ratio p-value	Implication
LIIP	**.000**	**Variable is endogenous**
LEXC	**0.756**	**Variable is exogenous**
LWPI	**0.065**	**Variable is exogenous**
LBSE	**0.593**	**Variable is exogenous**

The statistical results showed that exchange rate wholesale price, and stock market is exogenous while industrial production is endogenous. The diagnostics test allows us to check for specification problem in terms of autocorrelation, functional form, normality and heteroskedasticity. In addition, the coefficient of et-1 tells us how long it will take to get back to long-term equilibrium if that variable is shocked. The coefficient represents proportion of imbalance corrected in each period. For instance, in the case of the IIP Industrial production index, the coefficient is 0.12 this implies that, when there is a shock applied to this index, it would take, on average, 8.3 months for the index to get back into equilibrium with the other indices.

In addition, we have used the CUSUM and CUSUM SQUARE (Figure below) to check the stability of the coefficients. The CUSUM and CUSUMSQ tests employ the cumulative sum of recursive residuals based on the first set of observations and is updated recursively and plotted against the break points Here, it is found that the parameters are structurally unstable which indicates structural breaks. Structural breaks may be corrected by using dummy variables. The present scope of our project does not cover remedying the structural breaks and hence it has not been undertaken. Since VECM does not give information about relative exogeneity and endogeneity, we will have to perform the next step to identify the ranking of the variables.





5.6. Variance decomposition (VDC)

The forecast error variance decomposition presents a decomposition of the variance of the forecast error of a particular variable in the VAR at different horizons. It will break down the variance of the forecast error of each variable into proportions attributable to shocks in each variable in the system including its own. The variable, which is mostly explained by its own past shocks, is considered to be the most leading variable of all. While we have established that the IIP is the endogenous index, we have not been able to say anything about the relative exogeneity of the remaining indices. In other words, of the remaining indices, which is the most exogenous variable compared to others. As the VECM is not able to assist us in this regard, we turn our attention to variance decomposition (VDC). Variance Decompositions (VDCs) are made up of orthogonalized VDC and generalized VDC. We started out applying orthogonalized VDCs and obtained the following results

Forecast at Horizon = 24 (months)

	LIIP	LEXC	LWPI	LBSE
LIIP	0.50249	0.012725	0.14078	0.344
LEXC	0.0042816	0.95258	0.03505	0.0080869
LWPI	0.0089838	0.026792	0.90793	0.056292
LBSE	0.043786	0.31797	0.074552	0.56369

Forecast at Horizon = 48 (months)

	LIIP	LEXC	LWPI	LBSE
LIIP	0.3538	0.009474	0.19044	0.44629
LEXC	0.00438	0.95043	0.038154	0.007037
LWPI	0.00701	0.029717	0.90265	0.060628
LBSE	0.04535	0.32727	0.081969	0.54541

For the above two tables, rows read as the percentage of the variance of forecast error of each variable into proportions attributable to shocks from other variables (in columns), including its own. The columns read as the percentage in which that variable contributes to other variables in explaining observed changes. The diagonal line of the matrix (highlighted) represents the relative exogeneity. According to these results, the ranking of indices by degree of exogeneity (extent to which variation is explained by its own past variations) is as per the table below:

NO	INDEX
1	LEXC
2	LWPI
3	LBSE
4	L11P

Initially, we found this result is similar to our VECM result. Because we have found in VECM that the endogenous variable is LIIP, and in VDC the same variable is in fourth ranking so this confirm with our previous result. However, we should not forget that sometimes this one could give us wrong result because of the two important limitations of orthogonalized VDCs. Firstly it assumes that when a particular variable is shocked, all other variables are "switched off". Secondly and more importantly, orthogonalized VDCs do not produce a unique solution. The generated numbers are dependent upon the ordering of variables in the VAR. Typically, the first variable would report the highest percentage and thus would likely to be specified as the most exogenous variable. This is the case in our data, where LEXC, which appears first in the VAR order, is reported to be the most exogenous. To experiment with the extent to which this is true (that orthogonalized VDCs are "biased" by the ordering of variables), we changed the order of the VAR and found out completely different result.

Following this discovery, we decided to rely instead on Generalized VDCs, which are invariant to the ordering of variables.

In interpreting the numbers generated by the Generalized VDCs, we need to perform additional computations. This is because the numbers do not add up to 1.0 as in the case of orthogonalized VDCs. For a given variable, at a specified horizon, we total up the numbers of the given row and we then divide the number for that variable (representing magnitude of variance explained by its own past) by the computed total. In this way, the numbers in a row will now add up to 1.0 or 100%. The tables below show the result.

Forecast at Horizon = 24 (months)

	LIIP	LEXC	LWPI	LBSE
LIIP	0.50886	0.012978	0.13825	0.339914
LEXC	0.0036	0.800279	0.046905	0.149218
LWPI	0.00974	0.029074	0.930489	0.0307
LBSE	0.0343	0.248827	0.061194	0.655682

Forecast at Horizon = 48 (months)

	LIIP	LEXC	LWPI	LBSE
LIIP	0.363597	0.009811	0.178499	0.448093
LEXC	0.003683	0.798747	0.050516	0.147054
LWPI	0.007624	0.032376	0.925854	0.034145
LBSE	0.03532	0.254648	0.066745	0.643287

We can now more reliably rank the indices by relative exogeneity, as depicted in the table below.

NO	**Variable Relative Exogeneity**	
	At Horizon = 24	**At Horizon = 48**
1	LWPI	LWPI
2	LEXC	LEXC
3	LBSE	LBSE
4	LIIP	LIIP

From the above results, we can make the following key observations:

 From the above result we can see that our most exogenous variable is WPI in both horizon.

 The Generalized VDCs confirm the results of the VECM in that LIIP is the most endogenous variable.

 The relative rank in exogeneity is somewhat stable as time passes. Between 24 months and 48 months.

 The difference in exogeneity between the indices is not significant.

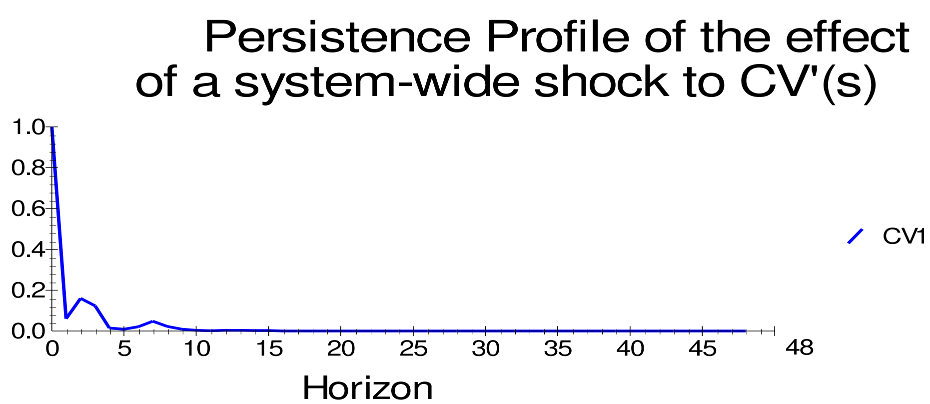
From the above result, we can conclude that, the WPI, which represent Inflation, will have a strong impact on BSE (stock market). Therefore, the policy makers should focus more and target the WPI.

5.7. Impulse Response Function (IRF)

The information, which is presented in the VDCs, also can be equivalently represented by Impulse Response Functions (IRFs). IRFs will present the graphical explanations of the shocks of a variable on all other variables. In other words, IRFs map the dynamic response path of all variables owing to a shock to a particular variable. The IRFs trace out the effects of a variable-specific shock on the long-run relations. For the sake of comprehensiveness, we put various graphs of IRFs. For illustration purpose, we see that one standard deviation shock to LIIP (the most endogenous variable) is having least impact on the endogenous variables of LEXC, LWPI and LBSE.

5.8. Persistence Profile:

The persistence profile illustrates the situation when the entire co-integrating equation is shocked, and indicates the time it would take for the relationship to get back to equilibrium. Here the effect of a system-wide shock on the long-run relations is the focus instead of variable-specific shocks as in the case of IRFs. The chart below shows the persistence profile for the co-integrating equation of this study, the chart indicates that it would take approximately 9 months for the co-integrating relationship to return to equilibrium following a system-wide shock.



Conclusion and policy implication:

This study examined the inter-linkage between the Indian stock market index and three macroeconomic variables, namely, the industrial production index, the wholesale price index to represent inflation and the exchange rate using Johansen's co-integration and VECM framework.

The analysis used the monthly data for the period of January 2000 to August 2013, which are obtained, from DataStream. 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 the Indian stock market index as proxied by BSE Sensex formed significant long-run relationship with three 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 economic activity represented by index of industrial production. A positive relationship between stock price and real output is consistent with Ratanapakorn and Sharma, (2007. They found similar results while testing on USA. The wholesale price index that proxied for inflation has found to be negatively related to stock price index, 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), also found a negative relationship for India. However, this finding is contrary Ratanapakorn and Sharma, (2007) who finds a positive relationship between inflation and stock price suggesting that equities serve as a hedge against inflation.

The present study confirms the beliefs that macroeconomic factors continue to affect the Indian stock market. However, the limitations of the study should not be over looked. The present study is limited to only three 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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