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Macroeconomic Factors and the Indian Stock Market: Exploring Long and Short Run Relationships

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ABSTRACT

The rapid growth of Indian economy during the last two decades raises empirical questions regarding the fundamental connection between stock price and key macroeconomic indicators. This paper aims to examine long and short run relations between selected macroeconomic indicators and stock market returns with reference to India. This study employs monthly data from July 2001 to July 2015 since major stock market reforms *viz*., ban of Badla system, introduction of rolling settlement and introduction of stock derivatives, were all implemented in July 2001. With the help of co-integration and error correction model (ECM), the study reveals the presence of long run relation between the BSE Sensex and select macroeconomic indicators *viz*., Exchange Rate, wholesale price index, T-bill rates and M3.

Keywords: Macroeconomic Indicators, Stock Returns, Co-integration
JEL Classification: G15

1. INTRODUCTION

There may be a strong intuitive appeal attached to the belief that relationships exist between macroeconomic fundamentals and equity returns, but we lack correspondingly strong empirical support that goes with it. Macroeconomic variables can be understood as: Variables reflecting general economic conditions, variables related to interest rate and monetary policy, variables concerning price level and variables involving international activities. General economic conditions include variables like industrial production index or unemployment rate. The variables concerning interest rate and monetary policy include interest rate, term spread, default spread, money supply, etc., Variables focussing on price level may be general price level index or inflation rate. Variables involving international activities are exchange rate or foreign direct investments (FDI), etc., Studies have used different macroeconomic variables to examine which factors have the most critical impact upon stock returns. One of the notable multi factor models, as proposed by Chen et al., (1986) used empirical evidence to extend other risk factors besides the notion of equity market risk premium as propagated by capital asset pricing model (CAPM). They used various macroeconomic shocks including, industrial production index, inflation, risk premium, default spread and term structure, as additional factors in the market model. There exists a huge volume of literature on how stock returns get influenced. Much of the investigation between stock returns and economic forces is based on the presumption that macroeconomic indicators are highly influential in predicting stock returns and asset prices.

One popular area of financial research is studies on the factors that affect stock returns. As per the basic standard stock valuation model, determinants of stock price are "expected cash flows" from the stock and "required rate of return" as per the riskiness of the stock. Macroeconomic indicators affect a firm's cash flows and also influences risk-adjusted discount rate. The required rate of return comprises of risk free rate along with the measure of asset's risk. This nominal risk free rate depends upon real interest rate as well as expected inflation. Risk free rate has an inverse relationship with stock prices. Similar is the case with inflation. Inflation depresses stock market (DeTina, 1991). Relationship of equity returns with money supply might be an empirical question. We know money supply is positively related with inflation rate, hence it might adversely affect stock returns. Money supply may also lead to increasing cash flows by building economic stimulus leading to increasing stock prices.

Expectations also play a very important role in determining stock returns and these expectations, whether adaptive or rational, get influenced by economic fundamentals. Changes in macroeconomic conditions affect current and future investment decisions i.e., an inflation shock may result in a change in the expected return of an asset.

Most popular models to determine stock returns in finance textbooks are CAPM and arbitrage pricing theory (APT). CAPM is derived from Markowitz's concept of diversification and it was further developed by Sharpe (1964), Lintner (1965), Mossin (1966). CAPM is generally considered a single factor model because it states that only market factor is to be considered for determining stock returns. Investors need to be compensated in two ways, time value of money and risk. Time value of money is represented by risk free rate that compensates for placing money in any investment over a period of time. Investors, after diversifying their portfolios, are concerned only with systematic risk or market risk (beta) which is inherent to the market. Sources of systematic risk could be interest rate changes, inflation or even recession as they affect the entire market. APT (Ross, 1976; Roll and Ross, 1980) is a form of multi-factor model which claims that shocks or surprises of possible multiple factors can be used to explain stock returns. An asset's return can be predicted using the relationship between the asset and many common risk factors. APT predicts a relationship between the returns of a portfolio and the returns of a single asset through a linear combination of many independent macroeconomic variables. A multi factor model can also be thought of as the one in which macroeconomic variables are used to explain stock returns.

Since information technology (IT) revolution, information or news is readily accessible. Access to information is easy and universal. This changing dynamics of the environment has indeed made financial markets more efficient. Stock markets react promptly to any news, good or bad, whether political tensions, war situations, regulatory changes in business environment or movements in global markets.

Efficient market hypothesis (EMH) is an idea partly developed in the 1960s by Eugene Fama. It states that it is impossible to beat the market because prices already incorporate and reflect all relevant information. One cannot outperform the overall market through expert stock selection or market timing, and the only way an investor can possibly obtain higher returns is by purchasing riskier investments. Stocks always trade at their fair value, making it impossible for investors to either purchase undervalued stocks or sell stocks for inflated prices. Asset prices fully reflect all available information. There are three variants of the hypothesis: "Weak," "semi-strong," and "strong" forms. The weak form of the EMH claims that prices on traded assets (e.g., stocks, bonds or property) already reflect all past publicly available information. The semi-strong form of the EMH claims both that prices reflect all publicly available information and that prices instantly change to reflect new public information. The strong form of the EMH additionally claims that prices instantly reflect even hidden "insider" information. EMH states that if the market is efficient then we cannot forecast stock returns leaving no arbitrage opportunities to make profit. If the market is efficient, it means that all the relevant information is captured and is getting reflected in the prices. We can say that if these macroeconomic variables are insignificant in explaining stock returns and stock returns are also insignificant in explaining macroeconomic variables, then the market is efficient.

Interpretation of co-integration with respect to market efficiency depends upon how efficiency is defined Mukherjee and Naka (1995). If we see market efficiency as lack of arbitrage opportunities, then the presence of co-integration (long run equilibrium relationships) among variables is a sign of market inefficiency.

Prominent macroeconomic variables generally considered are: Inflation rate, exchange rate, money supply, level of economic activity and interest rates. There cannot be a finite list. Other macroeconomic variables can be unemployment rate, savings, exports, FDI, fiscal policy (budget deficits), oil prices, and gold prices. Even the spread between short and long interest rates, expected and unexpected inflation, high and low grade bonds (Chen et al., 1986) can be analysed while observing stock returns.

Relationship between stock returns and macroeconomic variables can be viewed in two ways. One view is to see the stock market as the leading indicator of economic activity the macroeconomic variables based on the findings that stock market rationally signals changes in real activity. Another view is that macroeconomic variables influence and predict stock returns. We find that current economic activities can explain stock market returns since the stock market reflects macroeconomic variables on stock price indices. Knowledge of sensitivity of stock markets to key macroeconomic variables and vice versa is important in areas of investment, finance and business environment.

The present study improves the earlier studies in the Indian context and offers a value addition to the existing literature. This paper is organised as follows: Section 2 reviews previous literature followed by Section 3 giving data related issues. Section 4 details the methodology employed and Section 5 presents the results.

2. LITERATURE REVIEW

There exists vast literature on the association between macroeconomic variables and stock returns. Although results are mixed, most studies have shown evidence that there are significant relationships between macroeconomic variables and stock returns. An early paper that opened up avenues for research in this regard was by Chen et al. (1986). 'Simple and intuitive financial theory', as they put it, is a well-known phrase in literature. Economic news can be measured as innovations in variables. They tried to explore the set of economic variables that systematically influence stock returns and also asset pricing. These variables were, priori, sources of systematic risk. Economic variables which were significant in explaining stock returns were industrial production, changes in risk premium, twists in yield curve and also measures of unanticipated inflation and changes in expected inflation during periods of high volatility. Real per capita consumption and index of oil price get insignificant.

Starting with the developed countries, Morelli (2002) has taken monthly UK data from January 1967 to December 1995 and tried to analyse "conditional stock market volatility" and "conditional macroeconomic volatility." To estimate conditional volatility GARCH, ARCH models are used. Macroeconomic variables incorporated in the study are industrial production, real retail sales, money supply, inflation and exchange rate (German Deutsche mark/pound). A vector autoregressive (VAR) model of order 12 is constructed which indicates that only exchange rate (DM/pound) can explain some significance in predicting stock market volatility while no significance was observed in terms of ability of stock market's volatility to predict macroeconomic volatility. Results of regression analysis done on conditional stock market volatility estimated from ARCH model on all macroeconomic volatilities reveals that none of the macroeconomic volatilities can explain stock market volatility. In fact, only 4.4% of variation in stock market volatility is explained by macroeconomic volatility. They estimated a best-fit model for conditional stock market volatility where measures of conditional volatility of macroeconomic variables are included as weighted variables. Based on a significant change in log-likelihood value, best model is one in which "conditional volatility of inflation" is included. Overall they have concluded that volatility in macroeconomic variables selected in the study do not explain volatility in the stock market.

Flannery and Protopapadakis (2002) have estimated a GARCH model of daily equity returns in which realized returns and their conditional volatility depend upon 17 macro series announcements over the period 1980-1996. Out of these, three nominal factors, consumer price index (CPI), PPI and a monetary aggregate, are taken; three real factors, balance of trade, employment report and housing starts, are also considered. Popular overall measures of economic activity like industrial production or GNP are not taken into consideration as real GNP was not significantly affecting conditional return volatility nor was it affecting the trade volume. As per the results, out of the 17 macro indicators, six are strong risk factor variables. Two inflation measures, CPI and PPI, affect only level of market returns. Real variables like, balance of trade, employment/unemployment and housing, affect only conditional volatility of returns.

Norway is a small open economy with not so mature financial markets. Gjerde and Saettem (1999) have done a study on Norway using multivariate VAR framework. Apart from stock returns, they have taken macroeconomic variables like, interest rate, inflation, industrial production, consumption variable, oil prices, exchange rate (NOK/USD) and OECD industrial production index, taking monthly observations from 1974 to 1994. Consumption variable checks whether assets will be priced as per their co-variances with aggregate consumption (consumption based asset pricing model). Innovation accounting results reveal that domestic industrial production explains about 8% of variance in real stock returns whereas innovations in real stock returns account for only 1% of variance in industrial production. Stock returns show a delayed but positive response towards industrial production. Stock return's response is immediate and negative to changes in interest rate. Real interest rate changes affect both stock returns and inflation. Stock returns explain little variation in inflation. Norway is an oil-dependent country and hence stock returns respond actively to oil prices. Both oil prices and real activity affects stock returns here unlike the European markets.

Mukherjee and Naka (1995) have taken six macroeconomic variables, exchange rate, inflation, money-supply, real economic activity, long term government bond rate and call money rate in Japan. Monthly data was taken from January 1971 to December 1990. Vector error correction mechanism (VECM) is applied for analysis; they also apply likelihood ratio to check if linear trend exists. Results of trace test and λ_{max} test indicate that there is more than one co-integrating relation. They have based their analysis on the co-integrating vector that is represented by the largest Eigen-value. They found that a co-integrating relation exists and stock prices contribute to this. Results indicate that the relation between Tokyo stock exchange (TSE) and exchange rate is positive since TSE increases as Yen depreciates against US Dollar. Relation between TSE and Inflation is negative. Relationships between TSE and money-supply, and TSE and industrial production are positive. In Japan, money-supply's positive effect on stock prices through augmented corporate earnings overpowers the negative effect because of inflation. There is a negative relation between TSE and long term government bond rates but a positive relation between TSE and call money rates. They argue that in Japan it is possible that the nominal risk free component of discount rate in valuation model is better served by long term government bond rate rather than short term rate. They believe that VECM consistently outperforms VAR; with VECM one can avoid the potential misspecification bias inherent in VAR. According to them VAR is incapable of exploring long term as well as short term relations in the presence of co-integration. With the help of root mean square test and Theil's Inequality coefficient they show that forecasting errors are less with VECM as compared to VAR.

Considering Korea, a well cited paper is by Kwon and Shin (1999) who use co-integration test and granger causality test from a vector ECM (VECM) to check whether stock price indices are co-integrated with a set of macroeconomic variables namely, production index, exchange rate, trade balance and money supply. For stock returns they have taken value-weighted Korea composite stock price index and Small-size stock price index. Monthly data is studied from January 1980 to December 1992. Results indicate that there is no co-integrating relation between stock price indices and any single macro variable. In fact, stock indices are co-integrated with a combination of four macroeconomic variables. They claim that macroeconomic variables are significant in predicting changes in stock prices.

Pierdzioch et al. (2008) have opted for a recursive modelling approach to forecast stock market volatility in real time. They have used monthly real time macroeconomic variables for Germany from 1994 to 2005. To evaluate accuracy of these forecasts, they have used three different criteria - statistical criteria, utilitybased criterion and an options-based criterion. Results prove that the forecasts of stock market volatility based on real time macroeconomic data can be compared with the forecasts based on revised macroeconomic data.

Another important paper is by Darrat (1990) who used multivariate Granger causality to check if economic variables (including base money and fiscal deficit) affect stock returns in Canada. Monthly data is taken from January 1972 to February 1987. Darrat focussed on the role of fiscal policy (budget deficit) in determining stock prices. Toronto stock exchange 300 index is taken as a proxy for stock returns. Multivariate Granger causality test along with Akaike's final prediction error (FPE) and specific gravity criterion are applied. Percentage change in monetary base (average for the month) is taken as a proxy for monetary policy. Change in cyclically-adjusted (structural) budget deficit is taken as a proxy for fiscal policy. Monthly data on cyclically adjusted deficits are unavailable in Canada. Series is obtained by residuals from regressing actual total budget deficits on current and lagged values of industrial production index since monthly real GNP data is also not available. Other variables included in the study are: Industrial production index, long term interest rates, short term interest rates, exchange rate movements, inflation rate and volatility of interest rates. Common lag length for all variables may give biased results. Hence, with Akaike's FPE criterion, appropriate lag length for each explanatory variable is determined. Lag that minimizes autoregressive FPE is selected. Bivariate regression is estimated in which stock prices are regressed against own lagged values and on lagged values of other variables, taken one at a time. Specific gravity criterion is used to estimate trivariate regressions. Finally likelihood test is performed. Their results imply that in Canada budget deficits exert a significant lagged impact upon stock prices even when other variables are excluded. Monetary policy has insignificant lagged relationship with stock prices. In Canada stock prices fully reflect all available information on monetary policy, as revealed by the study.

For Singapore, Mookerjee and Yu (1997) have tested for degree of informational efficiency in stock market with respect to a subset of macroeconomic variables. Sample period spans from October 1984 to April 1993. Four macroeconomic variables are used: Two measures of money supply (narrow and broad), nominal exchange rate and aggregate foreign currency reserves. The all share price index was chosen to trace the stock market in Singapore. Engle and Granger co-integration test gives the result that stock prices are co-integrated with both money supply measures and aggregate foreign exchange measures, but not with exchange rate. They have made conclusions on efficiency by linking co-integration to market efficiency. Finding of co-integration is interpreted as potential market inefficiency. Three of the four macro indicators are co-integrated with stock prices, suggesting potential inefficiencies in long run. For short run, we get conflicting evidence on informational efficiency of the equity market in Singapore. Maysami et al. (2004) have examined the co-integration between macroeconomic variables and sector indices, mainly finance index, property index and hotel index. Monthly data is obtained from January 1989 to December 2001. Their findings include significant positive relationship between inflation and Singapore stock returns. Short term interest rates showed positive relationship with Singapore's equity market whereas long term interest rate showed negative relationship. Positive correlation is observed between money supply changes and stock returns. Similarly positive relationship is observed between exchange rate and Singapore stock market. As per the finance index, finance sector is significantly affected by changes in inflation rate, exchange rate, and both short term and long term interest rates. Short and long term interest rates, and money supply do not have significant effect on Singapore hotel index but significant negative relation is observed between the hotel sector and exchange rates.

It is interesting to see how developing markets respond to the economic fundamentals as compared to well developed and more organized markets. Talking about emerging economies, a study on Thailand by Tangjitprom (2011) uses four macroeconomic variables namely, unemployment rate, interest rate, inflation and exchange rate. Lead-lag relationship is analysed through VAR model and Granger causality test. Variance decomposition is used to examine sensitivity of stock returns to each macroeconomic factor. Sectorial analysis is done using sectorial indices as each industry is sensitive to macroeconomic indicators differently. Monthly data spans from January 2001 to December 2010. Due to unavailability of monthly gross domestic product (GDP) data unemployment rate, that represents general business condition and business cycle factor, is taken. To trace stock market movement SET50 index, MAI index and average stock return of top ten securities are taken. Regression analysis with macroeconomic variables as explanatory variables and stock returns as dependent variables shows that interest rate and exchange rate are significantly negative. Both inflation and unemployment rate get insignificant in explaining stock market performance. Using short term interest rate instead of long term, or using real variables instead of nominal does not alter the result. Variance decomposition reveals that interest rate is the most important economic variable in explaining stock returns. Few lagged macroeconomic variables can explain stock returns, whereas lagged stock returns can significantly explain most of the macroeconomic variables except unemployment rate. Hence stock market performance is a good indicator of the future macroeconomic scenario.

A well cited paper on India is that of Ahmed (2008). Analysis has been done taking quarterly data spanning from March 1995 to March 2007, using variables like, index of industrial production (IIP), money supply, interest rate, exchange rate, FDI inflows, and export earnings. For analysing stock returns, BSE Sensex and NSE Nifty have been taken. Toda and Yamamoto Granger causality test and Johansen's co-integration test were applied to check for long run direction of causality. Short run causal links were explored using variance decomposition and impulse response functions. Sims's VAR is applied. Co-integration regressions indicates the presence of long run relationship between stock prices-FDI, stock prices-money supply, stock prices-IIP. Movement in BSE Sensex influences exchange rate and IIP, but NSE Nifty does not influence them. Results reveal that NSE Nifty influences exchange rate, exports, IIP and money supply, while interest rate and FDI are causing

NSE Nifty returns. Broadly, same is observed for BSE Sensex. Results reveal that stock price movement is causing movement in IIP, implying stock prices lead real economic activity. FDI causes movement in stock prices but stock price movement does not affect FDI. Stock price movement affects export flows through its effect on exchange rate. In short run, Sensex and Nifty influence exchange rate. On the other side, exchange rate does not affect BSE Sensex and NSE Nifty. Study reveals that money supply does not affect stock returns but interest rate does. The paper also concludes that even monetary policy measures that affect interest rates are influential in determining stock returns.

Pal and Mittal (2011) observed Indian capital markets and macroeconomic variables like, inflation rate, interest rate, exchange rate and gross domestic savings (GDS). Quarterly data has been taken from the first quarter of 1995 to the last quarter of 2008. Co-integration test is applied to check for long run relationship and ECM is applied to check for short run patterns. They started with the null hypothesis that macroeconomic variables do not have any significant impact upon stock prices. S&P CNX Nifty and BSE Sensex serving as a proxy for stock returns have been taken as dependent variables. Partial elasticity analysis is done on logarithms of models. ECM shows that inflation rate affects both BSE Sensex and S and P CNX Nifty significantly. Interest rate impacts movements in S and P CNX Nifty. Exchange rate significantly affects BSE Sensex. GDS shows no association with BSE Sensex and S&P CNX Nifty. They conclude that macroeconomic variables do have a significant impact upon stock returns in the Indian context.

BSE Sensex and NSE Nifty show high correlation with each other because of similar composition. Results which indicate that these indices are reacting differently in the context of the same macroeconomic variable are questionable. Naik and Puja (2012) investigated Indian equity market through BSE Sensex and macroeconomic variables like, IIP, wholesale price index (WPI) as a measure of inflation, money supply, T-bill rates as a measure of interest rates and exchange rate. Monthly data is studied from April 1994 to June 2011. To check for long run equilibrium relationship, Johansen's co-integration and VECM are applied. Stock prices are positively related to money supply and IIP, and negatively related to inflation. Exchange rate and short term interest rate are found to be insignificant in explaining stock returns. Granger causality suggests that macro variables may be causing stock prices in long run but not in short run. Bidirectional causality exists between IIP and stock prices. Unidirectional causality is observed from money supply to stock prices, stock return to inflation and interest rate to stock indices.

Naka et al. (1998) tried to see the impact of economic reforms of 1991 on Indian capital markets. For equity market BSE data is taken. VECM is employed to check for co-integration (long run equilibrium relationship) among the factors. Through impulse response and variance decomposition they have demonstrated effects of macroeconomic factors on Indian stock markets. Macroeconomic variables considered in the study are: Industrial production index (proxy for output), CPI (proxy for inflation), M1 (narrow money; proxy for money supply) and money market rate in Bombay interbank rate (proxy for interest rate) and period of study ranges from the first quarter of 1960 to the fourth quarter of 1995. Their investigation implies that inflation and output growth are the main determinants of BSE and performance of BSE has improved as compared to pre-1991 period.

Another study on India by Singh (2010) attempted to explore causal relations between stock market and macroeconomic variables by applying Granger causality test. Monthly data from April 1995 to March 2009 has been used. Macro indicators like WPI, IIP and exchange rate are observed. BSE Sensex is taken as a proxy for Indian equity market. Strong correlation is observed between BSE Sensex-IIP and BSE Sensex-WPI, but not for exchange rate-BSE Sensex. Granger causality test indicated that IIP is the only variable having bilateral causal relationship with BSE Sensex.

Considering the lower middle income countries, Gunasekarage et al. (2004) have done a study on Sri Lanka, examining macroeconomic influence on stock market. They have used Colombo all share price index to represent the stock market. Macroeconomic variables like, money supply, T-bill (measure of interest rate), CPI (proxy for inflation rate) and exchange rate, are taken. Monthly data is analysed from January 1985 to December 2001. VECM, impulse response function and variance decomposition are employed to check for long run and short run relationships. Results from VECM suggest that lagged values of macroeconomic variables like, CPI, money supply and interest rate, significantly influence the stock market. Interest rate serves as the strongest determinant compared to other variables in the study. It influences stock returns and also gets influenced by stock returns. Except for interest rates (T-bill rates) stock indices are unable to explain any movement in other macroeconomic indicators. Both variance decomposition and impulse response function suggest that economic indicators can explain only a small margin of error variance of equity returns.

Sohail and Hussain (2009) have examined short run and long run relationships between macro indicators and stock returns in Pakistan. Macroeconomic variable like, CPI as a measure of inflation, IIP, real effective exchange rate, money supply and 3 month Treasury bill rate, are observed. For tracing Lahore stock exchange LSE25 index is taken. Monthly data spanning from December 2002 to June 2008 is taken. Co-integration test was applied to check for long run relationship. ECM checks for short run dynamics. Variance decomposition gives further evidence of interactions among variables. In long run, inflation is negatively impacting stock prices while IIP, real effective exchange rate and money supply are having a positive effect on stock returns. 3 month T-bill rate is insignificant in explaining stock returns in long run. Among macro indicators taken in the study inflation explained maximum variance.

After a thorough review of literature, we found that the following variables are extensively used in literature *viz*., money supply, interest rate, inflation rate and exchange rate, as macroeconomic indicators. Based on the underlying economic theory and literature, we frame the following hypotheses.

When we talk of inflation as per the money demand theory, economic activity is negatively related to inflation, therefore stock returns are also negatively influenced by inflation Fama (1981). An increase in inflation may also lead to an increase in nominal risk free rate, and also the discount rate, leading to declining stock prices as stock prices are the discounted value of expected cash flows. Thereby inflation and stock returns must show negative relation with each other. Geske and Roll (1983), Mukherjee and Naka (1995), Naka et al (1998), Sohail and Hussain (2009), Pal and Mittal (2011) show significant negative relation between inflation and equity returns.

Relationship between money supply and stock prices lies in ambiguity. If increase in money supply leads to economic stimulus resulting in corporate earnings, it will increase stock prices. However when increase in money supply leads to increase in inflation, it would raise discount rate, reducing stock prices. Hence relation between money supply and stock returns is still an empirical question. Mukherjee and Naka (1995) Sohail and Hussain (2009) show that money supply and stock prices positively relate to each other.

Interest rate is another fundamental macroeconomic variable having significant impact upon stock returns. Reduction in interest rate reduces the cost of borrowing, serving as an incentive for firms and increasing their stock prices. Hence, interest rates and stock returns must show negative relation with each other. Gjerde and Saettem (1999) also show interest rate to be negatively related to stock prices. Impact of exchange rate on an economy depends upon its level of international trade and also trade balance. Depreciation of currency leads to an increase in demand for exports, thereby increasing cash flows in the country under the assumption that demand for exports is elastic. In such a case, the impact of exchange rate depends upon whether the firm is an exporting firm or import dominant. Depreciation of domestic currency induces investors to shift funds from domestic assets to foreign currency assets, depressing stock prices. Hence we hypothesize a positive relation between exchange rate and equity market. Mukherjee and Naka (1995) conclude that exchange rate is positively related with stock returns whereas Pal and Mittal (2011) show significant negative relation between exchange rate and stock market returns.

3. DATA

In this paper, we investigate the case for India using monthly frequency of data and taking macro-economic variables namely, inflation rate, interest rate, money supply and exchange rate. We have taken WPI as a proxy for inflation. For interest rates, we use 365 days Government of India T-bill rates. For money supply, we have taken broad money (M3). Exchange rate is obtained through US Dollar/Indian Rupee FX Spot Rate. For tracking stock returns in India, we have taken S and P BSE Sensex, the benchmark stock index for the Indian equity market.

Level of economic activity is one of the crucial determinants of stock returns. GDP is the most comprehensive measure of real economic activity in an economy. In India, GDP data is available only on a quarterly basis. To avoid potential degrees of freedom problem in VAR model because of lack of observation points, we employ monthly data. IIP shows the amount of industrial production or level of manufacturing in an economy and is available at a monthly frequency, but over the years contribution of IIP is declining since the major contribution in GDP comes from the service sector and not from the manufacturing sector. As per Planning Commission report, in 2014 contribution from Industry is around 24.2% whereas Service sector contributes as much as 57.9%. Hence, we have excluded IIP from the study.

Data for exchange rate (US Dollar/Indian Rupee), S and P BSE Sensex and S and P BSE 500 is collected from Thomson Reuters. For interest rates, 365 days Government of India T-bill rate that is implicit yield at cut-off price (in Per cent) and M3 (broad money supply) is taken from EPWRF time series data base. The study covers the period from July 2001 to July 2015. The reason we have taken 2001 as the starting year is because Indian stock markets are at a nascent level and are more prone to manipulation coupled with physical exchange of shares and incomplete markets, with no efficient hedging instruments for investors and the presence of fixed period of settlement system. Indian financial markets have gone through several reforms during this period. Derivative instruments (index and stock) were introduced in India during 2000 and 2001. IPO relaxation for information technology, media and telecommunication companies, i.e., permission to issue a minimum of 10% shares, came into existence on 15th October 1999. Venture Capital guidelines came into existence on September 15, 2000. Collective Investment Scheme Regulations came into existence on July 15, 1999. Flexible face value concept came into existence on October 11, 1999. Negotiated deals were not permitted from September 14, 1999. Internet Trading was permitted by SEBI Board on January 25, 2000. Corporate Governance came into existence on January 1, 2000, to be adhered by all A group S&P CNX Nifty index companies by March 31, 2001. All deferral products namely, ALBM/BLESS/MCFS/CNS, ceased to be available for all scrips from July 2, 2001.With these infrastructure and regulatory improvements, Indian stock markets are in a far better position to absorb and react at a much faster pace to any information arrival. Most of the existing studies focussed a period of infancy level in Indian stock market and hence reported a bi-directional causality between most macro-economic variables and the stock market.

4. EMPIRICAL METHODOLOGY

In line with the literature, we examine long run relationships among macro variables and stock index returns by employing Co-integration analysis. A brief methodology on multivariate Co-integration is presented below.

Co-integration analysis is designed to find linear combination of variables that also removes unit root. For example, if Y_t and X_t are both I(1), then there may be a unique value of β for which Y_t - β_{Xt} is I(0), that is no unit root in the relation linking X_t and Y_t. Co-integration is a testable restriction on a dynamic model. Co-integration vectors, if exist, determine I(0) relations that hold between variables which are individually non-stationary. Such relations are often referred to as "long run equilibrium" relationships since they prove as attractors towards which convergence occurs. Conclusion on Co-integration cannot be made by a mere visual inspection of graphical plotting of variables that might look or do not look cointegrated. The only way to find is through a careful statistical analysis. Co-integration analysis is inherently multivariate, it considers a set of integrated variables as a single time series that cannot be cointegrated.

Johansen (1991) test is a preferable multivariate co-integration test that accounts for more than one cointegrating relation unlike Engle Granger test. The test for co-integration between the Xs is calculated by looking at the rank of the matrix Π. Rank of a matrix is equal to the number of its characteristic roots (eigenvalues) that are different from zero.

$$X_t = A_t X_{t-1} + \varepsilon_t \tag{1}$$

$$\begin{aligned}\Delta X_t &= A_t X_{t-1} - X_{t-1} + \varepsilon_t \\ &= (A_{t-1})\, X_{t-1} + \varepsilon_t \\ &= \Pi\, X_{t-1} + \varepsilon_t\end{aligned}$$

Where X_t denotes a vector of n variables; X_t and ε_t are n × 1 vectors and At is an n × n matrix of parameters. If rank of Π is 0, each element of Π equals 0. Then $\Delta X_t = \varepsilon_t$. Thus the first difference of each X_t is I(0) since all the $\{X_{i,t}\}$ sequences are unit root processes and there is no linear combination of the variable that is stationary. At the other extreme, suppose Π is of full rank, then long run solution is given by n independent equations. Each of these n equations is an independent restriction on the long run solution of the variables. The n variables in the system face n long run constraints, each of the n variables contained in vector X_t must be stationary with long run values. In general, if the rank of Π is *r*, then there are "*r*" co-integrating vectors. Number of distinct cointegrating vectors can be found by characteristic roots of Π. Rank of a matrix is equal to the number of characteristic roots that differ from zero. We can obtain estimates of Π and also the characteristic roots. We need to test for number of characteristic roots that are insignificantly different from 0. Johansen test comprises of Trace test and Max-Eigen test. λ_i denotes estimated values of characteristic roots obtained from estimated Π. Trace statistic tests whether number of distinct cointegrating vectors is less than or equal to r. The farther the estimated characteristic roots are from 0, the greater is λ trace. Max-Eigen statistic tests whether number of co-integrating vectors is *r*, against the alternative of *r*+1.

Meanwhile, co-integration as such does not speak anything about the direction of causality. Hence, estimation of ECM is important. The concept of error correction basically refers to the adjustment process between short-run disequilibrium and a desired long run position. As per Engle and Granger, if two variables are cointegrated, then there exists an error correction data generating mechanism, and vice versa. Two variables that are cointegrated would not drift apart over time; this concept provides insight into the long-run relationship between the two variables and testing for the co-integration between two variables.

$$\lambda_{trace}(r) = -T \sum_{j=r+1}^{p} In(1-\hat{\lambda}_j) \quad \lambda_{\max}(r, r+1) = -T\, In(1-\hat{\lambda}_{r+1}) \tag{2}$$

Where λ_j are the estimated values of characteristic roots (eigenvalues) obtained from Π` matrix. *T* = Number of observations, *r* = Number of co-integrating vectors. The trace test statistics test the null hypothesis that the number of distinct co-integrating vectors is less than or equal to r against the alternative hypothesis of more than r co-integrating relationships. It is clear that $\lambda_{trace} = 0$ when $\lambda_j = 0$. The farther the estimated characteristic roots are from zero, the more negative is ln $(1-\lambda_j)$ and larger would be the λ_{trace}. The maximum eigenvalue statistics test the null hypothesis that the number of co-integrating vectors is less than or equal to r against the alternative of r + 1 co-integrating vectors. Again, if the estimated value of the characteristic root is close to zero, λ_{max} will be small.

To examine the short run causality, Granger causality test is employed. Since the future cannot predict the past, if variable *X* granger causes variable *Y*, then changes in *X* should precede changes in *Y*. Therefore, a regression of Granger's concept of causality states that any time series X_t Granger-causes another time series Y_t, if series Y_t can be predicted with better accuracy by using past values of X_t rather than by not doing so, keeping other information identical, obtained by excluding all information on X_t from Y_t. Toda and Yamamoto (1995), propose an applicable methodology independent of the integration or co-integration properties of the model. In this method a modified Wald test is used to contrast the parameters of the VAR. An extended VAR model is used, whose order is determined by the number of optimal lag lengths in the system (k) and the maximum number of times one must differentiate the variables (d_{max}). When a VAR max ($k+d_{max}$) is predicted (where max d is the maximum order of integration to occur in the system), this test displays asymptotic chi-square distribution, it is also shown that if variables are integrated of order d, the usual selection procedure is valid whenever k ≥ d. Toda and Yamamoto test has been used to capture long-run causality pattern.

In the Granger test we deal with bilateral causality but many times we come across multivariable causality which can be resolved through vector auto regression. Models (VARs) were popularised by Sims (1980) as a natural generalisation of univariate autoregressive models. According to Sims, if there is true simultaneity among a set of variables, they should all be treated on an equal footing. There should not be any priori distinction between endogenous and exogenous variables. In VAR framework each of the current values depends on different combinations of the previous *k* values of both variables and error terms where *k* refers to the lag term.

$$Y_{1t} = \beta_{10} + \beta_{11}\, Y_{1t-1} + \beta_{1k}\, Y_{1t-k} + \alpha_{11}\, Y_{2t-1} + \alpha_{1k}\, Y_{2t-k} + u_{1t} \tag{3}$$

$$Y_{2t} = \beta_{20} + \beta_{21}\, Y_{2t-1} + \beta_{2k}\, Y_{2t-k} + \alpha_{21}\, Y_{1t-1} + \alpha_{2k}\, Y_{1t-k} + u_{2t}$$

Where u_{it} is a white noise disturbance term with $E(u_{it})=0$, (i = 1, 2), $E(u_{1t}, u_{2t})=0$.

The most fundamental advantage with VAR is that there is no need for the researcher to specify which variables are endogenous or exogenous - all are endogenous.

Impulse responses trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. So, for each variable from each equation separately, a unit shock is applied to the error, and the effects upon the VAR system over time are noted. Thus, if there are g variables in a system, a total of (g*g) impulse responses could be generated. Variance decompositions offer a slightly different method for examining VAR system dynamics. They give the proportion of the movements in the dependent variables that are due to their 'own' shocks versus shocks to the other variables. A shock to the i^{th} variable will, of course, directly affect that variable, but it will also be transmitted to all of the other variables in the system through the dynamic structure of the VAR. Variance decompositions determine how much of the s-step-ahead forecast error variance of a given variable is explained by innovations to each explanatory variable for s = 1,2.

5. EMPIRICAL RESULTS

The descriptive statistics for all five variables is shown in Table 1. These variables are BSE Sensex, M3 (broad money supply), WPI, and exchange rate and T-bill rates. For a standard normal distribution, skewness should be zero and kurtosis should be at three. It can be observed that frequency distribution of the above mentioned variables are not normal. The JarqueBera statistics also confirm the same. As is obvious, standard deviation indicates that stock returns are more volatile as compared to macroeconomic indicators. Since the time series analysis can only be done with a stationary data series so as to avoid spurious results, Augmented Dickey Fuller (ADF) test is employed to check for stationarity. As shown in Table 1, all the series are found to be at non-stationary at levels. However, after first differencing, we get stationary series for all the variables even at 1% level. Thus all the variables are integrated of the order I(1).

This table reports descriptive statistics of the variables used in the study for the period July 2001 to July 2015. Log (M3) stands for natural logarithm of month end broad money supply. Log (WPI) stands for natural logarithm of monthly average WPI. Log (exchange rate) stands for natural logarithm of monthly average of USD/INR. T-bill rate stands for monthly average of 365 days Government of India treasury bills. Last column reports daily percentage change in Sensex values. ADF test is employed to check the presence of unit root in the series at the levels and first differences.

Table 2 represents unrestricted co-integration rank test. Johansen's multivariate Co-integration test is employed to check for number of co-integrating relationships among the underlying variables. We observe trace statistic and max-Eigen statistic to identify the number of co-integrating vectors. Results indicate presence of one long run relationship between macro indicators and stock market returns.

This table reports test statistics of Trace and λ_{max} are based without a linear trend ($\mu = 0$). The critical values at 5% level are obtained from Osterwald-Lenum (1992). The null hypothesis implies at most r cointegrating vectors, where r is the order of co-integration.

Normalized co-integrating coefficients are displayed as follows:-

$X_t = (\text{Sensex}_t, \text{Tbill}_t, \text{WPI}_t, \text{XRate}_t, \text{M3}_t)$

$B_t = (1.00, 5.1464, -1.5666, -4.1392, -0.4907)$

The co-integrating relationship can be expressed as -

$$\underset{}{\text{Sensex}_t} = \underset{(1.06)}{1.5666\text{WPI}_t} + \underset{(1.64)}{4.1392\text{XRATE}_t} + \underset{(3.14)}{0.4907\text{M3}_t} - \underset{(-5.14)}{5.1464\text{Tbill}_t}$$

The t-statistics are reported in parentheses. The coefficients for WPI and money supply are positive and statistically significant. Interest rate shows negative and statistically significant relation with stock returns. Exchange rate shows positive but insignificant relation with stock returns.

For money supply, the positive relation indicates that an increase in money supply leads to economic stimulus resulting in corporate earnings, hence leading to an increase in stock prices. Mukherjee and Naka (1995), Sohail and Hussain (2009) show that money supply and stock prices positively relate to each other. As proposed, interest rate shows negative relationship with stock returns. Reduction in interest rate reduces the cost of borrowing, serving as an incentive for firms and increasing their stock prices. Gjerde and Saettem (1999) also show interest rate to be negatively related to stock prices. Exchange rate and stock returns show positive relation with each other. Depreciation of currency leads to an increase in demand for exports, thereby increasing cash flows in the country under the assumption that demand for exports is elastic. In such a case, impact of exchange rate depends upon whether the firm is an exporting firm or import dominant. Depreciation of domestic currency induces investors to shift funds from domestic assets to

Table 1: Descriptive statistics

Statistic	Log (M3)	Log (WPI)	Log (exchange rate)	T-bill rate	Change in Sensex %
Mean	12.99	4.95	3.88	6.77	1.49
Median	14.09	5.02	3.85	7.04	1.27
Maximum	15.21	5.23	4.19	9.92	28.26
Minimum	10.61	4.58	3.67	3.59	−23.89
Standard deviation	1.75	0.20	0.13	1.51	6.92
Skewness	−0.17	−0.37	0.79	−0.24	−0.18
Kurtosis	1.15	1.65	2.76	1.93	4.66
Jarque-Bera	24.86	16.52	17.79	9.67	20.40
Probability	0.00	0.00	0.00	0.01	0.00
ADF test-levels	−2.24	−1.83	−1.34	−2.79	−2.42
ADF test-first differences	−13.22	−12.72	−4.86	−15.48	−11.77

ADF test table values at 1%, 5% and 10% level are 4.01, 3.43 and 3.14 respectively foreign currency assets depressing stock prices. Mukherjee and Naka (1995) also conclude that exchange rate is positively related with stock returns. A contrasting result is obtained for inflation as it is showing a positive relation with stock returns. Maysami et al. (2004) and Ratanapakorn and Sharma (2007) show positive relation between inflation and stock returns. Indian economy as well as Indian capital markets are evolving at a rapid growth pace and hence equities are serving as a hedge against inflation.

Results of the VECM are presented in Table 3. As can be seen from the reported adjusted R^2, 11% of the variation in BSE Sensex is explained by the macroeconomic variables viz., interest rate (T-bill rates), money supply (M3), inflation (WPI) and exchange rate (USD/INR). Similarly, for interest rates, it is 6%, for money supply it stands at 6% and for exchange rate and inflation it is 4% and 4% respectively. It clearly suggests that only 11% of movements in stock returns are getting influenced by these macroeconomic variables at monthly frequency.

Table 2: Multivariate Co-integration tests using Johansen's method

Null: Number of cointegrated vectors	Trace statistic	Critical value at 5% level	Max-Eigen statistic	Critical value at 5% level
r=0	80.04	77.74	43.64	36.41
r≤1	36.39	54.64	20.39	30.33
r≤2	16	34.55	10.86	23.78
r≤3	5.13	18.17	3.12	16.87
r≤4	2.01	3.74	2.01	3.74

Panel A of this table reports long run relation (normalized cointegrating relation) coefficients between logged values of Sensex and logged values of macroeconomic indicators. Panel B reports the coefficients of VECM. The numbers in parentheses estimated coefficients are standard errors and the numbers in square brackets are t-statistics.

Co-integration results are reported in Table 3 which suggests that there exists long run relationships among variables, but says nothing about the direction of causality. Engle and Granger suggest that, if variables are co-integrated in long run then there must exist unidirectional or bidirectional relationship between variables. To shed more light into the findings of VECM model, the results of variance decomposition analysis are reported in Table 4. The reported figures indicate the percentage of movement in each variable that can be attributed to its own shock and the shocks to the other variables in the system. These are provided for five difference lagged time horizons: 1 month, 5 months, 10 months (short run), 15 months and 20 months (long run). The results support the argument that the movements in the Sensex can be explained by some of the macroeconomic indicators analysed. In the 1st month, 100% of the variability in the Sensex is explained by its own shocks while after 10 months, 84.73% of variability is explained by its own innovations; 7.37% by the shocks from T-bills; 6.27% by the shocks of WPI. Similarly, Sensex accounts for the variation after 10 months in Exchange rate by 18.74% and about 8.74% variation in T-bills. This further supports the earlier result that the direction of causality runs from Sensex to exchange rate.

Table 3: Vector error correction estimates

Panel A: Normalized cointegrating coefficients						
Variable	**LN_Sensex(−1)**	**LN_T-bill(−1)**	**LN_WPI(−1)**	**LN_XRate(−1)**	**LN_M3(-1)**	**Constant**
Coefficient	1.0000	−5.1464	1.5666	4.1392	0.4907	−29.8206
Standard error		(−1.0004)	(−1.4765)	(−2.5270)	(−0.1562)	
t-statistic		[−5.14439]***	[1.06102]	[1.63795]	[3.14129]***	
Panel B: Error correction coefficients						
Error correction	**D (LN_Sensex)**	**D (LN_T-bill)**	**D (LN_WPI)**	**D (LN_XRate)**	**D (LN_M3)**	
CointEq1	0.0116	0.0050	−0.0081	−0.0030	−0.0922	
	(−0.0050)	(−0.0072)	(−0.0036)	(−0.0017)	(−0.0266)	
	[2.3112]**	[0.6903]	[−2.2425]**	[−1.7336]*	[−3.4691]***	
D (LN_Sensex[−1])	−0.0181	0.2498	0.1291	0.0262	−0.4596	
	(−0.0893)	(−0.1278)	(−0.0644)	(−0.0304)	(−0.4730)	
	[−0.2025]	[1.9544]*	[2.0053]**	[0.8636]	[−0.9717]	
D (LN_T-bill[−1])	0.0553	−0.2435	−0.0288	−0.0133	0.0683	
	(−0.0567)	(−0.0812)	(−0.0409)	(−0.0193)	(−0.3005)	
	[0.9747]	[−2.9988]***	[−0.7041]	[−0.6881]	[0.2273]	
D (LN_WPI[-1])	0.2976	0.0191	0.0084	−0.0259	−0.2733	
	(−0.1069)	(−0.1530)	(−0.0771)	(−0.0363)	(−0.5662)	
	[2.7829]***	[0.1250]	[0.1087]	[−0.7117]	[−0.4827]	
D (LN_XRate[−1])	−0.2327	0.0807	0.5177	0.1415	−0.4980	
	(−0.2681)	(−0.3836)	(−0.1932)	(−0.0911)	(−1.4196)	
	[−0.8682]	[0.2103]	[2.6792]***	[1.5528]	[−0.3508]	
D (LN_M3[−1])	−0.0455	0.0177	−0.0020	0.0111	−0.0499	
	(−0.0146)	(−0.0209)	(−0.0105)	(−0.0050)	(−0.0772)	
	[−3.1179]***	[0.8466]	[−0.1924]	[2.2442]**	[−0.6461]	
C	0.0127	−0.0029	−0.0020	0.0014	−0.0088	
	(−0.0053)	(−0.0076)	(−0.0038)	(−0.0018)	(−0.0279)	
	[2.4083]**	[−0.3850]	[−0.5365]	[0.8011]	[−0.3135]	
Adjusted R^2	0.11	0.06	0.04	0.04	0.06	
F-statistic	4.42	2.72	2.11	2.04	2.63	

*,**,***Denote statistical significance at the 10%, 5% and 1% levels respectively

Table 4: Variance decomposition results

Panel A: Percentage of the Movement in the Sensex$_t$ explained by shocks					
Lags (n)	LN_Sensex$_{t-n}$	LN_T-bill$_{t-n}$	LN_WPI$_{t-n}$	LN_XRATE$_{t-n}$	LN_M3$_{t-n}$
1	100.00	0.00	0.00	0.00	0.00
5	91.38	1.61	4.93	0.11	1.96
10	84.73	7.37	6.27	0.42	1.20
15	77.50	14.04	6.88	0.78	0.80
20	71.07	19.99	7.19	1.11	0.64
Panel B: Percentage of a shock to Sensex$_{t-n}$ explaining movements in					
	LN_Sensex$_t$	LN_T-bill$_t$	LN_WPI$_t$	LN_XRATE$_t$	LN_M3$_t$
1	100.00	2.49	0.12	25.23	2.05
5	91.38	8.02	1.41	21.59	2.30
10	84.73	8.74	2.71	18.74	1.22
15	77.50	8.93	3.76	16.28	0.86
20	71.07	8.99	4.54	14.34	0.84

This table reports the results of variance decomposition analysis over five different lagged time horizons. Panel A reports the percentage movement in Sensex that can be attributed to itself and other variables. Panel B reports the percentage of movement in macroeconomic indicators that is attributed to Sensex.

6. CONCLUSION

This paper explored the nexus between Indian stock market and selected macro-economic indicators by performing necessary analysis that addresses long run and short run relations. Specifically, the study employs monthly data from July 2001 to July 2015 along with Johansen's co-integration analysis and granger causality tests are performed. The results are interesting and useful in understanding the dynamic relations between stock returns and macro-economic factors. The study finds support for the presence of one cointegrating vector between Sensex and macro-economic indicators viz., exchange rate, money supply, WPI and treasury bill rate.

Further, the study observes that three out of four factors (*viz*., WPI, money supply and T-bill) are relatively more significant in a long run relation. Turning to short run relations, the study reports bi-directional causality between Sensex and exchange rate. Inflation and money supply show positive and significant relation with stock returns. Interest rate shows negative and insignificant relation with stock market returns. We can say that Indian capital markets are showing signs of market inefficiency because of co-integration between stock returns and macroeconomic indicators.

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