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Macroeconomic variables and market expectations: Indian Stock Market

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Abstract. *Purpose: This study attempts to explore the relationships among stock market, investor sentiments and economic activity in Indian context. The study investigates the relationships between the Indian stock market prices (NSE Nifty 50; NSE 100 and NSE 500) and significant macroeconomic variables, along with market expectations measured by Volatility Index (VIX).*

Design/methodology/approach: Monthly time series data spanning from March 2009 to March 2017 has been used. The unit root test for stationarity, ARDL bound test for co-integration and Granger Causality have been employed to study the short run and long run dynamics.

Findings: *The findings of the study confirm the existence of co-integration among the variables, indicative of a long-run relationship. The long-run coefficients suggest Indian share prices are influenced positively by FIIs, Volatility Index and Inflation and negatively by Crude Oil Prices, Gold Prices and Exchange Rate. Money supply, Call Money Rate, Gross Fiscal Deficit and Index of Industrial Production prove to be insignificant in affecting the stock prices for all three indices. In Granger causality sense, it was found that the stock prices Granger Cause Crude Oil, Exchange Rate and Industrial Production for all three indices. It was also found that Exchange Rate and VIX Granger cause stock prices for NSE50 and NSE100. But for NSE500, the causality runs from stock prices to VIX.*

Originality/value: This study emphasizes the impact of macroeconomic variables and investor sentiments on the stock market in a developing economy.

Keywords: macroeconomic variables, Granger causality, co-integration, stock market, investor sentiment.

JEL Classification: C58, G10, G40.

1. Introduction

Stock prices have been considered as one of the best indicators of economic activity fluctuations. In the last two decades, there has been a lot of empirical studies to understand how the stock prices affect an economy and vice versa. The linkage of the macroeconomic variables with the stock market has always been a matter of investigation amongst researchers, investors and policymakers so as to study the implications of economic activity on stock markets. The stock markets indicators reflect the potential opportunities in the Indian economy. Stock prices get influenced by an extensive group of macroeconomic variables like Inflation, Money Supply etc. Therefore, it is expected that the performance of an economy gets reflected in its financial markets which in turn attracts more investors. India, being an emerging and developing economy carries huge expectations for the investors.

The stock markets show volatile behaviour over time. Excessive volatility adversely affects the economies and also disrupts the smooth functioning of financial markets. This excessive volatility may result in the shift of the investors' behavior to invest in risk-free assets compared to riskier ones. Therefore, understanding the dynamics of stock markets becomes necessary for macroeconomists, financial analysts and policymakers so that necessary policy measures can be taken. Since, the volatility patterns guide the investment spending by investors, identifying and thus accordingly designing the policies help developing greater confidence in investors.

2. Literature review

The literature provides a plethora of studies performed in an international and national context to analyze the implications of macro variables on stock prices. The pioneering studies in the field of stock market and economic activity nexus had focused on exploring the relationship between stock markets and macroeconomic variables in the international context (Fama, 1990), (Fama, 1981), (Geske and Roll, 1983) and (Chen et al., 1986).

In 1999, a study investigated whether macroeconomic variables could explain stock market returns or not in Korea by considering economic variables like production, trade balances, exchange rates and the money supply (Kwon and Shin, 1999).

For the analysis, Engle-Granger co-integration test and Granger causality tests were used through the Vector Error Correction Model. It was found that the market index and macroeconomic variables are co-integrated and stock price indices are not a leading indicator for economic activity. A study explored the long-run relationship between the Jordanian stock prices and macroeconomic variables such as exports, foreign reserves, interest rates, industrial production and inflation (Maghayereh, 2003).

Co-integration analysis with monthly time series data from January 1987 to December 2000 was used to explore the relationship. The study concluded that macroeconomic variables and stock prices are co-integrated and are significant in predicting stock price changes. Another study analyzed the effects of macroeconomic dynamics on the Turkish market (Erdogan and Ozlale, 2005).

The study revealed that stock return, exchange rates and the industrial production were positively related whereas the M1 (Circulation in Money) did not impact the stock return.

In 2006, a study attempted to examine the relationship between macroeconomic variables and stock prices for New Zealand from January 1990 to January 2003 (Gan et al., 2006).

The variables used for the study were the long-run and short-run interest rate, exchange rate, money supply, inflation rate, domestic retail oil price and GDP. Existence of a long term relationship between the selected variables and stock prices was confirmed for New Zealand. However, it was found that the New Zealand stock exchange is not a good indicator for macroeconomic variables in New Zealand (Singh, 2014).

A study analyzed the London stock returns and macroeconomic variables such as risk premium, term structure of interest rate, the money supply, exchange rate and unanticipated inflation and highlighted that U.K. stock market gets affected by macroeconomic factors significantly with each factor affecting different industry in a different manner (Gunsel and Cukur, 2007).

Coleman and Tettey (2008) studied the impact of macroeconomic variables on the Ghana Stock Exchange and concluded that inflation and lending rates from deposit money banks are negatively related to each other. Another study used macroeconomic variables such as inflation rate, interest rate, Gross Domestic Savings (GDS) and exchange rate of Indian economy and attempted to find their impact on BSE SENSEX and S&P CNX Nifty (Pal and Mittal, 2011).

A co-integration relationship between macroeconomic variables and Indian stock indices was found indicating a long-run relationship among the variables. A similar study between the BSE Sensex and macroeconomic variables was attempted which highlighted that macroeconomic variables and the stock market index are co-integrated and that the stock prices are positively related to the money supply and industrial production but negatively to inflation (Kumar and Padhi, 2012).

It was found that the short-term interest rate and exchange rate did not impact stock prices. Another study in Indian context examined the relationship between industrial production and stock prices and found no significant causal relationship between industrial production and share price; however, a positive relation between industrial production and stock prices was inferred (Sarbapriya, 2013). Another study, in the Indian context, attempted to explore the relationship between Sensex and macroeconomic variables and reported a high positive correlation of Sensex with macroeconomic variables (Mishra and Gupta, 2014).

Similarly, a significant positive impact of exchange rate and crude oil prices on stock market S&P CNX Nifty was observed in another study in the Indian context (Kumar, 2014).

There are a number of studies carried out to explore the relationship between the stock market and investor behaviour. A study investigated the dynamics between S&P 500 stock index, LIBOR, the slope of the yield curve and VIX index using ARIMA and VAR models and found weak evidence of statistically predictable patterns in the evolution of volatility in future prices (Konstantinidi and Skiadopoulos, 2011).

Another study concluded that VIX carries important forward-looking information which improves the precision of the conditional variance estimation and subsequently reveals a significantly positive relation (Kansas, 2012).

Another study delved into the relationship between VIX and the stock market returns of US, China, Brazil, and India from 1993-2007 using regression and concluded that the VIX is also a fear gauge for the equity markets of China, Brazil and India in addition to US (Sarwar, 2012).

3. Research gap and research problem

It is observed from the literature review that there are few studies which have considered the relationship between investor sentiment and the stock market as also studies that combine all the three factors namely economic activity, the stock market and investor sentiment in the Indian context. The need and motivation for this study are driven to examine the impact of sentiments on stock returns so as to understand Indian capital market behaviour along with an attempt to understand the impact of macroeconomic determinants on the stock prices. Moreover, inadequate studies in Indian context make it more imperative to analyze investor behaviour so that policy planners can take corrective measures proactively for the overall good of capital markets and investors can take more informed decisions while trading to optimize their returns vis-a-vis risk.

4. Objectives of the study

1. To understand and identify key macroeconomic variables that influence stock prices.
2. To explore the dynamic relationship between investor sentiment and stock prices.
3. To understand how different macro variables including investor sentiment impact the stock prices.

The present study considers the following null hypotheses:

H_{01}: The selected macroeconomic variables have no significant impact on the stock market.

H_{02}: The investor sentiment has no significant impact on the stock market.

H_{03}: There is no causal relationship among the macroeconomic variables, investor sentiment, and the stock market.

5. Methodology and selection of variables

The study employs econometric techniques of time series data to study the relationship between the Indian stock market (NSE50, NSE100 and NSE500), the selected macro variables (Exchange Rate, Inflation, Money Supply (M3), Industrial Production, Call Money Rate, Gold Prices, Crude Oil Prices, Gross Fiscal Deficit and Foreign Institutional Investors) and investor sentiment proxied by Volatility Index (VIX).

The monthly data was collected from March 2009 to March 2017, from different sources like NSE, RBI, Gold Council and Federal Reserve Economic Data of Federal Reserve Bank

of St. Louis. The time period is chosen based on the availability of the data as Indian VIX data is available from March 2009.

Table 1 represents a brief description of the selected variables. All the variables were converted to their scaled forms by taking the March 2009 as the base year and scaling all observations with respect to the base year, thus helping in making all variables comparable.

Table 1. *Data description*

Variable	Concept	Description	Units
sCLPR	Scaled closing prices of NSE50, NSE100 and NSE500 indices	Indian Share Prices	Crore(Rs.)
sVIX	Scaled volatility index for India	Volatility Index	
sWPI	Scaled whole price index (Inflation)	Whole Price Index(Inflation)	Base Year: 2004-05=100
sM3	Scaled broad money supply	Broad Money Supply	National currency in Billions
sCMR	Scaled Call Money Rate	Call Money Rate	Percent per annum
sCOIL	Scaled Crude Oil prices	Crude Oil Prices	Dollars per Barrel
sGP	Scaled Gold Prices	Gold Prices	Rupee per troy ounce
sFII	Scaled net flows of Foreign Institutional Investors	Net flows for Foreign Institutional Investors	Billion (Rs)
sGFD	Scaled Gross Fiscal Deficit	National Gross Fiscal Deficit	Billion (Rs)
sEXRT	Scaled Exchange Rate	Official Exchange Rate	National currency per US Dollar
sIIP	Scaled Index of Industrial Production	Industrial Production	Base Year: 2004-05=100

Selection of variables

Based on literature review, macro variables affecting stock prices were picked up to understand their relationship with stock prices. It was ensured that variables picked up for study have availability of data on a monthly basis. The key variables considered in the study are:

a) Stock market

Stock prices were considered as dependent variable that plays a major role in an economy. Through a stock market, the fund mobilization is possible and hence the development of a stock market is important from industry's as well as the investor's viewpoint.

b) Money supply

Money supply is one of the fundamental macroeconomic variables which are widely used in the literature to determine the stock prices. The monetary policy represents one of the most efficient instruments of central banks in different countries. With the help of monetary policy, central banks can influence the actual economic activity (Maskay, 2007). Though there had been extensive work in the literature, the relationship between money supply and stock price is still ambiguous.

According to the portfolio theory, an increase in the money supply may result in a portfolio change from non-interest bearing money assets to financial assets like stocks. Also, an economic stimulus induced by increased money supply helps in increasing the stock prices as it results in corporate earnings (Mukherjee and Naka, 1995). On the other hand, when the increased money supply causes an increase in inflation, then an increase in the money supply raises the discount rate and therefore reduces the stock prices.

c) Exchange rate

Nation's international trade in its economy, as well as the degree of the trade balance, determine the impact of exchange rate on stock prices. A number of studies can be found in literature supporting the hypothesis of existence of a causal relationship between stock prices and exchange rates. As suggested by 'goods market approaches' (Dornbusch et al., 1980), the changes in exchange rates affect the competitiveness of a firm. As many firms borrow in foreign currency, the exchange rate fluctuations affect the value of its earnings and costs. Hence, affecting the stock price.

Also, the exchange rate movements affect a firm's transaction exposure as future receivables and payables, denominated in foreign currency, get affected. An alternate explanation for the relationship comes from 'portfolio balance approach'. It is based on the fact that exchange rates are determined by the demand and supply of a currency. Thus, blooming markets or rising stock prices would attract capital flows from foreign investors causing an increase in the demand for domestic currency. Whereas, falling stock prices would induce investors to shift their funds out of the country leading to the depreciation of the domestic currency.

Since the US Dollar is considered to be one of the most dominating foreign currency for investment and trading, the present study has considered US Dollar against the Indian Rupee.

d) Gold prices

There are two different theories on the relationship between income and gold demand. A positive relationship between real income and gold prices is supported by the classical theory, while an inverse relationship is supported by the Keynesian theory arguing that more demand means more economic backwardness hence low income. The variable is of significant importance due to the fact that according to the World Gold Council (WGC), 11% of the global stock of Gold is owned by Indians (more than 18,000 tons of gold).

e) Crude oil price

Oil prices play a major role in affecting an economy. Higher crude oil prices adversely impact the current account and fiscal deficits. An increase in oil prices affects via two effects i.e. an income and a production cost effect, which leads to changes in aggregate output. As a result of increased production costs, the discretionary household income is lowered because the prices for heating oil and Gasoline increase.

This results into lower consumption which in turn affects the aggregate output adversely, which further leads to lower labor demand. Thus, the terms of trade for an oil importing economy gets affected adversely when there is an increase in oil prices which further results in a negative wealth effect on consumption because of decrease in income, and in turn to lower aggregate demand. Due to lower aggregate demand, the stock prices gets affected adversely because the expected cash flows for firms gets affected negatively resulting in stock market responding negatively to such developments.

f) Call money rate

Interest rates have an inverse relationship with the stock market. As the interest rates are hiked, borrowing money from the central bank becomes expensive. Consequently, financial

institutions often increase their rates which they charge to the customers. This affects the spending capability of households which affects business' revenues and profits.

Also, businesses are affected directly as well because they also need money to expand their operations. Since the interest rates get hiked which results in slow growth of the companies which in turn hits the stock prices. In this paper, the CMR has been used as a proxy for interest rates.

g) Inflation

Inflation is defined as a persistent rise in the general level of prices of several items over a period of time. It is measured by inflation rate; the annualized percentage change in the general price index over time. The index could be the Consumer Price Index (CPI) or the Wholesale Price Index (WPI) for specified categories of people like urban non-manual employees or agricultural workers.

An increasing inflation rate is a threat to an economy, thus by increasing interest rates, the central bank tries to control it hoping to siphon off the excess system liquidity. Because of increased interest rates, the investors are attracted towards fixed income instruments which results in less liquidity thereby less speculative demand for goods and hence slowing the general prices increase.

h) Gross fiscal deficit

It is believed that high budget balances should impact negatively the performance of the stock markets. This can be partly attributed to the fact that a country that runs a huge budget deficit will have to attract more foreign capital to finance their operations in the form of loans and hence these may lead to relatively high interest rates which will negatively impact the stock market (Nailantei, 2009).

i) FIIs

The common wisdom is that the stock market goes up when FIIs pump money and it goes down when they withdraw the money to invest in other markets. India opened its market to foreign investors in 1992. A developed stock market generally attracts portfolio investments. Foreign portfolio investments expand the demand base of the stock market and can also stabilize the market through investor diversification. The net investments by FII's in the Indian markets play a critical in market surge and fall on a daily basis. Hence, FIIs was considered as one of the important variables to understand its relationship with the stock market in the Indian context.

j) VIX

VIX is a measure of implied volatility. This indicator is known as the "investor fear gauge". It reflects investors' best predictions of near-term volatility or risk. It rises during the time of market turmoil and lessens as investors become complacent. A high VIX reflects increased investor fear and low VIX suggests complacency. In the present study, VIX has been used as a proxy for market expectations.

k) Industrial production

The index of industrial production (IIP) is a measurement which represents the status of production in the industrial sector for a given period of time compared to a reference period

of time. The logical relationship between Industrial Production and the stock market is a direct one. When there is a lower demand situation, the consumer spending also drops. This results in producers cutting down on the production which further affects the corporate sales and profits adversely, hence directly affecting the stock prices.

Descriptive statistics

Table 2 represents the summary statistics for the monthly series of the stock price indices and selected variables.

Table 2. *Summary statistics for the quarterly series*

Variable	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
SNSE50	212.6292	195.4716	49.00464	0.258672	1.892866	6.035783	0.048904
SNSE100	225.7121	206.3207	55.66437	0.298211	1.907847	6.258597	0.043748
SNSE500	228.0084	203.9981	57.55951	0.389627	1.963154	6.799242	0.033386
SCMR	134.8921	139.1566	36.18253	-0.62724	2.670747	6.798488	0.033399
SCOIL	179.0731	182.2518	59.13405	-0.24649	1.582323	9.105251	0.010539
SEXRT	109.6864	108.4017	16.01904	-0.03773	1.489445	9.245196	0.009827
SFII	1275.69	1308.238	1935.882	0.172208	2.874199	0.543395	0.762085
SGFD	135.1833	144.8608	138.7307	-0.71086	4.59504	18.45198	0.000098
SGP	158.5273	165.9114	29.5635	-0.68517	2.427645	8.913498	0.0116
SIIP	111.6866	111.897	8.287414	-0.02761	3.024484	0.014749	0.992653
SM3	179.8672	175.8548	50.30056	0.107956	1.755085	6.452244	0.039711
SVIX	51.59306	45.45455	17.18152	1.625019	5.738135	72.99305	0
SWPI	132.91	138.3806	15.1997	-0.6985	2.130538	10.94317	0.004205

The statistics given in Table 2 present the characteristics of the variables. The skewness and kurtosis are measures of symmetry and fatness of tails respectively. For a normal distribution, the values of skewness and kurtosis are 0 and 3 respectively. The data is said to be skewed left in case of negative values whereas the data is skewed right in case of positive values of skewness. Variables like Call Money Rate, Crude Oil prices, Exchange Rate, Gross Fiscal Deficit, Gold Prices, Industrial Production, and Inflation are found to be left-skewed as their values are negative. The remaining variables are found to be right skewed as they have positive values. Industrial Production, Gross Fiscal Deficit, and VIX are found to be leptokurtic meaning fatter tails while all other variables are found to be mesokurtic. The Jarque-Bera test for normality has resulted in no variables being normal. The values for JB statistic were found to be greater than zero which implies that the data does not follow a normal distribution.

6. Methodology

The present study has employed an Auto Regressive Distributed Lag (ARDL) bounds test approach. This technique was introduced by Pesaran, Shin and Smith (2001) to study the presence of long run relationships when the lagged values of both dependent and independent variables are used.

This technique is preferable when dealing with variables that are integrated of different order i.e. I(0), I(1) or combination of both. However, the technique doesn't work in case of variables that are integrated of order greater than 1. Therefore, it is necessary to check for stationarity of the variables. Another advantage is that in contrast to traditional methods

such as Johansen's test, Granger/Enger causality test and Vector Autoregression (VAR), ARDL can be used at level of variables to test for existence of a relationship. In other words, there is no need to difference the data to make it stationary. The study employs Augmented Dickey Fuller (ADF) and Philipps – Perron (PP) unit tests to check for stationarity.

For studying the relationship among the variables, following ARDL model was considered:

$$\Delta sCLPR_t = \lambda_{1,0} + \sum_{i=1}^{p1} \lambda_{1,1i} \Delta sCLPR_{t-i} + \sum_{i=0}^{p1} \lambda_{1,2i} \Delta sCMR_{t-i} + \sum_{i-0}^{p1} \lambda_{1,3i} \Delta sIIP_{t-i} + \sum_{i=0}^{p1} \lambda_{1,4i} \Delta sCOIL_{t-i} + \sum_{i=0}^{p1} \lambda_{1,5i} \Delta sEXRT_{t-i} + \sum_{i=0}^{p1} \lambda_{1,6i} \Delta sGP_{t-i} + \sum_{i=0}^{p1} \lambda_{1,7i} \Delta sFII_{t-i} + \sum_{i=0}^{p1} \lambda_{1,8i} \Delta sGFD_{t-i} + \sum_{i=0}^{p1} \lambda_{1,9i} \Delta \mathrm{sM3}_{1,9i} + \sum_{i=0}^{p1} \lambda_{1,10i} \Delta sWPI_{t-i} + \sum_{i=0}^{p1} \lambda_{1,11i} \Delta sVIX_{t-i} + \lambda_{1,12} sCLPR_{t-1} + \lambda_{1,13} sCMR_{t-1} + \lambda_{1,14} sIIP_{t-1} + \lambda_{1,15} sCOIL_{t-1} + \lambda_{1,16} sEXRT_{t-1} + \lambda_{1,17} sGP_{t-1} + \lambda_{1,18} sFII_{t-1} + \lambda_{1,19} sGFD_{t-1} + \lambda_{1,20} sM3_{t-1} + \lambda_{1,21} sWPI_{t-1} + \lambda_{1,22} sVIX_{t-1} + \epsilon_{1,t} \quad (1)$$

Where Δ is the first difference operator, $\varepsilon_{i,t}$ (i = 1, 2), is a disturbance term assuming white noise and normally distributed and sX is scaled transformation. The lag length has been selected using Schwarz (SIC) criteria.

The long run and short run coefficients were estimated using the ARDL model. The long run relationship is defined as to the state where the variables converge to some long-term values and do not change implying that the system is stable. Thus, the long-run elasticity of an explanatory variable is the long run coefficient of that explanatory variable which is defined as the coefficient of a lagged explanatory variable divided by the coefficient of the lagged dependent variable and multiplied by a negative sign (Bardsen, 1989). On the other hand, the short run elasticity is represented by the estimated coefficients of the first-differenced variables in the model.

The second step was to estimate the Error Correction Model (ECM). The error correction model is stated as under:

$$\Delta sCLPR_t = \mu_{1,0} + \sum_{i=1}^{P_{11}} \mu_{1,1i} \Delta sCLPR_{t-i} + \sum_{i=0}^{Q_{11}} \mu_{1,2i} \Delta sCMR_{t-i} + \sum_{i=0}^{Q_{12}} \mu_{1,3i} \Delta sIIP_{t-i} + \sum_{i=0}^{Q_{13}} \mu_{1,4i} \Delta sCOIL_{t-i} + \sum_{i=0}^{Q_{14}} \mu_{1,5i} \Delta sEXRT_{t-i} + \sum_{i=0}^{Q_{15}} \mu_{1,6i} \Delta sGP_{t-i} + \sum_{i=0}^{Q_{16}} \mu_{1,7i} \Delta sFII_{t-i} + \sum_{i=0}^{Q_{17}} \mu_{1,8i} \Delta sGFD_{t-i} + \sum_{i=0}^{Q18} \mu_{1,9i} \Delta sM3_{t-i} + \sum_{i=0}^{Q_{19}} \mu_{1,10i} \Delta sWPI_{t-i} + \sum_{i=0}^{Q_{20}} \mu_{1,11i} \Delta sVIX_{t-i} + \theta_1 ECT_{1,t-1} + e_{1,t} \quad (2)$$

In equation (2), the short run dynamics are captured by the first-differenced variables' coefficients. The lagged variables y_t and x_t are replaced by the Error Correction Term (ECT). The ECT coefficient θ_1 must be statistically significant and negative in order to converge to equilibrium. In addition to confirming the existence of a long run relationship, a significant ECT also determines the speed of adjustment towards the equilibrium.

Next methodology applied was Granger Causality test. To capture the Granger Causality between stock price index and explanatory variables, Wald test was used. Finally, the model is checked by diagnostics test for robustness.

7. Analysis, discussion and results

Before the estimation of the co-integration relationship by ARDL bound tests, the stationarity of the time series has been checked using Augmented Dickey-Fuller (ADF) test. The null hypothesis assumes the existence of stationarity. It may be observed from Table 3 that Industrial Production (IIP), Foreign Institutional Investors (FII) and VIX are I (0) in nature whereas all other variables have a unit root. Since there is a combination of I (0) and I (1) series, ARDL bound testing can be used to test the presence of co-integration.

Table 3. *Stationarity test results*

Variable	ADF		PP		Order of Integration
	t-stat	probability	t-stat	probability	
sCMR	-2.007	0.2835	-4.104818	0.0015	
ΔsCMR	-16.5316	0.0001	-23.94754	0.0001	I(1)
sIIP	-4.2055	0.0011	-4.072158	0.0017	
ΔsIIP	-5.39316	0	-18.44856	0.0001	I(0)
sCOIL	-1.32428	0.6157	-1.303272	0.6256	
ΔsCOIL	-7.39972	0	-7.3522	0	I(1)
sM3	3.245981	1	2.184114	0.9999	
ΔsM3	-8.1922	0	-2.750221	0.0695	I(1)
sEXRT	-0.62149	0.8598	-0.359383	0.9107	
ΔsEXRT	-7.30924	0	-7.309244	0	I(1)
sNSE100	-1.32252	0.6165	-1.301661	0.6263	
ΔsNSE100	-9.86681	0	-9.872855	0	I(1)
sFII	-6.09069	0	-6.129955	0	I(0)
sNSE500	-1.12593	0.703	-1.125142	0.7033	
ΔsNSE500	-9.42438	0	-9.420531	0	I(1)
sGFD	-2.10847	0.242	-9.77529	0	
ΔsGFD[1]	-10.0995	0	-24.31008	0.0001	I(1)
sVIX	-3.79664	0.0041	-3.79664	0.0041	
ΔsVIX	-9.3873	0	-14.43642	0.0001	I(0)
sGP	-2.0968	0.2465	-2.012525	0.2811	
ΔsGP	-11.5306	0.0001	-11.74357	0.0001	I(1)
sWPI	-2.18082	0.2146	-2.647921	0.0871	
ΔsWPI	-5.50849	0	-5.534657	0	I(1)
sNSE50	-1.50082	0.5291	-1.47647	0.5413	
ΔsNSE50	-10.2864	0	-10.3587	0	I(1)

The result for co-integration using bounds test are presented in Table 4. In all three cases i.e. NSE50, NSE100 and NSE500, the estimated F-statistic is higher than the upper bound or I [1] critical value. Therefore, the null hypothesis of no co-integration is rejected confirming the existence of co-integration. However, in case the estimated F-statistic is lower than the I [0] critical value, then it confirms the non-existence of the co-integration. The test renders inconclusive in case of F-statistic lying between the two bounds.

Table 4. *Bounds test for the existence of a co-integration relationship* (1)

NSE50			NSE100			NSE500		
Test Statistic	**Value**	**k**	**Test Statistic**	**Value**	**k**	**Test Statistic**	**Value**	**k**
F-statistic	5.220771	6	F-statistic	5.428645	6	F-statistic	5.667403	6
Critical Value Bounds								
Significance	**I0 Bound**	**I1 Bound**	**Significance**	**I0 Bound**	**I1 Bound**	**Significance**	**I0 Bound**	**I1 Bound**
10%	2.12	3.23	**10%**	2.12	3.23	**10%**	2.12	3.23
5%	2.45	3.61	**5%**	2.45	3.61	**5%**	2.45	3.61
2.50%	2.75	3.99	**2.50%**	2.75	3.99	**2.50%**	2.75	3.99
1%	3.15	4.43	**1%**	3.15	4.43	**1%**	3.15	4.43

It may be observed from Table 4 that for all the three indices namely NSE50, NSE100 and NSE500, the F-statistics are 5.221, 5.4287 and 5.6674 respectively. All the values are greater than their respective 1% critical I [1] values of 4.43. This implies that there is a co-integration relationship existing among the variables.

As shown in Table 5, the computed Breusch-Godfrey serial correlation Lagrange multiplier (LM) test statistic is 0.6781, 0.4836 and 0.4955 for NSE50, NSE100, and NSE500 respectively. They all are found to be statistically insignificant at 5% significance level which suggests the presence of serially uncorrelated disturbances. The insignificant test values of the Ramsey RESET test indicate the model's adequacy and for checking heteroscedasticity, Breusch-Pagan-Godfrey test has been used which suggests that the residuals have constant variance.

Table 5. *Diagnostic tests*

Breusch-Godfrey Serial Correlation LM Test:	**F-statistic**	**Prob. F**
NSE50	0.678104	0.5104
NSE100	0.483622	0.6183
NSE500	0.495469	0.6111
Heteroskedasticity Test: Breusch-Pagan-Godfrey	**F-statistic**	**Prob. F**
NSE50	0.817028	0.6131
NSE100	0.656753	0.7609
NSE500	0.406284	0.9402
Ramsey RESET Test	**F-statistic**	**Prob. F**
NSE50	1.870901	0.175
NSE100	2.143494	0.1469
NSE500	2.680797	0.1053

The estimated ARDL models are presented in Panel A of Table 6. The appropriate lag length has been selected using the SIC criterion. The general to specific methodology has been adopted here. Firstly, a general model was estimated. After this, the variables which were found to be insignificant were dropped and a specific model was estimated by keeping only the significant variables at 5% significance level.

This procedure was adopted to find the combination of variables which have a co-integration relationship among them. It may be observed from the Table 6 that Industrial Production (IIP), Money Supply (M3), Gross Fiscal Deficit (GFD) and Call Money Rate (CMR) come out to be insignificant variables for all the three indices. FIIs, Exchange Rate (EXRT), Inflation (WPI), Crude Oil, Gold Prices and VIX were found to be highly significant variables for all the indices denoting that they play a major role in Indian stock market. It is also observed that a significant positive relationship exists between stock

prices and FIIs and between stock prices and Inflation. Also, the lagged value of VIX shows a positive relationship with stock prices.

A significant negative relation is found between stock prices with gold prices, exchange rate, crude oil prices, and volatility index. The lagged variables of stock indices, FIIs, Inflation, and VIX are observed to be significant in all the three cases namely NSE50, NSE100 and NSE500. The lagged variables of Stock Index and VIX has a positive significant relation and lagged Inflation and lagged FIIs are found to have a negative relation with the stock market. The interest rates proxied by CMR came out to be insignificant which is in contrast to the similar studies by Adjasi (2009) who found a positive relation between Ghana Stock Exchange and interest rates, and Maghayereh (2003) who deduced a negative relation between interest rates and stock prices in Jordan.

Table 6. *Panel A – Estimated ARDL Models*

NSE50			NSE100			NSE500		
Variable	**Coefficient**	**Prob.***	**Variable**	**Coefficient**	**Prob.***	**Variable**	**Coefficient**	**Prob.***
SNSE50(-1)	0.745191	0	**SNSE100(-1)**	0.7622	0	**SNSE500(-1)**	0.79763	0
SVIX	-0.180227	0.0151	**SVIX**	-0.186338	0.0176	**SVIX**	-0.185097	0.0269
SVIX(-1)	0.356901	0	**SVIX(-1)**	0.379605	0	**SVIX(-1)**	0.415049	0
SFII	0.002904	0	**SFII**	0.003137	0	**SFII**	0.003244	0
SFII(-1)	-0.000885	0.0272	**SFII(-1)**	-0.000912	0.0296	**SFII(-1)**	-0.000845	0.0552
SGP	-0.16763	0.0004	**SGP**	-0.168202	0.0005	**SGP**	-0.152899	0.0021
SEXRT	-1.000048	0.0004	**SEXRT**	-1.077645	0.0003	**SEXRT**	-1.056445	0.0009
SWPI	3.388974	0.0001	**SWPI**	3.749508	0	**SWPI**	3.876865	0.0001
SWPI (-1)	-1.435893	0.0509	**SWPI (-1)**	-1.677618	0.0309	**SWPI (-1)**	-1.918802	0.0205
SCOIL	-0.204675	0	**SCOIL**	-0.22822	0	**SCOIL**	-0.227791	0.0001
C	-43.59305	0.0011	**C**	-48.04998	0.0007	**C**	-47.33725	0.0016

Table 6. *Panel B – Error Correction representation*

NSE50			NSE100			NSE500		
Variable	**Coefficient**	**Prob.***	**Variable**	**Coefficient**	**Prob.***	**Variable**	**Coefficient**	**Prob.***
D(SVIX)	-0.180227	0.0151	**D(SVIX)**	-0.186338	0.0176	**D(SVIX)**	-0.185097	0.0269
D(SCOIL)	-0.204675	0	**D(SCOIL)**	-0.22822	0	**D(SCOIL)**	-0.227791	0.0001
D(SEXRT)	-1.000048	0.0004	**D(SEXRT)**	-1.077645	0.0003	**D(SEXRT)**	-1.056445	0.0009
D(SFII)	0.002904	0	**D(SFII)**	0.003137	0	**D(SFII)**	0.003244	0
D(SGP)	-0.16763	0.0004	**D(SGP)**	-0.168202	0.0005	**D(SGP)**	-0.152899	0.0021
D(SWPI)	3.388974	0.0001	**D(SWPI)**	3.749508	0	**D(SWPI)**	3.876865	0.0001
CointEq(-1)	-0.254809	0	**CointEq(-1)**	-0.2378	0	**CointEq(-1)**	-0.20237	0.0002

The error correction estimates have been provided in Panel B of Table 6. Based on the results, the error correction terms have its expected negative sign and were found to be highly significant. A long run relationship can be inferred from significant error correction term between the stock returns and the selected macroeconomic variables. Also, the lagged differenced variables capture the short-run dynamics of the model.

The error correction term denotes the speed of adjustment for the system to come back to its equilibrium state. For NSE50, NSE100, and NSE500, the respective speeds are 25.5%, 23.8% and 20.2% which represents the adjustment speed back to the equilibrium for all three cases.

Table 7. *Long-run coefficients*

NSE50			NSE100			NSE500		
Variable	**Coefficient**	**Prob.**	**Variable**	**Coefficient**	**Prob.**	**Variable**	**Coefficient**	**Prob.**
SVIX	0.69336	0.0481	**SVIX**	0.81273	0.0458	**SVIX**	1.136298	0.0393
SCOIL	-0.803251	0	**SCOIL**	-0.959717	0	**SCOIL**	-1.125616	0
SEXRT	-3.924704	0	**SEXRT**	-4.531733	0	**SEXRT**	-5.220373	0
SFII	0.007924	0.001	**SFII**	0.009353	0.0011	**SFII**	0.011856	0.0027
SGP	-0.657868	0.0001	**SGP**	-0.707325	0.0003	**SGP**	-0.755541	0.0021
SWPI	7.664893	0	**SWPI**	8.712754	0	**SWPI**	9.675671	0
C	-171.081569	0.0056	**C**	-202.0607	0.0049	**C**	-233.91466	0.0168

The long-run coefficients for all the three indices are shown in Table 7 that reveals that all variables except Industrial Production, Gross Fiscal Deficit, Call Money Rate, and Money Supply form a significant long-run relationship with the stock market. The results are found to be coherent with the study carried out by Padhi et al. in the sense that there exists co-integration among the variables (Kumar and Padhi, 2012).

However, the outcome of this study does not conform with the findings of the above study establishing a significant relationship with money supply and industrial production. As such, results reveal that money supply and industrial production are found to be insignificant variables in affecting the Indian stock market. Even the exchange rate was found to be a significant variable affecting stock prices as opposed to the study carried out by Padhi et al. This study also confirms with the study attempted by M. Kumar, concluding that crude oil prices and exchange rate are significant variables affecting the Indian stock market (Kumar, 2014).

India, being an oil-importing economy gets affected negatively due to the increase in oil prices. Also, it has a negative relation with Gold prices, India being a major purchaser of Gold, following the Keynesian theory. As expected, a negative relation is found between the Indian stock market and crude oil prices.

Compared to the study attempted by Mukherjee and Naka (Naka et al., 2006), the present analysis found Inflation as the largest positive determinant contradicting the referred study. The result is in contrast with the study by Pal and Mittal, (2011).

This is an unexpected outcome as the liquidity constraints in the economy resulting from inflation results in a fall in the stock prices. However, a positive relation is also possible between Inflation and stock prices as supported by Fisher's theory. According to this theory, equity stocks serve as a hedge against inflation. If there is a rise in the general price level through increases in nominal stock market returns, then the investors are fully compensated for the rise and thus the returns are unchanged. From the policy perspective, it was observed that Inflation, Gold prices, and Crude oil prices are highly significant variables affecting the Indian stock market that need to be monitored and managed continuously for minimizing the adverse impact on stock prices. Apart from that, FIIs also play a major role in influencing Indian markets.

It may be observed from results for pairwise Granger causality test shown in Table 8 that for NSE50, the stock prices granger causes crude oil prices, industrial production, and exchange rate. In a study of Indian stock markets, the causal relationships between the industrial production and stock price index were examined (Agrawalla and Tuteja, 2008).

The study reported unidirectional causality running from economic growth to share price index, where economic growth has been proxied by index of industrial production. A study showed bidirectional causality between stock price and the rate of inflation, while the index of industrial production led the stock price (Bhattacharya and Mukherjee, 2002).

This study does not conform with the results, as the analysis reveals unidirectional Granger causality from the stock market to industrial production and no causation between Inflation and stock prices. There is bidirectional causality between exchange rate and stock prices. Also, a unidirectional causality exists from money supply to stock prices and from VIX to stock prices. In the case of NSE100 and NSE500, Granger causality was found to be existing from stock prices to industrial production, crude oil prices and exchange rate. Similar to NSE50, there is a bidirectional causality from exchange rate to stock prices for NSE100 and NSE500. Also, a unidirectional causality from Money Supply and VIX to stock prices was found for NSE100. But, for NSE500, the causality exists from stock prices to VIX meaning that stock prices lead VIX in case of NSE500.

Table 8. *Pairwise Granger Causality*

NSE50			NSE100			NSE500		
Null Hypothesis	**F-statistic**	**Prob.**	**Null Hypothesis**	**F-statistic**	**Prob.**	**Null Hypothesis**	**F-statistic**	**Prob.**
SCMR ≠SNSE50	0.30567	0.7374	SNSE100 ≠ SCMR	1.10162	0.3368	SNSE500 ≠ SCMR	1.03882	0.3581
SNSE50 ≠ SCMR	1.03848	0.3582	SCMR ≠ SNSE100	0.40214	0.6701	SCMR≠ SNSE500	0.52479	0.5935
SCOIL ≠ SNSE50	0.56877	0.5682	SNSE100 ≠ SFII	1.21377	0.3019	SNSE500 ≠ SCOIL	6.25221	0.0029
SNSE50 ≠ SCOIL	6.62595	0.0021	SFII ≠ SNSE100	0.47747	0.6219	SCOIL ≠ SNSE500	0.91223	0.4053
SEXRT ≠ SNSE50	5.20531	0.0073	SNSE100 ≠ SGFD	0.7077	0.4955	SNSE500 ≠ SEXRT	3.37881	0.0385
SNSE50 ≠ SEXRT	4.32309	0.0161	SGFD ≠ SNSE100	1.5875	0.2101	SEXRT ≠ SNSE500	4.92857	0.0093
SFII ≠ SNSE50	0.44451	0.6425	SNSE100 ≠ SGP	0.1857	0.8308	SNSE500 ≠ SFII	1.20448	0.3046
SNSE50 ≠ SFII	1.23834	0.2948	SGP ≠ SNSE100	0.04498	0.956	SFII ≠ SNSE500	0.60994	0.5456
SGFD≠ SNSE50	1.38181	0.2564	SNSE100 ≠ SIIP	5.43503	0.0059	SNSE500 ≠ SGFD	0.58673	0.5583
SNSE50 ≠ SGFD	0.74761	0.4764	SIIP ≠ SNSE100	1.16101	0.3178	SGFD ≠ SNSE500	1.70844	0.187
SGP ≠ SNSE50	0.06815	0.9342	SNSE100 ≠ SM3	1.57194	0.2133	SNSE500 ≠ SGP	0.24672	0.7819
SNSE50 ≠ SGP	0.1227	0.8847	SM3 ≠ SNSE100	4.03244	0.021	SGP ≠ SNSE500	0.01808	0.9821
SM3 ≠ SNSE50	3.6736	0.0293	SVIX ≠ SNSE100	6.12283	0.0032	SNSE500 ≠ SIIP	5.39646	0.0061
SNSE50 ≠ SM3	1.25104	0.2911	SNSE100 ≠ SVIX	2.01436	0.1394	SIIP ≠ SNSE500	1.12824	0.3281
SIIP ≠ SNSE50	1.04187	0.357	SWPI ≠ SNSE100	0.66016	0.5193	SNSE500 ≠ SM3	1.87414	0.1594
SNSE50 ≠ SIIP	5.2126	0.0072	SNSE100 ≠ SWPI	0.76741	0.4672	SM3 ≠ SNSE500	4.05163	0.0207
SVIX ≠ SNSE50	5.74185	0.0045	SNSE100 ≠ SCOIL	6.28064	0.0028	SVIX ≠ SNSE500	1.95516	0.1475
SNSE50 ≠ SVIX	1.99421	0.1421	SCOIL ≠ SNSE100	0.66982	0.5143	SNSE500 ≠ SVIX	6.73882	0.0019
SWPI ≠ SNSE50	0.81409	0.4463	SNSE100 ≠SEXRT	4.11532	0.0195	SWPI ≠ SNSE500	0.49234	0.6128
SNSE50 ≠ SWPI	0.8531	0.4295	SEXRT ≠ SNSE100	5.15999	0.0076	SNSE500 ≠ SWPI	0.8486	0.4314

8. Conclusion

The study investigated the relationship between the selected macro variables namely industrial production, gold prices, crude oil prices, inflation, FIIs, gross fiscal deficit, money supply, exchange rate, call money rate, and volatility index with that of Indian stock market using the bound testing procedure and error correction mechanism. The results indicate the presence of co-integration among the variables. It is observed that money supply, industrial production, gross fiscal deficit, and call money rate are insignificant variables whereas FIIs, gold prices, crude oil prices, VIX, inflation have a significant relationship with Indian stock market. Also, crude oil prices, gold prices, exchange rate, and VIX have a negative relation with stock market whereas, FIIs and Inflation have a positive relationship with the stock market in short-run. The findings of the study also reveal that in long-run, VIX has a positive relationship with the stock market. In terms of Granger causality, it was observed that for NSE50, the stock prices granger causes crude oil prices, industrial production and exchange rate while VIX granger causes stock prices. There is additional granger causality existing from exchange rate to stock prices, money supply to stock prices and from VIX to stock prices.

In comparison, Granger causality was found from stock prices to VIX in case of NSE500. Thus the findings of the study reveal that macroeconomic variables like FIIs, Gold Prices, crude oil prices, exchange rate, and inflation and market expectations influence the Indian stock market. Policy planners may focus on managing and monitoring the significant factors such as Inflation, Gold prices and Crude oil prices affecting the stock market. Above all, market expectations play a major role in the stock market and therefore policies prescription may need to take care of investor sentiments.

9. Limitations and future scope

A limitation of this study includes the parameters used for measuring inflation and indicators for investor sentiments. There could be multiple proxies for defining macro variables that can be used to undertake such studies. Further, the time series data was used on a monthly basis which excluded considering certain macro variables for which frequency of data availability in the Indian context is quarterly. Similar studies can be undertaken by considering sectoral indices to understand the implications of macro variables on sectoral stock indexes.

Note

(1) For GFD, the results from the ADF test and PP test were not matching. Hence, a further test for stationarity has been carried out using the KPSS method whose test statistic came out to be 0.071180 which is insignificant at 5% level. This helped in concluding that GFD has a unit root i.e. I [1].

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