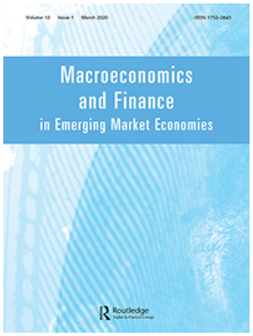

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The dynamics of macroeconomic variables in Indian stock market: a Bai–Perron approach

Narayan Parab and Y. V. Reddy

Goa Business School, Goa University, Taleigao, India

ABSTRACT
The stock market is dynamic, so also the economic conditions. Structural breaks are unexpected shifts which occur in a time-series data which may deteriorate the results. The study deals this situation using the Bai–Perron test and examines the impact of select macroeconomic variables on stock market returns and thereafter investigates the causal relations. The study evidenced a significant impact of macroeconomic variables on stock market returns, and such impact was found to be varying across structural periods. The results are aimed to contribute significantly to finance literature and assist market participants and research analysts in evaluating Indian stock market.

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1. Introduction

It is said that 'stock market discounts everything'. This signifies, whatever events which occur in an economy get reflected through stock market. The events may be rise or fall in inflation rates and interest rates; changes in government policies; government budget announcements; changes in balance of payment structure; currency appreciation or depreciation; recession or depression; natural calamities such as floods, cyclones and draughts or terrorist attacks and so on. Also, the events related to companies include dividend announcements, appointment of new directors, or CEOs, mergers, amalgamations, acquisitions, internal and external reconstructions, etc. The stock market acts as a barometer or mirror of the economy and thus reflects the impact of all these economic and financial events. Considering the significant importance of macroeconomic variables with regard to stock prices, many researchers have attempted to study these relationships using various models. How well the macroeconomic variables are able to explain the changes in stock equity returns in stock market is explained by Bilson, Brailsford, and Hooper (1999). Adam and Tweneboah (2008) examined the impact of macroeconomic variables on stock prices with reference to Ghana. The researchers also proved long-run relationship between stock prices and macroeconomic variables using Johansen's multivariate co-integration test. The paper also showed that in the short run, the exchange rates and inflation also influence stock prices. Sariannidis et al. (2009) used a Generalized Auto Regressive Conditional Heteroscedasticity (GARCH) model to study the impact of various macroeconomic variables on Dow Jones Wilshire 5000 and Dow Jones

CONTACT Narayan Parab parabnarayan9@gmail.com

sustainability indexes. The researchers concluded that the US stock market gets negatively affected by the returns in crude oil prices and positively affected by the returns of bond (10-year maturity). Also, the association of stock prices with exchange rate was found to be negative. Rasiah (2010) also investigated the long-run and short-run relationships between various macroeconomic factors and stock market using time-series analysis. The researchers applied co-integration test and vector error correction model (VECM) to demonstrate the results. The study proved the influence of money supply, consumer price index, and exchange rates in predicting stock returns.

Bilson, Brailsford, and Hooper (1999) attempted to study whether macroeconomic variables may form alternative for risk sources. The study found moderate evidence to prove this assumption. Also, using a principal component approach, the researcher investigated the commonalities in exposures across stock returns. However, little evidence is found showing such commonalities in the paper. Flannery and Protopapadakis (2001) estimated a GARCH model of daily returns, where the returns and volatility depend on macroseries announcements. Various factors studied by the researchers include monetary aggregate, balance of trade, CPI, employment report, PPI and housing starts. Li (2002) examined the association between returns from bonds and stocks. The relationship between stock–bond return with macroeconomic variables has been studied using an asset pricing model. The results showed that major changes in stock–bond correlations are due to changes in inflation. Using the Arbitrage Pricing Theory (APT) model, Cauchie, Hoesli, and Isakov (2003) analysed the determinants of stock returns with reference to Swiss stock market. The empirical results from the study showed that the factors which are determined statistically reflect better representation of determinants of stock returns than macroeconomic factors. The study concluded that stock returns are affected by local economic conditions as well as global economic conditions. Murinde and Poshakwale (2004) investigated the interactions between stock markets and foreign exchange market, pre and post adoption of Euro by the European Union countries. The researchers estimated and tested a bivariate vector autoregressive model. The study found that before Euro adoption, the stock prices significantly Granger caused the exchange rates in Hungary, Czech Republic and Poland. The causation with Hungary was unidirectional, whereas the causation with Czech Republic and Poland was found to be mutually reinforcing. The study also noticed a positive association among the stock markets in Czech Republic, Hungary and Poland after the Euro adoption. Kim and Moon (2005) analysed the relationship between returns from bonds and macroeconomic factors. According to the researchers, to predict the bond returns, single index consisting of money, real activities and inflation can be used. Rasmussen (2006) evaluated the relative performance of various predictive variables using time-series and cross-sectional methodology. The researcher examined the predictive variables' ability to decrease errors while pricing in conditional capital asset pricing model. The researcher concluded that, in the long horizon, the variables such as price–dividend ratio, price–consumption ratio and price–output ratio perform better than the other variables. Such variables also prove to be superior in reducing errors in pricing. Mahmood and Mohd Dinniah (2007) analysed the dynamic association between economic variables and stock prices in Australia, Korea, Japan, Malaysia, Hong Kong and Thailand. The researchers used the monthly data pertaining to foreign exchange rates, stock price indices, industrial production index and consumer price indices. The long-run association between stock returns and economic variables was found in Korea, Australia, Japan and Hong Kong. Whereas the study noticed a short-run association for all countries except for Thailand and Hong Kong. Humpe and Macmillan

(2007) examined if the number of macroeconomic variables has an impact on stock prices in Japan and US. The macroeconomic factors analysed include industrial production, money supply, consumer price index and interest rates. Co-integration analyses have been used by the researchers to explain the relationship between the macroeconomic variables with stock returns. The study concluded that for US data, industrial production is positively correlated with stock prices and that the relationship of stock prices with consumer price index and interest rates was found to be negative. Whereas, for Japanese data, the researchers found two co-integrating factors. For one factor, a negative correlation is noticed between stock prices and money supply and a positive correlation with industrial production. But for the second co-integrating factor, the study found the industrial production to be negatively affected by interest rate and consumer price index. Engle, Ghysels, and Sohn (2008) revisited the association between volatility in stock market and macroeconomic factors using a new model which was developed for the purpose of study, i.e. Generalized Auto Regressive Conditional Heteroscedasticity - Mixed Data Sampling (GARCH-MIDAS) model. The macroeconomic variables' studies include industrial production growth and inflation. The researchers noticed that industrial growth and inflation account for 10–35% of volatility forecasting. Hussain, Lal, and Mubin (2009) attempted to study the long-run association between stock prices and macroeconomic factors in Karachi Stock Exchange. Foreign exchange reserve (FER), wholesale price index, foreign exchange rate, industrial production index, money supply and gross fixed capital formation (GFCF) are some of the variables analysed by the researchers. Also econometric tests such as Johansen co-integration test and VECM were implemented for the purpose of the study. The results reflected that FERs and foreign exchange rates significantly influence the stock market. The paper also stated that among the selected macroeconomic variables, the inflation showed the highest forecast error for the index. A similar study analyzing the impact of macroeconomic variables on stock returns in Karachi Stock Exchange was done by Ilahi, Ali, and Jamil (2015). The study investigated the association between exchange rate, inflation rate and interest rate with the stock returns using data from 2007 to 2012. The researchers used multiple regression analysis to prove the results. The researchers noticed a weak association between stock returns and macroeconomic variables. Kim and Qi (2010) showed in his study that accruals quality and its effect of pricing differ with business cycles and macroeconomic factors. The overall results suggested that the contributor of the cost of equity capital and its effect of pricing was accruals quality and was related with the fundamental risk.

Paye (2011) tested if it is possible to improvise the predictability of volatility with the help of macroeconomic variables. Granger causality test was implemented by the researcher to prove the results. The study concluded that to forecast power related with macroeconomic variables, the volatility concentrates over the recession. Sharma, Singh, and Singh (2011) conducted a study to analyse the influence of macroeconomic variables on economic performance in India and Sri Lanka. The researchers studied the pattern of wholesale price index, consumer price index, gross national product, gross domestic product (GDP) and interest rates in Sri Lanka and India. Also, the researchers examined the impact of macroeconomic factors on GDP in Sri Lanka and India. The various tests used by the researchers for the purpose of study include Granger causality test, unit root test, vector autoregression and variance decomposition, co-integration test and variance decomposition analysis. Tangjitprom (2011) studied the significance of macroeconomic factors for determination of performance in stock market. To study this relationship, the researcher

used regression analyses. The results found that after adjusting for lags of data availability, the macroeconomic factors can explain stock returns. The study also made use of econometric tests such as Granger causality test and vector autoregression model. The results from these tests reveal that stock returns can be used to predict macroeconomic variables, but macroeconomic variables are found to be less important to forecast future stock returns. Lairellakpam and Dash (2012) focused on identifying factors which influence the volatility in the Indian stock market. The various macroeconomic variables analysed for the purpose of study include crude oil prices, rates of interest, exchange rates and gold prices. The researchers used the Granger causality test and vector autoregressive techniques to analyse the impact of these macroeconomic factors on stock volatility. Naik and Padhi (2012) investigated the association between macroeconomic variables such as wholesale price index, industrial production index, treasury bill rates, money supply and rates of exchange with the Bombay Stock Exchange (BSE) Sensex. To analyse the long-run relationships between these variables, the researchers applied Johansen's co-integration test and VECM. The results revealed the evidence of long-run association between these variables for the selected period, i.e. 1994–2011. The study noticed a positive association between stock prices and money supply and between stock prices and industrial production, but a significant negative association between stock prices and inflation. Using Granger causality test, the researchers proved that the selected macroeconomic variables cause the stock prices. Tripathi, Seth, and Bhandari (2015) conducted a study on macroeconomic factors and foreign direct investment (FDI). The macroeconomic variables analysed were inflation, exchange rate, Interest rate, S&P CNX 500 equity index, trade openness and Gross Domestic Product/Index of Industrial Production (GDP/IIP). The researchers used various statistical and econometric techniques such as Phillips Perron unit root stationary test, Augmented Dickey Fuller test, multivariate and bivariate regression analysis, Granger causality test, vector autoregression, impulse response analysis and Johansen's co-integration test. The results found a significant association of FDI with the macroeconomic variables except exchange rates. Tripathi and Kumar (2015) examined the relationship between interest rate, GDP, inflation, money supply, oil prices and exchange rate with the stock returns in Brazil, Russia, India, China, and South Africa (BRICS) markets for the period 1995 to 2014. The researchers used autoregressive distributed lag model to evaluate such a relationship. The study concluded that inflation and GDP are found not significantly affecting stock returns in most of the BRICS countries. Whereas a negative relationship of stock returns with exchange rate, oil prices and interest rate and a significant positive relationship of stock returns with money supply was noticed.

It is evident from the previous literature on stock returns and macroeconomic variables that many researchers have significantly contributed to this area of study. This proves the research area to be of eminent interest for many researchers. The prime focus has been found studying the US stock market thereby examining the long- and short-run relationships. The United States being associated with almost every country of the world, which have bilateral ties with regard to trade, policies and decisions, a majority of research studies are attracted by US stock markets, followed by European stock markets (Reddy and Narayan 2016). India, being an emerging economy with untapped financial resources is growing significantly with regard to stock markets. The Indian stock exchanges, i.e. BSE and National Stock Exchange (NSE), attract a large pool of domestic as well as foreign investors. Hence, the study concerning the influence of various

macroeconomic variables affecting stock markets is vital. Many Indian as well as foreign authors have addressed this issue. But since the economic conditions are dynamic, a more complex study considering larger samples and analysis through effective econometric models becomes necessary. The present research study will try to overcome the limitations of previous studies relating to stock returns and macroeconomic variables and analyse the influence of these variables. The study aims to analyse the relationship between select macroeconomic variables and stock market returns and thereafter examines the impact of select macroeconomic variables on stock market returns and also investigates the causation effect between select macroeconomic variables and stock market returns. The analysis will be performed considering data of 20 years, i.e. April 1996–March 2016, which include macroeconomic variables such as gold prices, silver prices, FER, inflation rate, interest rate, crude oil prices, Real Effective Exchange Rate (REER), FDI, foreign portfolio investment (FPI), broad money (M3), narrow money (M1), imports of goods and services and exports of goods and services which are in monthly series, GDP, GFCF, private final consumption expenditure (PFCE), government final consumption expenditure (GFCE) and current account balance (CAB) in quarterly series and tax revenue, agriculture value added (AVA), Industry Value Added (IVA) and services value added (SVA) in annual series data. The stock returns will be computed in monthly, quarterly and annual series while analysing with the respective type of macroeconomic variable. The study is aimed to contribute significantly to the finance literature and assist market participants and research analysts in evaluating the Indian stock market. The study examines a large pool of macroeconomic variables which will help the government to understand the key role played by each macro economic variable in present times.

2. Methodology

The present study utilized various statistical and econometric tools and techniques to support the analysis of objectives set for the purpose of the study. A detailed overview of the methodology used in the current study is elaborated in the present section which focuses on the period considered for study, sample design, data variables and data sources and various statistical and econometrics techniques employed using econometric softwares. Such techniques are briefly explained to get an understanding about the relevance of these techniques in the present study and equations are incorporated to support the analysis.

The study attempts to investigate the association of various macroeconomic variables with stock returns. The study considers a period of 20 years, i.e. from April 1996 to March 2016, to examine the impact of macroeconomic variables on stock market returns. As the period of study is spread over two decades and includes the financial crisis in the year 2008 and other economic events, the study suspects the presence of structural breaks. The structural break presence may deteriorate the results. Therefore, the analyses are performed considering this aspect. The study identifies and selects various macroeconomic variables through in-depth content analysis and thereby constructs 22-factor macroeconomic variables wagon wheel. The study considers a large pool of 22 macroeconomic variables considering the research gaps identified. Previous studies have been focusing on key macroeconomic variables; however, the effect of other excluded variables cannot be denied. How these variables individually affect the

stock market returns is very crucial. Using the data available from official websites of World Bank, International Monetary Fund, Organization for Economic Co-operation and Development, Federal Reserve Economic Data (FRED) and Reserve Bank of India (RBI), the study identified 1523 macroeconomic variables. The variables were further reduced to 40 based on their relevance. And finally, 22 variables were identified using extensive literature review and economic theories supporting the expected impact of macroeconomic variable on stock market returns.

The study has considered Nifty 50 index returns as a proxy of the Indian stock market. The NSE being India's largest stock exchange and world's third biggest stock exchange in terms of transactions, the study considered a prominent index of NSE, i.e. Nifty 50 Index. The 22 macroeconomic variables identified are represented in Figure 1.

The macroeconomic variables considered for the study include gold prices, silver prices, FER, inflation rate, interest rate, crude oil prices, REER, FDI, FPI, broad money (M3), narrow money (M1), imports of goods and services and exports of goods and services which are in monthly series, GDP, gross fixed capital formation, private final consumption expenditure, government final consumption expenditure and current account balance in quarterly series and tax revenue, AVA, IVA and SVA in annual series data. Likewise, the stock returns are computed in monthly, quarterly and annual series while analysing with the respective type of macroeconomic variable. Such data pertaining to

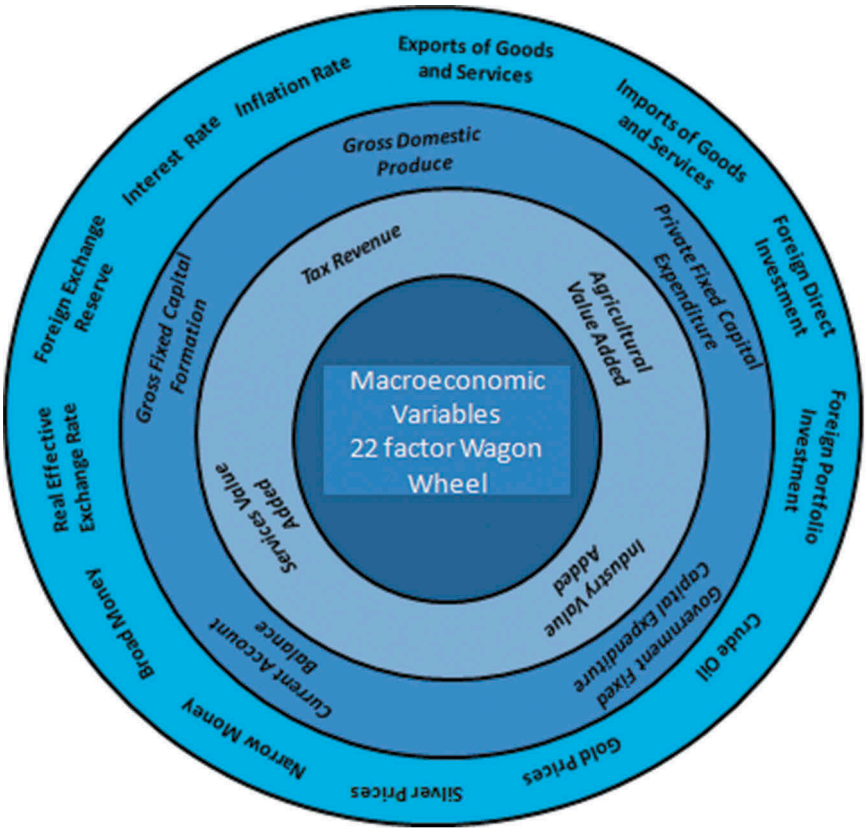

Figure 1. Macroeconomic variables wagon wheel.

closing prices of Nifty 50 Index were obtained from the official website of NSE of India. The required data relating to macroeconomic variables have been extracted from the official websites of World Bank, FRED and RBI. The returns from the stocks have been computed using formula Ln($Po/P1$), where Po is the price at the end of the period and $P1$ signifies price at the beginning of the period. The returns are converted into log form for normality purpose. The study utilizes various statistical and econometric techniques such as summary statistics, correlation analysis, Granger causality test, Bai–Perron test and cumulative sum (CUSUM) test.

Summary statistics considered for the study include mean, standard deviation, skewness and kurtosis. The mean which is a measure of central tendency, also known as average, is used as a performance measure. Higher value of mean is regarded to be better depending on the nature of the variable. In contrast, standard deviation is a measure of dispersion which signifies variation in the data. Lower value of standard deviation is treated as better as it signifies less variation. Skewness is a measure of the symmetry of the data. It gives an idea whether the data are symmetrical, positively skewed or negatively skewed. In case of skewness, if β_1 is equal to 0, it is regarded as symmetrical, if β_1 more than 1 then it is positively skewed and if β_1 less than 1, it is called as negatively skewed. Kurtosis focuses on the flatness of the data. It assumes all the bell-shaped curves to be symmetrical but with different heights. Here, if β_2 is equal to 0 or 3, it is regarded as mesokurtic, if β_2 more than 0 or 3, it will be leptokurtic and if β_2 less than 0 or 3, it will be platykurtic. Comparison of β_2 with 0 or 3 depends on the nature of the output. As such, skewness and kurtosis give an idea of normality of the data and the overall summary statistics gives an understanding about the nature of the data. Correlation analysis has been utilized to evaluate the relationship between selected variables. The study utilizes widely used and accepted measure of Pearson's correlation to achieve such correlation analysis. Pearson's correlation not only signifies how strong the relationship is, but it also shows the direction, that is whether the relationship is positive or negative. If Pearson's correlation (r) is equal to 0, it indicates the existence of no relationship, if r more than 0, it shows a positive relationship and when r is less than 0 it signifies a negative relationship. At no point, the relationship can be less than −1 or more than +1. P values can be used to support the Pearson's correlation to show whether such relationships are significant or not. To examine the impact of macroeconomic variables on stock market returns, the study utilizes Bai–Perron test instead of normal ordinary least squares as it suspects the presence of structural breaks. The structural changes or structural breaks are unexpected shifts which occur in a time-series data due to any event, which may bring in forecasting errors or make the model unreliable. Such a situation is dealt with by using Bai–Perron test. The Bai–Perron test is better as compared to the Chow test in evaluating structural breaks as it allows for more than one structural break and automatically detects it. Bai–Perron test also provides the results for various periods as identified by breaks. This gives an understanding of impact during different periods. The stability of the model is examined using CUSUM test, also referred to as the cumulative sum control chart. The test gives the results in the form of chart which consist of the upper control limit (UCL) and lower control limit (LCL). When a particular model lies between UCL and LCL at the selected level of significance, the model is considered to be stable. The correlation analysis provides the extent of the relationship between two or more variables and

regression analysis gives an understanding about the presence of any significant impact; however, both fail to determine which variable causes the other. Causality is important as to evaluate the causation effect between selected variables. The study utilizes one of the widely used Granger causality test to serve this purpose. The Granger causality test will reveal the presence of unidirectional or bidirectional causality between the variables.

The following models were developed for the purpose of the study:

$$\mathrm{LNIR} = \alpha_1 + \beta_1 \mathrm{LGOLD} + \varepsilon_1 \tag{1}$$

where LNIR is the log of Nifty 50 index returns, α_1 is a constant term, β_1 is the slope coefficient, LGOLD represents log of gold prices and ε_1 symbolizes the disturbance term of the model.

$$\mathrm{LNIR} = \alpha_2 + \beta_2 \mathrm{LSILVER} + \varepsilon_2 \tag{2}$$

where LNIR is the log of Nifty 50 index returns, α_2 is a constant term, β_2 is the slope coefficient, LSILVER represents the log of silver prices and ε_2 symbolizes the disturbance term of the model.

$$\mathrm{LNIR} = \alpha_3 + \beta_3 \mathrm{LFER} + \varepsilon_3 \tag{3}$$

where LNIR is the log of Nifty 50 idex returns, α_3 is a constant term, β_3 is the slope coefficient, LFER represents the log of FER,s and ε_3 symbolizes the disturbance term of the model.

$$\mathrm{LNIR} = \alpha_4 + \beta_4 \mathrm{LINFL} + \varepsilon_4 \tag{4}$$

where LNIR is the log of Nifty 50 index returns, α_4 is a constant term, β_4 is the slope coefficient, LINFL represents the log of inflation rates and ε_4 symbolizes the disturbance term of the model.

$$\mathrm{LNIR} = \alpha_5 + \beta_5 \mathrm{LINT} + \varepsilon_5 \tag{5}$$

where LNIR is the log of Nifty 50 index returns, α_5 is a constant term, β_5 is the slope coefficient, LINT represents the log of interest rates and ε_5 symbolizes the disturbance term of the model.

$$\mathrm{LNIR} = \alpha_6 + \beta_6 \mathrm{LCOIL} + \varepsilon_6 \tag{6}$$

where LNIR is the log of Nifty 50 index returns, α_6 is a constant term, β_6 is slope coefficient, LCOIL represents log of crude oil prices and ε_6 symbolizes the disturbance term of the model.

$$\mathrm{LNIR} = \alpha_7 + \beta_7 \mathrm{LREER} + \varepsilon_7 \tag{7}$$

where LNIR is the log of Nifty 50 index returns, α_7 is the constant term, β_7 is the slope coefficient, LREER represents the log of REER and ε_7 symbolizes the disturbance term of the model.

$$\mathrm{LNIR} = \alpha_8 + \beta_8 \mathrm{LFDI} + \varepsilon_8 \tag{8}$$

where LNIR is the log of Nifty 50 index returns, α_8 is a constant term, β_8 is the slope coefficient, LFDI represents the log of FDI and ε_8 symbolizes the disturbance term of the model.

$$LNIR = \alpha_9 + \beta_9 LFPI + \varepsilon_9 \tag{9}$$

where LNIR is the log of Nifty 50 index returns, α_9 is the constant term, β_9 is the slope coefficient, LFPI represents the log of FPI and ε_9 symbolizes the disturbance term of the model.

$$LNIR = \alpha_{10} + \beta_{10} LBM + \varepsilon_{10} \tag{10}$$

where LNIR is the log of Nifty 50 index returns, α_{10} is the constant term, β_{10} is the slope coefficient, LBM represents the log of broad money and ε_{10} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{11} + \beta_{11} LNM + \varepsilon_{11} \tag{11}$$

where LNIR is the log of Nifty 50 index returns, α_{11} is a constant term, β_{11} is the slope coefficient, LNM represents the log of narrow money and ε_{11} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{12} + \beta_{12} LIMP + \varepsilon_{12} \tag{12}$$

where LNIR is the log of Nifty 50 index returns, α_{12} is a constant term, β_{12} is the slope coefficient, LIMP represents the log of imports of goods and services and ε_{12} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{13} + \beta_{13} LEXP + \varepsilon_{13} \tag{13}$$

where LNIR is the log of Nifty 50 index returns, α_{13} is a constant term, β_{13} is the slope coefficient, LEXP represents the log of exports of goods and services and ε_{13} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{14} + \beta_{14} LGDP + \varepsilon_{14} \tag{14}$$

where LNIR is the log of Nifty 50 index returns, α_{14} is the constant term, β_{14} is the slope coefficient, LGDP represents the log of GDP and ε_{14} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{15} + \beta_{15} LGFCF + \varepsilon_{15} \tag{15}$$

where LNIR is the log of Nifty 50 index returns, α_{15} is a constant term, β_{15} is the slope coefficient, LGFCF represents the log of gross fixed capital formation and ε_{15} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{16} + \beta_{16} LPFCE + \varepsilon_{16} \tag{16}$$

where LNIR is the log of Nifty 50 index returns, α_{16} is a constant term, β_{16} is the slope coefficient, LPFCE represents the log of PFCE and ε_{16} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{17} + \beta_{17} LGFCE + \varepsilon_{17} \tag{17}$$

where LNIR is the log of Nifty 50 index returns, α_{17} is a constant term, β_{17} is the slope coefficient, LGFCE represents the log of GFCEand ε_{17} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{18} + \beta_{18} LCAB + \varepsilon_{18} \tag{18}$$

where LNIR is the log of Nifty 50 index returns, α_{18} is a constant term, β_{18} is the slope coefficient, LCAB represents the log of CABand ε_{18} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{19} + \beta_{19}LTAX + \varepsilon_{19} \tag{19}$$

where LNIR is the log of Nifty 50 index returns, α_{19} is a constant term, β_{19} is the slope coefficient, LTAX represents the log of tax revenue and ε_{19} symbolizes the disturbance term of the model.

$$LNIR = \alpha_{20} + \beta_{20}LAVA + \varepsilon_{20} \tag{20}$$

where LNIR is the log of Nifty 50 index returns, α_{20} is a constant term, β_{20} is the slope coefficient, LAVA represents the log of agricultural value added and ε_{20} symbolizes the disturbance term of the model.the

$$LNIR = \alpha_{21} + \beta_{21}LIVA + \varepsilon_{21} \tag{21}$$

where LNIR is the log of Nifty 50 index returns, α_{21} is a constant term, β_{21} is the slope coefficient, LIVA represents the log of IVA and ε_{21} symbolizes disturbance term of the model.

$$LNIR = \alpha_{22} + \beta_{22}LSVA + \varepsilon_{22} \tag{22}$$

where LNIR is the log of Nifty 50 index returns, α_{22} is a constant term, β_{22} is the slope coefficient, LSVA represents the log of SVA and ε_{22} symbolizes the disturbance term of the model.

The study makes sure that the classical linear regression model assumptions are fulfilled during the research. For this purpose, the study made use of augmented Dickey-Fuller test to examine the stationarity of data (H0: variable has a unit root), Breusch–Godfrey serial correlation LM test to check the presence of autocorrelation (H0: there is no autocorrelation) and heteroscedasticity test: ARCH to test the presence of heteroscedasticity (H0: there is no heteroscedasticity) in the data. For analysis purpose, the stock returns are considered as the dependent variable and macroeconomic variables as regressors. Independent analyses are performed and the results are sorted using MS Excel. The study utilized econometric software E-views to obtain the results.

3. Results and discussion

3.1. Summary statistics

Table 1 summarizes the summary statistics of stock market returns and 22 macroeconomic variables. Mean, the measure of performance herein, is used not to compare all the variables together, but to indicate the average performance of the respective variable. The standard deviation reflects the variation in data over the period of time. The study found positive skewness of data in case of gold prices, silver prices, FER, inflation rate, REER, FDI, FPI, broad money, imports of goods and services, government final capital expenditure, CAB, IVA and SVA. Negative skewness was noticed for data pertaining to Nifty 50 index returns, crude oil prices, narrow money, exports of goods and services, GDP, gross fixed capital formation, private final capital expenditure, tax

Table 1. Summary statistics results of stock market returns and macroeconomic variables.

Series	Variables	$\bar{x}$	σ	$\beta 1$	$\beta 2$
Monthly series	LNIR	0.944885	7.028898	−0.487919	4.476896
	LGOLD	0.654072	3.493527	0.468828	4.522002
	LSILVER	0.637133	5.579050	0.414768	6.119757
	LFER	1.350718	2.583042	0.175293	5.140744
	LINFL	−0.559201	19.62724	2.164244	27.22610
	LINT	−0.004019	4.834211	−1.607144	20.72644
	LCOIL	0.405541	9.160512	−0.681411	3.821515
	LREER	0.186781	1.620825	0.136645	3.997047
	LFDI	1.239015	62.42710	0.365107	5.067989
	LFPI	8.707021	130.1677	0.169714	4.725785
	LBM	1.205611	0.842214	0.298561	8.069179
	LNM	0.989473	2.514375	−5.102060	75.06344
	LIMP	1.166420	9.955858	0.137807	2.440840
	LEXP	1.085642	10.94063	−0.279566	3.590717
Quarterly series	LNIR	2.515737	11.7691	−0.03296	3.159071
	LGDP	2.918647	1.694687	−0.06706	2.821046
	LGFCF	2.985492	2.919922	−0.56112	9.642152
	LPFCE	2.796736	2.27095	−0.37045	7.419438
	LGFCE	2.868484	17.82014	0.08765	3.32338
	LCAB	2.788349	90.74478	0.165458	6.454869
Annual series	LNIR	10.51791	31.34933	−0.66560	3.563728
	LTAX	0.744574	6.415266	−0.57530	2.263252
	LAVA	−2.30106	3.233408	−0.87489	3.344438
	LIVA	−0.45834	2.734827	1.263746	3.978909
	LSVA	1.398894	1.454274	0.18898	2.421958

Source: Author's compilation.
Note: $\bar{x}$, σ, $\beta 1$ and $\beta 2$ represent mean, standard deviation, skewness and kurtosis, respectively.

revenue and agricultural value added. The data were found to be leptokurtic for the variables except imports of goods and services, GDP, tax revenue and services value added. The summary statistic results are provided to know the nature of the data before proceeding for the advanced analyses.

3.2. Test of stationarity

The data are considered to be stationary when the mean, variance and coariance are stable over a period of time. The data can be made stationary by transforming to log, first differencing or second differencing. The study used the augmented Dickey-Fuller test to check the stationarity of the data, the results of which are reflected in Table 2. The results indicate the rejection of null hypotheses at 1% level of significance. Hence, the data pertaining to stock market returns and selected macroeconomic variables are stationary at a level which is favourable in the context of the present study.

3.3. Relationship between stock market returns and macroeconomic variables

Table 3 reveals the relationship between stock market returns and 22 macroeconomic variables. The results revealed a negative relationship of stock market returns with gold prices, FER, inflation rate, broad money, government final capital expenditure, and SVA. The association of stock market returns with silver prices, interest rate, crude oil prices, FDI, FPI, narrow money, REER, imports of goods and services, exports of goods and services, GDP, GFCF, PFCE, CAB, tax revenue, agricultural value added and IVA was

Table 2. Results of the augmented Dickey–Fuller test.

Series	Variables	ADF test statistic	Probability
Monthly series	LNIR	−15.43215	0.0000***
	LGOLD	−14.19289	0.0000***
	LSILVER	−11.71918	0.0000***
	LFER	−5.992328	0.0000***
	LINFL	−13.65642	0.0000***
	LINT	−8.332460	0.0000***
	LCOIL	−13.03329	0.0000***
	LREER	−12.35461	0.0000***
	LFDI	−10.91698	0.0000***
	LFPI	−21.05693	0.0000***
	LBM	−3.859911	0.0027***
	LNM	−12.14365	0.0000***
	LIMP	−26.04480	0.0000***
	LEXP	−3.541531	0.0004***
Quarterly series	LNIR	−7.345205	0.0000***
	LGDP	−8.773257	0.0000***
	LGFCF	−8.242537	0.0000***
	LPFCE	−12.03822	0.0001***
	LGFCE	−15.44824	0.0001***
	LCAB	−13.06730	0.0000***
Annual series	LNIR	−5.699905	0.0000***
	LTAX	−4.064200	0.0003***
	LAVA	−7.055398	0.0001***
	LIVA	−11.75105	0.0001***
	LSVA	−7.951361	0.0000***

Source: Author's compilation.
Note: ***1% level of significance.

Table 3. Results of correlation analysis.

Variables	Pearson correlation	Significance (Two-tailed)
LGOLD	−0.152	0.136
LSILVER	0.073	0.475
LFER	−0.089	0.382
LINFL	−0.079	0.441
LINT	0.240	0.018**
LCOIL	0.217	0.032**
LREER	0.202	0.047**
LFDI	0.221	0.029**
LFPI	0.046	0.657
LBM	−0.029	0.781
LNM	0.069	0.500
LIMP	0.210	0.039**
LEXP	0.095	0.355
LGDP	0.264	0.015**
LGFCF	0.157	0.151
LPFCE	0.087	0.427
LGFCE	−0.105	0.338
LCAB	0.087	0.428
LTAX	0.516	0.017**
LAVA	0.097	0.667
LIVA	0.085	0.713
LSVA	−0.789	0.412

Source: Author's compilation.
Note: ***1% level of significance, **5% level of significance, *10% level of significance.

noticed to be positive. However, evidence of significant relationship was found only in

case of interest rate, crude oil prices, REER, FDI, imports of goods and services, GDP and tax revenue.

3.4. Causation effect between stock market returns and macroeconomic variables

The present study attempts to examine the causation effect between stock returns and 22 macroeconomic variables. The required analyses are performed using Granger causality test and the output is depicted in Table 4. The results revealed a miniature evidence of causality between stock returns and 22 macroeconomic variables. Unidirectional causality was noticed from FDI to stock market returns at 10% level of significance. Also, unidirectional causality from stock returns to FERs and crude oil prices was evidenced at 1% level of significance and from stock returns to CABat 10% level of significance. Bidirectional causality was noticed only in case of interest rate.

3.5. Regression analysis with structural breaks

The study performed a regression analysis considering the presence of structural breaks in the data. To account for such structural breaks, the Bai–Perron test has been used. The study identified five breaks spread in the years 2008 (subprime mortgage crises in the United States), 2013 (Indian rupee depreciation), 2015 (Chinese stock market meltdown) and 2016 (Brexit referendum and demonetization). The study evidenced a significant impact of gold prices, silver prices, FER, crude oil prices, REER, FPI, narrow money,

Table 4. Results of Granger causality test.

	Causation effect from macroeconomic variables to stock market returns		Causation effect from stock market returns to macroeconomic variables	
Variables	F-statistic	Probability	F-statistic	Probability
LGOLD	1.15059	0.3181	0.18419	0.8319
LSILVER	0.81144	0.4454	1.79235	0.1687
LFER	0.23738	0.7889	5.46873	0.0047***
LINFL	0.96619	0.3820	0.83702	0.4342
LINT	2.83117	0.0623*	6.51854	0.0020***
LCOIL	0.20316	0.8163	8.30783	0.0003***
LREER	0.00515	0.9949	1.55821	0.2126
LFDI	2.46593	0.0870*	1.74963	0.1760
LFPI	0.23035	0.7947	1.42013	0.2472
LBM	0.59338	0.5532	0.38203	0.6829
LNM	0.51482	0.5982	1.05105	0.3511
LIMP	0.42905	0.6516	1.06514	0.3462
LEXP	0.74338	0.4766	0.41169	0.6630
LGDP	1.15354	0.3208	1.98024	0.1449
LGFCF	0.26271	0.7696	1.70383	0.1887
LPFCE	0.20519	0.8149	0.32639	0.7225
LGFCE	0.90751	0.4077	0.70681	0.4963
LCAB	0.27718	0.7587	2.41238	0.0963*
LTAX	0.21321	0.8106	1.01863	0.3864
LAVA	0.40752	0.6729	0.05615	0.9456
LIVA	1.19449	0.3319	0.73780	0.4959
LSVA	1.38953	0.2815	1.58773	0.2391

Source: Author's compilation.
Note: ***1% level of significance, *10% level of significance.

imports of goods and services, GDP, private fixed capital expenditure, government-fixed capital expenditure and tax revenue on stock market returns, and such impact was found to be varying across different structural periods as reflected in Table 5. All the regression models were found to be stable using CUSUM test as reflected in Appendix. All the models lie within the critical levels of CUSUM test and hence considered to be stable.

3.6. Test for examining serial correlation and heteroscedasticity

Table 6 indicates the result of the Breusch–Godfrey serial correlation Lagrange Multiplier (LM) test and heteroscedasticity test: ARCH. For regression results and analyses to be reliable, the variables should not be serially correlated nor heteroscedastic. In other words, there should not be autocorrelation and heteroscedasticity in the data. It is evident from Table 6 that the null hypotheses get failed to be rejected at the required level of significance in case of stock returns and macroeconomic variables except tax revenue, agricultural value added, Industry Value Added and Service Value Added. Therefore, the variables considered in the present study do not contain autocorrelation. As the variables tax revenue, agricultural value added, IVAand SVA were in annual series, the Bai–Perron test fails to identify the structural breaks considering such limited period. Hence, miniature evidence of autocorrelation is witnessed for such variables. The results of heteroscedasticity test: ARCH indicates a failure in rejection of null hypothesis at the required level of significances. Thus, there is no presence of heteroscedasticity in developed models which is considered to be favourable in the context of the present study.

4. Conclusion

The economic theory pertaining to macroeconomic variables and stock market returns is very dynamic. Although the stock prices are expected to move in relation to macroeconomic variables, it may not happen sometimes due to dynamic investment behaviour. The expected relation of macroeconomic variables with stock market returns and results obtained in the current study is elaborated as follows. The expected relation of gold and silver prices with stock market returns is negative. This is because when the investors get higher returns in stock markets, they tend to transfer their investments from gold, silver, etc. to stock market with a hope to earn very high returns. Also, when the stock market is highly volatile and risky, investors tend to transfer those funds to safer avenues like investment in gold and silver. Such a negative relationship is expected to be more with gold than silver, with gold being a prime commodity for investment from several decades. The study found evidence of such a relationship to be low negative but insignificant. The study expected a positive relationship of GDP, GFCF, tax revenue, AVA, IVA, SVA, FERs, FDIs, FPIs, broad money, narrow money and exports of goods and services with stock market returns. But a significant positive relationship was noticed only in the case of interest rate, crude oil prices, REERs, FDI, imports of goods and services, GDP and tax revenue. The positive relationship is justified in the case of FDI, GDP and tax revenue as these are positive economic indicators. Anything which is

Table 5. Results of the Bai–Perron test.

Variable	Structural breaks	Coefficient	Standard error	*t*-statistic	*p* value
LGOLD	1996M01 – 2007M12	0.047963	0.186033	0.257817	0.7968
	2008M01 – 2012M12	−0.485413	0.278322	−1.74406	0.0824*
	2013M01 – 2014M12	−0.393527	0.228967	−1.71870	0.0869*
	2015M01 – 2015M12	0.327068	0.414907	0.788293	0.4313
	2016M01 – 2017M08	0.007385	0.216356	0.034133	0.9728
LSILVER	1996M01 – 2007M12	0.217964	0.122737	1.775863	0.077*
	2008M01 – 2012M12	0.149927	0.160311	0.935228	0.3506
	2013M01 – 2014M12	−0.183878	0.136584	−1.34626	0.1794
	2015M01 – 2015M12	0.271186	0.286698	0.945894	0.3451
	2016M01 – 2017M08	0.002283	0.003966	0.575506	0.5655
LFER	1996M01 – 2007M12	−0.186625	0.234137	−0.79707	0.4262
	2008M01 – 2012M12	−0.666587	0.398653	−1.67209	0.0958*
	2013M01 – 2014M12	−0.768222	0.274185	−2.80183	0.0055***
	2015M01 – 2015M12	−1.338357	0.591723	−2.26179	0.0246*
	2016M01 – 2017M08	0.003575	0.006697	0.533778	0.594
LINFL	1996M01 – 2007M12	−0.035827	0.027456	−1.30488	0.1931
	2008M01 – 2012M12	−0.06672	0.089892	−0.74221	0.4587
	2013M01 – 2014M12	−0.029855	0.057919	−0.51546	0.6067
	2015M01 – 2015M12	0.01764	0.076011	0.232068	0.8167
	2016M01 – 2017M08	−0.005327	0.008	−0.66581	0.5061
LINT	2005M01 – 2017M05	−1.176189	0.436001	−2.697673	0.0078***
	2008M01 – 2017M05	0.063466	0.115051	0.551630	0.5821
LCOIL	1996M01 – 2007M12	0.051713	0.067849	0.762179	0.4467
	2008M01 – 2012M12	0.236446	0.112808	2.096001	0.0371**
	2013M01 – 2014M12	0.02735	0.136163	0.20086	0.841
	2015M01 – 2015M12	−0.014872	0.083866	−0.17732	0.8594
	2016M01 – 2017M08	0.007046	0.050139	0.140531	0.8884
LREER	1996M01 – 2007M12	−0.340962	0.401279	−0.84968	0.3963
	2008M01 – 2012M12	1.095357	0.558318	1.961888	0.0509*
	2013M01 – 2014M12	1.295137	0.393032	3.295246	0.0011***
	2015M01 – 2015M12	0.961796	0.671472	1.43237	0.1533
	2016M01 – 2017M08	−0.00605	0.012579	−0.48097	0.631
LFDI	1996M01 – 2007M12	0.00545	0.008589	0.634533	0.5263
	2008M01 – 2012M12	0.017835	0.021548	0.827699	0.4086
	2013M01 – 2014M12	−0.005853	0.016141	−0.36263	0.7172
	2015M01 – 2015M12	0.02255	0.023396	0.963848	0.3361
	2016M01 – 2017M08	−0.000836	0.001732	−0.48280	0.6297
LFPI	1996M01 – 2007M12	0.01259	0.00665	1.893185	0.0595*
	2008M01 – 2012M12	−0.000498	0.008477	−0.05877	0.9532
	2013M01 – 2014M12	0.016548	0.009909	1.669995	0.0962*
	2015M01 – 2015M12	−0.016547	0.037354	−0.44299	0.6582
	2016M01 – 2017M08	−0.00566	0.006544	−0.86487	0.3879
LBM	1996M01 – 2007M12	0.745809	0.742804	1.004045	0.3163
	2008M01 – 2012M12	−1.67195	1.572291	−1.06338	0.2886
	2013M01 – 2014M12	−0.767585	1.419019	−0.54092	0.589
	2015M01 – 2015M12	−1.54595	3.029428	−0.51031	0.6103
	2016M01 – 2017M08	0.187728	0.663975	0.282733	0.7776
LNM	1996M01 – 2007M12	0.786488	0.468189	1.679851	0.0942*
	2008M01 – 2012M12	0.227326	0.817134	0.278199	0.7811
	2013M01 – 2014M12	−0.332656	0.810869	−0.41024	0.682
	2015M01 – 2015M12	0.365,642	2.142804	0.170637	0.8646
	2016M01 – 2017M08	0.183757	0.109858	1.67267	0.0956*
LEXP	1996M01 – 2007M12	−0.03575	0.058534	−0.61075	0.5419
	2008M01 – 2012M12	0.08399	0.117189	0.716702	0.4742
	2013M01 – 2014M12	0.165963	0.077633	2.137786	0.0335**
	2015M01 – 2015M12	−0.106242	0.101891	−1.04269	0.2981
	2016M01 – 2017M08	0.073781	0.123173	0.599005	0.5497
LIMP	1996M01 – 2007M12	−0.032991	0.051879	−0.63592	0.5254
	2008M01 – 2012M12	0.107371	0.106458	1.008576	0.3142
	2013M01 – 2014M12	−0.047533	0.088272	−0.53848	0.5907
	2015M01 – 2015M12	−0.022073	0.132358	−0.16677	0.8677
	2016M01 – 2017M08	0.085499	0.101833	0.839598	0.4019

(*Continued*)

Table 5. (Continued).

Variable	Structural breaks	Coefficient	Standard error	*t*-statistic	*p* value
LGDP	1996Q2 – 2007Q4	2.466393	1.29746	1.90094	0.0612*
	2008Q1 – 2012Q4	2.207755	1.375269	1.605327	0.1126
	2013Q1 – 2014Q4	0.887719	1.308104	0.678631	0.4995
	2015Q1 – 2015Q4	−0.676809	0.914107	−0.74040	0.4614
	2016Q1 – 2017Q2	1.09171	1.93853	0.563164	0.575
LGFCF	1996Q2 – 2007Q4	0.325498	0.720522	0.451754	0.6528
	2008Q1 – 2012Q4	1.064877	0.83567	1.274279	0.2065
	2013Q1 – 2014Q4	0.771255	1.179517	0.653874	0.5152
	2015Q1 – 2015Q4	3.018899	1.976348	1.527514	0.1308
	2016Q1 – 2017Q2	−5.602269	4.552657	−1.23055	0.2223
LPFCE	1996Q2 – 2007Q4	0.612857	0.852913	0.718546	0.4747
	2008Q1 – 2012Q4	0.818855	1.260801	0.649472	0.518
	2013Q1 – 2014Q4	0.518742	0.819145	0.633272	0.5285
	2015Q1 – 2015Q4	0.338086	1.757919	0.192322	0.848
	2016Q1 – 2017Q2	−3.512282	2.024547	−1.73484	0.0869*
LGFCE	1996Q2 – 2007Q4	0.029063	0.149908	0.193871	0.8468
	2008Q1 – 2012Q4	−0.166564	0.133398	−1.24862	0.2157
	2013Q1 – 2014Q4	−0.090476	0.085106	−1.0631	0.2911
	2015Q1 – 2015Q4	−0.088183	0.052405	−1.68270	0.0966*
	2016Q1 – 2017Q2	0.140283	0.104394	1.343789	0.1831
LCAB	1996Q2 – 2007Q4	0.024671	0.021179	1.164847	0.2478
	2008Q1 – 2012Q4	−0.005295	0.030749	−0.17220	0.8637
	2013Q1 – 2014Q4	0.033726	0.021367	1.578433	0.1187
	2015Q1 – 2015Q4	−0.044079	0.032317	−1.36394	0.1767
	2016Q1 – 2017Q2	−0.019318	0.031604	−0.61124	0.5429
LTAX	1996–2016	2.521719	0.960278	2.62603	0.0166**
LAVA	1996–2016	0.937133	2.213873	0.4233	0.6768
LIVA	1996–2016	0.980049	2.620164	0.374041	0.7125
LSVA	1996–2016	−4.072929	4.856367	−0.838678	0.4121

Source: Author's compilation.
Note: ***1% level of significance, **5% level of significance, *10% level of significance.

expected to be good for the economy is also expected to be favourable for the stock market as it acts as a barometer of the economy. However, interest rates, crude oil prices, REERs and imports being negative economic indicators, a positive relationship of such variables with stock market returns is contradictory in nature. This signifies that market discounted such results in advance and thus evidence of such miniature relationship.

The unidirectional causality from FDI to stock market returns shows the positive approach markets have for FDI as such investments are expected to contribute significantly to the economy and the society. Interest rates are still prominent macroeconomic indicators which gain attention from market participants. The present study finds bidirectional causality between interest rates and stock market returns. However, causality from interest rates to stock returns was found to be weak as compared to causality from stock market returns to interest rates. The changes in interest rates are speculated by the market in advance before their announcements by RBI and as such resulting into weak causality when they are announced. Although there is bidirectional causality between interest rates and stock market returns, it is more inclined toward causality from stock market returns to interest rates. Unidirectional causality from stock returns to macroeconomic variables has also been evidenced in case of FERs, crude oil prices and

Table 6. Results of serial correlation and heteroscedasticity.

	Breusch–Godfrey serial correlation LM test		Heteroscedasticity test: ARCH	
Variables	*F*-statistic	Prob. Chi-square	*F*-statistic	Prob. Chi-square
LGOLD	0.730301	0.4671	0.000021	0.9963
LSILVER	0.178113	0.8299	0.000149	0.9902
LFER	0.524612	0.5783	0.005936	0.9384
LINFL	0.175790	0.8319	0.023790	0.8769
LINT	0.657861	0.5070	1.225389	0.2671
LCOIL	0.382579	0.6704	0.338190	0.5596
LREER	0.557872	0.5586	0.063915	0.7997
LFDI	0.271045	0.7531	0.000689	0.9790
LFPI	0.208972	0.8036	0.029689	0.8627
LBM	0.318972	0.7164	0.016249	0.8982
LNM	0.254665	0.7661	0.023485	0.8777
LIMP	0.342564	0.6990	0.006583	0.9351
LEXP	0.276803	0.7486	0.028895	0.8645
LGDP	1.730847	0.1460	0.062567	0.8002
LGFCF	1.869176	0.1261	2.301268	0.1300
LPFCE	1.985527	0.1116	0.161248	0.6847
LGFCE	1.786762	0.1376	0.247773	0.6149
LCAB	1.143747	0.2749	0.008247	0.9268
LTAX	4.937524	0.0211**	1.579962	0.2040
LAVA	2.485512	0.0930*	0.331716	0.5475
LIVA	4.205060	0.0310**	0.677393	0.3944
LSVA	6.352527	0.0112**	0.281652	0.5788

Source: Author's compilation,
Note: **5% level of significance, *10% level of significance.

CAB. This reveals that the effect of stock market returns on these variables cannot be denied.

The study evidenced a significant impact of gold prices, silver prices, FER, crude oil prices, REER, FPI, narrow money, imports of goods and services, GDP, private fixed capital expenditure, government fixed capital expenditure and tax revenue on stock market returns, and such impact was found to be varying across different structural periods but justifies the economic theory. The impact was found to be varying during the year 2008 due to subprime mortgage crises in the United States, during 2013 due to Indian rupee depreciation, during 2015 due to Chinese stock market meltdown and during 2016 due to Brexit referendum and announcement of demonetization. As macroeconomic variables and stock market returns are dynamic, it becomes necessary to study how these macroeconomic variables affect stock market returns for different time periods. The evidence of impact across structural breaks shows the relevance of the Bai–Perron test which takes into account such breaks. The study faces the limitation as it does not examine the volatility across structural periods identified. There exists a scope for further research focusing on volatility measurement across structural periods which will be an add-on to the Bai–Perron test. The results of the study will assist market participants to frame investment strategies and market regulators to examine the dynamic role played by macroeconomic variables in the context of the Indian stock market.

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No potential conflict of interest was reported by the authors.

Notes on contributors

Narayan Parab, Ph.D. is an Assistant Professor in Goa Business School, Goa University. His area of interest includes Econometrics for Finance, Stock Market Analysis and Derivatives Markets. He has presented papers in International Conferences and published papers in various journals including SCOPUS indexed journals.

Prof. Y. V. Reddy, Ph.D. is the Registrar at Goa University and Professor, Goa Business School (on lien), Goa University. He has more than 31 years of teaching experience. His areas of interest include Accounting and Finance, Derivatives Markets, Financial Management and Cost and Management Accounting. He has published research papers in both national and international journals including SCOPUS indexed journals and presented research papers at national and international conferences. He has guided 17 doctoral works for the award of PhD. He is actively involved in academic and administrative committees constituted by Goa University as chairman and member.

ORCID

Narayan Parab http://orcid.org/0000-0002-8570-3965

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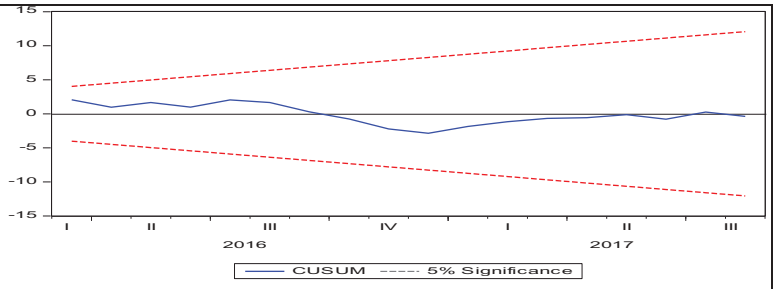
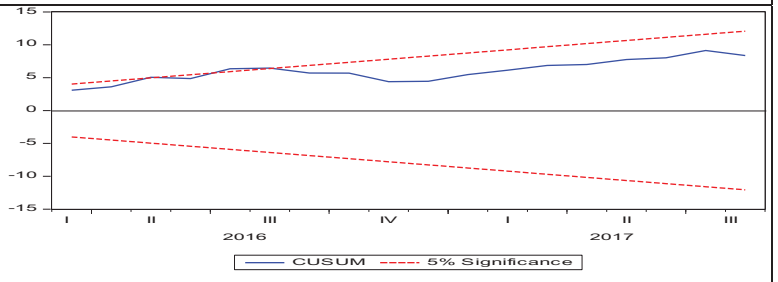
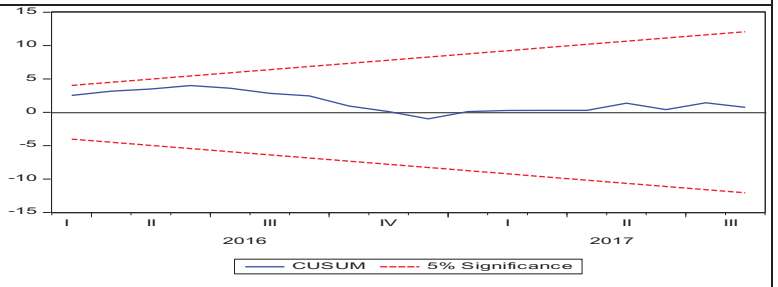
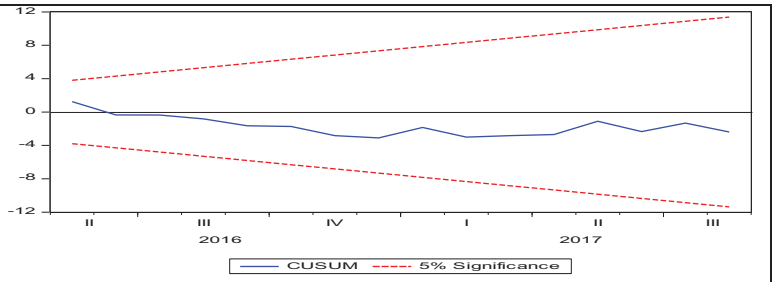
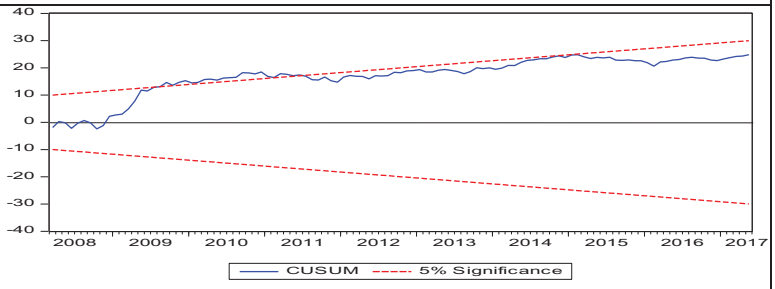
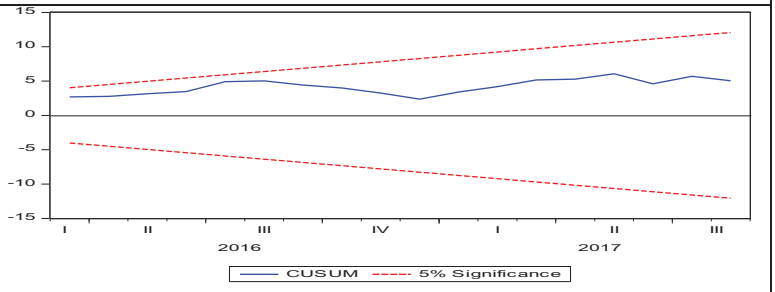
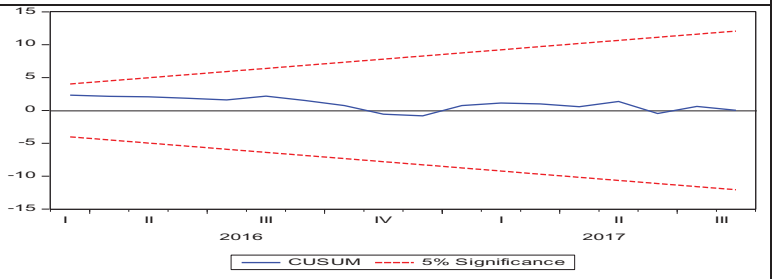
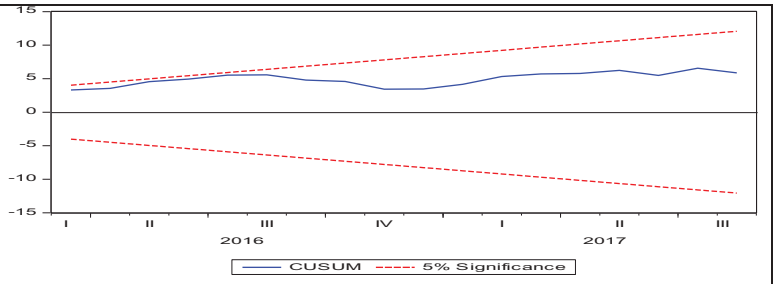
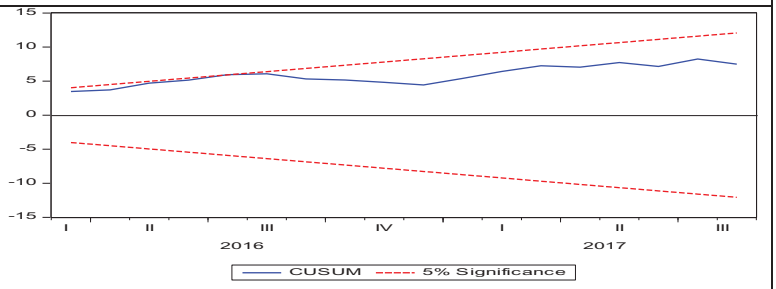
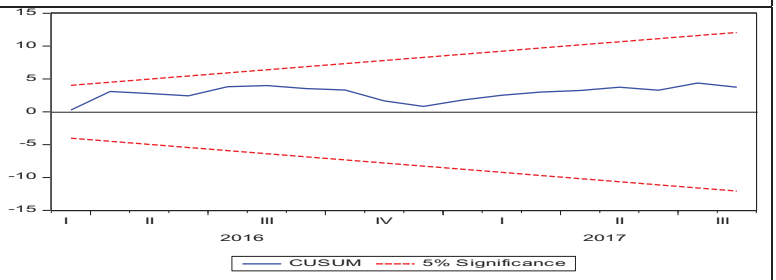
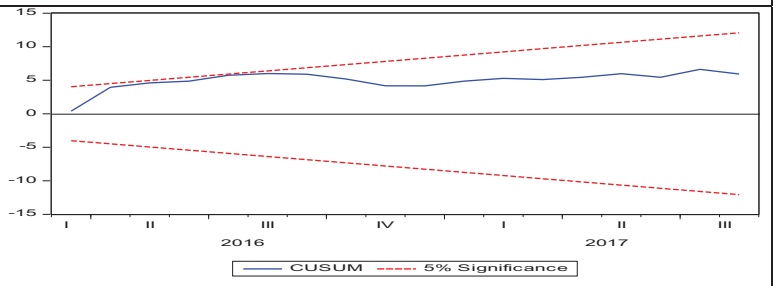
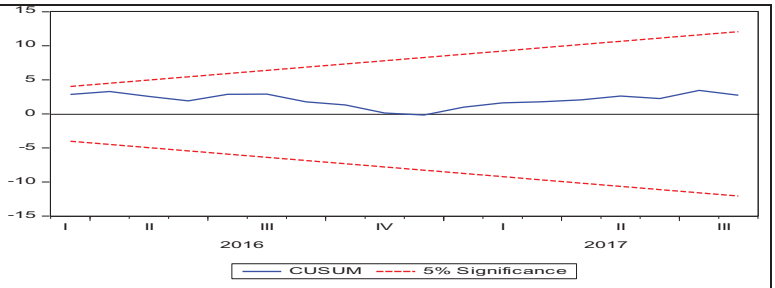
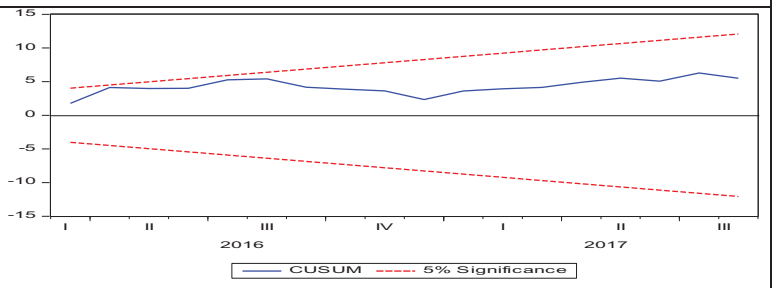
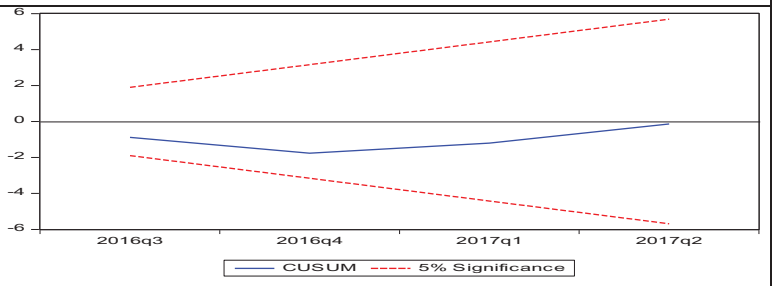
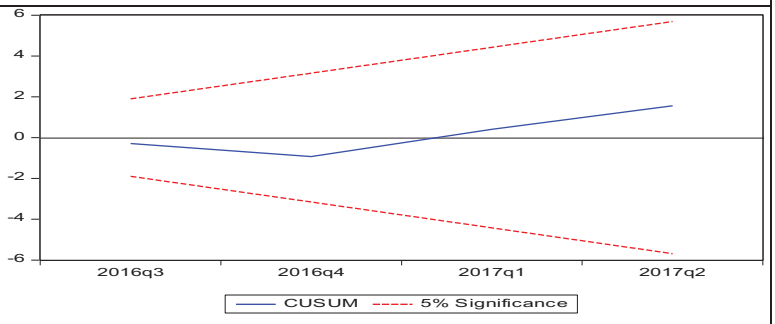
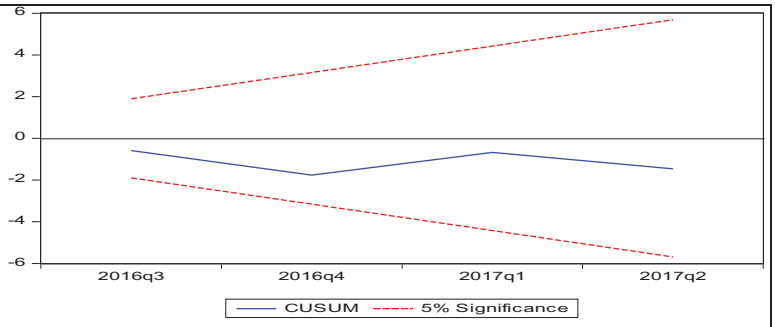
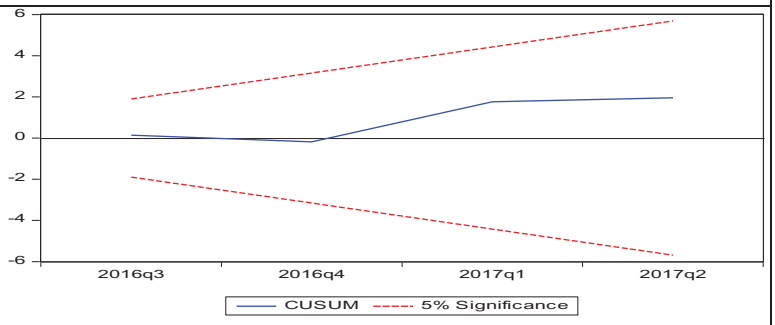
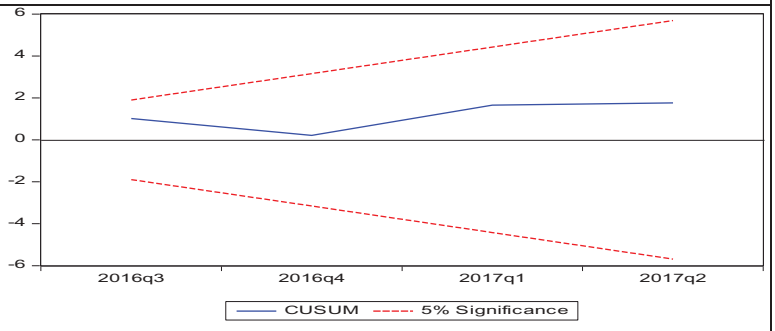
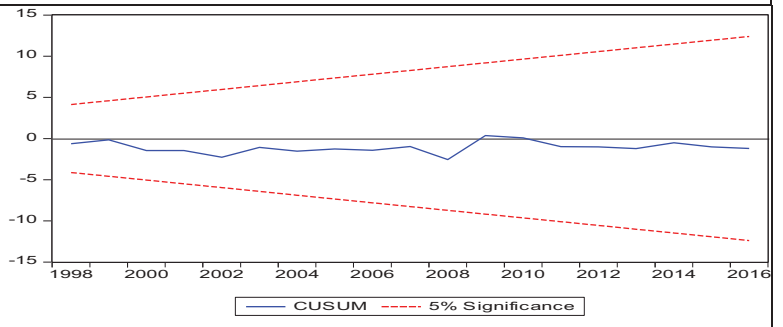
Appendix Results of CUSUM test

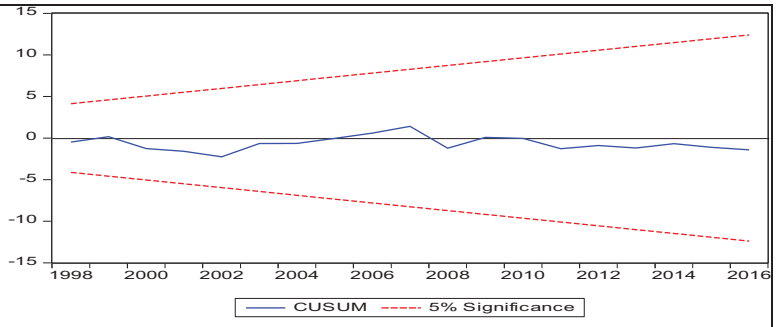
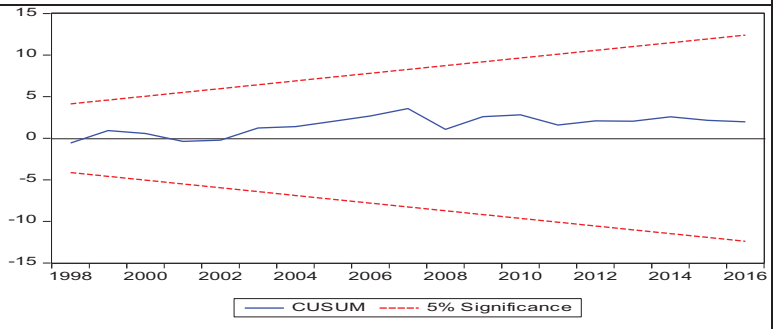
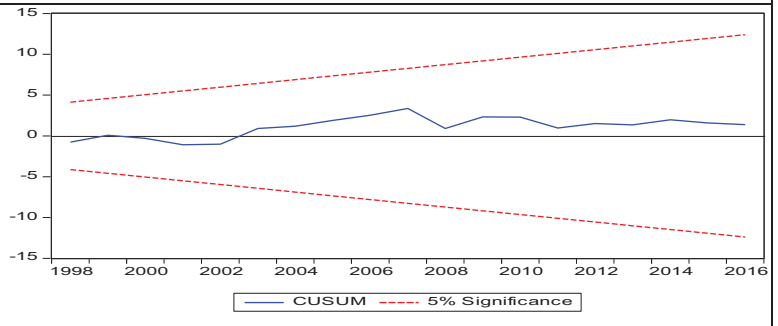
LGOLD	
LSILVER	
LFER	

LINFL	
LINT	
LCOIL	
LREER	

LFDI	
LFPI	
LBM	
LNM	

LIMP	
LEXP	
LGDP	
LGFCF	

LPFCE	
LGFCE	
LCAB	
LTAX	

LAVA	
LIVA	
LSVA	

Source: Author's Compilation.