The Impact of Macroeconomic Factors on the Indian Stock Market : An Assessment

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Abstract

The present study attempted to analyze the relationship between selected macroeconomic variables: interest rate, inflation rate, foreign institutional investments, foreign exchange reserves, gold prices, money supply, and India's stock market index, that is, the Bombay Stock Exchange from April 2012 – June 2020. Various studies in the well-documented literature have examined the association between macroeconomic variables and the stock market in diverse ways and forms. This paper encapsulated the long-run and short-run dynamics of the relation between the variables, as mentioned above, with the ARDL model's help. The empirical analysis displayed a strong liaison between India's stock market and money supply, foreign institutional investment, foreign exchange reserves, wholesale-price index, and call money rate (interest rate). Further, it also showed a negative and significant long-term adjustment coefficient.

Keywords : **macroeconomic variables, stock market returns, ARDL, cointegration**

JEL Classification Codes : E44, G10

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Capital markets, especially stock markets, have played a significant role in India's emerging sectors over the last several years. Stock markets play an essential role in an economy's growth by providing capital requirements to the industries, participating in the country's income distribution by expanding company ownership by issuing stocks to the public, harnessing savings, and reducing the cost risk of production. Thus, the stock market's strength can significantly impact the economy by affecting the real economy's activities. Simultaneously, a shock may lead to a market collapse, resulting in significant disturbances in living standards.

It is asserted that if the stock market operates optimally, then it would help the economy in three ways: (a) enhance domestic savings, (b) distribute investment resources in an optimal manner, and (c) attract foreign portfolio investment.

Thus, the stock market makes it attractive for households to easily save and invest in financial instruments and provide long-term capital to the firms. Similarly, a well-developed equity market attracts foreign investors to invest in stocks of domestic companies, thereby increasing share prices and reducing capital costs to the domestic country's corporations by lowering the price-earnings ratio. When the pricing of shares is efficient, it is pertinent to note that it will help the firm's shares increase in value, thereby reducing capital cost.

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In India, in the past decade, various stock market indicators, such as market capitalization, the depth and breadth of the market, daily trade, and the stock market indices, have shown tremendous growth. Experts view this development as a sign of the country's economic progress. In this context, the stock market has long been an intriguing topic for researchers and policymakers because of its innate nature. More specifically, whether the stock market's efficient functioning encourages or results from economic activity has attracted much attention in the last few years (Celebi & Honig, 2019; Megaravalli & Sampagnaro, 2018). A quick review of the existing literature reveals no consensus on the stock market's link with major macroeconomic indicators. Multiple studies have produced widely disparate results. Different methodology, various sets of data, and different research periods could all account for these variations. As a result, a current study on the impact of multiple variables on India's stock markets is required. Following the above, the present study examines whether the stock prices and some selected economic variables, namely call money rate, foreign institutional investment, foreign exchange reserves, money supply, gold prices, and inflation rate, are connected in India. If such a link does exist, then the authorities can exploit it to invite foreign investment. The direction of causation will also be explored.

Further, unlike the past studies, the current research also looks at the short-term relationships between India's stock market and different macroeconomic indicators.

The Association Between the Performance of the Stock Market and Macroeconomic Variables

The underlying link between the stock market and some macroeconomic variables is discussed in the ensuing paragraphs.

Call Money Rate

In monetary policy's daily conduct, it is perhaps the most observed variable in countries like India. It is regularly used to achieve short-run monetary policy objectives, and it is used as a substitute for the interest rate. Whenever the call money rate increases, it will negatively affect the stock prices. When the interest rate is high, the corporate sector's borrowing cost will be higher, and the corporate profit will lower, causing the price of shares to fall.

Furthermore, when the interest rate rises, so does the opportunity cost of holding money, producing an exchange of stocks for interest-bearing assets, and a drop in stock prices. Therefore, investors will be motivated to reallocate their asset portfolio in the case of a higher interest rate. Besides, it may also increase the cost of borrowing money to purchase shares.

Foreign Institutional Investment

One of India's stock market's essential features in the last 20 years has been the growing participation of foreign institutional investors (FIIs). With the commencement of financial sector reforms in the early 1990s, there has been a substantial change in policy regarding foreign direct investment (FDI) and portfolio flows. Over the years, the investment by FIIs has become one of the biggest drivers of the financial markets, having an investment of more than ₹12 lakh crores in Indian stock markets. Jeyanthi (2016) stated that FIIs positively impacted the stock market and brought out business transparency. The influence is so high that any withdrawal from the market by institutional investors makes the domestic investors fearful and, in turn, drags down the market.

Foreign Exchange Reserves

The monetary authorities' ability to restrain fluctuations in the balance of payments depends upon the country's

foreign exchange reserves regardless of foreign exchange rate regimes. As a result, an increase in reserves will benefit the stock market for three reasons. First, it will avoid negative evaluations by financial market participants worldwide, especially in emerging and developing economies. Second, higher foreign exchange reserves increase the country's creditworthiness, making the stock market more receptive to foreign investment. Third, the greater the reserves, the lower the rate of interest, which causes investments and output to rise. The higher gross investment could signal to market participants that companies expect higher sales and earnings for the future.

Money Supply

Money supply determines the purchasing power. Therefore, the potential demand for goods and services and higher circulation of money make it possible for the public to have more cash, thus increasing investment in stocks. This will make other avenues of investment, such as debt instruments, unattractive. Therefore, the connection between the supply of money and the equity market is relatively straightforward – stock prices increase when the money supply in the economy is high.

Gold Prices

The evidence of the connection between the gold prices and the stock market can be traced to classical economists and Keynes. According to classical literature, gold prices and real income have a positive association, implying that gold prices and share prices are positively linked. At the same time, Keynes argued that more demand means more economic backwardness and low income, highlighting the inverse relationship. However, historically, it has been observed that gold performs very well when the stock prices are low. This is because gold is considered a safe haven; traders tend to go into defensive mode and prefer gold to relatively risky stocks, especially during severe financial turmoil. Thus, a negative relationship between prices of gold and prices of stock can be expected.

Inflation Rate

Generally, inflation negatively influences the stock market. There are three reasons for this. First, a higher rate of inflation tends to push up the rate of interest, making debt instruments more attractive. Moreover, a higher inflation rate may reduce earnings of the public sector undertakings, leading to decreased stock prices. Third, by increasing a firm's production cost, inflation reduces the anticipated flow of cash, corporate revenues, and profits. Moreover, during high inflation, workers may lose their jobs, which would reduce production, thus causing stocks to depreciate. The independent variables and their proxies used in this study are summarized in Table 1.

Table 1. ***Variables and Their Proxies Used in the Study***

Variables	Proxy	Unit
Call Money Rate	Weighted average call money rates	Percent per annum
Foreign Institutional Investment	Net portfolio flows	₹ billion
Foreign Exchange Reserves	Total foreign exchange reserve	₹ billion
Money Supply	Broad money (M3)	₹ billion
Gold	Gold Prices	₹ Per 10 gms
Inflation Rate	Wholesale price index	Index number

Literature Review

The literature on the stock market's relationship with macro variables dates to 1977 when Kraft and Kraft (1977) investigated the correlation between the S&P 500 index and money supply & the corporate interest rate in the United States of America and found a negative association between the S&P 500 index and the supply of money. Sirucek (2012) focused on the association within the US stock indices – Dow & Jones and S&P 500 and various macro-economic variables between 1982 and 2012. Based on the linear regressive model results compiled by adopting the OLS method, the model tracking the impact of selected variables on DJIA appeared to be statistically significant. This model also confirmed the economic theory justifying the impact of variables on the share prices. Similarly, Jareño and Negrut (2016) studied the connection between the US stock market and relevant macroeconomic variables. They found that all other variables significantly affected the stock market except the consumer price index.

Studies were also conducted in other countries. For instance, Madsen (2002) studied 18 OECD countries and found negative inflation and positive gross domestic product relation with their stock markets. Dritsaki –Bargiota and Dritsaki (2004) checked the ASE index (Athens) relationship with inflation, interest rate, and industrial production and discovered a negative interest rate and inflation, while a positive industrial production was observed. Celebi and Honig (2019) analyzed the macroeconomic variable's effects on the stock exchange in Germany before and after the financial crisis period. They discovered that various country economic variables had a delayed impact on stock market performance.

Researchers have endeavored to study this issue in India also. Singh (2010) revealed a bidirectional relationship between BSE Sensex and the industrial output index, while the wholesale price index and the market were related unidirectionally. While Sahu and Dhiman (2011), as per the correlation and Granger causality approach, found that there was no substantial link between BSE Sensex and real GDP in India. A similar conclusion was concluded by Pal and Mittal (2011) by using the Johansen cointegration test.

Ray (2012) also examined the relationship between Sensex and other fundamental economic variables. They found that inflation and interest rate were negatively related with the index, and the rest of the variables were positively related. Makan et al. (2012) analyzed the stock market's influence with macro variables. They found that mostly the exchange rate, FII, and call rate influenced the stock market. Further, FIIs and the Sensex shared a positive relationship while others shared a negative relationship. Venkatraja (2014) revealed in his study that the wholesale price index, industrial production index, foreign institutional investment, and real exchange rate influenced the BSE index positively to a higher degree. At the same time, Sensex was influenced inversely by the gold prices.

In contrast, Kaur and Bhatia (2015) revealed no relationship of macroeconomic variables on the manufacturing firms' functioning listed on the BSE 500. In their study, De and Chakraborty (2015) used firm-level Indian panel data from 2003 – 2013 to examine the relationship between stock return volatility and FII holdings in a VAR framework. The findings revealed that there was no causal link between the two variables.

Similarly, Dadhich et al. (2015) used ARCH-GARCH to examine the influence of foreign institutional investments on the Indian stock market's volatility from 2004 – 2014. They discovered that foreign institutional investors (FIIs) were a significant contributor to the stock market volatility in India. In another study, Kaur (2016) analyzed the effect of 10 macroeconomic variables on one Indian stock market index : the BSE index, and found the relationship to be insignificant (p.61). Tripathi et al. (2016) used a regression model to investigate the relationship between the Indian stock market, represented by the BSE Sensex, and key macroeconomic variables: index of industrial production (IIP), foreign direct investment (FDI), and wholesale price index (WPI) of the Indian economy from 2002 – 2003 to 2012 – 2013. They discovered that IIP was a significant predictor of the BSE Sensex, but neither FDI nor WPI was significant.

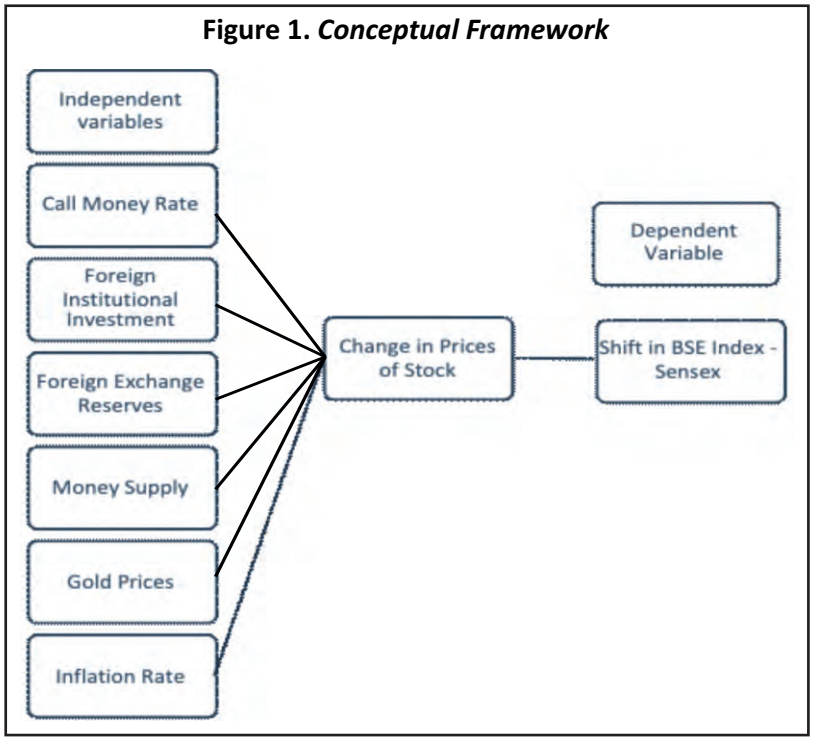
Megaravalli and Sampagnaro (2018) studied the impact of macroeconomic factors on stock markets of three

countries – India, China, and Japan from 2008 – 2016. They concluded that there was no significant relationship between the variables in the long run except for inflation. In contrast, Ashwani and Sheera (2018) captured the roles of macroeconomic variables in explaining the volatility of the Indian stock market using the recently developed MIDAS GARCH approach. The study observed that macroeconomic variables such as exchange rate, money supply, treasury bills rate, along with the controlling variables of net foreign institutional investment and stock turnover ratio, had predictable capacity for stock market volatility. Similarly, from their analysis, Bhuvaneshwari and Ramya (2018) found that all the study variables were cointegrated. It was determined that selected macroeconomic variables could correct the disequilibrium in the price movements of select stock indices. Furthermore, it was found that sectoral stock indices responded and fluctuated with shocks to FDI, exports, and imports at a certain level of variation. However, Keswani and Wadhwa (2019), who evaluated macroeconomic variables such as disposable income and inflation on the Indian stock market, did not find a significant impact.

The brief foregone survey of the literature shows no unanimity between the stock market's relationship with various macroeconomic variables. The findings of multiple studies vary at large, and these differences could be accorded to different methodologies used, numerous variables, and other individual research periods. Further, some of the studies have considered only one or a few variables, and lagged values are also missing in these studies. Hence, contemporary research needs to be conducted to study the macroeconomic variables' impact on India's stock markets. In this context, the present study examines the short-term and the long-term relationship between India's stock market and selected macro-economic variables – call money rate, foreign institution investment, foreign exchange reserves, money supply, gold prices, and inflation rate.

Based on the above literature review and the relationship between the macroeconomic variables and the stock market performances as described in the earlier section, the study's conceptual framework to investigate the effects of the independent variables on the dependent variable is presented in Figure 1.

Figure 1. ***Conceptual Framework***



Data Source and Methodology

To carry out the analysis, monthly data from April 2012 – June 2020 of the Bombay Stock Exchange containing 99 data points were considered. The Sensex index, the benchmark index of the Bombay Stock Exchange, is utilized as a proxy for the Indian stock market in this study, and the data were obtained from the BSE's official website. The data of other variables included in the study — call money rate, foreign institutional investment, foreign exchange reserves, gold prices, money supply (M3), and the wholesale price index — were collected from various Reserve Bank of India publications.

The study employs autoregressive distributed lag (ARDL) model to establish the connection between the macro-economic variables and stock market returns. The basic form of this model is:

$$Y_t = \beta_0 + \beta_1 y_{t-1} + \ldots\ldots + \beta_p y_{t-\mathrm{p}} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \ldots\ldots\ldots + \alpha_q x_{t-q} + \varepsilon_t \qquad (1)$$

here, ε_t is a random term often called a 'disturbance' term. Here, y_t is explained partially by its own lagged values, and hence, the model is autoregressive. Further, the model also has a distributed lag in consecutive lags of the 'x,' which is an explanatory variable. Often, the present value of x_t is not included in the model's structure.

So the general model is ARDL *(p,q)*, where *p* is the lag value of the dependent variable, and *q* is the lag value of regressors. Previous literature has used ordinary least square (OLS) estimates to study the relationship between the variables, but it does not provide an accurate estimation. The OLS estimates give a biased coefficient estimate because of the dependent variable's lagged values as a regressor. If the error term (disturbance term) ε_t is autocorrelated, OLS will also be inconsistent. Further, OLS is an estimation method used to determine the regression model's parameters. It is used when the predictor and the predicted variables are integrated at the same level/stationary ; whereas, ARDL cointegration models are used when the variables included in the model are integrated at different levels. It helps determine the short-term and long-term relationships between the variables that cannot be resolved with the OLS method's help (Shrestha & Bhatta, 2018). Therefore, to present a better insight into the association between the variables, the ARDL model has been used in the study. The preliminary analysis of the data satisfies the model's assumption, stating that the variables' integration level is a mixture of $I(0)$ and $I(1)$.

The Model

The autoregressive distributed lag model regresses the Sensex on its lag values and the lagged values of the macroeconomic variables selected (independent variables). Thereby, it establishes short and long-term relationships among the variables.

Initially, the long-run relationship is built with the help of the following equation:

$$\Delta(ssx)_t = \beta_0 + \beta_1 (ssx)_{t-1} + \beta_2 (cmr)_{t-1} + \beta_3 (fii)_{t-1} + \beta_4 (fer)_{t-1} + \beta_5 (gp)_{t-1} + \beta_6 (ms)_{t-1} + \beta_7 (wpi)_{t-1} + \Sigma^{p}_{i=1} \beta_8 \Delta(ssx)_{t-i} + \Sigma^{q}_{i=1} \beta_9 \Delta(cmr)_{t-i} + \Sigma^{r}_{i=1} \beta_{10} \Delta(fii)_{t-i} + \Sigma^{s}_{i=1} \beta_{11} \Delta(fer)_{t-i} + \Sigma^{t}_{i=1} \beta_{12} \Delta(gp)_{t-i} + \Sigma^{t}_{i=1} \beta_{13} \Delta(ms)_{t-i} + \Sigma^{u}_{i=1} \beta_{14} \Delta(wpi)_{t-i} + \varepsilon_t \qquad (2)$$

After the regression, the Wald test is tested to verify the long-run association with *F*-statistic's help and deduce the short-run relationships.

After that, an error correction model was computed to investigate the variables' short-run dynamics, a modified version of ARDL. The equation for the short-run association is shown below:

$$\Delta(ssx)_t = \beta_0 \Sigma^{p}_{i=1} \beta_8 \Delta(ssx)_{t-i} + \Sigma^{q}_{i=1} \beta_9 \Delta(cmr)_{t-i} + \Sigma^{r}_{i=1} \beta_{10} \Delta(fii)_{t-i} + \Sigma^{s}_{i=1} \beta_{11} \Delta(fer)_{t-i} + \Sigma^{t}_{i=1} \beta_{12} \Delta(gp)_{t-i} + \Sigma^{t}_{i=1} \beta_{13} \Delta(ms)_{t-i} + \Sigma^{u}_{i=1} \beta_{14} \Delta(wpi)_{t-i} + ECT_{t-1} \qquad (3)$$

Here, Sensex is regressed with its lag value and the rest of the macroeconomic variables along with the lagged value error correction term. It is believed that the stationary and the lagged values will help establish the short-term connections ; whereas, the non-stationary variables will deduce a long-run relation.

Finally, to confirm the indicative characteristics of the model, the study uses the following test of diagnostic:

- To ascertain the stability of the model, the "CUSUM and CUSUM squared tests" were conducted (see Appendix Figure A1 and Figure A2).
- To verify for autocorrelation errors: The Breusch – Godfrey serial correlation Lagrange multiplier test was run (see Appendix Table A1).
- For the heteroscedasticity, the Breusch – Pagan – Godfrey test was conducted (see Appendix Table A2).

Analysis and Results

Augmented Dickey – Fuller (ADF)Test

An essential assumption of the ARDL model is that it can be applied only if the variables are integrated at *I*(0) and *I*(1). The unit root test results for stationarity carried out with the help of ADF are represented in Table 2.

The money supply, call money rate, and wholesale price index are integrated at the first level; foreign institutional investment, foreign exchange reserves, and gold prices are integrated at the zero level. Since the results satisfy the assumption, the model can be applied. Moreover, without omitting any long-run information, it blends the short-term consequences of the variables with a long-term equilibrium along with the error correction term. As a result, this model is used to examine both short-run and long-run correlations between macro-economic variables and the Sensex returns.

Table 2. ***Augmented Dickey - Fuller Test***

Level of Integration/Variables	Money Supply	Foreign Institutional Investment	Foreign Exchange Reserves	Gold Prices	Call Money Rate	Wholesale Price Index
I(0)	–2.251	–7.636*	–4.628*	–5.073*	–1.981	–2.695
I(1)	–4.185*				–7.885*	–5.878*

Note. * shows significance at 5%.

The Autoregressive Distributed Lag Model

The model developed follows ARDL (1,0,1,1,1,0,4) and the criterion used for selecting the model is the Akaike information criterion (HQ). The long-term association is shown in Table 3.

In the model, the dependent variable has one lag. The regressors in the model – call money rate has four lags; foreign exchange reserves, foreign institutional investment, and wholesale price index have one lag; and money supply and gold prices have no lags. Most of the model's regressors evident from the table are statistically significant. Table 3 shows that the Sensex is influenced by the lag of its value, money supply, lagged value of wholesale price index, FII, and call money rate at the 95% significance; whereas, the present value of foreign exchange reserves and its lag and the first lag of call money rate influences the Sensex at 90% significance. This implies that other chosen variables influence the stock market in the long run except for gold prices, the current wholesale price index, and call money rate.

Furthermore, the Wald test is conducted to verify both the term's relations between the variables. The results

Table 3. ***The ARDL Model***

Conditional Error Correction Regression	
Variable	**Coefficient**
SENSEX (lag 1)	–0.126*
Money Supply	–0.002*
Foreign Exchange Reserves	0.004**
Foreign Exchange Reserves (lag 1)	0.002**
Gold Prices	0.027
Wholesale Price Index	114
Wholesale Price Index (lag 1)	301*
Foreign Institutional Investment	0.013
Foreign Institutional Investment (lag 1)	–0.045*
Call Money Rate (Interest Rate)	87.2
Call Money Rate/Interest Rate (lag 1)	–1006**
Call Money Rate/Interest Rate (lag 2)	–177
Call Money Rate/Interest Rate (lag 3)	–619*

Note. *** shows significance at higher than 40%.

** shows significance at higher than 10%.

* shows significance at 5%.

Table 4. ***Wald Test***

Test Statistic	Value	Significance	*I*(0)	*I*(1)
F-statistic	6.85	10%	1.99	2.94
		5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99

are shown in Table 4. The value of the *F*- statistics is 6.85. *I*(0) represents the lower bound in the table, and *I*(1) illustrates the upper bounds. The null hypothesis states no relationship between the stock market and the selected macroeconomic variables in the co-integrated error correction model. Since this test's relevant critical value bounds are 99%, 97.5%, 95%, and 90%, the confidence interval exceeds the *F*-statistic value, and the null hypothesis is rejected. These results suggest the existence of a long-term association between the stock market performance and the variables.

After establishing a long-term relationship and the bounds tests, the following analysis constitutes a short-run relation (Table 5).

In the short run, as specified in Table 5, the dynamic movements of all the macroeconomic variables are shown by the estimated coefficients. It depicts that all of these variables, except gold prices and call money market, are significant at 90% or 95%. The foreign institutional investment and money supply are significant at a 90% confidence interval, while the wholesale price index and foreign exchange reserves are significant at 95%. Thus, it can be confirmed that except for gold prices, all the other chosen variables have both short-run and long-run links with the stock market.

Finally, the coefficient of the error correction model, coefficient λ, i.e., Coint Eq(–1), is statistically significant and negative. This suggests that the variables converge to equilibrium in the long run, conforming to a stable

Table 5. ***Short-Run Relationship***

Levels Equation	
Variable	**Coefficient**
Money Supply	–0.017**
Wholesale Price Index	2393*
Foreign Institutional Investment	–0.357**
Foreign Exchange Reserves	0.010*
Gold Prices	0.218
Interest Rate	6964

Note. *** shows significance at higher than 40 %.

** indicates significance at higher than 10 %.

* shows significance at 5%.

long-run relationship and the presence of cointegration between the dependent and the independent variables. The value of λ is equal to $\lambda = 0.12$, which signifies that the stock market returns will come back after aftershocks in the macroeconomic variables in the long run at the speed of 120% per year.

Conclusion

The study investigates the relationship between stock market returns in terms of proxy chosen as Bombay Stock Exchange's index – the Sensex and the determined macroeconomic variables of India – call money rate (interest rate), foreign institutional investment, foreign exchange reserves, gold prices, money supply, and wholesale price index (inflation rate) using the ARDL model. The ARDL model results indicate a long-run and short-run relationship between the Sensex and the call money rate, foreign institutional investment, foreign exchange reserves, wholesale price index, and money supply at various significance levels. At the same time, gold prices do not impact the stock market.

The results indicate that most of the relationships are in line with their theoretical foundations, except for money supply, which is assumed to be positively related and turns out to be negative, and gold prices, which are supposed to have a negative impact on the stock market but do not show any influence on the market. Other variables, such as foreign institutional investment and foreign exchange rate, show a positive relationship with the stock market. At the same time, call money rate and inflation rate show a negative impact on the market. This finding is in line with the results obtained by Sarker and Mondal (2016).

Further, the study also indicates the depth of the stock market activities through the speed of adjustments towards the long-run equilibrium by estimating the error term, which is negative and highly significant. The rate of adjustment is 120% between short-run dynamics and long-run equilibrium values, and it is the rate at which the market will adjust to changing economic circumstances.

Policy Implications

The above findings would augment the investor's portfolio knowledge and assessment regarding the stock market's sensitivity to any macroeconomic variables change. Moreover, it would bolster the portfolio manager's ability to make significant investment decisions by providing them with enhanced insights into portfolio selection, macroeconomic risk, country risk, risk-return relationship, and diversification of risk corresponding to the country and the world. These estimations will also benefit the policymakers and regulators to formulate

appropriate monetary and fiscal policy stances and shield the Indian market against global risk related to foreign exchange reserves and interest rate changes.

Limitations of the Study and Scope for Further Research

- The study has been done for a limited period from April 2012 – June 2020. The research period can be extended for further research.
- The macroeconomic variables considered for the research are limited to call money rate, foreign institutional investment, foreign exchange reserves, gold prices, money supply (M3), and the wholesale price index. Many other macroeconomic variables can be used to study the relationship. Further, the study considers only firms listed on the BSE500 Index, and it could be extended to cover firms listed on the National Stock Exchange to provide a comparative picture.
- The sector-wise impact of macroeconomic variables can be ascertained in future studies.
- The results are drawn based on the ARDL model to derive a short-term and long-term relationship. Other statistical techniques, such as the vector error correction model, can be used to conduct the same study.

Authors' Contribution

Dr. Dinkar Nayak conceived the idea and developed the research design to undertake the empirical study. He extracted highly reputed research papers, filtered these based on keywords, and generated concepts and codes relevant to the study design. He also verified the analytical methods and supervised the study. The data collection and data analysis were done by Rubina Barodawala using Eviews. Dr. Dinkar Nayak wrote the manuscript in consultation with Rubina Barodawala.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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Appendix

Diagnostic Checking

CUSUM and CUSUM square test

Figure A1. ***CUSUM Test***

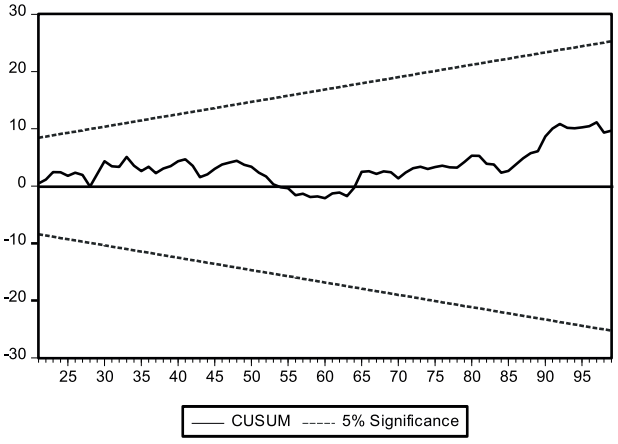
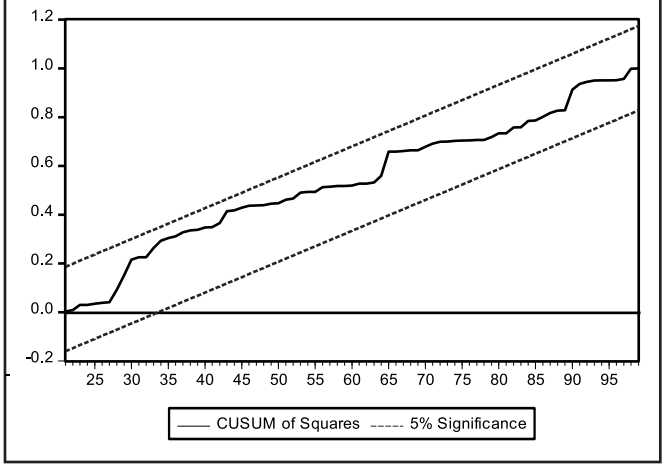


Figure A2. ***CUSUM Square Test***



As it is clear from Figures A1 and A2, the plots of the CUSUM and CUSUM square test fall within the boundaries of the confidence interval, and hence, these statistics confirm the stability of the regressors in the long run.

Breusch–Godfrey Serial Correlation Lagrange Multiplier test is used to check for autocorrelation errors in the model.

Table A1. ***Serial Correlation Test***

Breusch – Godfrey Serial Correlation LM Test			
F-statistics	2.413	Probability *F*(2,77)	0.10

The null hypothesis of the Breusch – Godfrey serial correlation test states that there is no serial autocorrelation in the model. Since the probability of the *f*-statistics of the model is greater than the 5% significance level, the null hypothesis is accepted, and there is no serial autocorrelation found in the ARDL model.

Breusch – Pagan – Godfrey test is used for checking heteroscedasticity.

Table A2. ***Heteroscedasticity Test: Breusch – Pagan – Godfrey***

F-statistics	1.009	Probability *F*(14,79)	0.4532
Observed *R*-squared	14.257	Probability Chi-square(14)	0.4307

The null hypothesis of the Breusch – Pagan – Godfrey heteroscedasticity test states that there is the same variance in the model. The probability value of the *f*-statistics is greater than 0.05, that is, greater than the 5% level of significance. Thus, in this case, the null hypothesis is accepted for no heteroscedasticity in the ARDL model.

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