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Research paper

Exploring The Dynamic Relationship between Macroeconomic Variables on India's Premier Benchmark Sensex 30 Index

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Abstract

The purpose of the study is to examine the impact of macroeconomic indicators on the closing prices of the BSE Sensex 30, a key benchmark index in India known for its volatility in response to economic conditions. This research is particularly relevant in the context of economic shocks, as it aims to recommend the adoption of appropriate economic policies that could benefit the stock market index, ultimately advancing growth in the capital market. Using the ordinary least squares (OLS) method, the study analyzes the effect of various macroeconomic variables on the BSE Sensex. Additionally, the complex relationship between these variables is explored using the Johansen Cointegration test and evidenced through the Vector Error Correction (VECM) model. The findings reveal that GDP, the Index of Industrial Production (IIP), India's foreign trade, gold prices, Foreign Direct Investment (FDI), and money supply significantly influence the BSE Sensex. However, External Commercial Borrowing, the Consumer Price Index (CPI), exchange rates, and foreign exchange, which showed the highest Variance Inflation Factors (VIF), were excluded from the study based on OLS results. In conclusion, the study advocates for the implementation of suitable economic policies that support the stock market, thereby aligning with investors' interests and promoting capital market growth.

Keywords: *Cointegration; Econometrics; Multicollinearity; OLS; VECM JEL: G1; G40; O16.*

1. Introduction

Stock markets react to various macroeconomic variables, viz. Gross Domestic Product (GDP), Inflation, Crude Oil, Index for Industrial production(IIP), Interest rate, Balance of payment (BOP), etc. Indian stock markets, being one of the largest markets in the world, react to various macroeconomic shocks positively and negatively [1,2], and forecasting becomes a challenge due to volatility in Indian key benchmark indices such as the BSE Sensex 30. Hence, assessing the long-term association of macroeconomic variables with the BSE Sensex 30 is essential for investment decisions. Investor sentiment generally boosts when the BSE Sensex 30 Index performance is better and the other-way around [3]. To understand a stock market's long-term association with macroeconomic variables, the Cointegration test is inevitable [4]. Due to pandemic shocks, it is evident that establishing a long-term association among the said macroeconomic variables provides valuable insights to investors for quick decisions [5].

The Strength of the long-term association between independent variables like IIP, Inflation, Interest rates, Gold prices, Exchange rate, FII, and supply of Money, and the Dependent variable Sensex is assessed through Cointegration, Granger Causality, and the Vector Error Correction model, which is emphasized in recent past literature (28). There exist mixed results of the impact of macroeconomic variables on stock markets. But, when analyzed through OLS, where logged data should be checked for stationarity, which avoids spurious regression, ensuring the presence of an arbitrage opportunity for earning above normal returns based on the exchange rate variable [6], [7]. The relationship between stock markets and macroeconomic factors is studied globally through the application of Arbitrage Pricing theories, the discounted cash flow method, and capital asset pricing models, which are unsuitable for emerging markets like India, as the market is deficient. Hence, domestic macroeconomic factors have a long-term impact on stock markets [8]. The market relies on an optimistic macroeconomic environment, but firm-specific and unforeseen events in the economy also affect stock markets. The factor analysis method can be employed to assess the above impact. The Indian Stock market is a weak form of Efficient because of the non-existence of a relationship between Call money, Foreign Institutional Investors, Inflation rate, Index for Industrial Production, and BSE 500 [9]. A short-term causality check is vital, and FII inflow and outflow change the movement of IPO in India [10].

The study examines the impact of seven macroeconomic variables—including GDP, business confidence index, foreign direct investment, corporate bond yield, T-bill yield, interbank rate, and BSE Sensex performance—on IPO activity in India from 2011 to 2020, revealing that business confidence, GDP, market performance, and FDI significantly influence IPO volume over time using VAR, variance

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decomposition, and impulse response analyses (28). The stock market reacts to the performance of the firm-specific factors and unforeseen events in the economy. An association between Indian stock markets and various macroeconomic factors has been studied and identified that Indian stock markets improve with the increase in the Inflow of foreign investment [11]. Appreciation in the value of INR/USD needs to improve to facilitate a Bullish trend in the market. Principal component analysis is used for extracting variables into factors, which resulted in three variables, namely macroeconomic, capital market performance, and macro-environment [12]. Capital Market Performance was highly positive to the growth of Capitalization, whereas the Stock market is highly responsive to Capital Market performance [13]. Long-term association among the BSE Index and a few macroeconomic variables like IIP, CPI, M1, analyzed through the vector Error Correction model. The association between the stock market Index and macroeconomic variables was studied through Box-Jenkins employing the ARIMA test. The results exhibit a weak form of efficiency for BRIC Markets [14].

VECM overcomes misspecification biases of conventional VAR models, yielding superior assessments of long-term association among variables and the indices [15]. How macroeconomic variables can influence different sectors of stock markets in the US and Canada is investigated and results indicate a positive impact on the economy [16]. There is a stable long-term association between macroeconomic variables used in the study and different sector indices of the US. BRICS countries ' stock markets always have asymmetric dependence on oil price shocks [17], which is further investigated through the framework of quantile regression, resulting in positive shocks of crude oil having a greater impact on bull markets, whereas negative shocks of crude oil have a greater impact on bear markets [18]. Lagged parameters can cause more volatility in Sensex, which is identified through exchange rates versus Sensex. Adoption of appropriate economic policies is beneficial and helps in the growth of capital markets [19]. Often, money supply as a macroeconomic variable affects the stock prices positively and negatively [20]. FDI inflows are dependent on government policies, and each dollar in foreign affiliate will reduce the domestic capital stock by 20 to 40 percent [21]. Whereas outward FDI on stock price crash risk is more significant when companies invest in a more convenient form of business [22]. As part of Government policies, Fiscal deficit affects the performance of stock markets in India, where the government should make appropriate policies to reduce fiscal deficit in turn helps in the movement of Indian stock prices, as public interests are largely involved. The above literature provides most Individual macroeconomic variables that affect the stock prices. The current study undertook many macroeconomic variables, which were further narrowed down to a selective approach after an assumption check.

Lack of understanding of stock prices and the effect of various macro variables on stock prices makes many investors lose their money. Furthermore, prices are volatile due to macro variable shocks, and it is evident for policymakers to come out with effective decisions for the protection of investors' interests, and equally important for financial analysts for analyzing the right stocks for advising clients. Hence, the study focused on accurate ARIMA (p,d,q) model optimum decision making [23].

[1]The primary objective of the study is to analyse the effect of selected macroeconomic variables on the BSE Sensex 30. Furthermore, to investigate the long-term association among selected macroeconomic variables and the BSE Sensex 30. Finally, to evaluate the existence of an association through the VAR/VECM model.

2. Data and methodology

Yearly data of independent variables for the Period 2011-12 to 2022-23 is sourced from the Reserve Bank of India[1], Department of Industrial Policy and Promotion[2] (DIPP), and dependent variables are sourced from Bombay Stock Exchange[3]. The independent variables identified for the study are Gross Domestic Product, Consumer price index, Lending rate, oil Prices, Fiscal Deficit, balance of payment, Foreign Direct Investment, Net Portfolio Investment, Exchange rate, India's Foreign Trade, Index for Industrial Production, Money Supply (M0, M1, M3) and India External Debt (ECB). The dependent variable considered for the study includes the BSE Sensex 30.

The study considers the listed macroeconomic variables in assessing their impact on Indian key Benchmark indices such as the BSE Sensex 30. The Cointegration test is applied to analyze the long-term association, along with the Granger Causality test to determine the causal relationship between dependent and independent variables. Furthermore, it is administered through the Vector Error Correction model. The Novelty is bringing in the BSE index for the study, which is a driving factor for major Bull and Bear markets [24]. EViews and Gretl platforms are used for testing the data.

Thus, the model can be expressed as follows:

$$BSE = \alpha + \beta(1) \times CPI + \beta(2) \times BOP + \beta(3) \times ECB + \beta(4) \times ER + \beta(5) \times FDI + \beta(6) \times FER + \beta(7) \times GDP + \beta(8) \times IFT + \beta(9) \times GOLD + \beta(10) \times IIP + \beta(11) \times M1 + \beta(12) \times M2 + \beta(13) \times M3 + \beta(14) + et \quad (1)$$

Where:
BSE: Dependent variable
α: Constant or Intercept
β: Beta Coefficient
et: error term
The following is Table 1 displays explanatory and explained variables: variable name, description, symbol, and from where it is sourced.

3. Description of variables

Table 1: Exhibits Description of Variables, Such as Variable Name, Description, Symbol, and from Where It Is Sourced, Are Mentioned

SL. No	Variables	Description	Symbol	Source
1	Gross Domestic Product	GDP growth is often considered a leading indicator of stock market performance. Gross Domestic Product is the total monetary value of all finished goods and services produced within a country's borders in a specific period. Expressed in crores of INR	GDP	Reserve Bank of India (www.rbi.org.in)

[1] Website of Reserve Bank of India URL: https://www.rbi.org.in
[2] Website of Department for Promotion of Industry and Internal Trade URL: https://www.dpiit,.gov.in
[3] Website of Bombay Stock Exchange URL: https://bseindia.com

2	Inflation	Inflation is the rate of increase in prices over a given period. Measured in terms of CPI. Consumer Price Index, Base Year 2012, 2016. Expressed in points	CPI	Reserve Bank of India (www.rbi.org.in)
3	Exchange Rate	An exchange rate is the relative price of one currency expressed in terms of another currency. Expressed as the average exchange rate of INR per USD	ER	Reserve Bank of India (www.rbi.org.in)
4	External Commercial Borrowings	The portion of the country's debt that is borrowed from foreign lenders. Shown as INR in Crores	ECB	Reserve Bank of India (www.rbi.org.in)
5	Index of Industrial Production	IIP is an Index for India that details the growth of various sectors in an economy, and it is measured as the General Index of Industrial Production, Base year 2011-12. Expressed in points	IIP	Reserve Bank of India (www.rbi.org.in)
6	Gold Prices	Gold is a vital layer of diversification to an investment portfolio. Investments such as stocks falter, but gold has a tendency to outperform. Expressed as the average gold price in INR per 10 grams	GP	Reserve Bank of India (www.rbi.org.in)
7	Foreign-Trade	Exchange of goods and services between two or more countries in the international market. Shown as INR in Crores	IFT	Reserve Bank of India (www.rbi.org.in)
8	Balance of Payments	Measured all of the international monetary transactions within a certain period. Expressed in crores of INR	BOP	Reserve Bank of India (www.rbi.org.in)
9	FDI-Inflows	Measures the investment made in a country by another country	FDIi	Department for Promotion of Industry and Internal Trade (www.dpiit.gov.in)
10	Money supply	The total amount of Money- Cash, coins, and balances in bank accounts in circulation. Measured as Reserve Money(M0), Narrow Money(M1), Broad Money(M3) expressed in Lakh crores of INR.	M0, M1, M3	Reserve Bank of India (www.rbi.org.in)
11	Bombay Stock Exchange	BSE Sensex	BSE	BSE India (https://www.bseindia.com)
12	Foreign Exchange Reserves	Assets held on reserve by the RBI in foreign currencies. It has a positive and significant effect on the stock market and is shown as INR in Crores	FER	Reserve Bank of India (www.rbi.org.in)
13	Fiscal Deficit	Budgetary policies aimed at reducing fiscal deficits through restriction measures or revenue-raising measures are positively pursued by investors, strengthening market confidence and supporting stock prices. Measured in absolute terms, expressed in crores of INR.	FD	Reserve Bank of India (www.rbi.org.in)

Source: Author's compilation.

4. Data analysisSSS

Table 2 deals with descriptive statistics, where the BSE index value indicates the average performance of the stock market during the period. The positive skewness suggests that the distribution is slightly skewed to the right, implying a longer tail on the positive side of the distribution. The GDP data suggests the average economic output during the period. The negative skewness implies that the distribution is slightly skewed to the left, with a longer tail on the negative side. Furthermore, the study is enhanced with the Ordinary Least Squares method with assumption check, and the process of the study is given below.

Table 2: Descriptive Statistics

Statistic	BSE	GDP	CPI	ER	ECB	IIP	IFT	M1	M2	M3	BOP	FDI
Mean	33212.08123	2759606.135	139.4185185	64.975763	2573160	129.087	88713.64815	131313997.8	3433313.576	133402023	47775.98	22438.5
Standard Deviation	14426.28651	701012.3818	20.56360656	10.5367128	893756.8	21.06028	39470.27056	942533974.1	2352599.123	5389203.94	89688.58	11636.02
Kurtosis	-0.50534739	-0.26301703	0.462854071	-0.5552356	0.945234	0.14045	1.365491741	53.99976436	22.77786579	0.89841134	1.657002	0.923615
Skewness	0.798205476	-0.46636902	0.346132605	0.37047641	0.121873	0.601424	1.178919783	7.348445619	4.036729789	0.46446923	0.003987	0.844353
Minimum	16482.43	1156466	105.2	44.708	995779	84	-208252	1472040.29	1498991.623	5687610.07	-242411	5114
Maximum	65729.16333	3979161.543	185.5	82.651	4145281	180.1	-24888	692922626454	1733236 2.54	2488652 8.5	239583	58264
Count	54	54	54	54	54	54	54	54	54	54	54	54

Source: Author's compilation.

Figure 1 illustrates the structural progression of the research methodology, beginning with the Ordinary Least Squares (OLS) method. This is followed by an examination of Cointegration and the Vector Error Correction Model (VECM). Diagnostic research is subsequently explained

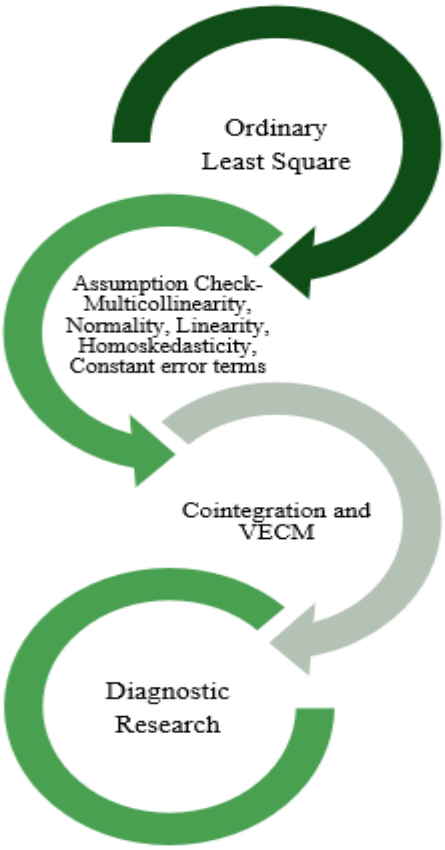


Fig. 1: Ordinary Least Squares (OLS) Method.

The study flow includes the ordinary least squares method followed by assumption checks like linearity, Normality, Multicollinearity, heteroskedasticity, and diagnostic tests. We have predicted the prices of BSE through the application of Auto Regressive Integrated Moving Averages (ARIMA) and the long-term association among macroeconomic variables and Sensex through the Johansen Cointegration test, and its viability is tested through the Vector Error Correction Model. while for the short term, its cause and effect is identified through the Granger causality test.
Table 3 presents the Ordinary Least Squares (OLS) estimation for cross-sectional data.

Table 3: Ordinary Least Squares for Cross-Sectional Data

Dependent Variable: BSE Method: Least Squares Date: 03/24/24 Time: 17:12 Sample: 154 Included Observation: 54				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	178.6834	43.00885	4.154573	0.0002
BOP	0.009545	0.003825	2.495692	0.0168
ECB	0.004572	0.002773	1.648545	0.1071
ER	-228.9416	161.1547	-1.42063	0.1632
FDI	-0.104698	0.033019	-3.17081	0.0029
FER	0.009894	0.001453	6.807077	0
GDP	-0.00058	0.001289	-0.45016	0.655
IFT	-0.078364	0.013082	-5.99013	0
Gold	-0.397996	0.081452	-4.88629	0
IIP	68.60878	15.77604	4.348921	0.0001
M1	4.86E-07	2.78E-07	1.748322	0.0881
M2	-0.000183	0.000114	-1.60012	0.1174
M3	8.16E-05	0.000202	0.404717	0.6878
CPI	-14957.38	7504.856	-1.99303	0.0531
R -Suqared	9.92E-01	Mean dependent var		33212.08
Adjusted R-squared	0.98892	S.D dependent var		14426.29
S.E. of regression	1.52E+03	Akaike info criterion		17.70731
Sum squared resid	92239787	Schwarz criterion		18.22298
Log likelihood	-4.64E+02	Hannan-Quinn criterion		17.90618
F-statistic	364.8684	Durbin-Wats on stat		1.6598935
Prob(F-statistic)	0.00E+00			

Source: Author's compilation.

Table 4 indicates the variance Inflation factor for the selected variables.

Table 4: Varience Inflation Factor

Variance Inflation Factors Date: 04/02/24 Sample: 154 Included Observation: 52 Variable	Coefficient Variance	Uncentered VIF	Centered VIF
GDP(-1)	2.66E-06	109.894	5.824051
BOP	3.68E-05	1.985433	1.534128
GOLD(-1)	0.013719	89.67757	7.437414
IFT(-1)	0.000492	22.91565	3.563072
IIP(-1)	668.0592	57.56557	1.470479
M2(-1)	5.50E-08	4.824096	1.532227
FDI(-1)	0.004623	15.25036	3.165597
M1(-2)	1.02E-06	57.19787	9.776761
C	23526147	120.1368	NA

Source: Author's compilation.

Figure 2: A normality test is a statistical procedure used to determine whether a dataset is well-modeled by a normal distribution (bell-shaped curve). This is essential for many parametric statistical tests (like t-tests, ANOVA, and regression) that assume normality of residuals or variables.

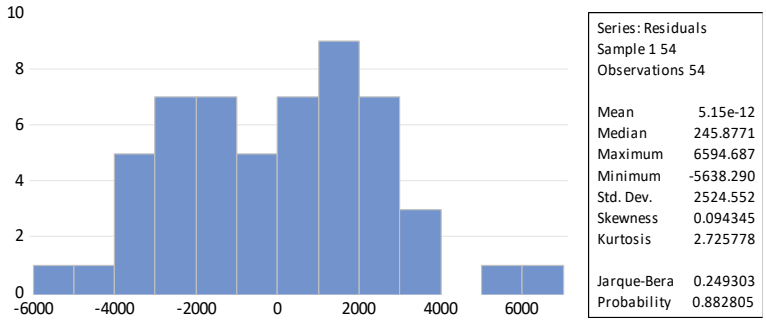


Fig. 2: Normality Test.

Source: Author's compilation.

Figure 3: The CUSUM test (Cumulative Sum test) is a diagnostic tool used to detect structural breaks or instability in time series regression models — especially in the coefficients over time. It's commonly applied after estimating a model (like ARDL) to test the stability of parameters.

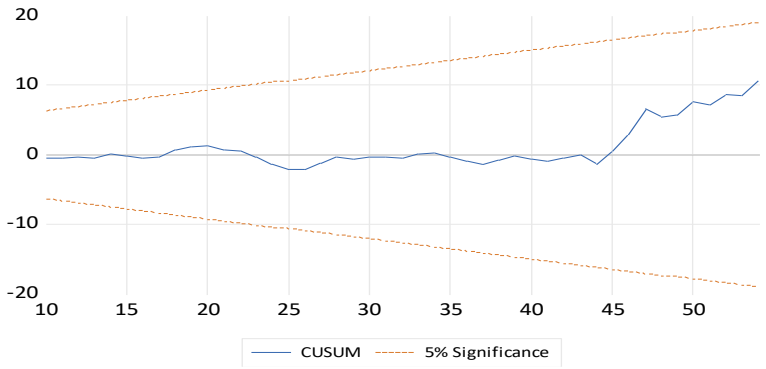


Fig. 3: Cusum Test.

Source: Author's compilation.

Table 5 illustrates that the VAR lag length refers to the number of lagged observations included in the Vector Autoregressive model. This parameter determines how many past values of each variable are used to predict the current value of all variables in the study. Selecting an appropriate lag length is crucial for accurate forecasting and inferences in the VAR model [25-26].

Table 5: VAR Lag Length

Var Lag Order Selection Criteria Endogenous Variables: BSE CPI BOP FDI GDP IFT GOLD IIP M1 M2 Exogenous Variables: C Date: 03/24/24 Time: 17:34 Sample: 154 Included observations: 52 Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5940.269	NA	1.17E+87	228.8565	229.2317	229.0004
1	-5601.667	5.339494*	1.29e+83*	219.6795	223.8071*	221.2619*
2	-5501.122	119.881	1.92E+83	219.6585*	227.5385	222.6795
* indicates lag order selected by the criterion LR: sequential modified LR test statistic (each test at 5% level)						

FPE: Final Prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Author's compilation.

Table 6 demonstrates whether a linear combination of non-stationary time series variables is stationary. It suggests a long-term relationship between the variables, indicating that they move together over time.

Table 6: Cointegration Test

Date: 04/12/24 Time:19.05				
Sample (adjusted): 354				
Included observation: 52 after adjustments				
Trend assumption: Linear deterministic trend				
Series: BSE BOP FDI GDP GOLD IFT IIP M1 M2				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No.of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.771257	278.5521	197.3709	0
Atmost 1*	0.657927	201.844	159.5297	0
Atmost 2*	0.551863	146.062	125.6154	0.0016
Atmost 3*	0.421049	104.3238	95.75366	0.0113
Atmost 4*	0.36863	75.90387	69.81889	0.0151
Atmost 5*	0.331582	51.99102	47.85613	0.0194
Atmost 6*	0.29271	31.04322	29.79707	0.0358
Atmost 7	0.203679	13.03486	15.49471	0.1135
Atmost 8	0.0222656	1.191682	3.841465	0.275
Trace test indicates 7 Cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**Mackinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No.of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None*	0.771257	76.70809	58.43354	0.0004
Atmost 1*	0.657927	55.78206	52.36261	0.0215
Atmost 2*	0.551863	41.73817	46.23142	0.1402
Atmost 3*	0.421049	28.41993	40.07757	0.532
Atmost 4*	0.36863	23.91285	33.87687	0.4619
Atmost 5*	0.331582	20.9478	27.58434	0.2794
Atmost 6*	0.29271	18.00836	21.13162	0.1295
Atmost 7	0.203679	11.84318	14.2646	0.1167
Atmost 8	0.0222656	1.191682	3.841465	0.275
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**Mackinnon-Haug-Michelis (1999) p-values				

Source: Author's compilation.

Table 7 indicates the Cointegrating coefficients of the variables.

Table 7: Cointegration Equations

1 Conintegrating Equation(s): Log likelihood -5075.709								
Normalized cointegrating coefficients (standard error in parentheses)								
BSE	BOP	FDI	GDP	GOLD	IFT	IIP	M1	M2
1	-0.00222	1.672224	-0.0174	0.721924	-0.17534	-10.6553	-0.01754	-0.00302
	(0.01455	(0.16242	(-0.00308)	-0.2357	-0.04774	-50.9207	-0.00207	-0.00062

Source: Author's compilation.

5. VECM model

The substituted values in the equation are as follows.

$$BSE(-)=69927.32 + 0.1635 \times BOP(-1) -0,5074 \times FDI)-1) + 0.0172 \times GDP(-1) + 1.5519 \times GOLD(-1)-0.1798 \times IFT(-1)+109.4351 \times IIP(-1)-0.0284 \times M1(-1) + 0.01851 \times M2(-1) \quad (2)$$

Table 8 demonstrates the causality relationship between chosen macroeconomic variables and the BSE Sensex 30 Index.

Table 8: Granger Causality Test Results

Pairwise Granger Causality Tests			
Date: 04/12/24 Time: 18:23			
Sample: 154			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
BOP(-1) does not Granger Cause BSE(-1)	51	1.89973	0.1612
BSE(-1) does not Granger Cause BOP(-1)		0.28315	0.7547
FDI(-1) does not Granger Cause BSE(-1)	51	3.74835	0.031
BSE(-1) does not Granger Cause FDI(-1)		2.96466	0.0615

GOLD(-1) does not Granger Cause BSE(-1)	51	5.49421	0.0073
BSE(-1) does not Granger Cause GOLD(-1)		4.59139	0.0152
GDP(-1) does not Granger Cause BSE(-1)	51	2.87728	0.0665
BSE(-1) does not Granger Cause GDP(-1)		3.04927	0.0571
IFT(-1) does not Granger Cause BSE(-1)	51	2.14206	0.129
BSE(-1) does not Granger Cause IFT(-)		3.47411	0.0393
IIP(-1) does not Granger Cause BSE(-1)	51	1.01816	0.3693
BSE(-1) does not Granger Cause IIP(-1)		0.51634	0.6001
M1(-1) does not Granger Cause BSE(-1)	51	8.67803	0.0006
BSE(-1) does not Granger Cause M1(-1)		5.41037	0.0078
M2(-1) does not Granger Cause BSE(-1)	51	0.18339	0.833
BSE(-1) does not Granger Cause M2(-1)		3.384	0.0426
FDI(-1) does not Granger Cause BOP(-1)	51	0.00978	0.9903
BOP(-1) does not Granger Cause FDI(-1)		0.47826	0.6229
GOLD(-1) does not Granger Cause BOP(-1)	51	1.59938	0.2131
BOP(-1) does not Granger Cause GOLD(-1)		0.67836	0.5125
GDP(-1) does not Granger Cause BOP(-1)	51	0.79266	0.4587
BOP(-1) does not Granger Cause GDP(-1)		1.10044	0.3413
IFT(-1) does not Granger Cause BOP(-1)	51	7.60482	0.0014
BOP(-1) does not Granger Cause IFT(-1)		0.57792	0.5651
IIP(-1) does not Granger Cause BOP(-1)	51	0.76249	0.4723
BOP(-1) does not Granger Cause IIP(-1)		0.08073	0.9226
M1(-1) does not Granger Cause BOP(-1)	51	2.80234	0.0711
BOP(-1) does not Granger Cause M1(-1)		4.49692	0.0165
M2(-1) does not Granger Cause BOP(-1)	51	0.1467	0.864
BOP(-1) does not Granger Cause M2(-1)		0.23404	0.7923
GOLD(-1) does not Granger Cause FDI(-1)	51	3.92116	0.0268
FDI (-1) does not Granger Cause GOLD(-1)		1.17664	0.3174
GDP(-1) does not Granger Cause FDI(-1)	51	5.89701	0.0052
FDI(-1) does not Granger Cause GDP(-1)		3.04472	0.0573
IFT(-1) does not Granger Cause FDI(-1)	51	4.22733	0.0206
FDI(-1) does not Granger Cause IFT(-1)		3.63475	0.0342
IIP(-1) does not Granger Cause FDI(-1)	51	1.4475	0.2457
FDI(-1) does not Granger Cause IIP(-1)		0.39809	0.6739
M1(-1) does not Granger Cause FDI(-1)	51	8.22548	0.0009
FDI(-1) does not Granger Cause M1(-1)		4.06605	0.0237
M2(-1) does not Granger Cause FDI(-1)	51	0.63331	0.5354
FDI(-1) does not Granger Cause M2(-1)		1.58514	0.2159
GDP(-1) does not Granger Cause GOLD(-1)	51	0.87638	0.4231
GOLD(-1) does not Granger Cause GDP(-1)		1.54865	0.2234
IFT(-1) does not Granger Cause GOLD(-1)	51	3.51891	0.0378
GOLD(-1) does not Granger Cause IFT(-1)		3.60862	0.035
IIP(-1) does not Granger Cause GOLD(-1)	51	4.30972	0.0193
GOLD(-1) does not Granger Cause IIP(-1)		1.00368	0.3744
M1(-1) does not Granger Cause GOLD(-1)	51	2.92522	0.0637
GOLD(-1) does not Granger Cause M1(-1)		3.3799	0.0427
M2(-1) does not Granger Cause GOLD(-1)	51	0.84844	0.4347
GOLD(-1) does not Granger Cause M2(-1)		5.26457	0.0087
IFT(-1) does not Granger Cause GDP(-1)	51	0.3249	0.7242
GDP(-1) does not Granger Cause IFT(-1)		1.07436	0.3499
IIP(-1) does not Granger Cause GDP(-1)	51	2.88821	0.0658
GDP(-1) does not Granger Cause IIP(-1)		0.60094	0.5525
M1(-1) does not Granger Cause GDP(-1)	51	4.03774	0.0242
GDP(-1) does not Granger Cause M1(-1)		2.72137	0.0764
M2(-1) does not Granger Cause GDP(-1)	51	0.05387	0.9476
GDP(-1) does not Granger Cause M2(-1)		2.55469	0.0887
IIP(-1) does not Granger Cause IFT(-1)	51	0.29364	0.7469
IFT(-1) does not Granger Cause IIP(-1)		0.00932	0.9907
M1(-1) does not Granger Cause IFT(-1)	51	6.43808	0.0034
IFT(-1) does not Granger Cause M1(-1)		1.22186	0.3041
M2(-1) does not Granger Cause IFT(-1)	51	1.39099	0.2591
IFT(-1) does not Granger Cause M2(-1)		2.43348	0.0989
M1(-1) does not Granger Cause IIP(-1)	51	0.51949	0.5983
IIP(-1) does not Granger Cause M1(-1)		0.36403	0.6969
M2(-1) does not Granger Cause IIP(-1)	51	10.1243	0.0002
IIP(-1) does not Granger Cause M2(-1)		2.31296	0.1104
M2(-1) does not Granger Cause M1(-1)	51	0.07289	0.9298
M1(-1) does not Granger Cause M2(-1)		3.87829	0.0278

Source: Author's compilation.

6. Results & discussion

The current study investigated the dynamic relationships between the BSE Sensex 30 index and various macroeconomic variables such as GDP, inflation, IIP, BOP, and Gold prices. To test the hypothesis, the OLS regression was used. The findings of the study revealed that there exists a significant effect of macroeconomic variables which is impacting on the BSE Sensex 30. These findings are in line with [4,7,9,13,14] who exhibited similar results in the emerging economies. Unique's explanatory power of independent variables is highly relevant in estimating the dependent variable closing price, and hence VIF or closely related tolerance level (TIs) are frequently used to check multicollinearity. High Variance Inflation Factors (VIFs) for variables such as ECB, ER, FER, and M3 indicated significant

multicollinearity, prompting their removal to enhance the model's reliability. Post-removal, remaining variables showed acceptable VIFs, confirming the absence of multicollinearity. The Breusch-Pagan-Godfrey test yielded a p-value of 0.0561, suggesting consistent residual variance (homoscedasticity), while normality checks verified that the data followed a normal distribution, essential for valid statistical inference. Serial Correlation is a popular test, and in the current study, Serial correlation tests, including Durbin-Watson, demonstrated no significant serial correlation in the residuals, supporting the model's accuracy and robustness, and results are in line with the literature [23]. These variables are subjected to high VIF due to decision-making in terms of interest rates by the central bank and fiscal budgets by the Government, and also these variables are affected by geopolitical factors. The Cusum test showed stable residuals within acceptable limits, indicating model reliability. The Ramsey RESET test confirmed linearity with a probability value of 0.97. Using the VAR Lag Order Selection Criteria, a lag length of two (2) was chosen, guiding the implementation of the Autoregressive Distributed Lag (ARDL) model for assessing short-term dynamics. Cointegration tests such as the Bounds test and Maximum Eigenvalue test indicated a significant long-term association between the BSE Sensex index and other macroeconomic variables, with the latter providing a p-value of 0.0215 at lag 1. This evidence of cointegration underlines the presence of a stable long-term relationship, offering insights into the nuanced interaction between the BSE index and macroeconomic factors over time [12], which showed similar outcomes in the emerging economies.

The analysis established a long-run relationship between the macroeconomic variables and the BSE Sensex 30 index based on the criterion that the coefficient should be negative and statistically significant ($p < 0.05$). From the results, the coefficient C(8) was found to be significant, confirming a long-term relationship. Short-run associations were evaluated using the Granger causality test, which demonstrated that FDI, Gold, and M1 have a causal effect on BSE Sensex with significant p-values of 0.0310, 0.0073, and 0.00008, respectively. Conversely, BOP, GDP, IFT, IIP, and M2 were found to have p-values above 0.05, indicating no significant short-run association with BSE Sensex. This suggests that these variables do not have a causal impact on the BSE index in the short run. The Pairwise Granger Causality tests reveal several statistically significant causal relationships at the 5% level. Notably, FDI, GOLD, GDP, and M1 significantly Granger-cause BSE, suggesting that changes in these macroeconomic indicators can help predict stock market movements. There is also bidirectional causality between BSE and GOLD, and BSE and M1, indicating a feedback loop between these variables. Additionally, IFT Granger-causes BOP, while GDP and M1 Granger-cause FDI, highlighting the influence of domestic economic activity on foreign investment. Other notable relationships include GOLD ↔ IFT and M2 → IIP. Overall, the results suggest strong interlinkages between financial markets and macroeconomic variables, with monetary aggregates (M1, M2) and external sector indicators (FDI, IFT) playing key predictive roles. The Vector Error Correction Model (VECM) is applied to the positive and negative impact of identifiable variables on Sensex. Based on reversing the signs, the equation obtained indicates BOP, GDP, Gold, IIP have a positive impact of 0.1635,0.0172,1.5519,109.4351, and 0.0185, respectively at the first order of difference, whereas FDI, IFT, and M1 hurt BSE to an extent of 0.5074,0.1798, and 0.0284, respectively [12]. These results show the maximum likely effect of variables on the movement of the BSE Sensex 30, which provides an insight to retail investors, high net worth individuals (HNIs), domestic individual investors (DII), and other stakeholders interested in decision-making.

The above VECM model evaluates the positive and negative impact of selected macroeconomic variables on the dependent variable, such as the BSE Sensex 30. VECM is employed once cointegration is confirmed among variables, indicating their association. After stationarizing the variables, signs in the VECM results need to be reversed to accurately determine the positive and negative effects of the variables on the BSE Sensex 30 [15].

7. Conclusion

In today's dynamic economic landscape, marked by technological advancements, globalization, and liberalization, the need to diversify risk and closely monitor changes in the economic environment has become paramount. This involves examining a plethora of macroeconomic indicators, including GDP, inflation, FDI, IIP, IFT, and gold prices, among others, to gauge their impact on market dynamics [15]. The study aimed to comprehend how changes in these indicators impact BSE Sensex 30 prices, which are set as a vital gauge of stock market performance in India.

The study meticulously selected ten macroeconomic variables initially, which were subsequently narrowed down to 9 based on their impact and the highest variance inflation factor (VIF) assumption check. Additionally, various diagnostic checks were performed to ensure the robustness of the analysis. These checks included assessing linearity using the Ramsey Reset Test, normality through the Jarque-Bera test, evaluating correlation effects via the Correlation Q, and examining serial correlation. Moreover, the stability of the model was scrutinized using the Cusum test.

The empirical objectives were examined through the Johansen Cointegration test, which indicated the existence of a long-term association between the selected macroeconomic variables and BSE Sensex 30 closing prices [19]. Likewise, employing Vector Error Correction Models (VECM) elucidated the intricate positive and negative relationships among these variables and their impact on the BSE Sensex 30 [26]. This comprehensive approach sheds light on the nuanced dynamics between macroeconomic indicators and stock market performance, offering valuable insights for investors and policymakers. The government should take a strategic decision in addressing geopolitical issues, which helps in a strong GDP, stabilized inflation and interest rates, and a reduction in import costs due to better BOP, FDI, and FII flows into our companies.

The study considered various macroeconomic factors as explanatory variables and the BSE Sensex 30 as the predicted variable and evidenced that there exists an association. Furthermore, predictive analysis can be considered on the BSE Sensex 30 by researchers. Likewise, research can be continued by consideration of variables such as tech-advanced, which may be suitable for obtaining better results. The current study focuses on awareness and applicability of the econometric model. There is scope for further research that can be conducted by applying Machine Learning and Artificial Intelligence (AI) models to forecast their success rate, and also can be compared with other emerging economies.

Data Availability Statement: The data used for the study shall be shared on request from the authors.

Conflicts of Interest: The authors declare that they have no conflicts of interest. All coauthors have reviewed and agreed with the contents of the manuscript, and there are no financial interests to report.

Further Scope of Research: The study is limited to the Indian key benchmark index, and it can be extended to Nifty and global markets. The study can also be extended through the application of Machine Learning models along with Econometric models.

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