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AN EMPIRICAL STUDY OF THE EFFECTS OF MACRO-ECONOMIC FACTORS ON THE PERFORMANCE OF STOCK MARKET

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Abstract

The stock market is a key indicator of a country's economic health, but it remains vulnerable to fluctuations in macroeconomic variables. Fluctuations in factors like inflation, interest rates, exchange rates, and GDP growth can significantly influence stock prices, market stability, and investor confidence. These macroeconomic shifts create challenges for individual and institutional investors, who may find it difficult to predict market movements. Investors must navigate these complexities by understanding how macroeconomic factors impact stock market performance. This study investigated the effect of macroeconomic variables on the performance of the Indian Stock Market to test whether a change in macroeconomic variables leads to a change in the stock market. For the study, ten macroeconomic variables are chosen, namely Inflation rate, Exchange rate, Gold Price, Silver Price, Foreign exchange reserve, Bank Rate, Consumer price index, Wholesale price index, Index of Industrial Production, and Trade balance. This study uses the monthly data for 10 years, starting from 2014 to 2024. The data is analyzed by using statistical techniques such as the augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, Kwiatkowski- Phillips-Schmidt-Shin (KPSS) test, Multivariate correlation, Regression Analysis, Granger causality test, and Neural network approach. For the study, Nifty 50 is taken as the dependent variable, and all macroeconomic factors are independent variables. The study reveals a significant relationship between the selected macroeconomic factors and the Indian stock market, specifically Nifty 50.

Keywords:

Nifty 50, Macroeconomic Factors, Augmented Dickey Fuller Test, Granger Causality Test, Neural Network

1. INTRODUCTION

The influence of macroeconomic variables on stock market performance, particularly in the Indian context, has been widely studied. Research indicates that factors such as inflation, exchange rates, industrial production, and fiscal policies play a pivotal role in shaping stock market movements. For instance, Bhuiyan and Chowdhury (2020) studied the U.S. and Canadian stock markets and found that macroeconomic shifts cause different responses in stock indices, often leading to uneven trends [1]. Similarly, Abbas et al. (2019) investigated the Chinese stock market, establishing a strong correlation between stock returns, volatility, and macroeconomic fundamentals like inflation and monetary policies [2].

In India, Gurloveleen and Bhatia (2015) demonstrated that key macroeconomic variables, such as inflation and industrial production, significantly impact stock prices, particularly within the BSE 500 framework [3]. Gopinathan and Raja Sethu Durai (2019) further reinforced this understanding by providing new insights into the relationship between macroeconomic factors and stock market performance in India, reaffirming the importance of these economic indicators in explaining market movements [8].

These studies highlight the importance of monitoring macroeconomic variables to predict stock market performance across different regions, emphasizing their relevance for investment strategies and economic policymaking. Further investigations, such as those by Libing Fang et al. (2018) in the U.S. gold futures market [4] and Maria Ghani et al. (2022) on the Pakistan stock market [6], provide additional evidence of the broader applicability of macroeconomic variables in financial markets. Researchers like Lucca Siebra de Pontes and Leandro Chaves Rego (2022) have also explored the impact of macroeconomic variables on the topological structure of the Brazilian stock market, applying a complex network approach [5].

The Indian stock market has been a key focus of research, with studies highlighting the influence of factors such as foreign exchange reserves, bank rates, and trade balances on market performance. Gopinathan and Raja Sethu Durai (2019) emphasize that a deeper understanding of these macroeconomic indicators is crucial for forecasting stock market behavior, particularly in emerging markets like India [8]. Ahuja et al. (2012) examined the impact of macroeconomic factors on Indian stock prices [11], while Abdul Rafay et al. (2014) explored causal relationships between macroeconomic variables in developing economies [10]. Additional studies, such as those by Naik and Padhi (2012) on macroeconomic fundamentals and stock prices [36], Pal and Mittal (2011) on Indian capital markets [35], and Hosseini and Ahmad (2011) on the role of macroeconomic variables in China and India [34], further reinforce the link between macroeconomic indicators and stock market behavior.

Thus, empirical evidence highlights the crucial role of macroeconomic variables in shaping stock market performance, particularly in emerging markets like India. This study seeks to deepen the understanding of these relationships, offering insights that can guide investment strategies and inform policy decisions in the Indian market and beyond.

2. METHODOLOGY OF THE STUDY

This study aims to analyze the effect of macroeconomic variables on the performance of the Indian stock market, specifically assessing their relationship with the Nifty 50 index, a key benchmark of market performance. The selected independent macroeconomic variables include the inflation rate, exchange rate, gold price, silver price, foreign exchange reserves, bank rate, consumer price index (CPI), wholesale price index (WPI), index of industrial production (IIP), and trade balance. By leveraging statistical and econometric techniques, this research aims to provide empirical insights into how macroeconomic fluctuations influence stock market movements in India.

2.1 UNIT ROOT TESTS

Unit root tests assess whether the time series data is stationary, which is essential for accurate analysis. Non-stationary data can produce misleading results, making it crucial to check for stationarity before further examination.

The Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are commonly used to determine the stationarity of a time series. The ADF and PP tests both check for the presence of a unit root, indicating non-stationarity. In these tests, the null hypothesis suggests that the series is non-stationary, while the alternative hypothesis suggests it is stationary. On the other hand, the KPSS test assumes the series is stationary around a deterministic trend and tests if the series follows a stable trend. The null hypothesis of the KPSS test is stationarity, while the alternative hypothesis suggests non-stationarity.

2.2 MULTIVARIATE CORRELATION ANALYSIS

Once the stationarity of the variables is confirmed, multivariate correlation analysis is employed to examine the linear relationship between the Nifty 50 index and the selected macroeconomic variables.

2.3 REGRESSION ANALYSIS

To quantify the effect of the selected macroeconomic variables on the Nifty 50 index, a multivariate regression analysis is conducted. The regression model takes the Nifty 50 index as the dependent variable and the macroeconomic variables as independent variables.

2.4 GRANGER CAUSALITY TEST

The Granger causality test is used to see if one time series can predict another. In this study, the aim is to check if changes in macroeconomic variables can predict changes in the Nifty 50 index.

2.5 NEURAL NETWORK MODEL

A neural network, inspired by the structure and function of the human brain, consists of layers of interconnected artificial neurons. Each neuron in the network processes input data, applies an activation function, and passes the result to subsequent layers.

- **Input Layer:** This layer receives external data (such as macroeconomic variables) and serves as the entry point for information, much like sensory organs in the human brain.
- **Hidden Layers:** These intermediate layers simulate the brain's processing capability, where each neuron transforms the data through weighted connections and activation functions to capture complex patterns and relationships.
- **Output Layer:** The final layer produces the output or prediction, analogous to how the brain makes decisions or generates responses based on processed information.

Throughout the learning process, the neural network adjusts the weights of connections between neurons, similar to how the human brain strengthens neural connections during learning, ultimately improving its ability to make accurate predictions.

2.6 DATA AND PERIOD OF STUDY

This study examines 10 macroeconomic factors identified through a comprehensive review of existing literature, as they are believed to have a significant impact on the stock market. For the analysis, daily closing prices of the Nifty 50 index were obtained from the National Stock Exchange (NSE) website, while data on the macroeconomic factors was sourced from the Reserve Bank of India (RBI) website. The study covers the period from April 2014 to March 2024. By examining the relationship between these macroeconomic indicators and the Nifty 50's performance, the aim is to identify trends and insights. Ultimately, this research strives to improve the understanding of how macroeconomic variables influence stock market movements.

3. RESULTS AND DISCUSSION

The unit root tests: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS are used to evaluate the stationarity of key economic variables, which is crucial for time series analysis.

Table.1. Unit root test

Factors	ADF Test				Philip Perron Test				KPSS Test	
	At level		At 1st diff		At level		At 1st diff		At level	At 1st diff
	t-stat	Prob	t-stat	Prob.	t-stat	Prob.	t-stat	Prob.		
Inflation	-2.86	0.05	-9.55	0.00	-3.41	0.01	-8.93	0.00	0.30	0.13
Exchange Rate	-0.62	0.86	-12.13	0.00	-0.51	0.88	-12.16	0.00	1.23	0.10
Gold Price	1.57	0.99	-12.60	0.00	1.16	1.00	-12.56	0.00	1.23	0.49
Silver Price	-0.56	0.87	-11.43	0.00	-0.08	0.95	-11.82	0.00	1.10	0.23
Forex Reserve	1.00	1.00	-8.84	0.00	0.70	0.99	-8.97	0.00	1.26	0.20
Bank Rate	-1.98	0.30	-5.52	0.00	-1.85	0.35	-10.13	0.00	0.75	0.46
CPI	0.80	0.99	-8.46	0.00	0.80	0.99	-7.88	0.00	1.32	0.17
WPI	-1.45	0.56	-1.18	0.68	-1.48	0.54	-1.55	0.50	1.12	0.25
IIP	-6.81	0.00	-11.25	0.00	-6.79	0.00	-32.48	0.00	0.07	0.10
Trade balance	-2.28	0.18	-15.22	0.00	-2.97	0.04	-17.22	0.00	0.68	0.13
Nifty 50	-10.73	0.00	-2.14	0.23	-2.26	0.19	-10.74	0.00	1.22	0.22

3.6 NON-STATIONARITY AT LEVEL

Most of the variables are non-stationary at the level. This implies that these variables exhibit trends, seasonality, or other patterns over time.

Table.2. Multivariate correlation

Factors	Nifty 50	Inflation	Exchange Rate	Gold Price	Silver Price	Forex Reserve	Bank Rate	CPI	WPI	IIP	Trade Bal
Nifty 50	1	0.10	0.72	0.01	0.01	0.04	0.70	-0.02	-0.01	0.01	-0.32
Inflation	0.10	1	-0.02	-0.03	-0.06	-0.03	-0.05	-0.01	-0.02	0.08	0.07
Exchange Rate	0.72	-0.02	1	0.02	0.03	0.00	0.96	0.00	0.00	0.03	-0.39
Gold Price	0.01	-0.03	0.02	1	0.95	0.00	0.01	0.96	0.00	0.02	-0.01
Silver Price	0.01	-0.06	0.03	0.95	1	0.03	0.02	0.91	0.00	0.04	-0.03
Forex Reserve	0.04	-0.03	0.00	0.00	0.03	1	-0.01	0.00	0.01	0.06	0.06
Bank Rate	0.70	-0.05	1	0.01	0.02	-0.01	1	-0.01	0.01	0.03	-0.43
CPI	-0.02	-0.01	0.00	0.96	0.91	0.00	0.00	1	0.00	-0.01	0.00
WPI	-0.01	-0.02	0.00	0.00	0.00	0.00	0.01	0.00	1	-0.02	-0.03
IIP	0.01	0.08	0.03	0.02	0.04	0.06	0.03	-0.01	-0.02	1	0.05
Trade balance	-0.32	0.07	-0.39	-0.01	-0.03	-0.06	-0.43	0.00	-0.03	0.05	1

3.7 STATIONARITY AFTER FIRST DIFFERENCING

However, these variables become stationary after first differencing, as shown by both the ADF and PP tests (with p-values < 0.05). This means that the series, converted into first differences, do not have a unit root and are stable over time.

Table.3. Regression Analysis

	Unstandardized Coefficients		Sig.	Hypothesis
	B	Std. Error		
Constant	23617.23	3038.3	0	-
Inflation	288.953	85.08	0.001	Rejected
Gold	0.732	0.475	0.012	Rejected
Silver	0.125	0.03	0	Rejected
Forex Reserve	-0.003	0.001	0	Rejected
Exchange Rate	217.132	62.29	0.001	Rejected
Bank Rate	1091.57	154.74	0	Rejected
CPI	-267.34	40.032	0	Rejected
WPI	54.059	40.419	0.184	Accepted
IIP	-14.785	7.135	0.041	Rejected
Trade balance	27.868	33.369	0.405	Accepted

The KPSS test results are consistent with the findings of the ADF and PP tests. For most variables, the KPSS test at the level shows high test statistics, confirming non-stationarity. After first difference, these variables show stationarity.

There is a positive correlation between Inflation, Exchange Rate, Gold and silver Prices, Forex Reserves, Bank rate Index of industrial production, and Nifty 50. It means that these macroeconomic variables tend to move in the same direction as the Nifty 50 index. When these factors increase, the Nifty 50 generally also increases, and when they decrease, the Nifty 50 tends to fall as well.

There is a negative correlation between the Consumer Price Index, Wholesale price index, Trade balance, and the Nifty 50. it means that these macroeconomic variables tend to move in the opposite direction to the Nifty 50 index. When these factors increase, the Nifty 50 tends to decrease, and when they decrease, the Nifty 50 tends to rise.

Looking at the above regression table, it is found that the Inflation rate, Exchange rate, Gold Price, Silver Price, Foreign exchange reserve, Bank rate, Consumer price index, and P-value are less than the critical P-value o.05, so here we reject Null Hypothesis and accept the Alternative Hypothesis. This means that the inflation rate, exchange rate, gold price, silver price, foreign exchange reserve, bank rate, and consumer price index have a significant relationship with Nifty 50. The Wholesale price index, Index of Industrial Production, and Trade balance P-value are more than the critical P-value 0.05, so we accept the Null Hypothesis and reject the alternative. It means that the Wholesale price index and Trade balance have no significant relation with the Nifty 50.

In this analysis of regression, Y= Dependent variable, X= Independent variable

$$Y=\beta0+\beta X1+\beta X2+\beta X3+\beta X4+\beta X4+\beta X5+ \beta X6+ \beta X7+ \beta X8+ \beta X9+ \beta X10$$

β = Nifty 50

X1 = Inflation Rate

X2 = Gold Price

X3 = Silver Price

X4 = Foreign Exchange Reserve

X5 = Exchange Rate

X6 = Bank Rate

X7 = Consumer Price Index

X8 = Wholesale Price Index

X9 = Index of Industrial Production

X10 = Trade Balance

Y = (23617.233)+(288.953) X1+(0.732) X2+(0.125) X3+(-0.003) X4+(217.132) X5+(1091.569) X6+ (-267.344) X7+ (54.059) X8+ (-14.785) X9+ (27.868) X10

Table.4. Granger Causality test

Null hypothesis	F-Statistic	Prob.
Nifty 50 VS Inflation	0.06	0.94
Inflation VS Nifty 50	5.65	0.00
Exchange Rate VS Nifty 50	0.09	0.91
Nifty 50 VS Exchange Rate	0.56	0.57
Gold Price VS Nifty 50	1.09	0.34
Nifty 50 VS Gold Price	0.21	0.81
Silver Price VS Nifty 50	0.79	0.46
Nifty 50 VS Silver Price	0.17	0.85
Forex Reserve VS Nifty 50	0.92	0.40
Nifty 50 VS Forex Reserve	0.21	0.81
Bank Rate VS Nifty 50	0.39	0.68
Nifty 50 VS Bank Rate	0.32	0.73
CPI VS Nifty 50	0.55	0.58
Nifty 50 VS CPI	0.06	0.95
WPI VS Nifty 50	1.46	0.24
Nifty 50 VS WPI	0.08	0.92
IIP VS Nifty 50	0.14	0.92
Nifty 50 VS IIP	0.15	0.87
Trade Balance VS Nifty 50	0.15	0.87
Nifty 50 VS Trade Balance	0.83	0.44

The only significant Granger causality is from Inflation to Nifty 50 ($p = 0.00$), suggesting that inflation data can predict movements in the Nifty 50 index. For all other variables (exchange rate, gold price, silver price, forex reserves, bank rate, CPI, WPI, IIP, trade balance), there is no evidence of Granger causality between them and Nifty 50 in either direction.

Table.5. Neural Network Approach

Network Information			
Input Layer	Covariates	1	Inflation Rate
		2	Gold price
		3	Silver price
		4	Forex reserves
		5	Exchange rate
		6	Bank Rate
		7	CPI
		8	WPI
		9	IIP
		10	Trade balance
	Number of Units		10
	Rescaling Method		Standardized
Hidden Layer	for Covariates		
	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1		7
	Activation Function		Sigmoid
	Dependent Variables	1	Nifty 50
	Number of Units		1
	Rescaling Method		-
Output Layer	for Scale Dependents		Normalized
	Activation Function		Sigmoid
	Error Function		Sum of Squares

Table.6. Independent Variable Importance

	Importance	Normalized Importance
Inflation	0.028	14.50%
Gold Price	0.042	21.20%
Silver price	0.122	62.40%
Forex reserve	0.14	71.80%
Exchange rate	0.015	7.80%
Bank Rate	0.196	100.00%
CPI	0.159	81.10%
WPI	0.048	24.50%
IIP	0.13	66.50%
Trade balance	0.12	61.30%

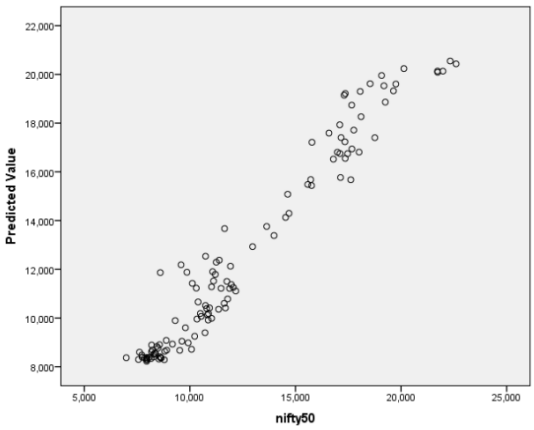

Fig.1. Neural network prediction graph of Nifty 50

This Graph implies how the neural Network has worked in Predicting the Nifty 50 from the Since the researcher has chosen the results to appear on Sigmoid Nature in training, we see an S-shaped pattern here. Predicted Nifty 50m scatters around Rs.21,000/-.

Table.7. Nifty 50 Prediction and error calculation

Date	Actual Nifty 50	Neural Network	
		Predicted Nifty 50	Error
01-03-2023	17,359.75	19300.07	-11.17%
01-04-2023	18,065.00	19616.83	-8.59%
01-05-2023	18,534.40	19531.15	-5.37%
01-06-2023	19,189.05	19604.48	-2.16%
01-07-2023	19,753.80	18862.04	4.51%
01-08-2023	19,253.80	19323.8	-0.36%
01-09-2023	19,638.30	19954.34	-1.60%
01-10-2023	19,079.60	20237.64	-6.06%
01-12-2023	21,731.40	20086.44	7.56%
01-01-2024	21,725.70	20137.52	7.31%
01-02-2024	21,982.80	20132.93	8.41%
01-03-2024	22,326.90	20548.46	7.96%
Average error %			0.04%

This table presents the Nifty 50 values predicted using the Neural Network approach, along with the corresponding error percentages compared to the actual Nifty 50 values over one year. Based on the average error percentage derived from this table, it can be inferred that the Neural Network approach demonstrates a high level of accuracy in predicting Nifty 50 movements.

4. CONCLUSION

The study concluded that there is a positive relationship between the stock market and all macroeconomic variables. It means an increase in the macroeconomic variables will also lead to an increase in the stock market, and a decrease in macroeconomic variables will lead to a decrease in the stock market. The use of a neural network model for predicting Nifty 50 based on macroeconomic factors showed promising results, with a very low average error of 0.04%. Overall, this empirical study highlights the potential of neural networks in financial forecasting, particularly when accounting for the effects of complex macroeconomic factors on stock market performance. Further model improvements and the inclusion of additional market-specific variables could enhance the accuracy of future predictions.

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