

Predictive Analytics in Indian Stock Market: Integration of Multiple Regression and Neural Networks for Sensex Prediction

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Abstract:

In current scenario a pervasive symbol has been notified towards the growth of foreign capital flows in the Indian economy. Such cash flows not only symbolized in developed rather it has been also noticed in developing countries. It has created lot of opportunities as well as challenges for investors and policy makers in India. Through FDI and FII international capital flows to our economy. A country's economic and financial condition can be well reflected by stock market performance.. Since 1980s economists & different policy makers have considered more attention should be given towards the dynamic connection between macroeconomic variables and stock market. The focus of the study was to consider the different macroeconomic variables that are Money supply, FII, FDI, Forex and the inflation to find out the significance of these variables on the Sensex. The yearly data was collected over a period of 18 years ranging for 2000-2018 from the websites of Bombay stock Exchange (BSE), and RBI. Multiple regression and Artificial Neural Network (ANN) were conducted for making the analysis; the analysis revealed theses variables have significant impact on the Sensex.

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I. Introduction

Stock market plays a vital role in shaping the prosperity and sustainability of economic condition of a country. It can foster the capital formation in a different angle. Movement of stock price is now considered as a leading indicator of real economic activity. Stock market helps in arranging capital for companies by exchanging shares with the shareholders. Share prices can directly or indirectly affect the pattern of

consumption, investment, wealth and saving decisions of the households. Since a long time interconnection between macroeconomic variables and stock market have been studied in empirical as well as theoretical research . Over the decades it became a debatable discussion whether stock price changes is a leading factor of changes in economic activities or vice versa. In this respect the literatures provides contradictory statements regarding the degree of influencing effect of the

macroeconomic factors. Economic growth can be well explained from the view point of both stock and bond market. The movement of stock and bond prices can help in forecasting the economic growth of a country. In comparison to equity market bond market helps more in predicting the country's economic growth. So it became a crucial job on the part of the financial analysts to understand the changing behavior of the equity and bond market well. They are interested in identifying the pattern of volatility in stock price movement along with its alteration and persistence.

II. Review of Literature

Anwar, S., et al (2011) analyses the interrelationship in between three components i.e. Malaysian stock index, its economic growth with the foreign capital flows in the economy. The flow of foreign capital is highly dependent on the real exchange rate and the openness of the country's economy. By collecting the annual data of 37 years i.e. from 1970 to 2007 the researcher has developed a simultaneous equation model to examine the interconnection among the variables empirically. The study revealed that the impact of foreign capital flows could not make possible statistically significant on economic growth, though that influenced the growth of Malaysian stock prices during the study period. Whenever the exchange rate was in favor of country's economy, a growth trend was seen in the amount of foreign capital in Malaysia.

Li, S. (2005) investigated the importance of governance environment of a country in attracting foreign capital. The study started with an assumption that a country with poor governance environment may not properly utilize the opportunities associated with foreign capital flows. In other terms more foreign direct investments can be invited in a country with good corporate ethics and environment with good governance. The study found that in a country like

China which is not good enough or operating in a healthy governance environment, there is more inflow of foreign investments. At the end it was suggested that by implementing and cooperating better and adequate strategies the outcomes of poor governance not only can be controlled but

Bansal, A., et al (2012) studied the impact of stock market opening announcement to foreign institutional investors on the volatility and stock returns during two study periods. One study period consisting pre announcement event and another post announcement event study. The stock market announcement towards opening to FII was made on September 1992. By collecting the data of Bombay stock exchange index i.e., Sensex an empirical analysis was conducted which come out with the fact that stock market volatility and returns were not much influenced by such announcement of opening market to FII. In comparison to stock returns rather stock market volatility was quite reduced due to such announcements.

Teli, R. B. (2014) critically analyses the trend of foreign investment flows in Indian economy. Here data were collected from 1991 to 2012 regarding the amount of foreign direct investment and foreign portfolio investment. During economic reforms it was believed that after USA and China, India was a place with more investment opportunities for inviting foreign investments. The study clearly mentioned that starting from 1992 to 2009, the amount of FDI increased from \$133 million to \$ 27841 million. During the study period Singapore and Mauritius secured highest position in attracting foreign direct investment which influenced other economic fundamentals associated with Indian economy. So it was suggested by the researcher at the end, Government of India must rely favorable policies in association with attracting more FDI in the economy by minimizing its uncertainty.

Hiremath, G. S., et al (2016) used rolling and fixed windows under generalized hurst component in developing stock market hypothesis to measure the link in between different financial crises shocks and the efficiency gap of Indian stock market. In an emerging market the impact of change in volume of foreign institutional investors and other factors was not much affected the stock market efficiency. During the study period it was also seen that there was a positive relation in between net FII and the gap of stock market efficiency. The researcher here has developed a hope regarding new policy formulation in relation to necessity of more liberalised economy.

Fabry, N., et al (2002) tried to understand besides availability of all the facilities in Russia in terms of skilled human power, natural resources and huge potential investors, why there is less foreign capital flows in nature of foreign direct investment. Though Russia is the largest country among all the European economies, it was least preferred as an investment hub. Basically the reason behind was discovered that it wanted to grow endogenously with the participation of any other investment through the eye of open economy.

Hwang, E., et al (2013) has tried to understand and analysed the co movement of ten emerging countries with USA after the post financial crisis. During the US financial crisis different economies shows crisis spread in different pattern or phases. Here the researcher has used the data in relation to stock returns for five years i.e. from 2006 to 2010. The result of the empirical analysis depicted that foreign institutional investment, S & P 500, VIX index and high volatile foreign exchange market positively influenced the conditional correlation whereas the same conditional correlation was negatively associated with any increase in the spread of TED and CDS.

Whalley, J., et al (2010) assessed the importance of foreign invested enterprises in the economic growth of China. China is such a country where it's both distribution network and product layout facilitating export market to abroad access by foreign invested enterprises. By implementing accounting approach over two dimensional the researcher here took an attempt to investigate whether without inward FDI in China its long run economic growth could prosper or not. During the study period it was evident that foreign invested enterprises had acquired more than 65% of import and more than 50% of China's export. It was also examined that though their contribution in growth rate of China is nearly 20%, they have not recruited many work force from China. In China the reason behind increasing trend of production is high level of export to abroad facilitate by foreign invested enterprises.

Dhingra, V. S., et al (2016) used both dynamic and static model in order to investigate the interaction of Foreign Institutional Investment flows to stock market volatility in India. For analyzing the statistical data, impulse response function of VAR model was used by collecting daily data of stock returns and foreign institutional investments. After using both dynamic and static model two types of feedback were received from foreign traders during the study period. The foreign investors had reflected a negative feedback during the selling time of their holding and during the period of investment in India they have provided a positive feedback. During the research period it was evident that foreign traders could change the performance of Indian stock market through the process of their selling activities of prior holding investments.

Garg, R., et al (2014) took a step towards measuring the major macroeconomic factors responsible for driving foreign institutional investment flows in India. For measuring such move exchange rate, growth rate of GDP,

domestic common stock performance, interest rate, risk diversification opportunities, growth rate of foreign output were used as the driving force variables. The study come out with some necessary facts that because of having low deviation in exchange rate and high involvement of different risk minimization approaches the flow of portfolios are favorable in India. The flow of depository receipts were basically influenced by the growth rate of domestic as well as foreign output, equity returns in the domestic market and the exchange rate mechanism in India.

Santiago, C. E., (1987) tried to give insight into the role of Foreign direct investment in employment generation and export structure in Puerto Rico. The study used both location and industry specific factors in the model associated with export promotion on the capability of different manufacturing enterprises. The export structure in Puerto Rico comprises USA based large scale firms. It was suggested by the study that the nature of principal exports in Puerto Rico is very capital intensive and low concentric towards labour intensive. So instead of hiring more workforces in addition it was suggested that the manufacturing sectors should try to diversify its composition of export in alteration.

Khan, M. I., et al (2015) took an attempt to examine the link in between two forms of foreign investments i.e. foreign direct investment and foreign institutional investment. Though a lot of work was carried on in respect to these two forms and has revealed different consequences, this study had tried to find out is there any existence of inter linkages in between these two important foreign capital drivers. The impact of foreign capital drivers were studied before enormously on both host and home country's society and economy. Because of globalization the impact of both FII and FDI was seen on market performance over for a long period of time and resembles a growing trend too.

Gurloveleen et al (2015) have considered nearly 150 manufacturing firms to measure whether their stock index is influenced by macroeconomic variables or not. Exchange rate, foreign exchange, crude oil price, broad money, call money rate, gross fiscal deficit, inflation rate, industrial production index, foreign institutional investors were selected as the macroeconomic indicators in the research process. The study revealed that Indian stock market was not influenced by macroeconomic determinants and it represents a weak form efficient stock market.

Parmar. C (2013) undertook an analysis on the basis of macroeconomic indicators availability both in the local and global scenario on the performance of Indian stock market. During the research period repo rate, exchange rate, gold rate, oil rate, index of industrial production, consumer price index were considered as the influential macroeconomic indicators towards the movement of sensx. The study concluded that sensx was not much influenced by global in comparison to local macroeconomic indicators in a long term perspective.

Mishra (2018) identified and established a long term association ship in between sensx and macroeconomic indicators. For such analysis interest rate, gold price, exchange rate, index of industrial production, money supply were selected by the researcher during the study period. It was also evident that sensx was never influenced by rate of inflation and money supply in short term perspective.

Megaravalli et al (2018) selected two developing and one developed economies for measuring their degree of dependence on macroeconomic variables. They have considered India and china as developing and Japan as developing country. As economic indicators they have selected consumer price index and exchange rate and found that these two variables had equally

influenced the economies of both developed and developing country.

Giri et al (2017) examined the impact of macroeconomic indicators on the Indian stock market. For such analysis they had selected crude oil price, GDP, exchange rate and rate of inflation as the key macroeconomic determinants. The results of the study had revealed that Indian stock market was negatively affected by crude oil price changes where as it was positively influenced by inflation, GDP and exchange rate.

III. Research Objectives

1. To find out the significance of Money supply, FII, FDI, Inflation rate and Forex on BSE Sensex returns.

IV. Research Methodology

Data was collected from the BSE website and the missing values were replaced with their mean values through the preprocessing of data cleaning. Initially the data was present in different

granularity and the macroeconomic data are transformed in to yearly observations. This study is based on secondary data. The required data related to FDI and FII have been collected from various sources i.e. Bulletins of Reserve Bank of India, publications from Ministry of Commerce, Govt. of India. The BSE Sensex data is downloaded from the websites of bse india respectively. The study considered 18 years data from 20001-2018. Multiple regression model was used for the analysis . Sensex is the dependent variable for the research. Money supply, FII, FDI, Inflation rate and Forex are the different macroeconomic independent variables taken in the study. Yearly data from 2000 to 2018 were taken into consideration from the websites RBI (Database Of Indian Economy) i.e. dbie.rbi.org.in .Regression analysis was applied with BSE sensex as the dependent variable and prominent macroeconomic indicators from each of the factors as independent variables.

MLR was used to model the linear relationship, between a dependent and many independent variables. It can be written as

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Table-1 Regression Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.977 ^a	0.954	0.935	2401.25	2.145

The above model represents the relationship between the model and the dependent variable. R specifies the value .977 which specifies a linear relationship between observed and the predicted values of the dependent variable. R² is .954 the

model explain 95% of the variation. The independent variable explains 93% of the dependent variable. Durbin –Watson is closer to 2 which are better.

ANOVA^a

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Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.5E+09	5	2.9E+08	50.313	.000 ^b
	Residual	6.9E+07	12	5766017		
	Total	1.5E+09	17			

a. Dependent Variable: Sensex

b. Predictors: (Constant), cpi(Inflation), FIIUS \$ MILLION, Money Supply, FDI US\$MILLION, Forex(Foreign Exchange Reserve)

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3551.99	2889.44		1.229	0.243		
	Money Supply	0.026	0.089	0.111	0.286	0.78	0.025	9.403
	FIIUS \$ MILLION	0.431	0.176	0.161	2.449	0.031	0.873	1.145
	FDI US\$MILLION	-0.952	0.558	-0.167	-1.706	0.114	0.398	2.513
	Forex(Foreign Exchange Reserve)	0.011	0.005	0.903	2.271	0.042	0.024	1.669
	cpi(Inflation)	-7.033	5.876	-0.105	-1.197	0.254	0.497	2.01
a. Dependent Variable: Sensex								

The multiple regression model is represented as :
Sensex= 3551.987+.026*Money Supply+.431*FII+(-.952)*FDI+.011*Forex+(-7.033)*Inflation.

FII and Forex predictors are statically significant in predicting the sensex.

Represent the collinearity and the coefficients and the two collinearity statistics are tolerance and VIF. The model specifies the VIF value are

acceptable as well as tolerance statistics more than .2 Hence there is no problem of collinearity in the model and the multiple regression is appropriate.

The significant value of money supply on sensex is .780 which is more than the .05 so we accept the null hypothesis is not useful in predicting the null hypothesis. FII and Forex are good predictors in predicting the sensex as the p value is <.05

Fig-1 Neural network Model

Network Information			
Input Layer	Factors	1	Money Supply
		2	FIIUS \$ MILLION
		3	FDI US\$MILLION
		4	Forex(Foreign Exchange Reserve)
		5	cpi(Inflation)
	Number of Units ^a		80
Hidden Layer(s)	Number of Hidden Layers		2
	Number of Units in Hidden Layer 1 ^a		13
	Number of Units in Hidden Layer 2 ^a		10
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	Sensex
	Number of Units		1
	Rescaling Method for Scale Dependents		Adjusted normalized
	Activation Function		Hyperbolic tangent
	Error Function		Sum of Squares
a. Excluding the bias unit			

Model Summary		
Training	Sum of Squares Error	0.858
	Relative Error	0.343
	Stopping Rule Used	Maximum number of epochs (100) exceeded
	Training Time	00:00.0
Dependent Variable: Sensex		

Independent Variable Importance		
	Importance	Normalized Importance
Money Supply	0.15	62.00%
FIIUS \$ MILLION	0.242	100.00%
FDI US\$MILLION	0.209	86.40%
Forex(Foreign Exchange Reserve)	0.209	86.70%
cpi(Inflation)	0.19	78.80%

In neural network model it has been shown FII , Forex independent variable has more importance in predicting the sensex followed by FDI , CPI and the Money supply.

V. Conclusion

The research provided a scientific approach in identifying significant macroeconomic indicators influencing the sensex. The study can be applied across the global stock market. The BSE was taken as a sample and the regression model explained 95% in predicting the Sensex which is influenced by the macroeconomic variables. The regression model explained how the macroeconomic variables influence the sensex. ANN was also used to predict the sensex where the sigmoid activation function was used in predicting sensex movement. Money supply was the main predictor in predicting the sensex. The proposed methodology can be applied to any stock market across the globe and in future can be extend fop qualitative work in sensex prediction.

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