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A Study on Determinants Affecting BSE Sensex in India: A Macroeconomic Approach

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Abstract—The Bombay Stock Exchange (BSE) is the largest securities market in India. The stock market, being one of the prime avenues for investments, is an important indicator of the Indian economy. Hence, it becomes important to study the factors that affect it. BSE Sensitive Index (Sensex), though sensitive to many economic factors is still a vital phenomenon for Indian market. We have tried to examine the primary factors responsible for affecting Bombay Stock Exchange (BSE) in India. We have considered the following determinants in our study: Crude oil price, Wholesale price index (Inflation), Exchange rate, Foreign Exchange Reserve (Forex), Repo rate, Foreign Domestic Investment (FDI), Call money rate, FII (Foreign Institutional Investor) Investment and Gold price. We have carried out a retrospective study and identified the major factors influencing BSE Sensex using Multiple Linear Regression, Variable Selection and Variance Reduction techniques and tried to establish a model for BSE Sensex based on the prime factors affecting it. Finally, we have tried to improve our model by solving the problem of multicollinearity using Ridge Regression method and obtained an optimal model of BSE Sensex for future prediction.

Keywords— *Bombay Stock Exchange, BSE Sensex, Multicollinearity, Multiple Linear Regression, Ridge Regression, Variable Selection.*

I. INTRODUCTION

BSE Sensex is the most popular stock market index in India. It is basically a reflector of the fitness of the stock markets in India. The fluctuations in Sensex on the Bombay Stock Exchange (BSE) demonstrate the ups and downs of the Indian stock market. Sensex is regularly monitored by many market experts, brokers, businessmen, investors and several other stakeholders in India. With more importance given to ease of doing business, manufacturing sector, industries and indigenous production than ever before, it becomes important to explore the dynamics of the stock market in India.

Around the world, research is continuously being carried out on topics related to stock market. Researchers are interested in identifying the various factors responsible for causing fluctuations in stock market. Our study focuses on studying the stock market behaviour with respect to the Indian economy. We have based our study on the BSE index which forms our database. In our study, we have tried to examine the interrelationships between different macroeconomic determinants affecting Bombay Stock Exchange (BSE). Further, we have attempted to forecast the index movement in the future using the relationship between macroeconomic variables.

The main objective of the study is to find the major macroeconomic factors affecting BSE Sensex and determine an optimal model establishing a relationship between BSE Sensex and significant macroeconomic factors. The aim is to remove all possible irregularities of the model and use it for prediction of future trend and value of BSE Sensex.

The paper is organized as follows, Section I contains the introduction and objective of our study, Section II contains short review of relevant work in the past few decades, Section III describes the research methodology and data used in our study, Section IV encompasses the results obtained and their discussions, Section V contains the conclusion and way forward for future research.

II. RELATED WORK

In the past decades, many researchers attempted to use different methods in order to predict the movements of the share markets. Plenty of studies have been carried out and various methods devised for making predictions about share markets. We give below a brief review of literature to throw light on work done by other researchers on the stock market fluctuations.

R. Aggarwal, 1981 [1] studied the relation between value of the U.S. dollar and U.S. stock prices. He found that the value of the U.S. dollar and U.S. stock prices are positively correlated and that the U.S. stock market is influenced by the fluctuation in the exchange rates.

E. Bartov and G. M. Bodnar, 1994 [2] found that lagged changes in the dollar are a significant variable in explaining current abnormal returns of our sample firms, suggesting that mispricing does occur.

B. M. Kais, 2015 [3] used various non-linear models to analyse the volatility behaviour of the Tunisian stock returns series index TSR in daily frequency. He tried to find a best fit model for future forecast using ARCH models.

K. E. Homa and D. M. Jaffee, 1971 [4] tried to study the relationship between the money supply and stock market using regression analysis techniques. He concluded that a good relation exists between them.

S.D. Vashishtha, U. Singh and R. Kumar, 2013 [5] studied the effect of economic growth rates on capital market movements. They found that there exists an inverse relationship between the correlation of S&P BSE SENSEX with IIP and BSE SENSEX with WPI.

A. C. Christofi and A. Pericli, 1999 [6] investigated the dynamics between five major Latin American stock markets (Argentina, Brazil, Chile, Colombia and Mexico) using correlation techniques. They found that these markets show more volatility spillovers than other countires.

A. Naka, T. Mukherjee and D. Tufte, 1998 [7] used vector error correction model (VECM) to study the impact of macroeconomic variables on Indian stock markets. They found that industrial production is the largest positive determinant of Indian stock prices and inflation is the largest negative determinant

P. Purey and A. Patidar, 2018 [8] tried to predict stock market prices using machine learning techniques like neutral networks. They used supervised learning for more accuracy in prediction.

These studies helped us to identify the different variables needed for our analysis and motivated us to carry out further studies on this important topic.

III. METHOD AND MATERIAL

The different methods and materials used in this paper are given in this section. Various statistical techniques used are described in brief below.

1) **Karl Pearson Correlation Coefficient**
   The Karl Pearson's correlation coefficient measures the extent of a linear relationship between two variables and is denoted by *r* or r_{xy} (x and y being the two variables involved).
2) **Multiple Linear Regression**
   Multiple linear regression is used to model the relationship between two or more independent variables and a dependent variable by fitting a linear equation to the given data.
3) **Multicollinearity**
   When one or more regressor variables in a multiple regression model are highly correlated then this is known as multicollineairty. When the assumption of linear independency of regressor variables gets violated then the problem of multicollinearity arises.
4) **Variable Selection**
   From the set of regressor variables on which data is collected, some can be dropped before a final working model is built. Variable selection method is used to find an optimal set of regressor variables. We have used Forward Selection Method to get the final model.
5) **Ridge Regression**

It is one of the procedures to deal with the problem of multicollinearity. The ridge estimator is found by solving a slightly modified version of the normal equations. The modified normal equation in calculating Ridge estimator is given by:

$$(X'X + kI)\ \hat{\beta}_R = X'Y \quad \text{_____(1)}$$

On solving Equation (1) we get the Ridge estimator $\hat{\beta}_R$ as follows:

$$\hat{\beta}_R = (X'X + kI)^{-1} X'Y \quad \text{_____(2)}$$

where $k \geq 0$ is a constant selected by the analyst.

As the ridge estimator has less variance than the ordinary least square estimator, $\hat{\beta}_R^*$ is a more stable estimator of β than is the unbiased estimator estimator $\hat{\beta}$ (OLS estimator).

In our study, we have included the following macroeconomic factors as determinants: Crude oil price, Wholesale price index (Inflation), Exchange rate, Foreign Exchange Reserve (Forex), Repo rate, Foreign Domestic Investment (FDI), Call money rate, FII (Foreign Institutional Investor) Investment and Gold price.

The data is quantitative and is collected from authentic sources like RBI, SEBI, BSE, etc. The sample includes data on BSE Sensex, Crude oil price, Wholesale price index (Inflation), Exchange rate, Foreign Exchange Reserve (Forex), Repo rate, Foreign Domestic Investment (FDI), Call money rate, Foreign Institutional Investor (FII) and Gold price. We have collected data on each factor for six years on monthly basis from January 2008 to March 2014.

IV. RESULTS AND DISCUSSION

The notations used for various variables involved in our study are given in the following table.

Table 1. Variables involved in the analysis

Variables	**Y**	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**	**X_7**	**X_8**	**X_9**
Factor	BSE Sensex	Oil price	WPI	Exchange rate	Foreign exchange reserve	Repo rate	FDI	Call money rate	FII	Gold price

RESULT I

We have calculated the Karl Pearson's Correlation Coefficient between the BSE Sensex (i.e. Dependent Variable) and determinants (Independent Variables) involved in our study.

Table 2. The Karl Pearson's Correlation Coefficients between the BSE Sensex and determinants

BSE Sensex	**Oil price**	**WPI**	**Exchange rate**	**Foreign exchange reserve**	**Repo rate**	**FDI**	**Call money rate**	**FII**	**Gold price**
1	0.6419	0.1900	0.3084	0.5461	0.1357	0.0602	0.5249	0.2857	0.5778

DISCUSSION

From Table 2 it is observed that Oil price has maximum correlation with BSE Sensex and FDI has minimum correlation coefficient.

RESULT II

We have presented the entire statistical analysis in the following six steps.

STEP I. MULTIPLE LINEAR REGRESSION

As from Table 2 we observe that BSE Sensex has positive correlations with other determinants, in the first step we fit a Multiple Linear Regression model to the data.

A multiple regression model is fitted to the data set and the analysis is carried out to examine the impact of the determinants affecting BSE Sensex. Using BSE Sensex as our response (or dependent) variable and other determinants/factors as our regressor (or independent) variables.

The response variable is regressed on all the nine regressor variables and the results are shown in Table 3.

Table 3. Multiple Regression Model.

	Estimate	Standard error	t value	Pr(>|t|)
(Intercept)	1.716e+04	3.780e+03	4.539	2.66e-05 ***
Oil price	1.572e+00	5.305e-01	2.964	0.00430 **
WPI	4.963e+01	9.060e+01	0.548	0.58581
Exchange rate	-2.659e+02	1.130e+02	-2.353	0.02182 *
Foreign exchange reserve	7.856e-01	6.682e-01	1.176	0.24419
Repo rate	-1.494e+03	2.430e+02	-6.145	6.31e-08 ***
FDI	-2.678e-03	3.735e-02	-0.072	0.94307
Call money rate	4.512e+02	2.373e+02	1.901	0.06194 .
FII	3.677e-02	1.639e-02	2.243	0.02850 *
Gold price	6.082e-01	7.232e-01	0.841	0.40361

*Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Model Summary I:
Residual standard error: 1667 on 62 degrees of freedom
Multiple R-Squared: 0.7218, Adjusted R-squared: 0.6814
F-statistic: 17.87 on 9 and 62 DF, p-value: 3.626e-14

DISCUSSION

The regression output reveals that the multiple coefficient of determination R^2 equals 0.7218. This implies that 72.18% of variation in BSE Sensex is explained by the multiple linear regression between Y and the set of explanatory variables (X_1, X_2, ……., X_9). This is also confirmed by the F statistic at 5% level of significance. However, when we look at the individual significance of the determinants, we observe that independent variables such as WPI, Foreign exchange reserve, FDI, Call money rate and Gold price are statistically insignificant at 5% level. We next try to investigate the presence of multicollinearity in the model.

STEP 2: MULTICOLLINEARITY DIAGNOSTICS

The following two methods are used for detection of multicollinearity.

a) Examination of the Correlation Matrix

The correlation matrix puts light on the linear relationship between the regressor variables used in our study. Correlation matrix for the determinants considered in our study is given in Table 4.

Table 4. Correlation matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9
X1	1	0.2585	**0.6466**	**0.8719**	**0.6554**	0.1966	**0.8143**	-0.0117	**0.7679**
X2	0.2585	1	-0.1725	0.0331	0.4399	-0.0765	0.4892	-0.0645	0.1247
X3	**0.6466**	-0.1725	1	**0.8949**	0.2607	-0.0101	0.2985	0.0069	**0.7149**
X4	**0.8719**	0.0331	**0.8949**	1	0.4823	0.036	**0.6065**	0.0463	**0.8662**
X5	**0.6554**	0.4399	0.2607	0.4823	1	0.1815	**0.7871**	-0.1638	0.4455
X6	0.1966	-0.0765	-0.01	0.036	0.1815	1	0.1422	-0.0822	0.0685
X7	**0.8143**	0.4892	0.2985	**0.6065**	**0.7871**	0.1422	1	-0.0967	**0.5768**
X8	-0.0117	-0.0645	0.0069	0.0463	-0.1638	-0.0822	-0.0967	1	0.2166
X9	**0.7679**	0.1247	**0.7149**	**0.8662**	0.4455	0.0685	**0.5768**	0.2166	1

DISCUSSION

From Table 4, it is observed that some independent variables are highly correlated with each other. These are given in bold face. Thus, it is clear that multicollinearity is present in the model.

b) Variance Inflation Factor (VIF)

Table 5. Variance inflation factors for various determinants

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9

VIF	**11.356494**	1.739208	**11.388241**	**32.996638**	2.795627	1.3007	6.524662	1.274888	5.243136

DISCUSSION

It is observed from Table 5 that the variance inflation factors for $\mathbf{X_1}$(Oil price), $\mathbf{X_3}$(Exchange rate) and $\mathbf{X_4}$(Foreign exchange reserve) are greater than 10. This also confirms the presence of multicollinearity.

STEP 3: VARIABLE SELECTION

a) Forward Selection method

As multicollineariy has been detected, we tried to find the optimal subset of determinants so that the effect of multicollinearity is lessened and we get a better fit. Using the Forward Selection procedure, we determined the optimal subset of regressors X_1, X_5, X_7, X_8, X_3 and X_4. We again regressed the response on this subset of regressors and obtained the following regression estimates.

Table 6. Forward Variable Selection Model

	Estimate	Standard error	t value	Pr(>|t|)
(Intercept)	1.597e+04	2.583e+03	6.184	4.65e-08 ***
Oil price	1.520e+00	4.795e-01	3.171	0.00232 **
Repo rate	-1.471e+03	2.361e+02	-6.228	3.92e-08 ***
Call money rate	4.971e+02	2.262e+02	2.197	0.03156 *
FII	4.183e-02	1.516e-02	2.760	0.00750 **
Exchange rate	-2.900e+02	1.088e+02	-2.665	0.00969 **
Foreign exchange reserve	1.045e+00	5.418e-01	1.928	0.05823 .

Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Model Summary II:

Residual standard error: 1644 on 65 degrees of freedom
Multiple R-Squared: 0.7163, Adjusted R-squared: 0.6901
F-statistic: 27.35 on 6 and 65 DF, p-value: 5.019e-16

DISCUSSION

It is observed that multiple coefficient of determination R^2 equals 0.7163. This implies that 71.63 percent of variation in BSE Sensex (Y, response), is explained by the multiple linear regression relationship between Y and the set of explanatory variables (X_1, X_5, X_7, X_8, X_3, X_4). R^2 for this model is less than the full model as it contains lesser number of regressors than the full model. However, R^2- adjusted for this model 0.6901 is greater than the R^2- adjusted value for the full model i.e. 0.6814.
Thus, from Table 6 the model obtained using Forward regression method is given as follows:

$$y = (1.597*10^4) + (1.520)\ x_1 + (-1.471*10^3)\ x_5 + (4.971*10^2)\ x_7 + (4.183*10^{-2})\ x_8 + (-2.900*10^2)\ x_3 + (1.045)\ x_4 \quad \text{_____(3)}$$

b) Residual Plot

We have next used the above regression model to obtain the residuals. These are plotted below.

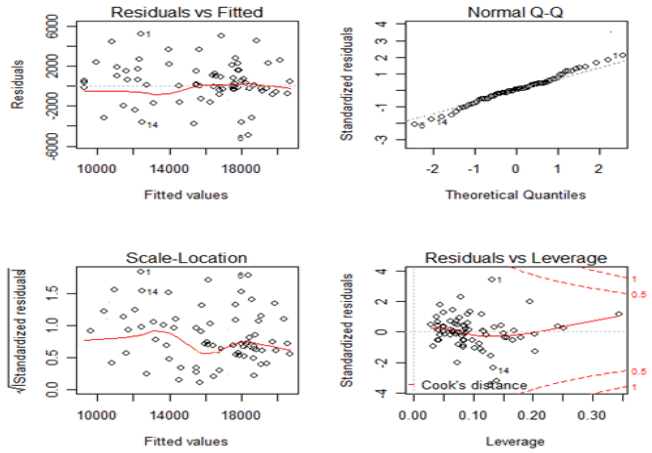

Figure 1. Residual plots

DISCUSSION

From the plot of residuals versus fitted values and the plot of standardized residuals versus fitted values in Figure 1, we see that residuals are random, nicely centred at zero, and have no outliers. Furthermore, variance is constant. From the Q-Q plot we see that the assumption of normality is validated. From the plot of residuals versus leverage we see that Cook's distance is within ± 0.5. So there are no influential observations. The model seems to be good.

STEP 4: PREDICTION

Using the final model given by equation (3) based on the coefficients shown in Table 6, we have tried to predict the share prices for the year 2014. We have collected the data on Oil price, Exchange rate, Foreign exchange reserve, Repo rate, Call money rate and Foreign Institutional Investor (FII) on monthly basis for the period from January 2014 to March 2014. Using the final model and data on regressor variables selected in the final model, we tried to predict the share prices for the first three months (January, February and March) of 2014 to verify if our model is correct.

The actual and predicted values of BSE Sensex for the months of January, February and March are given in the table below:

Table 7. Actual and predicted values of BSE Sensex for 2014

Month	Actual (BSE Sensex)	Predicted (BSE Sensex)
January	20513.85	19018.45
February	21120.12	19225.3
March	22386.27	20285.41

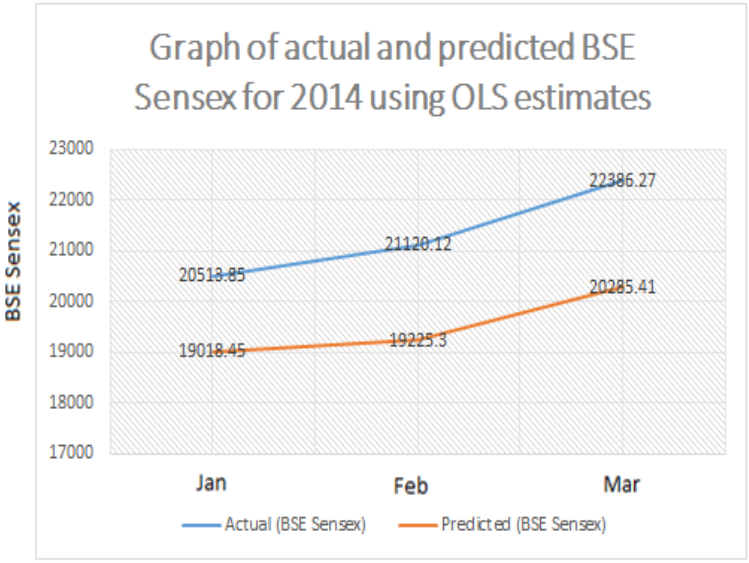

Figure 2. Graph of actual and predicted BSE Sensex for 2014 (using OLS estimates)

DISCUSSION

From Figure 2 we observe that, even though the values of actual BSE Sensex and predicted BSE Sensex differ, the trend they follow are highly similar.

STEP 5: RIDGE REGRESSION AS A REMEDY TO MULTICOLLINEARITY

Even after getting a model with good fit, it may happen that the prediction power of the model is low. We observed that even in the final model multicollinearity is present. Hence, in order to obtain more accurate predictions, it is necessary to deal with the problem of multicollinearity. We used ridge regression method to solve this problem of multicollinearity. This reduces the variance of the estimator of regression coefficient $\hat{\beta}$ and thus helps to increase the prediction power of the model.

Ridge Estimator

The ridge estimator is found by solving a slightly modified version of the normal equations of the ususal regression model. Specifically we define the ridge estimator $\hat{\beta}_R$ as the solution to:

$$(X'X + kI)\ \hat{\beta}_R = X'Y \qquad \text{From} \quad (1)$$

The ridge estimator is given by,

$$\hat{\beta}_R = (X'X + kI)^{-1} X'Y \qquad \text{From (2)}$$

where X is the design matrix of regressors X1, X3, X4, X5, X7 and X8. Y is the response vector and $k \geq 0$ is a constant selected by the analyst. The procedure is called Ridge regression.

Starting with k=0.001, we tried different values of k with an increment of 0.001. Using Equation (2) we found the regression coefficient estimates for different values of k (given in Appendix) and plotted these values to obtain the Ridge trace. As k increases, $\hat{\beta}_R$ (ridge regression coefficient) becomes more stable.

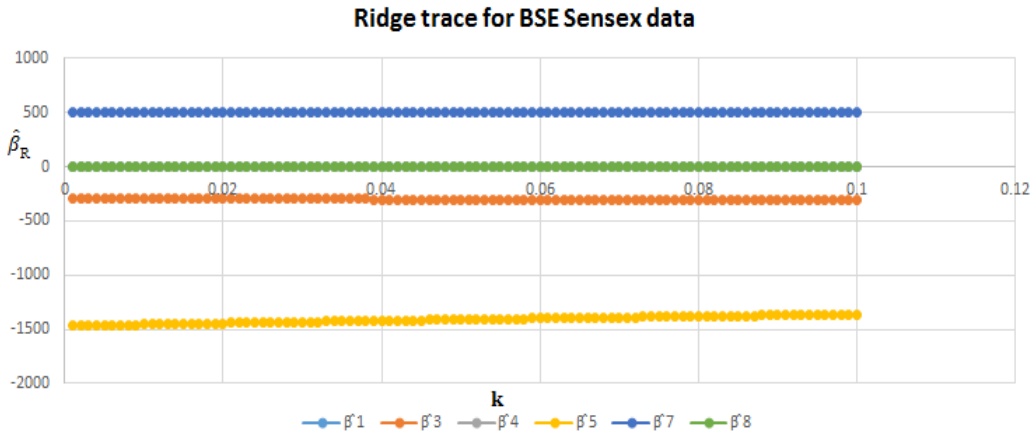

Figure 3.Ridge trace for BSE Sensex data

It is observed from Figure 3, in the range k= (0.02 to 0.04), $\hat{\beta}_R$ has been found to be reasonably stable and thus we have taken k=0.03. From Equation (2) for k=0.03, $\hat{\beta}_R = (\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_3, \hat{\beta}_4, \hat{\beta}_5, \hat{\beta}_7, \hat{\beta}_8)$, the vector of regression coefficients for different determinants comes out to be as follows:

Table 8: Ridge estimates of regression coefficients

	(Intercept)	**Oil price**	**Repo rate**	**Call money rate**	**FII**	**Exchange rate**	**Foreign exchange reserve**
Ridge estimate	1.49e+04	1.38e+00	-2.97e+02	1.17e+00	-1.43e+03	4.99e+02	4.18e-02

Thus, our final model using the Ridge regression estimators obtained in Table 8 is given by:

$y = (1.49*10^4) + (1.38)\, x_1 + (-2.97*10^2)\, x_5 + (1.17)\, x_7 + (-1.43*10^3)\, x_8 + 4.99*10^2)\, x_3 + (4.18*10^{-2})\, x_4$ _____(4)

Using the final model given by equation (4) we obtained its residuals and calculated the residual standard error.

On comparing the residual standard error from Model Summary II, it is observed that the residual standard error has reduced from 1644 to 1575.568.

STEP 6: PREDICTION USING RIDGE ESTIMATES

The ridge regression procedure has reduced the impact of multicollinearity and thus has increased the prediction power of the model. Using the ridge estimates of regression coefficients from Table 8, we have again predicted the share prices for the first three months of 2014.

The actual and predicted values of BSE Sensex for the months of January, February and March 2014 are given in the following table:

Table 9. Actual and predicted values of BSE Sensex for 2014

Month	**Actual(BSE Sensex)**	**Predicted (BSE Sensex) (using OLS estimator)**	**Predicted (BSE Sensex) (using Ridge Regression estimator)**
January	20513.85	19018.45	19201.74
February	21120.12	19225.3	19406.47
March	22386.27	20285.41	20496.46

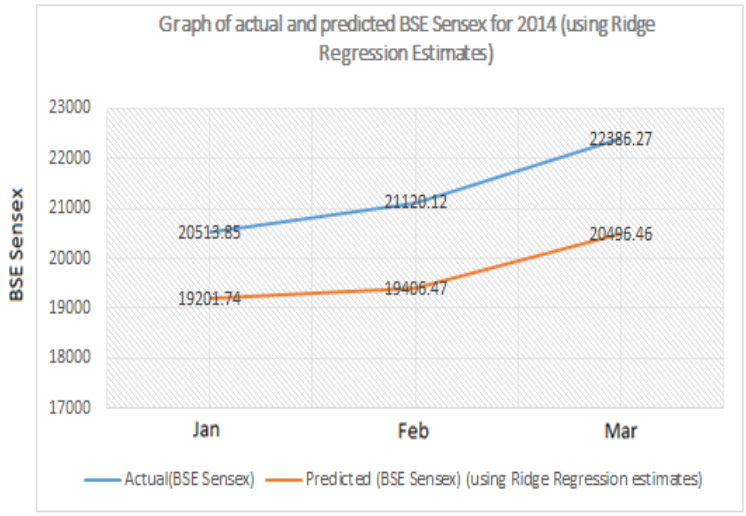

Figure 4. Graph of actual and predicted BSE Sensex for 2014 (using Ridge Regression Estimates)

DISCUSSION

On comparing Figure 2 and Figure 4, we observe that the difference between the actual BSE Sensex values and the predicted BSE Sensex values is reduced. From Figure 4, we observe that even though the values of actual BSE Sensex and predicted BSE Sensex are different, the trend they follow are highly similar.

IV. CONCLUSION

In this paper, we have tried to establish an optimum model for BSE Sensex based on some macroeconomic determinants of significance. From our analysis we have found that Oil price, Exchange rate, Foreign exchange reserve, Repo rate, Call money rate and Foreign Institutional Investor (FII)are the factors significantly affecting the fluctuations in BSE Sensex. Crude oil prices have an impact on the complete logistics of an industry and in turn influence BSE Sensex. The appreciation and depreciation of Indian Rupee influence foreign investments in India, affecting the values of BSE Sensex. Thus, Exchange rate, Foreign exchange reserve, FII are crucial for BSE Sensex. Repo rate and Call money rate are vital rates influencing market movements in an economy.

The movements in the value of BSE Sensex are also influenced by some other factors such as international financial policies and sanctions, RBI policies, social factors, political disturbances and other Government policies. Due to the constraint on data base we have not considered the impact of political turbulence and other factors on BSE Sensex. We have carried out our study considering only nine independent variables but effect of other factors on BSE Sensex can also be studied in further research. Our research can be applied to study the factors affecting fluctuations in all stock exchange indices throughout the world.

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APPENDIX

All the analysis in our study is done using Statistical Package – R. Commands and/or outputs in various steps of our analysis are given below.

A) Ridge regression as a remedy to multicollinearity

Table B.1. Starting with k=0.001 and with an increment of 0.001, the regression coefficient estimates for different values of k are given the following table.

k	β0	β1	β3	β4	β5	β7	β8
0.001	15935.45	1.5155	-290.2396	1.049199	-1469.195	497.134	0.0418323
0.002	15896.21	1.510545	-290.4959	1.053723	-1467.871	497.201	0.0418326
0.003	15857.16	1.505615	-290.751	1.058225	-1466.554	497.267	0.0418328
0.004	15818.3	1.500709	-291.0048	1.062705	-1465.242	497.333	0.0418331
0.005	15779.63	1.495828	-291.2574	1.067163	-1463.937	497.399	0.0418333
0.006	15741.16	1.49097	-291.5088	1.071599	-1462.638	497.464	0.0418336
0.007	15702.86	1.486136	-291.7589	1.076014	-1461.345	497.529	0.0418339
0.008	15664.76	1.481325	-292.0078	1.080407	-1460.059	497.594	0.0418341
0.009	15626.83	1.476537	-292.2556	1.084779	-1458.778	497.658	0.0418344
0.01	15589.09	1.471773	-292.5021	1.08913	-1457.504	497.721	0.0418347
0.011	15551.53	1.467032	-292.7475	1.09346	-1456.235	497.785	0.0418349
0.012	15514.16	1.462313	-292.9917	1.09777	-1454.973	497.847	0.0418352
0.013	15476.96	1.457618	-293.2347	1.102058	-1453.717	497.91	0.0418354
0.014	15439.93	1.452944	-293.4766	1.106326	-1452.466	497.972	0.0418357
0.015	15403.09	1.448293	-293.7173	1.110574	-1451.221	498.034	0.041836
0.016	15366.42	1.443665	-293.9569	1.114801	-1449.983	498.095	0.0418362
0.017	15329.92	1.439058	-294.1953	1.119009	-1448.749	498.156	0.0418365
0.018	15293.6	1.434473	-294.4326	1.123196	-1447.522	498.217	0.0418367
0.019	15257.45	1.42991	-294.6688	1.127364	-1446.3	498.277	0.041837
0.02	15221.46	1.425368	-294.9039	1.131512	-1445.084	498.337	0.0418372
0.021	15185.65	1.420848	-295.1379	1.13564	-1443.874	498.396	0.0418375
0.022	15150.01	1.416349	-295.3708	1.139749	-1442.669	498.456	0.0418377
0.023	15114.53	1.411871	-295.6026	1.143839	-1441.47	498.514	0.041838
0.024	15079.22	1.407415	-295.8334	1.14791	-1440.276	498.573	0.0418382
0.025	15044.07	1.402978	-296.063	1.151962	-1439.087	498.631	0.0418385
0.026	15009.08	1.398563	-296.2916	1.155995	-1437.905	498.688	0.0418387
0.027	14974.26	1.394168	-296.5192	1.160009	-1436.727	498.746	0.041839
0.028	14939.59	1.389794	-296.7457	1.164005	-1435.555	498.803	0.0418392
0.029	14905.09	1.38544	-296.9711	1.167982	-1434.388	498.86	0.0418395
0.03	14870.75	1.381105	-297.1955	1.171941	-1433.226	498.916	0.0418397
0.031	14836.56	1.376791	-297.4189	1.175882	-1432.07	498.972	0.04184
0.032	14802.53	1.372497	-297.6413	1.179805	-1430.918	499.028	0.0418402
0.033	14768.66	1.368222	-297.8627	1.18371	-1429.772	499.083	0.0418405
0.034	14734.94	1.363967	-298.083	1.187597	-1428.631	499.138	0.0418407

0.035	14701.37	1.359731	-298.3024	1.191466	-1427.495	499.192	0.041841
0.036	14667.96	1.355515	-298.5208	1.195318	-1426.365	499.247	0.0418412
0.037	14634.69	1.351318	-298.7382	1.199152	-1425.239	499.301	0.0418415
0.038	14601.58	1.34714	-298.9546	1.202969	-1424.118	499.354	0.0418417
0.039	14568.62	1.34298	-299.17	1.206768	-1423.002	499.408	0.0418419
0.04	14535.8	1.33884	-299.3845	1.210551	-1421.891	499.461	0.0418422
0.041	14503.13	1.334718	-299.598	1.214316	-1420.785	499.514	0.0418424
0.042	14470.61	1.330615	-299.8105	1.218065	-1419.684	499.566	0.0418427
0.043	14438.24	1.32653	-300.0221	1.221797	-1418.587	499.618	0.0418429
0.044	14406	1.322463	-300.2328	1.225512	-1417.496	499.67	0.0418432
0.045	14373.91	1.318415	-300.4425	1.229211	-1416.409	499.721	0.0418434
0.046	14341.97	1.314384	-300.6513	1.232893	-1415.327	499.772	0.0418436
0.047	14310.16	1.310371	-300.8592	1.236559	-1414.249	499.823	0.0418439
0.048	14278.5	1.306377	-301.0662	1.240209	-1413.177	499.874	0.0418441
0.049	14246.97	1.3024	-301.2723	1.243843	-1412.109	499.924	0.0418444
0.05	14215.59	1.29844	-301.4774	1.24746	-1411.045	499.974	0.0418446
0.051	14184.34	1.294498	-301.6817	1.251062	-1409.986	500.024	0.0418448
0.052	14153.23	1.290573	-301.885	1.254648	-1408.932	500.073	0.0418451
0.053	14122.25	1.286666	-302.0875	1.258218	-1407.882	500.122	0.0418453
0.054	14091.41	1.282775	-302.2891	1.261773	-1406.836	500.171	0.0418455
0.055	14060.7	1.278902	-302.4899	1.265312	-1405.795	500.219	0.0418458
0.056	14030.13	1.275045	-302.6897	1.268836	-1404.759	500.268	0.041846
0.057	13999.69	1.271205	-302.8887	1.272345	-1403.727	500.315	0.0418462
0.058	13969.38	1.267382	-303.0869	1.275838	-1402.699	500.363	0.0418465
0.059	13939.2	1.263576	-303.2842	1.279316	-1401.675	500.41	0.0418467
0.06	13909.15	1.259785	-303.4806	1.282779	-1400.656	500.457	0.0418469
0.061	13879.23	1.256012	-303.6762	1.286228	-1399.641	500.504	0.0418472
0.062	13849.44	1.252254	-303.871	1.289661	-1398.631	500.551	0.0418474
0.063	13819.77	1.248513	-304.0649	1.29308	-1397.624	500.597	0.0418476
0.064	13790.24	1.244787	-304.258	1.296485	-1396.622	500.643	0.0418479
0.065	13760.82	1.241078	-304.4503	1.299874	-1395.624	500.689	0.0418481
0.066	13731.54	1.237384	-304.6418	1.30325	-1394.63	500.734	0.0418483
0.067	13702.37	1.233706	-304.8325	1.306611	-1393.641	500.779	0.0418486
0.068	13673.33	1.230044	-305.0224	1.309958	-1392.655	500.824	0.0418488
0.069	13644.42	1.226397	-305.2114	1.31329	-1391.673	500.869	0.041849
0.07	13615.62	1.222766	-305.3997	1.316609	-1390.696	500.913	0.0418492
0.071	13586.95	1.21915	-305.5872	1.319913	-1389.722	500.957	0.0418495
0.072	13558.39	1.215549	-305.7739	1.323204	-1388.753	501.001	0.0418497
0.073	13529.96	1.211963	-305.9598	1.326481	-1387.787	501.045	0.0418499
0.074	13501.64	1.208393	-306.145	1.329744	-1386.826	501.088	0.0418501
0.075	13473.45	1.204837	-306.3294	1.332994	-1385.868	501.131	0.0418504

0.076	13445.37	1.201296	-306.513	1.33623	-1384.914	501.174	0.0418506
0.077	13417.4	1.19777	-306.6959	1.339452	-1383.964	501.216	0.0418508
0.078	13389.56	1.194259	-306.878	1.342662	-1383.018	501.259	0.041851
0.079	13361.82	1.190762	-307.0593	1.345858	-1382.076	501.301	0.0418513
0.08	13334.2	1.18728	-307.24	1.34904	-1381.137	501.343	0.0418515
0.081	13306.7	1.183812	-307.4198	1.35221	-1380.203	501.384	0.0418517
0.082	13279.31	1.180358	-307.599	1.355367	-1379.272	501.425	0.0418519
0.083	13252.03	1.176919	-307.7774	1.35851	-1378.345	501.467	0.0418522
0.084	13224.86	1.173494	-307.955	1.361641	-1377.421	501.507	0.0418524
0.085	13197.8	1.170083	-308.132	1.364759	-1376.501	501.548	0.0418526
0.086	13170.86	1.166685	-308.3082	1.367864	-1375.585	501.588	0.0418528
0.087	13144.02	1.163302	-308.4837	1.370957	-1374.672	501.629	0.041853
0.088	13117.29	1.159933	-308.6586	1.374037	-1373.764	501.668	0.0418533
0.089	13090.67	1.156577	-308.8327	1.377104	-1372.858	501.708	0.0418535
0.09	13064.16	1.153235	-309.0061	1.380159	-1371.956	501.748	0.0418537
0.091	13037.76	1.149906	-309.1788	1.383202	-1371.058	501.787	0.0418539
0.092	13011.46	1.146591	-309.3508	1.386232	-1370.164	501.826	0.0418541
0.093	12985.27	1.143289	-309.5221	1.389251	-1369.272	501.864	0.0418544
0.094	12959.18	1.14	-309.6928	1.392257	-1368.385	501.903	0.0418546
0.095	12933.19	1.136725	-309.8627	1.395251	-1367.501	501.941	0.0418548
0.096	12907.31	1.133463	-310.032	1.398233	-1366.62	501.979	0.041855
0.097	12881.54	1.130214	-310.2006	1.401203	-1365.742	502.017	0.0418552
0.098	12855.86	1.126978	-310.3686	1.404162	-1364.868	502.055	0.0418554
0.099	12830.29	1.123755	-310.5359	1.407108	-1363.998	502.092	0.0418557
0.1	12804.82	1.120545	-310.7025	1.410043	-1363.131	502.129	0.0418559

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