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Forecasting BSE Sensex under Optimal Conditions: An Investigation Post Factor Analysis

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Abstract

The following paper tries to investigate and predict optimal condition of the primary factors responsible for affecting Bombay Stock Exchange (BSE) in India. We considered the following determinants Oil prices, Gold price, Cash Reserve Ratio, Food Price Inflation, Call Money Rate, Dollar Price, F D I, Foreign Portfolio Investment and Foreign Exchange Reserve (Forex). We have taken into consideration the Multicollinearity problem among different macroeconomic variables and attempted to eliminate it. To do this analysis we have taken monthly basis database of different economical variables. Then we applied Factor Analysis to find out Factors affecting BSE Sensex. We found that Dollar Price along with "Factor 1"i.e; "External Reserve" and "Factor score 2"i.e; "Inflation Inertia" are significantly affecting BSE Sensex. Then with the help of Linear Programming Problem the optimality conditions of the primary factors are traced out to ascertain the optimal value of BSE Sensex.

Keywords: Multiple Regression analysis, Multicollinearity, Factor Analysis and Linear Programming Problem.

Introduction

Stock market is one of the major economic reflectors. Indian economy is currently emerging as a global super power. Due to low labor cost and skillful manpower sectors like textile, garments, manufacturing, banking and insurance has made a significant contribution to foster the growth potentials of the economy. The Structural Adjustment Program adopted in 1991 had focused on stabilization and structural reforms in this respect the changeover from inward orientation to outward strategies has generated euphoria in the stock market. Hence the "opening up" of the economy has been successful in spreading its tentacles over the economy. There are several factors which are directly or indirectly related to stock prices. Here while observing stock market behavior we have taken into consideration Bombay Stock Exchange sensitive index (BSE) in our database. In this paper we considered the following determinants Oil prices, Gold price, Cash Reserve Ratio, Food price inflation, Call money rate, Dollar price, F D I, Foreign Portfolio Investment and Foreign Exchange Reserve (Forex).

In our previous paper we have estimated the relationship between BSE Sensex and some other important economical factors and got some interesting results related to this. We have taken into consideration the Multicollinearity problem among different independent variables and attempted to eliminate it. We have used statistical methods to do the analysis based on monthly basis database of different economical factors. Finally we got some relationships of those factors with BSE Sensex. In our analysis we found that Dollar price along with "Factor 1"i.e; "External Reserve" and "Factor score 2"i.e; "Inflation Inertia" are significantly affecting BSE Sensex.

In this paper we tried to find out the optimality conditions as well as the optimal value of the BSE Sensex. The optimality problem is represented as Linear Programming Problem keeping in mind various constraints. To find out the optimal values we have used Lingo 9.0 software to solve the problem.

Literature Review

In the past decades, many researchers attempted to use different methods in order to predict decision regarding share markets. Here we have described some previous research works related to our analysis sectors and tried to find out their limitations to improve the analysis process better than before.

Firstly we reviewed on those papers/ articles where relation between stock prices and call money rate were analyzed. In the paper of Kenneth E. Homa & Dwight M. Jaffee (1971) they have used stock price as a dependent variable and supply of money as an independent variable. As he said, the nature of the relationship between the money supply and common stock prices can be most easily described if a share of common stock is viewed as an asset that yields its return to the investor over time. In this study the relationship between the money supply and the stock market is estimated using the techniques of regression analysis.

One attempt at estimating such relationship for use in simulating monetary effects within a macroeconomic model is described in the research of Robert H. Rasche and Harold T. Shapiro (1968). A fuller discussion of this common stock valuation formula can be found in Burton G. Malkeil (1963), Martin Feldstein (1980) discussed a crucial cause of the failure of share prices to rise during a decade of substantial inflation. The analysis here indicates that this inverse relation between higher inflation and lower share prices during the past decade was not due to chance or to other unrelated economic events. One of the analyses by Franco Modigliani and Richard Cohn (1979) also shows that it is unnecessary to invoke a theory of systematic error of the type.

According to Kenneth E. Homa & Dwight M. Jaffee (1971), while forecasting share prices, further realism could be introduced. In particular, short sales of stock, the tax treatment of short term and long term capital gains, bills perhaps other assets, all could be introduced into the simulation. Finally, more practical use might be made of timing implications of the model if forecasts were generated on a monthly or weekly basis.

So we have tried with some other assets and economical factors to make the forecasting more realistic according to this papers author's suggestion. According to Martin Feldstein (1980), full understanding of the equilibrium relation between share prices and inflation requires extending the current analysis in a number of ways. A more explicit portfolio model could derive asset demand equations from expected utility maximization and could recognize that some institutional holdings are really indirect ways for individuals to hold assets in a tax-favored way. For that purpose we have included Gold price as a risk less assets in a tax-favored way. Martin Feldstein (1980) also concluded his study saying that the simplification that the capital stock remains constant should be replaced by a more dynamic model that recognizes the effect of inflation on capital accumulation.

We have done our analysis using some more dynamic model like correlation analysis, regression analysis .The lacking of Martin Feldstein (1980) analysis was, a complete analysis of the effect of inflation on share prices requires considering a wider range of alternative investments and incorporating the possibility that perceived risk varies with inflation which was absent here. So we tried to consider a wide range of alternative investments on monthly basis data to make the analysis more efficient.

The Global Economic Slowdown had a recessionary impact on the financial market leading to decline in share prices and indices. In the recovery phase the economy has adopted expansionary fiscal policy to accelerate aggregate demand. In this respect RBI has adopted a contractionary monetary policy overcome the crisis which led to higher interest rate on bank deposits. Then we have tried to review on those papers/ articles which have done analysis to check whether stock prices and oil price are related to each other or not. John Mauldin (2003) reported in an article of Swiss America Trading Corporation on the relationship between oil prices and stock prices, where he found strong evidence that changes in oil prices forecast stock returns. This predictability is especially strong in the developed countries markets. Among his (John Mauldin (2003)) chosen 12 of the 18 countries, changes in oil prices significantly predict future market returns on a lagging monthly basis. Not surprisingly, a rise on oil price suggests a lower stock market and a drop in oil price infers a rise in stock prices. The magnitude of the oil price shift is also carried over into the magnitude of the expected increase/decrease in stock prices.

John Mauldin (2003) used such a method, while adding alpha or excess returns over buy and hold, is still volatile as heck (that's a technical term) and is wrong over 40% of the time in most countries. It is just that when it is right, the returns are excessive. This also means that there could be certain random entry/trend following variables. Though the study clearly showed that oil prices and stocks, especially if there are big moves in oil, tend to go in opposite directions. Here we saw that though John Mauldin (6) found a relationship between share price and oil price, but it is wrong over 40% of the time in most countries. So we have tried to find this relation using different method to see whether the significance level could be high.

The issue of whether stock prices and exchange rates are related or not have received considerable attention after the East Asian crises. During the crises the countries affected saw turmoil in both currency and stock markets. If stock prices and exchange rates are related and the causation runs from exchange rates to stock prices then crises in the stock markets can be prevented by controlling the exchange rates. Moreover, developing countries can exploit such a link to attract/stimulate foreign portfolio investment in their own countries. Similarly, if the causation runs from stock prices to exchange rates then authorities can focus on domestic economic policies to stabilize the stock market. If the two markets/prices are related then investors can use this information to predict the behavior of one market using the information on other market.

This article of R. Smyth and M. Nandha (2003) examines the relationship between exchange rates and stock prices in Bangladesh, India, Pakistan and Sri Lanka using daily data over a six-year period from 1995 to 2001. Both the Engle-Granger two-step and Johansen cointegration methods suggest that there is no long-run equilibrium relationship between these two financial variables in any of the four countries. Granger causality tests find that there is unit-directional causality running from exchange rates to stock prices in India and Sri Lanka, but in Bangladesh and Pakistan exchange rates and stock prices are independent. Most of the empirical literature that has examined the stock prices-exchange rate relationship has focused on examining this relationship for the developed countries with very little attention on the developing countries. The results of these studies are, however, inconclusive. Some studies have found a significant positive relationship between stock prices and exchange rates (for instance Smith (1992), Solnik (1987), and Aggarwal (1981)) while others have reported a significant negative relationship between the two (e.g., Soenen and Hennigar (1988)). On the other hand, there are some studies that have found very weak or no association between stock prices and exchange rates (for instance, Franck and Young (1972), Eli Bartov and Gordon M.Bodnor (1994)).

The study by Naeem Muhammad and Abdul Rasheed (2001) uses monthly data on four South Asian countries, including Pakistan, India, Bangladesh and Sri- Lanka, for the period January 1994 to December 2000. They employed cointegration, vector error correction modeling technique and standard Granger causality tests to examine the long-run and short-run association between stock prices and exchange rates. The results of this study show no short-run association between the said variables for all four countries. There is no long-run relationship between stock prices and exchange rates for Pakistan and India as well. However, for Bangladesh and Sri Lanka there appear to be a bi-directional causality between these two financial variables.

There is no theoretical consensus on the relationship between stock prices and exchange rates either. For instance, portfolio balance models of exchange rate determination postulate a negative relationship between stock prices and exchange rates. Franck and Young (1972) was the first study that examined the relationship between stock prices and exchange rates. They use six different exchange rates and found no relationship between these two financial variables. Aggarwal (1981) explored the relationship between changes in the dollar exchange rates and change in indices of stock prices. He uses monthly U.S. stock price data and the effective exchange rate for the period 1974-1978. His results, which were based on simple regressions, showed that stock prices and the value of the U.S. dollar is positively related and this relationship is stronger in the short run than in the long run. Solnik (1987) examined the impact of several variables (exchange rates, interest rates and changes in inflationary expectation) on stock prices. He uses monthly data from nine western markets (U.S., Japan, Germany, U.K., France, Canada, Netherlands, Switzerland, and Belgium). He found depreciation to have a positive but insignificant influence on the U.S. stock market compared to change in inflationary expectation and interest rates. Soenen and Hanniger (1988) employed monthly data on stock prices and effective exchange rates for the period 1980-1986. They discover a strong negative relationship between the value of the U.S. dollar and the change in stock prices. However, when they analyzed the above relationship for a different period, they found a statistical significant negative impact of revaluation on stock prices. Amare and Mohsin (2000) examine the long-run association between stock prices and exchange rates for nine Asian countries (Japan, Hong Kong, Taiwan, Singapore, Thailand, Malaysia, Korea, Indonesia, and Philippines). They use monthly data from January 1980 to June 1998 and employed cointegration technique. The long-run relationship between stock prices and exchange rates was found only for Singapore and Philippines. They attributed this lack of cointegration between the said variables to the bias created by the “omission of important variables”. When interest rate variable was included in their cointegrating equation they found cointegration between stock prices, exchange rates and interest rate for six of the nine countries.

To examine the long-run relationship between stock prices and exchange rates Naeem Muhammad and Abdul Rasheed (2001) employ the standard technique of cointegration. In another work Tamnun E Mursalin, Ahmed Tanvir and Dr. Md. Jahangir Alam (2006) analyzed impact of various economical and social determinants to predict decision of investors.

Research Model

We fit a Multiple Regression Model to the data set and carryout the analysis to examine the impact of the determinants affecting Sensex and at the same time computing the degree of association among the determinants. Further Factor Analysis is carried out to categorize the determinants into groups. Eventually the crucial factors among Oil prices, Gold price, Cash Reserve Ratio, Food price inflation, Call money rate, Dollar Price, F D I, Foreign Portfolio Investment and Foreign Exchange Reserve (Forex) are traced out using the above methodology. We have collected each sector's three years database on monthly basis from specific sources. There are some holidays which didn't match in both share market & bank or exchange office. So we had to take previous working day's closing price as those days share price.

In this paper we found out the optimality conditions as well as the optimal value of the BSE Sensex. The optimality problem is represented as Linear Programming Problem keeping in mind various constraints. To find out the optimal values we have used Lingo 9.0 software to solve the problem.

Background of Empirical Studies

Generally the efficient market hypothesis states that markets are efficient if prices fully reflect all available factors. Our analysis was based on some strong statistical methods like Correlation analysis, Regression analysis, Multiple Regression Analysis, Factor Analysis and Linear Programming Problem.

Regression Analysis

Then we have done the regression analysis to justify the relation's strength or weakness like as we have found that there is a significant relation between share price and other specific factors but we don't know how strong the relationship are. So by this analysis we have tried to figure it out. Regression analysis is a method of modeling the relationships among two or more variables. It is used to predict the value of one variable given the values of the others. We first review the basic theory on crisp multiple linear regression. Suppose we have some data $(x_{1j}, x_{2j}, \ldots\ldots, x_{mj}, y_j)$, $j = 1, 2, \ldots.., n$, on $(m + 1)$ variables $x_1, x_2, \ldots\ldots, x_m$ and Y. The values of x_i ($i = 1, 2, \ldots. m$) are known in advance and Y is a random variable. We assume that there is no uncertainty in the data for x_i. We cannot predict a future value of Y with certainty. So we decide to focus on the 'mean of Y', E(Y). Here we assume that E(Y) is a linear function of x_i's, say

$$E(Y) = A_0 + A_1x_1 + \ldots\ldots + A_mx_m.$$

Our model is $Y_j = A_0 + A_1x_{1j} + \ldots\ldots + A_mx_{mj} + \varepsilon_j$, $j = 1, 2, \ldots. n$.

The basic regression equation for the 'mean of Y' is $y = A_0 + A_1x_1 + \ldots\ldots + A_mx_m$, and we wish to estimate the values of A_i ($i = 0,1, 2, \ldots. m$).

Here we need the (1 - β)100% confidence interval for A_i (i = 0, 1, 2, …. m), where β is the level of significance. First we require the crisp point estimators of A_i (i = 0, 1, 2, …. m) and σ^2, where σ^2 is the unknown population variance. We use the matrix notation to describe the estimators and their confidence intervals.
Let us define the vectors as
$\mathbf{A} = [A_0, A_1, \ldots\ldots A_m]$, $\boldsymbol{\varepsilon} = [\varepsilon_1, \varepsilon_2, \ldots \varepsilon_n]$, $\mathbf{y} = [y_1, y_2, \ldots\ldots, y_n]$ and the m × n matrix X as

$$X = \begin{pmatrix} 1 & x_{11} & \cdots & x_{m1} \\ 1 & x_{12} & \cdots & x_{m2} \\ \cdots & \cdots & \cdots & \cdots \\ 1 & x_{1n} & \cdots & x_{mn} \end{pmatrix}$$

We also define $\hat{\mathbf{A}} = [\hat{A}_0, \hat{A}_1, \ldots, \hat{A}_m]$ as the vector of point estimate of **A**. Then $\hat{\mathbf{A}}^{t} = (X^tX)^{-1}X\mathbf{y}^t$, which gives $\hat{A}_0, \hat{A}_1, \ldots, \hat{A}_m$.

Multiple Regression Analysis

We have done multiple regression analysis also to check multiple variables effect on share price changes. Multiple regression is used to account for (predict) the variance in an interval dependent, based on linear combinations of interval, dichotomous, or dummy independent variables. Multiple regression can establish that a set of independent variables explains a proportion of the variance in a dependent variable at a significant level (through a significance test of R^2), and can establish the relative predictive importance of the independent variables (by comparing beta weights). Power terms can be added as independent variables to explore curvilinear effects. Cross-product terms can be added as independent variables to explore interaction effects. One can test the significance of difference of two R^2's to determine if adding an independent variable to the model helps significantly. (G. David Garson (2003)).

In general, multiple regression procedures will estimate a linear equation of the form:

$$Y = a + b_1 * X_1 + b_2 * X_2 + \cdots + b_n * X_n$$

In the above the regression coefficients (or B coefficients) represent the independent contributions of each independent variable to the prediction of the dependent variable. Here Y = BSE Sensex, X_1 = Dollar price, X_2 = Oil price, X_3 = Food price inflation and so on according to our analysis.

Multicollinearity

Multicollinearity is one of the important problems in multiple regression analysis. It is usually regarded as a problem arising out of the violation of the assumption that explanatory variations are linearly independent. However, the mere satisfaction of this assumption does not preclude the possibility of an approximate linear dependence among the explanatory variables and hence the problem of multicollinearity. In other words, generally we do not speak in terms of the presence of the absence of multicollinearity, but in terms of its degree. A review of the treatment of multicollinearity in literature reveals that the hypothesis about the consequences of multicollinearity is that a high degree of multicollinearity leads to high standard errors of the estimates. What is implied here is that had the interdependence among the explanatory variables been low, the estimated coefficients would have been statistically more significant. Another consequence of multicollinearity as argued currently is that the inclusion of a strongly correlated variable will bring only a marginal increase inR^2. That is, if Y is regressed on X2 and if X3 is highly correlated with X2 then the inclusion of X3 as another explanatory variable in the equation will result in only a slight increase in R^2, if at all any. The above two consequences of multicollinearity are considered to be valid under all conditions. In fact, these consequences are the direct results of the major assumption that the estimated variance of the true error term is not being affected by the degree of multicollinearity. It is our contention that the estimated variance of the true error term need not be invariant to the degree of multicollinearity. It is argued here that a high degree of multicollinearity can result in a lower estimate of the variance of the true error term. In fact under certain condition, a high degree of multicollinearity will always lead to a lower estimated value for the variance of the error term. Then it follows that firstly, a high degree of multicollinearity need not always result in high values of the standard errors of the estimates. Secondly, inclusion of a highly correlated variable (correlated with the existent explanatory variables) can some-times inflate the value of R^2. Thus, if data exhibit some degree of multicollinearity it need not always be reflected in the standard errors being large. In such a case we do not have any 'built in safeguard' against any rash interpretation of predicted value. Moreover, the high R^2 or r^2 and t values in the regression could have resulted from the high degree of multicollinearity.

Factor Analysis

Factor analysis is a collection of methods used to examine how underlying factors or determinants influences the responses on a number of measured variables. There are basically two types of factor analysis: exploratory and confirmatory. Exploratory factor analysis (EFA) attempts to discover the nature of the constructs influencing a set of responses. Confirmatory factor analysis (CFA) tests whether a specified set of constructs is influencing responses in a predicted way. Factor analyses are performed by examining the pattern of correlations (or co variances) between the observed measures. Measures that are highly correlated (either positively or negatively) are likely influenced by the same factors, while those that are relatively uncorrelated are likely influenced by different factors.

Empirical Studies and Results

Data

The sample includes data of BSE Sensex, Oil prices, Gold price, Cash Reserve Ratio, Food price inflation, Call money rate, Dollar price, F D I, Foreign Portfolio Investment and Foreign Exchange Reserve (Forex) on monthly basis for the period from Jan'07 to Mar'10. There are some holidays which didn't match in both share market & bank or exchange office. So we had to take previous day's closing price as those days parameters. To verify accurate gold price, we had to convert international price rate (which was in dollar) into IRS.

Empirical Results and Discussions

The empirical results are presented here in the different subsections.

Correlation Analysis

Here we used Pearson correlation analysis. It assumes that the two variables are measured on at least interval scales, and it determines the extent to which values of the two variables are "proportional" to each other.

Table 1: Correlation analysis of different determinants in comparison to BSE Sensex.

Pearson Correlation Method	**Correlations**
Share Price	1.000
Dollar Price	-0.705820539
Oil Price	0.530762551
Food Price Inflation	-0.032220835
Gold Price	0.213896051
Call Money Rate	0.199697234
CRR	0.38248643
FDI	0.115076
FPI	-0.1333682

Regression & Factor Output Analysis

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	FOREX, FDI, CMR, FPI, CRR, Foreign, Gold, OIL, Doller[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Sensex

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.889[a]	.791	.726	1557.25103

a. Predictors: (Constant), FOREX, FDI, CMR, FPI, CRR, Foreign, Gold, OIL, Doller

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	60401.394	12242.893		4.934	.000		
	Gold	7.812	4.294	.386	1.819	.079	.160	6.258
	FPI	167.114	160.660	.186	1.040	.307	.226	4.431
	CMR	85.579	90.240	.126	.948	.351	.409	2.448
	CRR	-78.145	441.748	-.031	-.177	.861	.237	4.223
	OIL	-72.427	43.770	-.532	-1.655	.109	.070	14.334
	Doller	-1169.062	243.581	-1.607	-4.799	.000	.064	15.551
	FDI	.107	.144	.113	.743	.464	.314	3.184
	Foreign	.038	.213	.029	.180	.858	.275	3.641
	FOREX	.061	.036	.494	1.679	.104	.083	11.994

a. Dependent Variable: Sensex

Correlation Matrix[a]

		Gold	FPI	CRR	OIL	Doller	Foreign	FOREX
Correlation	Gold	1.000	.760	-.213	.188	.353	.639	.707
	FPI	.760	1.000	-.374	-.130	.543	.745	.618
	CRR	-.213	-.374	1.000	.724	-.627	-.179	-.358
	OIL	.188	-.130	.724	1.000	-.589	-.153	-.103
	Doller	.353	.543	-.627	-.589	1.000	.578	.787
	Foreign	.639	.745	-.179	-.153	.578	1.000	.675
	FOREX	.707	.618	-.358	-.103	.787	.675	1.000

a. Determinant = .001

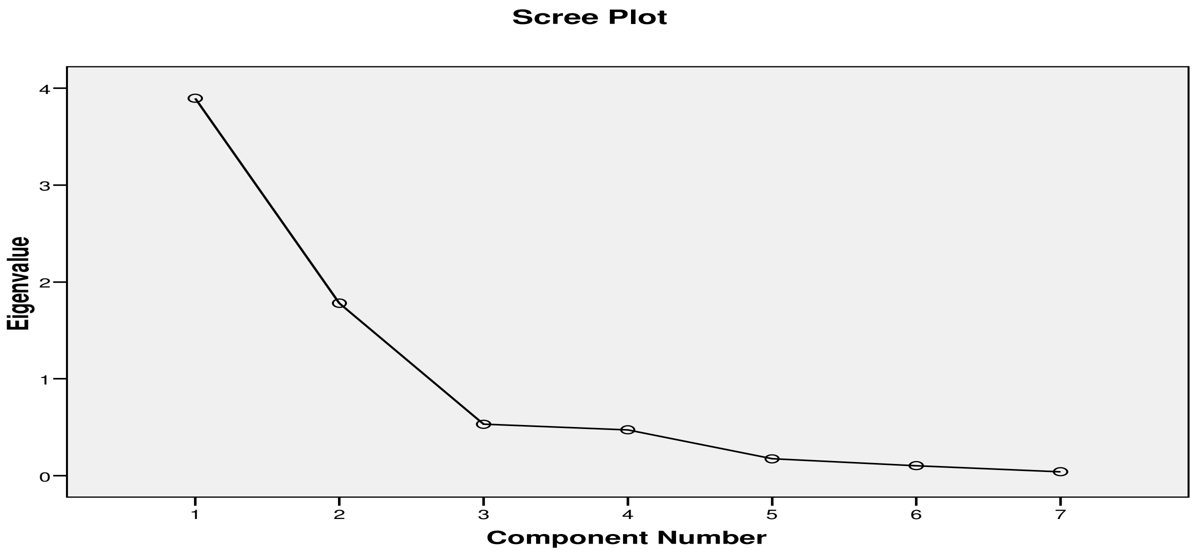
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.620
Bartlett's Test of Sphericity	Approx. Chi-Square	231.726
	df	21
	Sig.	.000

Total Variance Explained

Component	Initial Eigenvalues Total	Initial Eigenvalues % of Variance	Initial Eigenvalues Cumulative %	Extraction Sums of Squared Loadings Total	Extraction Sums of Squared Loadings % of Variance	Extraction Sums of Squared Loadings Cumulative %	Rotation Sums of Squared Loadings Total	Rotation Sums of Squared Loadings % of Variance	Rotation Sums of Squared Loadings Cumulative %
1	3.896	55.658	55.658	3.896	55.658	55.658	3.379	48.267	48.267
2	1.780	25.434	81.091	1.780	25.434	81.091	2.298	32.824	81.091
3	.531	7.583	88.674						
4	.474	6.771	95.445						
5	.174	2.492	97.937						
6	.103	1.476	99.414						
7	.041	.586	100.000						

Extraction Method: Principal Component Analysis.



Component Matrix[a]

	Component	
	1	2
FOREX	.868	
Doller	.854	
FPI	.842	
Foreign	.809	
Gold	.734	.543
OIL		.868
CRR	-.602	.652

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Rotated Component Matrix[a]

	Component	
	1	2
Gold	.907	
FPI	.861	
FOREX	.849	
Foreign	.846	
OIL		.946
CRR		.864
Doller	.573	-.720

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Foreign, Gold, FOREX, FPI[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: REGR factor score 1 for analysis 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.991[a]	.982	.980	.14214108

a. Predictors: (Constant), Foreign, Gold, FOREX, FPI

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-4.002	.163		-24.581	.000
	Gold	.003	.000	.403	10.051	.000
	FPI	.058	.013	.193	4.637	.000
	FOREX	1.11E-005	.000	.266	7.431	.000
	Foreign	.000	.000	.265	7.001	.000

a. Dependent Variable: REGR factor score 1 for analysis 1

“Factor 1”i.e; “External Reserve” Group=-4.002 + .003*GOLD + 0.058*FPI + 0.00001*FOREX + 0.0001*FOREIGN

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	CRR, OIL[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: REGR factor score 2 for analysis 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.981[a]	.963	.961	.19834199

a. Predictors: (Constant), CRR, OIL

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-4.362	.179		-24.433	.000
	OIL	.031	.002	.674	14.453	.000
	CRR	.320	.040	.376	8.054	.000

a. Dependent Variable: REGR factor score 2 for analysis 1

"Factor score 2"i.e; "Inflation inertia" Group= -4.362 + 0.031*OIL + 0.320*CRR

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.874(a)	.764	.744	1505.73923

a Predictors: (Constant), Dollar, REGR factor score1 for analysis 1, REGR factor score2 for analysis 1

Coefficients(a)

Model		Unstandardized Coefficients		T	Standardized Coefficients	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta	Lower Bound	Upper Bound	B	Std. Error
1	(Constant)	57423.040	5027.179		11.423	.000	47217.324	67628.756
	REGR factor score 1 for analysis 1	2206.555	360.209	.742	6.126	.000	1475.292	2937.817
	REGR factor score 2 for analysis 1	-848.169	374.423	-.285	-2.265	.030	-1608.288	-88.051
	Dollar	-953.222	112.123	-1.310	-8.502	.000	-1180.844	-725.600

a Dependent Variable: Sensex

So the objective function deduced from regression equation of Dependent variable and three factors is:

z=57423.04+2206.555*("Factor 1"i.e; "External Reserve")-848.169*("Factor score 2"i.e; "Inflation inertia")-953.222*(Dollar);

Table for range of BSE Sensex, Economical Variables and Factor Scores

Variable	Min Value	Max. Value
BSE Sensex	8762.88	20325.27
Gold	631.17	1134.72
FPI	5.47	17.79
FOREX	12356	86547
FOREIGN	1458	9687
OIL	40.61	132.47
CRR	5	9
DOLLAR	39.42	52.36
EXTERNAL RESERVE	1.49412	1.61295
INFLATION INERTIA	1.26442	2.60521

Thus the LPP model:

Max Z =57423.04+2206.555*(-4.002 + .003*x1 + 0.058*x2 + 0.00001*x3 + 0.0001*x4)-848.169*(-4.362 + 0.031*x5 + 0.320*x6)-953.222*x7;
-4.002 + .003*x1 + 0.058*x2 + 0.00001*x3 + 0.0001*x4 >= -1.54286;
-4.002 + .003*x1 + 0.058*x2 + 0.00001*x3 + 0.0001*x4 <= 1.69244;
-4.362 + .031*x5 + 0.320*x6 >= -1.47359;
-4.362 + .031*x5 + 0.320*x6 <= 1.94929;
x7 >= 39.42;
x7 <= 52.36;
x1 >= 631.17;x1 <= 1134.72;
x2 >= 5.47;x2 <= 17.79;x3 >= 12356;x3 <= 86547;x4 >= 1458;
x4 <= 9687;x5 >= 40.61;x5 <= 132.47;x6 >=5;x6 <=9;

! x1=Gold, x2=FPI,x3=Forex,x4=Foreign,x5=Oil,x6=CRR,x7=Dollar.

Global optimal solution found at iteration: 0
Objective value: 24831.34

Variable	Value	Reduced Cost
Z	24831.34	0.000000
X1	1134.720	0.000000
X2	17.79000	0.000000
X3	86547.00	0.000000
X4	3929.900	0.000000
X5	40.61000	0.000000
X6	5.092187	0.000000
X7	39.42000	0.000000

The impact of the determinants affecting Sensex has been captured statistically by the multiple regression models. The regression output reveals that 79% of the variation in Sensex can be explained by the determinants taken under study. This is confirmed by the F statistic at 5% level. The remaining 21% is left unexplained. The model has a better goodness of fit. However when we look at the individual significance of the determinants it provides a different picture. All the independent variables except Dollar price are statistically insignificant at 5% level. So in spite of high R^2, the OLS estimates may have large variance and covariance. This reflects the association among the independent variables. The presence of Multicollinearity problem within the data set is evident from the above result. This calls for diagnostic tests to affirm the presence of the problem. There by we go for correlation matrix.

The matrix provides an introspective view regarding the inter relationship among the variables. That means the cell other than the shaded region explains strong correlations. Intuitively when the values of r are less than -0.7 or more than 0.7 then the independent variables are highly correlated to each other. So there is no way of disentangling the separate influence of the variables. The determinant value close to 0 confirms high correlation between independent variables. Further, there are certain diagnostic tests that affirm multicollinearity. The KMO Bartlett Test Statistic is equal to 0.620 which exceeds 0.5 and hence, the Null hypothesis of spherical matrix is rejected. This conclusion is further supported by Bartlett Test of sphericity where the χ^2 statistic is significant at 5% level. Hence non spherical correlation matrix confirms the presence of multicollinearity.

From the correlation matrix it is evident that CMR and FDI do not have any association with other independent variables. Hence they do not have multicollinearity problem. Further analysis is carried out except this two variables.

So to reduce the severity of the problem and to eliminate it we have to go for data reduction with the help of factor analysis. There by using the extraction method via Principal component analysis the communalities are computed. According to total variance explained matrix the first two components explains 81% of the change in the independent variables. Further the graphical representation in terms of scree plot reflects that there exists closeness among different eigen values of different component numbers. Since there exists a combination among independent variables within this data set as confirmed by the previous tests, data reduction is necessary. In this regard the original data set is converted to groups on the basis of principal components. This is done by extraction method under factor analysis.

Our component matrix table shows Dollar, Forex, FPI, Foreign Portfolio Investment and CMR will clearly be included in Component 1 and Gold, Oil and CRR in component 2. Since Gold and CRR belong to both the components with different Loadings we have done rotation.

After rotation, loading of factors corresponding to different variables changes their corresponding values. The corresponding matrix represents two components which includes the variables on the basis of Varimax rotation method. According to this matrix, Gold, Forex, FPI, Foreign Portfolio Investment and Dollar belongs to Component1 and Oil, CRR and Dollar belongs to component 2. Dollar is included in both components. Further regression analysis is conducted between regression factor score1 with respect to corresponding variables i.e; Gold, Forex, Foreign Portfolio Investment and FPI. While considering Factor score1, the model yields better goodness of fit as measured by R^2 when we consider Dollar as separate variable. The model summary shows that it is able to explain 98% of the variation in Factor score 1 due to the above mentioned variables. All the variables are statistically significant at 5% level.

Further regression is carried out with respect to factor score 2 corresponding to variables CRR and Oil. The model summary reflects that 96% is explained by factor score 2, all the variables are statistically significant at 5% level of significance.

Final regression is carried out between Dollar, factor score 1 and Factor score 2. In this case, the overall model is statistically significant. It explains 76% of the variation in the dependent variables by the independent variables. Further all the coefficients are statistically significant at 5% level.

Factor 1 can be named as “External Reserve” and Factor score 2 can be named as “Inflation induced variables”.

Discussions

The investigation reflects the optimal value of the Sensex is 24831.34. This optimal value is obtained when Gold is1134.720, FPI is17.79000, Forex86547.00, Foreign is 3929.9000, Oil is 40.61000; CRR is 5.092187 and Dollar is 39.42000. It reflects that those macroeconomic variables which have positive influence on BSE Sensex they are close to the maximum value whereas other influencing variables in our discussion are close to their minimum values.

Conclusion

In our research, we tried to find out the relationship between BSE Sensex and some other important economical factors and got some interesting results related to this. We have used statistical methods to do the analysis based on monthly basis database of different economical factors. Finally we got some relationships of those factors with BSE Sensex. In our analysis we found that dollar price along with Factor 1i.e; “External Reserve” and Factor score 2i.e; “Inflation induced variables” are significantly affecting BSE Sensex. In the context of Indian economy the appreciation of Dollar will bring in more foreign exchange reserve which will act as stimulant to foster growth and in this process the injection of capital flows will affect Sensex. It is evident from the coefficient table that the rise in the price of Dollar has a positive impact on Sensex.

It is obvious question any investor will ask what are the optimal condition when BSE Sensex can reach its optimal value. Our investigation started with this quest. We are able to form Linear programming Problem with this objective keeping in mind fluctuation in macroeconomic variables and Factor scores which we obtained from factor analysis which gives the constraints conditions.

Several other factors like Government Policies, political turbulence, investors confidence and social variables affects fluctuations in BSE Sensex which can be analyzed statistically in future studies. Due to the constraints on data base we have not considered the impact of political factors and turbulence on BSE Sensex. Here we have analyzed nine independent variables but more quantitative factors can be included in further research. The nonlinear dimension is yet to be explored.

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