Macroeconomic Determinants to Forecast Stock Market Index

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Abstract

Stock market is one of the channels through which household savings get effectively invested by deriving an advantage of high liquidity. Industries fulfill their need of funds through primary market which results in future returns for economy as a whole, in the form of GDP growth, employment, monetary gains (capital and dividend), technological advancements and many other tangible and intangible forms. Thus, there exists interdependency between growth of the economy and growth of capital markets. Forecasting of stock prices is questioned by several hypotheses like efficient market and random walk. In this paper, attempt has been made to forecast stock prices based on fundamental analysis approach. The SENSEX has been forecasted as a function of three macro-economic variables: forex rate, fiscal deficit and money supply. Statistically significant model to forecast SENSEX has been obtained using concepts of stationarity, co-integration and granger's causality. SENSEX is expected to touch a level of 37,037 under the most likely scenario, 38,549 under optimistic scenario and 34,440 under pessimistic scenario by March 2017.

Keywords: *Macro-economic variables, Stationarity, Co-integration, Granger's causality, SENSEX*

Introduction

Stock markets play a very important role in the growth of industries, which eventually contributes to overall growth of the economy. Stock market is one of the channels through which household savings get effectively invested by deriving an advantage of high liquidity. Industries fulfill their need of funds through primary market which results in future returns for economy as a whole, in the form of Gross Domestic Product (GDP), employment, technological advancements and many other tangible and intangible benefits. Thus, there exists interdependency between growth of the economy and growth of the capital markets. So, understanding the linkage between the two is important. Forecasting of aggregate variables helps policy planners to take policy decisions pertaining to monetary and fiscal policies. On the other hand, forecasting the growth of capital market helps investors to take decisions for channelization of their savings amongst alternate avenues. As far as forecasting stock prices is concerned, hypotheses like efficient market and

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random walk deny its possibility. However, empirically it has been tested that, in general, degree of efficiency of Indian markets is not strong. This paper attempts to forecast SENSEX as a function of macro-economic variables, using linear regression and applying concepts of stationarity and co-integration by time series analysis.

Literature Survey

There have been several studies investigating impact of different macro-economic variables on stock market. Bhattacharya and Mukherjee (2002), have found that there is no causal linkage between stock prices and money supply, stock prices and national income, and stock prices and interest rate; Index of Industrial Production (IIP) leads the stock prices and there exists a two way causality between stock prices and rate of inflation. Ray and Vani (2004) reveal that interest rate, output, money supply, inflation rate and the exchange rate have considerable influence on the stock market movement (SENSEX), while other variables such as fiscal deficit and foreign institutional investment (FII) have a negligible impact on the stock market. Nair (2008) has concluded that real income, its growth rate and interest rate significantly affect stock market development interest rate affect negatively, while FII, exchange rate and inflation do not affect stock market significantly. Insignificant role of FII is contrary to general belief that FII's are one of the major drivers of the stock markets. Dasgupta (2012) has shown that, in the long-run, stock markets as proxied by SENSEX are positively related to interest rates (proxy-call money rate) and real economic activity (proxy-IIP), while negatively related to inflation (proxy-wholesale price index (WPI)) and exchange rate (Indian National Rupees/United States Dollar-INR/$). The study has called for inclusion of more macro-economic variables to improve the results. Singh (2010) has concluded a two-way causality between SENSEX and IIP while Agrawala (2008) has reported one way causality running from industrial production to stock index. Srivastav (2010) has concluded that stock markets of emerging economies like India are affected more by domestic macro-economic factors rather than global factors. The three variables significantly affecting SENSEX are industrial production, WPI and interest rate (10 year govt. bond rate). In his study, he also established that exchange rate and Morgan Stanley Capital International (MSCI) world index have been insignificant in affecting SENSEX. Vaisla et al, (2010) have predicted nifty as a function of industrial production, WPI, exchange rate, net investment by FIIs, export, import, money supply-narrow money (M1) and money supply-broad money (M3), and concluded that neural networks outperform statistical techniques. Manish and Agarwal (2010) have included United States of America (USA) GDP, standard and poor (S&P) index and USA interest rate in the model along with Indian macro-economic variables of gold price, WPI, IIP and Fiscal deficit. Majumdar and Hussain (2010) have applied artificial neural networks to forecast nifty which was validated with an average accuracy of 69.72%. They have called for inclusion of other macro-economic variables and other international stock market indices in the model to forecast the stock market.

Hsing (2011) has concluded that more real GDP growth, a lower ratio of the government deficit to GDP, a higher ratio of M3 to GDP, a lower domestic real interest rate, depreciation of the rand (South African currency), a lower inflation rate, a higher USA stock price, or a lower USA government bond yield would help the South African stock market. Wickremasinghe (2006) has highlighted violation of semi-strong version of efficient market hypothesis for Sri Lankan stock market. The macro-economic variables considered were exchange rate, consumer price index (CPI), three month fixed deposit rate, USA stock index, M1 and GDP which all formed a co-integrating relationship with Sri Lankan stock index. Menike (2006) has found out that Colombo stock exchange exhibits an inverse relationship with exchange rate, concurrent inflation rate and treasury bill rate, and a direct relationship with money supply. Mohsen (2006) has shown that Iran stock markets are informationally inefficient with respect to money supply, trade balance and industrial production. There exists a one way causality between the macro variables and the stock market such that macro variables lead stock

prices, which is inconsistent with the findings of Fama (1991) and Geske and Roll (1983). Ogunmuyiwa and Asaolu (2010) have found out a weak relationship between domestic macro-economic variables and the Nigerian stock market. They have called for further investigation suspecting global macroeconomic variables as main drivers of Nigerian stock market. Osamwonyi and Osagie (2012) have found out that inflation (proxy-CPI) is positively related to stock index (Nigeria), both in long and the short-run; GDP affects positively and significantly in the long-run; exchange rates affect positively in the short-run but negatively in the long-run, and money supply (M2) affects stock index negatively both in the short and the long run. Maysami, Howe and Hamzah (2004) have found out a significant co-integrating relationship between Singapore stock market and short and long-term interest rates, industrial production, price levels, exchange rate and money supply. Gay (2008) has reported insignificant relationship between stock market index and the macro-economic variables of exchange rate and oil price for Brazil, Russia, India, and China.

It is evident from the above literature search that findings of the above studies differ for reasons such as variation in the time period of data considered in the study, use of different techniques, linear and non-linear, to quantify the relationships and use of different tests to test co-integration, stationarity and causality. Although, there have been numerous studies conducted in Indian context to study causal relationship between stock market and macro-economic variables, these studies lack focus on long term linkages with a view to forecast SENSEX. With the above in backdrop, this paper attempts to use empirical approach to forecast SENSEX as a function of macro-economic variables.

Objective of Study

The objectives of the study are :

- To find the causal relationship between SENSEX and important macro-economic variables.
- To forecast SENSEX by obtaining a significant co-integrating relationship between SENSEX and macro-economic variables.

Macroeconomic Variables and Stock Market

BSE Sensex: Bombay Stock Exchange Sensitive Index i.e. generally called BSE 30 is a free float of weighted stock market index of 30 financially sound companies listed on BSE. These constitute some of the largest and actively traded companies' stocks, representing various industrial sectors of Indian economy. It is considered as the key indicator and barometer of stock exchange performance and is widely used for study on capital markets. This represents around 50% of total market capitalisation and was considered as a dependent variable for the study.

Inflation and interest rates: Based on Dividend Discount Model, anticipated rise in inflation level can affect stock prices in different ways. When interest rates rise due to an increase in rate of inflation, firms may increase their prices in line with the cost, stock prices remain stable. In case firms are unable to increase prices in line with the cost, it would cause a decline in stock prices.

Money supply: The effect of the money supply on stock prices can work in two opposite ways. Monetary growth, due to its positive relationship with the inflation rate, should adversely affect the stock prices. On the other hand, increase in money supply brings economic stimulus, resulting in increased corporate earnings and increased stock prices. Further, since money supply has an inverse relationship with the interest rate, it should have a positive influence on the stock prices as there is a negative relationship between the interest rate and stock market. The implication of money supply on the stock market requires identification of dominant macro-economic variables.

The study considered M1(narrow money) as an indicator of money supply as against M3 (broad money) because it is more liquid and has direct bearing in terms of capacity of investors to invest in the stock markets. M1 constitutes currency with the public plus current deposits with the banking system, plus demand liabilities portion of savings

deposits with the banking system and other deposits with the RBI which has a direct bearing on available liquidity in the system that can be deployed for various purposes including investment in stock exchange by investors. Against this, M3, which is a broad money, has certain limitation as far as liquidity in the market is concerned, as it comprises M2 plus term deposits of residents with a contractual maturity of over one year with the banking system and call/term borrowings from 'non-depository' financial corporations by the banking system.

Forex rate: When domestic currency depreciates with respect to foreign currency, the impact would be different for import and export based companies. Cost of production would increase, resulting in a decline of earnings in case of companies which over-depend on import of raw materials and other factors of production, which would result in decline of stock prices. Companies, which export their products, experience opposite effect due to depreciation of the domestic currency, as their earnings increase.

FII: Inflow of FII shows confidence of foreign investors in domestic market, therefore, stock prices are expected to increase when there is FII inflow. Similarly, outflow of FII shows loss of confidence of foreign investors in domestic market; therefore, stock prices are expected to decrease in this case.

Fiscal deficit: If there is an increase in fiscal deficit, it may be expected that government increases various taxes to fill the gap. This anticipated increase in taxes results in decline of expected corporate earnings, hence, negatively affecting stock prices. Also, when fiscal deficit is anticipated to be increased, it might be expected that government's demand for money would increase and it possibly will sell more securities (g-secs), increasing the risk free interest rate and hence, lowering the stock values.

IIP or GDP: Increase in IIP or GDP is an indication of increase in the corporate earnings which enhances the present value of the firm. It also increases the disposable income that may result in increase in retail investment in the stock market, giving rise to upward movement in the stock market.

Non-agricultural GDP: Over the years, the composition of GDP has completely changed in favour of services sector as against agriculture sector. In the GDP computation, around 86% weight is given to non-agriculture GDP accruing from industry and services sector. It is this component of GDP that has more to do with stocks listed in capital market. Hence, an attempt was made to consider non-agriculture GDP as an independent variable influencing stock markets.

Data and Methodology

Macro-economic variables differ in their units and range of their magnitude. Therefore, in this study, data of all the variables was indexed to make them comparable. Indexing does not change Ordinary Least Square (OLS) estimates as long as the transformation is linear. Each data series was indexed by taking its June 2000 level as 100. The variables considered in the study are: SENSEX - Bombay Stock Exchange (BSE) 30, fiscal deficit, forex reserves, Index of Industrial Production (IIP), Non-agricultural gross domestic product (NAGDP), money stock, Net foreign institutional investment (NFII), exchange rate, repo rate and Wholesale price index (WPI). Quarterly data of all the variables has been used from June 2000 to June 2013 for estimation. The data involved in this paper is mainly time series data. The trends in macro-economic variables over the time were studied first to get an idea of their stationarity. All the time series were tested for their order of stationarity by Augmented Dickey Fuller (ADF) test for unit root.

The general methodology applied after hypothesizing the economic rationale in the form of a mathematical equation is based on work of Granger. Granger defined a framework for working with time series data. Commonly known as Granger's Causal Relationship, which states that when cause occurs before the effect, for example, capital formation and money supply both increase before growth of GDP in subsequent years, it is possible to find a significant empirical relationship between the cause and effect using

OLS, provided the co-efficient of the cause individually passes the t-test of significance and the equation passes the F-test of overall significance. If an equation passes both t and F-test of significance, then Granger causality exists between the variables. Granger's Causal Relationship may be one way or two ways. To obtain a non spurious model for forecasting purposes, co-integration test was applied on the model to ensure that regression is meaningful and no valuable information is lost in the process. ADF test was applied on the error term to simply check whether the model was co-integrated or not (Appendix I).

To forecast the aggregate stock prices, BSE 30 (SENSEX) was taken as dependent variable, as SENSEX represents nearly 50% of the market capitalization of BSE. By using multiple iterations and applying the significance tests, insignificant variables were dropped from the model. Also, model was checked for the suspected auto correlation multi-collinearity. To overcome the problem of auto correlation, model was transformed according to generalized least squares algorithm. To remove multi-collinearity, WPI was dropped. Further, Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) techniques were used to test the forecasting ability of the model. For long term forecasting, the explanatory variables were projected. Money supply was projected on the basis of its historic growth rate, while fiscal deficit was projected as per targets set by the government. Exchange rate was assumed for different scenarios. A scenario analysis has been done with respect to the explanatory variables and values of the dependent variable have been forecasted for three scenarios (optimistic, most likely and pessimistic) for the period June 2014-March 2017 (assumptions given in Appendix II).

Data Analysis

The initial model considered to predict SENSEX included independent variables as - fiscal deficit, forex reserve, IIP, non-agricultural GDP, money stock, net FII, exchange rate, repo rate and WPI. After estimating the parameters for the linear fit, co-efficient of forex reserve, IIP, non-agricultural GDP, net FII and repo rate were found out to be insignificant. Net FII was transformed non-linearly to investigate whether it really did affect SENSEX, and results firmly showed the insignificance of net FII in predicting SENSEX. Therefore, forex reserve, IIP, non-agricultural GDP, net FII and repo rate were dropped from the model. Next, linear model with SENSEX as dependent variable and forex rate (INR/$), fiscal deficit, M1 and WPI as independent variables, was estimated using OLS.

Basic model to project SENSEX

$SENSEX_t = \beta_1 + \beta_2 x Fiscal\ deficit_t + \beta_3 x M1_t + \beta_4 x Forex\ rate_t + \beta_5 x WPI_t$

H_0: All β_i's=0 i.e. no variable explains variation in SENSEX

H_1: At least one of β_i's is non zero i.e. at least one of independent variables significantly explains SENSEX

The specifications of the model estimated are as follows:

Table 1: Coefficients and t statistics

Independent variable	Coefficient	t-statistic	p-value
Fiscal deficit	-0.07	-2.28	0.03
M1	1.20	4.90	0.00001
Forex rate	-4.49	-6.85	<0.00001
WPI	-0.72	-0.67	0.51

F(4,48)-Statistic: 221.64 (p-value: 2.70e-30), R^2: 0.95 (95% of the variation in dependent variable is being explained by selected independent variables), Durbin Watson statistic: 1.12, Rho: 0.43

It is observed that the Durbin Watson statistic is 1.12, which is lower than the critical value (d_l) for the taken model specifications. Therefore, Durbin Watson statistic indicated the presence of auto-correlation in the model. So, for this model, no conclusion could be drawn regarding acceptance or rejection of the null hypothesis.

Removing auto-correlation

As auto correlation was detected in basic model to SENSEX, it was necessary to eradicate it before proceeding to co-integration analysis. In this study, it was decided to correct auto correlation by transforming the model. Following the literature, model was re-estimated through generalized least squares regression. The methodology is as follows:

Consider a two variable regression model:

$$Y_t = \beta_1 + \beta_2 x X_t + u_t \quad (1)$$

And assume that error term follows auto correlation of order 1:

$$\text{Therefore } u_t = \rho u_{t-1} + \epsilon_t \quad (2)$$

Where ρ is the coefficient of first order auto correlation

If equation 1 holds at time t, it also hold true at time (t-1). Hence,

$$Y_{t-1} = \beta_1 + \beta_2 x X_{t-1} + u_{t-1} \quad (3)$$

Multiplying equation3 by ρ on both the sides, and then subtracting it from equation 1, we get

$$Y_t - Y_{t-1} = \beta_1 x(1-\rho) + \beta_2 x(X_t - X_{t-1}) + \epsilon_t \quad (4)$$

Where $\epsilon_t = (u_t - \rho u_{t-1})$

Expressing equation 4 as:

$$Y_t^* = \beta_1^* + \beta_2^* x X_t^* + \epsilon_t \quad (5)$$

Where $\beta_1^* = \beta_1 x(1-\rho)$, $Y_t^* = (Y_t - \rho Y_{t-1})$, $X_t^* = (X_t - \rho X_{t-1})$ and $\beta_2^* = \beta_2$

Since the error term in equation 5 satisfies the usual OLS assumptions, OLS can be applied to transformed variables Y* and X* and obtain the estimators with optimum properties.

ρ-the coefficient of first order auto correlation was estimated by estimating the equation 2 with respect to our basic model.

Transformed model to project SENSEX

$SENSEX_t^* = \beta_1^* + \beta_2^* x \text{Fiscal deficit}_t^* + \beta_3^* x M1_t^* + \beta_4 x \text{Forex rate}_t^* + \beta_5^* x WPI_t^*$

The specifications of the model estimated are as follows:

Table 2: Coefficients and t statistics

Independent variable	Coefficient	t-statistic	p-value
Fiscal deficit*	-0.04	-1.72	0.09
M1*	0.82	3.20	0.002
Forex rate*	-4.50	-6.12	<0.00001
WPI*	0.89	0.79	0.45

F(4,47)-Statistic: 91.61 (p-value: 1.40e-21), R^2: 0.89 (89% of the variation in dependent variable is being explained by selected independent variables), Durbin Watson statistic: 1.57, Rho: 0.18

The Durbin Watson statistic is 1.57, which is greater than the critical value (d_u) for the number of observations and parameters considered in the model. Therefore, the problem of auto correlation was removed from the model after transformation.

The next important thing to be checked in the model was whether the variables were co-integrated or not. As all the variables involved in the analysis are time series and non-stationary, the regression could produce spurious results. Stationarity of the error term implies that the model is co-integrated. So, ADF test (including 4 lags), detailed in appendix, was applied on the residuals to check their stationarity.

Table 3: Results of ADF test on residuals

	Model		
n=47	No drift and no trend	Drift but no trend	Drift and trend
Tau critical at 5%, n=45	-1.95	-2.93	-3.5
	Tau statistic		
	-3.01	-2.97	-2.29

Based on the model with no drift and no trend and, the model with drift but no trend, we rejected the null hypothesis of ADF test i.e. we rejected the hypothesis of non stationarity of the error term. Hence, the model was concluded to be co-integrated.

Since the model was concluded to be co-integrated, Granger's causality test was valid to be applied. Applying Granger's causality test on the estimated parameters of the model:

H_0: All β_i*'s=0 i.e. no variable explains variation in SENSEX*

H_1: At least one of β_i*'s is non zero i.e. at least one of independent variables significantly explains SENSEX*

As it can be observed, F statistic is significant at 0.1% level indicating that the predictive power of model is high. Co-efficient of determination of the model is 89%. t-statistics for M1 and forex rate are significant at 1% level of significance; while fiscal deficit was significant at 10% level of significance. t-statistic for WPI is observed to be insignificant. However, it was observed that WPI had a significant relationship with SENSEX when regressions were performed with monthly data. So, multi-collinearity was suspected in the model. On analysis, using pair wise correlation coefficients, it was observed that M1 and WPI were highly correlated which resulted in high standard error of co-efficient of WPI. It was also observed that M1 had a greater share in explaining variation in SENSEX as compared to WPI. So, to assess the individual effects of explanatory variables on SENSEX, WPI was dropped in estimating a model free from multi-collinearity. Therefore, the model was modified as under:

$SENSEX_t^* = \beta_1^* + \beta_2^* x \text{Fiscal deficit}_t^* + \beta_3^* x M1_t^* + \beta_4 x \text{Forex rate}_t^*$

The specifications of the model estimated are as follows:

Table 4: Coefficients and t statistics

Independent variable	Coefficient	t-statistic	p-value
Fiscal deficit*	-0.04	-1.76	0.08
M1*	1.01	17.17	<0.00001
Forex rate*	-4.28	-5.93	<0.00001

F(3,48)-Statistic: 108.26 (p value: 2.27e-21), R^2: 0.87 (87% of the variation in dependent variable is being explained by selected independent variables), Durbin Watson statistic: 1.74, Rho: 0.10

The Durbin Watson statistic is 1.74, which is greater than the critical value (d_u) for the number of observations and parameters considered in the model. Therefore, model is free from auto-correlation.

Following are the results of ADF test (including 4 lags) which was applied on error term:

Table 5: Results of ADF test on residuals

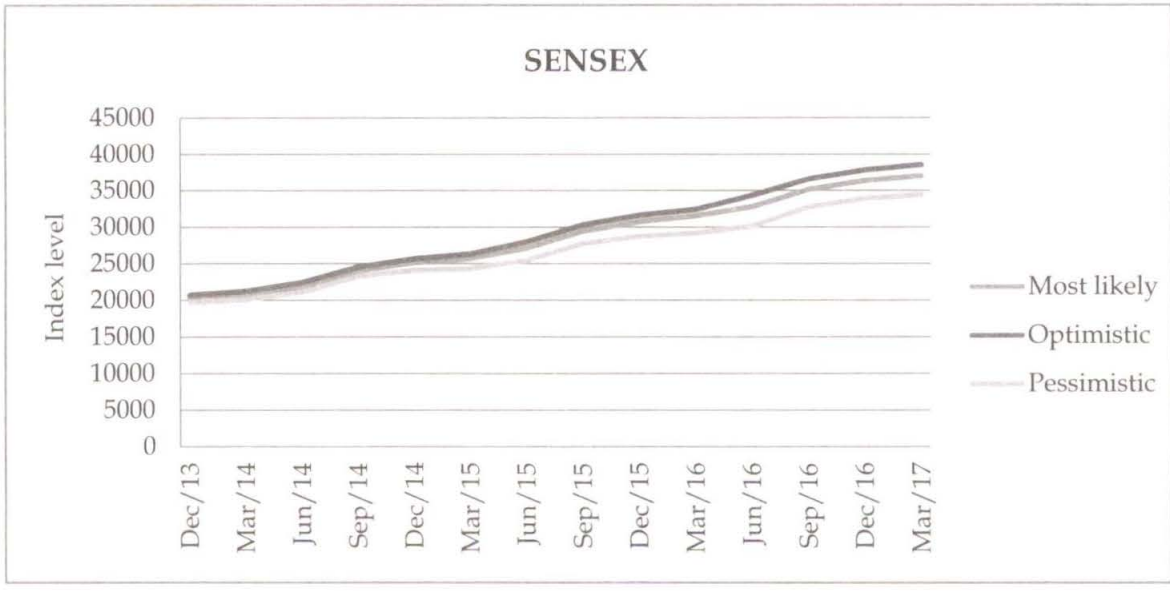
	Model		
n=47	No drift and no trend	Drift but no trend	Drift and trend
Tau critical at 5%, n=45	-1.95	-2.93	-3.5
	Tau statistic		
	-3.01	-2.97	-2.93

F statistic is significant at 0.1% level indicating that the predictive power of model is high implying the rejection of the null hypothesis. Coefficient of determination of the model is 87%. t-statistics for M1 and forex rate are significant at 1% level of significance while, it is significant at 10% level for fiscal deficit.

Based on the parameters estimated, and estimating explanatory variables as mentioned in methodology section, SENSEX has been forecasted under three different scenarios. Assumptions for estimating future values of significant explanatory variables are given in appendix. Considering the assumptions and applying the model for forecasting SENSEX as a function of fiscal deficit, M1 and forex rate give rise to following forecasted values for SENSEX under three scenarios namely, most likely, optimistic and pessimistic.

Table 6: Forecasted SENSEX

	Most likely	Optimistic	Pessimistic
Jun-14	21,852	22,442	21,089
Sep-14	24,035	24,544	23,230
Dec-14	25,158	25,679	24,098
Mar-15	25,728	26,311	24,300
Jun-15	27,139	28,007	25,428
Sep-15	29,433	30,327	27,702
Dec-15	30,743	31,633	28,755
Mar-16	31,547	32,417	29,173
Jun-16	32,780	34,301	30,121
Sep-16	35,140	36,568	32,712
Dec-16	36,378	37,819	33,915
Mar-17	37,037	38,549	34,400



Thus, SENSEX is likely to touch a figure of 37,037 under the most likely, 38,549 under optimistic and 34,440 under pessimistic scenario by March 2017.

Findings of the study suggest that forex reserve, IIP, non-agricultural GDP, net FII and repo rate have been insignificant in explaining any variation in SENSEX. Forex rate (INR/$) has been found to affect SENSEX negatively, that is depreciating rupee affecting SENSEX negatively and vice versa. Fiscal deficit has also been affecting the SENSEX negatively. Money supply as proxied by M1 has affected SENSEX positively. Inflation as proxied by WPI has affected SENSEX negatively. SENSEX, forex rate, fiscal deficit, M1 and WPI were found to be co-integrated when the error term of the model was checked for I(0) stationarity.

Summary and Conclusions

Thus, the above study reveals that the most prominent macro-economic variables to forecast SENSEX are fiscal deficit, forex rate (INR/$) and money supply (M1). Amongst these, fiscal deficit affects SENSEX negatively, forex rate affects negatively i.e. depreciating rupee affects SENSEX negatively and M1 affects SENSEX positively. Impact of forex rate on SENSEX is far greater than the other two variables. M1 also affects SENSEX considerably, and SENSEX is least affected by fiscal deficit amongst the three variables. In the backdrop of relevance of macro-economic variables to forecast capital market, this study based on co-integrating linear regression reveals that SENSEX is likely to touch level of 37,037 under the most likely, 38,549 under optimistic and 34,440 under pessimistic scenario by March 2017. As the interdependency between the economic growth and growth of capital markets can be clearly observed, any policy change that will escalate economic growth will also boost stock market up. SENSEX is expected to grow in the range of 34,440 to 38,549, if government policies are suitably geared up for achieving the assumed growth rates coupled with the assumptions on other independent variables. Thus, the emerging scenario about stock markets in India reveals that the average growth in returns is likely to be in the range of 17 to 21 percent per annum, hence providing a good incentive to investors to invest in stock markets. This will generate a greater interest of investors in the stock market in coming years. So, investors in the capital markets are expected to increase multifold.

Limitations and Scope for Improvements

The study is based on linear relationship between the economic variables. Researchers claim to have obtained better results using non-linear techniques like artificial neural networks. Many important variables like FII, GDP, IIP and repo rate failed to show causal relationship with SENSEX, which was not as expected. Fitting a non linear model using techniques other than regression could probably show better results. To further improve the results and overcome the shortcomings of this paper, latest literature on forecasting techniques could be utilized and results could be compared with the results of linear techniques. The forecasts have been made without considering any dummy variable for external shocks like global recession, natural calamity etc. which affect corporate earnings unexpectedly. Such variables can be accounted to yield improved forecasting results.

References

Agarwalla, R. K., & Tuteja, S. K. (2008). Share Prices and Macro-economic Variables in India: An Approach to Investigate the Relationship between Stock Markets and Economic Growth. *Journal of Management Research*, 8(3), 136-146.

Bhattacharya, B., & Mukherjee, J. (2002). The Nature of the Causal Relationship between Stock Market and Macro-economic Aggregates in India: An Empirical Analysis. Paper Presented at *4th Annual Conference on Money and Finance*, Mumbai, India.

Committee, Nobel Prize (2003). Time-series Econometrics: Co-integration and Autoregressive Conditional Heteroskedasticity. Paper provided by Nobel Prize Committee in its *Series on Nobel Prize in Economics documents* with No. 2003-1.

Dasgupta, R. (2012). Long-Run and Short-Run Relationships between BSE SENSEX and Macro-

economic Variables. *International Research Journal of Finance and Economics*, (95), 135-150.

Fama, E.F. (1990). Stock Returns, Expected Returns, and Real Activity. *Journal of Finance*, 45(4), 1089-1108.

Gay, R.D. (2008). Effect Of Macro-economic Variables On Stock Market Returns For Four Emerging Economies: Brazil, Russia, India, And China. *Jr International Business and Economics Research Journal*, 7(3), 1-8.

Gujarati, D. N., Porter, D. C., & Gunasekar, S. (2012). Autocorrelation. In *Basic Econometrics* (pp. 436-491). New Delhi: McGraw Hill.

Gujarati, D. N., Porter, D. C., & Gunasekar, S. (2012). Time Series Econometrics. In *Basic Econometrics* (pp. 780-819). New Delhi: McGraw Hill.

Hsing, Y. (2011). Stock Market & Macroeconomic Variables in a BRICS Country and Policy Implications. *International Journal of Economics and Financial* Issues, 1(1), 12-18.

Majumdar, M., & Hussain, M. D. (2010). Forecasting of Indian Stock Market Index Using Artificial Neural Network. Retrieved December 20, 2012 from www.nseindia.com/content/research/FinalPaper206.pdf

Manish, M. K., & Agarwal, P. (2011). Effect of Economic Variables of India and USA on the Movement of Indian Capital Market: An Empirical Study. Paper presented at *Eighth AIMS International Conference on Management*, Ahmedabad, India.

Maysami, R. C., Howe, L. C., & Hamzah, M.A. (2004). Relationship between Macro-economic Variables and Stock Market Indices: Co-integration Evidence from Stock Exchange of Singapore's All-S Sector Indices. *Journal Pengurusan*, (24), 47-77.

Mehrara, M. (2006). The Relationship between Stock Market and Macro-economic Variables: a Case Study for Iran. *Iranian Economic Review*. 10(17). Retrieved December 20, 2012 from http://journals.ut.ac.ir/page/download-E9UHk4mj65g.artdl

Menike, L.M.C.S. (2006). The Effect of Macro-economic Variables on Stock Prices in Emerging Sri Lankan Stock Market. *Sabaragamuwa University Journal*, 6(1), 50-67.

Nair, L. R. (2008). Macro-economic Determinants of Stock Market Development in India. *NSB Management Review*, 1(1), 1-10.

Ogunmuyiwa, M. S., & Asaolu, T. O. (2011). An Econometric Analysis of the Impact of Macroecomomic Variables on Stock Market Movement in Nigeria. *Asian Journal of Business Management*, 3(1), 72-78.

Osamwonyi, I. O., & Osagie, E. I. E. (2012). The Relationship between Macro-economic Variables and Stock Market Index in Nigeria. *J Economics*, 3(1), 55-63.

Ray, P., & Vani, V. (2004). What Moves Indian Stock Market: A Study on the Linkage with Real Economy in the Post-Reform Era. Paper presented at *The Sixth Annual Conference on Money and Finance in The Indian Economy*, Mumbai, India.

Singh, D. (2010). Causal Relationship Between Macro-Economic Variables and Stock Market: A Case Study for India. *Pakistan Journal of Social Sciences (PJSS)*, 30(2), 263-274.

Srivastava, A. (2010). Relevance of macro-economic factors for Indian stock market. *Decision*, 37(3), 60-79.

Vaisla, S., Bhatt, A.K., & Kumar, S. (IJCNS) (2010). Stock Market Forecasting using Artificial Neural Network and Statistical Technique: A Comparison Report. *International Journal of Computer and Network Security*, 2(8), 50-55.

Wickremasinghe, G. (2006). *Macro-economic forces and stock prices: Some empirical evidence from an emerging stock market*. Accounting and Finance Working Paper 06/14, School of Accounting and Finance, University of Wollongong. Retrieved December 20, 2012 from http://ro.uow.edu.au/cgi/viewcontent.cgi?article=129&context=accfinwp.

Appendix I

ADF test

ADF test for each of the series was applied using the following three models:

1. Y_t is a random walk:

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \epsilon_t$$

2. Y_t is a random walk with drift:

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \epsilon_t$$

3. Y_t is a random walk with drift around a stochastic trend:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta Y_{t-i} + \epsilon_t$$

In each case, the null and the alternate hypotheses are:

H_0: $\delta=0$ i.e. there is a unit root and the time series is non stationary

H_1: $\delta<0$ i.e. there is no unit root and the time series is stationary

Appendix - II

Assumptions to estimate explanatory variables

Following assumptions were made for three different scenarios regarding GDP growth and Fiscal deficit:

Table 7: Assumption to estimate explanatory variables

Assumptions	Most Likely	Optimistic	Pessimistic
Real GDP Growth Rate	6.0%	7.5%	5.0%
GDP Inflator Growth Rate	7.5%	7.0%	8.0%
Fiscal Deficit as % of GDP 2013-14	5.0%	5.0%	6.0%
Fiscal Deficit as % of GDP 2014-15	5.0%	4.5%	6.0%
Fiscal Deficit as % of GDP 2015-16	4.0%	4.0%	5.0%
Fiscal Deficit as % of GDP 2016-17	4.0%	3.5%	5.0%

To estimate Fiscal deficit for different quarters, historic share of different quarters in yearly Fiscal deficit was used.

Table 8: Quarterly share of fiscal deficit

	Historic Average % Share of Q's in total Fiscal deficit	Standard Deviation
Q1	35.35%	18.89%
Q2	14.10%	14.68%
Q3	17.21%	10.12%
Q4	33.35%	9.97%

- Compounded Quarterly Growth Rate of M1: 3.37%.
- Forex rate (INR/$) was assumed as per the following table:

Table 9: Assumptions for forex rate

Quarter	Most likely	Optimistic	Pessimistic
Jun-14	59	58	60
Sep-14	58.5	57.5	60
Dec-14	58	57	60
Mar-15	57.5	56.5	60
Jun-15	57	55	60
Sep-15	56.5	54.5	60
Dec-15	56	54	60
Mar-16	55.5	53.5	60
Jun-16	55	52	60
Sep-16	55	52	60
Dec-16	55	52	60
Mar-17	55	52	60