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IMPACT OF MACRO ECONOMIC VARIABLES ON INDIA'S STOCK MARKET: A DYNAMIC OLS APPROACH

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ABSTRACT

The present study makes an attempt to investigate the impact of India's macroeconomic variables on the India's flagship Stock Index: the NSE Nifty. The variables include monthly log transformed prices of the key macro variables viz. money supply, industrial production , rupee –dollar foreign exchange rate, Oil Price and Yield on Government Bonds. For financial variables, closing monthly prices of NSE Nifty, Oil Prices and rupee-dollar foreign exchange rate have been taken into consideration and analysis has carried out for a ten year period April 2008 to March 2018. For other macro variables we have taken closing value of their respective indices. The study employs Dynamic OLS technique of Stock and Watson(1993), a co-integration technique which corrects for simultaneity bias. To correct for the short run dynamics, an error corrective mechanism has also been established parsimoniously. Other tests included in the study are the Augmented Dickey Fuller for detection of unit root of variables and Causality tests between Nifty and each of the macro economic variables under study. The Dynamic OLS was carried out at optimal AIC Lag Identification criteria with maximum limit set at '3' lags and '3' leads. The Dynamic OLS was subject to parsimonious adjustment and the results showed that only three variables, CPI, Forex and Oil were having a co-integrating relation with the dependent variable NSE Nifty Prices. The Parsimonious ECM relation to determine the equilibrium link between short and long run and the results showed that lagged error term was significant and also negative with a figure of 0.51 thereby showing 51 % backward movement towards equilibrium in one period. The

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unit root diagnostic tests confirmed that time series of all the independent variables was stationary only at 1st difference with only NSE Nifty being stationary at level .

Keywords: NSE Nifty, Dynamic OLS, Dickey Fuller GLS. Parsimonious Adjustment, ECM.

INTRODUCTION

The seminal research work by Fama(1970) whereby he classified market efficiency into three layers; namely the weak, semi strong and strong forms could be said to be the foundation of research in the area of identification of factors responsible for the movement of the stock markets.It is a well known fact that the factors impacting the stock prices are endless and the list not only includes all types of corporate information but also information on political front, global clues from other major exchanges , Oil, Gold & Currency Movements & also performance on account of macro fundamentals of the economy which include inflation, employment, interest rates, GDP, Industrial Production etc. Now the question arises; How do we link these factors to market efficiency; and the answer is that market efficiency hypothesis clearly states that for an efficient market, every available information which can affect the stock prices must be factored into the current stock price which simply means that all the factors stated above are already included in arriving at the country's stock index which is the proxy for movement of the stock market.

Thus Fama's (1970) market efficiency hypothesis showed the way for many researchers to test this hypothesis on different markets, exploring the linkages between different markets and also studying the impact of different variables responsible for movement of stock prices including the macro economic variables. Coming to the macro economic factors impacting markets, initially in the early seventies, the researchers focused on developed stock markets which was later extended to other markets including emerging markets but only after a decade (i.e. from eighties) (Osamwonyi, I. O., & Evbayiro-Osagie, E. I. (2012))Although the interest in the emerging markets has grown quite substantially especially during the

last two decades, researchers have found that both risk and return are higher in these markets as compared to developed markets Harvey, C.R (1995)

A lot of research studies have found positive relation between stock market movements and developments on macro variables in both developed and emerging markets. Many economists however link this to the celebrated discounting approach to stock valuation which clearly states that the current price of stock is nothing but present value of infinite flow of future dividends; but future dividends are a function of how the macro-economic variables perform, showing that relation between real economy and stock prices is very strong.

We can understand the relation between macro economic variables & stock markets with the following flow diagram :-

The flow diagram clearly reveals that when macro economic indicators are strong, it impacts the markets positively. On the other hand when things are not good on the macro front e.g.in times of low growth rate, rising prices and interest rates, weakening of the domestic currency, fall in employment, poor consumer demand etc. it has an identical impact on the corporates i.e. companies too shell or postpone most of their plans due to poor demand in the economy. Then it also happens that some of the companies also turn up poor performance which results in investors selling their stocks thereby resulting in fall in the stock prices. Thus the above analysis clearly reveals that there is a strong linkage between macro variables and stock markets and macros are responsible to some extend for bullish or bearish sentiment on the markets.

Notable researchers who found the positive relation between the two include Osamwonyi, I. O et.al.(2012);Rahman, et.al. (2009); Sohail, N., & Hussain, Z. (2009); Lee, M., & Gan, C. (2006) ; Chen et al (2005); Hooker, (2004); Gjerde et. al. (1999) &Fama and French, (1988).

Considering the above background, an attempt has been made to determine whether there exists a positive relation between India's macro variables and its stock market performance. To this end, we have considered five macro variables and these include Consumer Price Index, Yield on Government Bond, Index of Industrial Production, Foreign Exchange Rates and Oil Prices and its impact is seen on NSE Nifty; the prominent stock Index of India. The data is log transformed monthly closing data for these variables for the ten year period April 2008-March 2018 & the analysis has been carried both at levels & on first differenced data(total no. of observations are 120 for each variable). To test the relation between these variables we have applied Dynamic OLS Co-integration (DOLS) technique developed by Stock &Watson (1993). Although a number of co-integration techniques like Engle, R. F., & Granger, C. W. (1987); Johansen, S. (1988); Johansen, S., & Juselius, K. (1990); ARDL with partial bounds given by Pesaran, M. H.& Shin, Y (1999) and so on have been used by the researchers over the years to develop a co-integration relation, in our study we have chosen DOLS Co-integration technique .

DOLS has an advantage as it corrects for the simultaneity bias by including lags and leads of I(1) first differenced regressors which also makes the estimators obtained from the model asymptotically normal. The technique of DOLS is also becoming popular as we can use both I(O) & I(1) regressors in our regression & can also interpret the coefficients directly from the results. Further, not many researchers have employed this technique for test of co-integration especially pertaining to time series data. The superiority of DOLS co-integration technique is clearly visible in the results of our study where the technique identified only three variables viz. CPI, Foreign Exchange Rate and Oil having a co-integrating relation with the stock index movement leaving out the other three otherwise important variables viz. money supply, industrial production and Yield on Government Bonds.

The rest of the paper is structured as follows: Section 2 reviews the existing work done in the area of establishing linkages between the movement of the Stock Markets and Macro Economic Indicators. Section 3 discusses the research objectives & techniques used in the study. Section 4 gives the methodology employed along with hypothesis to be tested. Section 5 provides empirical results of the study & its interpretation. Section 6 gives the conclusion & policy implications which is followed by references (Section 7) & Appendices (Section 8).

REVIEW OF LITERATURE

Under this section we review some of the important studies which have empirically and conceptually tested the inter-linkages between Stock Markets &Macro Economic Variables. Different methodologies have been used by the researchers to test these linkages, however there appears to be some consensus in terms of macro variables used by the researchers. Most of the researchers have used inflation, interest rate, money supply & a proxy for economic growth either GDP or Industrial Production as their key variables.

Gay, R. D. (2016) examined for BRIC nations the relation between stock index & two macro variables namely exchange rate & oil using Box-Jenkins ARIMA model. The results showed no significant influence of exchange rate & oil on stock indices of any of the BRIC nations. It was held that this may be due to influence of other economic variables like interest, inflation, trade etc. which were ignored in the study. Further research on linking present & past stock returns could also not be proved in the study suggesting that the markets of all the BRIC nations did exhibit market efficiency in weak-form Oriwo, A., &Ochieng, D. E. (2012)made a study on the relation between Stock Index of Kenya and performance of macroeconomic variables for the period March 08-March 12. The macroeconomic variables included in the study were Interest rate (lending), Inflation & 91 day T-bill rate. The results showed that 91–day t-bill had a strong negative while inflation had a weak positive relation with the stock Index. The diagnostic tests showed that residuals were normally distributed, free from autocorrelation, however multicolinearity was positive between 91 day T-bill

rate & interest lending rates. Osamwonyi, I. O., & Evbayiro-Osagie, E. I. (2012) made an attempt to establish the relation between Nigeria's Stock Index & it's macroeconomic variables by considering yearly data (1975-2005). The variables included in the study were inflation, interest rate, GDP, Money Supply, Fiscal deficit & foreign exchange rate. The model established was long run co-integration & equilibrium relation using VECM. It was seen that inflation, GDP, forex rate, & MS did influence Nigerian Stock Index either in the long-run, however interest rate was negatively related to stocks. The results actually proved that macroeconomic variables did influence stock markets of Nigeria to a great extent.

Singh, T., Mehta, S., & Varsha, M. S. (2011) established a linear relation between macroeconomic variables (GDP, inflation, exchange rate & employment) and stock portfolio returns of Taiwan for the study period Jan03- Dec08. The stock portfolios which were dependent variable were constructed using following yardsticks; Market Cap, Price to Book Value, Price Earnings, & earnings yield. The results of the study showed that GDP & exchange rate impacted all types of portfolio returns except portfolio of smaller companies. However the other two macro variables; MS & employment were not found to be impacting stock returns Rahman, A. A., Sidek, N. Z. M., &Tafri, F. H. (2009) investigated the co-integrating relation between select macro variables & stock indices for Malaysia using a VAR-VECM framework. The results showed that Malaysian stock markets formed a co-integrating relation with many macro variables like exchange rate, interest rate, reserves, industrial production and money supply. It was also seen that stock market was sensitive to all the six macro variables studied as given by lag exclusion test & impulse response functions. The Variance Decomposition showed that stock markets interact in a dynamic manner to industrial production and reserves as compared to other variables. Humpe, A., & Macmillan, P. (2009) empirically investigated the role of macro variables in stock market movements in Japanese and US Markets (monthly data, 40 year period). The co-integration and ECM were tested and it was found that Industrial Production was positively impacting while Inflation & long-term interest rate was negatively influencing the US Stock markets. As far as Japanese Markets were concerned, IP did impact stock prices positively, however the markets were

negatively related to Money Supply in Japan. Further IP was found to be negatively related to Inflation & interest rate. Sohail, N., &Hussain, Z. (2009) examined the inter-relation between Stock Exchange of Lahore and Macro Economic Variables for the period Dec 2002-June 2008 using monthly returns data. The long run relation developed using co-integration showed two long run relations between stock market and macro variables. All the variables were found to be I (1) stationary. Amongst the variables, inflation was the only variable having negative relation with stock prices, while Industrial production, real exchange rate, and Money supply had a positive relation. Treasury Bill was however insignificant. The error corrective terms were negative and significant and the speed of adjustment towards equilibrium was rather fast. The Variance Decomposition showed that inflation explained the maximum variance.

Ben Naceur, S., Ghazouani, S., &Omran, M. (2007) investigated the role of macroeconomic determinants on development of stock markets using data from 12 MENA countries. The results showed that four variables namely financial intermediaries, saving rate, market liquidity & inflation played a major role in stock market development. Further the results showed that stock markets & financial intermediaries played a complimentary role in achieving economy's growth. The methodology used was panel fixed and random effect model to study the relation. Lee, M., &Gan, C. (2006)examined the relation between stock market of New Zealand & macro variables which included CPI, Long term and Short term interest rates, Exchange rate, GDP, M1 Money Supply & Oil Prices. The econometric tools of Causality, Co-integration, Impulse and Variance Decomposition were applied to study this relation. The results showed that the stock markets were consistently determined by three major macro indicators namely GDP, Interest rates & Money Supply but no evidence was found for stock index to impact these variables. The impulse results showed that the innovation of CPI had negative effect on Stock Market.. The Variance Decomposition results indicated that the variation in stock markets could be easily explained by Interest rates (both long and short run), Money Supply & GDP.Maysami, R. C., Howe, L. C., &Rahmat, M. A. (2005) investigated

the long run equilibrium relation between thematic stock indices on Singapore Stock Market & macro-economic variables. The results showed co-integrating relation between both stock & property index with macro indicators like price levels, exchange rate, interest rates, money supply & industrial production. On the other hand hotel index was co-integrated with only select macro variables.

Garcia, V. F., & Liu, L. (1999) applied pooled regression with a sample of fifteen countries to test the relation between macro variables and stock market performance for the period 1980-1995. The results showed that inflation, real level of income, development of financial intermediaries, stock market liquidity and savings as important determinants of market capitalization. The results also showed that stock markets and financial intermediaries were complimenting each other.Naka, A., Mukherjee, T., &Tufte, D. (1998) empirically tested for long-term equilibrium relation between BSE Sensex & select macroeconomic variables which included IIP, CPI, M1, Money Market rate and investment. The results showed that industrial production was the largest positive & inflation largest negative determinant of Indian stock prices The VECM showed three short- long run equilibrium relation among the variables.

RESEARCH GAP

The review of literature clearly reveals that quite a few macro variables do impact the stock markets ; the foremost being the interest rates which in most of the studies was found to be negatively related to stock returns. Another important variable which most of the studies have taken was inflation and this too was negatively related with stock index in majority of the studies. Apart from the above variables, Industrial Production was also included as one of the important variables in determining the stock returns by majority of these studies and its relation was positive with the stock returns. Other variables which have considered by researchers include foreign exchange, GDP, Money Supply, Crude Price Movement etc. These variables have shown a mixed trend with some of them being significant in studies while the same variables were found to be insignificant in other studies. A no. of research techniques

have been employed by the researchers including testing for Cause-Effect Relation, testing co-integration through Engle Granger or Johansen Co-integration, studying the relation as a VAR-VECM framework etc. However not many researchers seem to have employed Dynamic OLS technique for studying the inter-linkages between stock index and macro the variables. Therefore under the present study we develop a Dynamic OLS Regression to test for the co-integration amongst the variables; stock prices and macro variables. The DOLS has been developed by Stock & Watson (1993) & has a no. of additional advantages like it corrects for the simultaneity bias by including lags and leads of regressors thereby making the estimators asymptotically normal. Further the results not only tell us about the co-integrating variables but also helps us in interpreting the coefficients directly from the obtained results.

RESEARCH OBJECTIVES AND TECHNIQUES

The following are the Research objectives of the Study:

(I) To test for possible inter-linkages between NSE Nifty prices on one hand and Consumer Price Index, Yield on Government Bond, Index of Industrial Production, Foreign Exchange Rates and Oil Prices on the other.

(ii) To determine if any error correcting mechanism can be established which corrects the disequilibrium between long run and short run for the co-integrated variables

The following techniques have been employed to achieve the above research objectives:

(I) Parsimonious Dynamic OLS Co-integration Model for the variables under the study.

(ii) Uni-directional causality from macroeconomic variables to NSE Nifty Prices

(iii) Stationarity tests (using ADF test Statistic) & Normality of Variables (using JB test)

METHODOLOGY ADOPTED

Test for Stationarity of Variables

Applying ADF unit root test (with intercept and trend) we develop the following equations (i to vi) for this purpose.

$$\Delta \text{NSE Nifty}_t = \beta_{1,1} + (\beta_{1,2} - 1)\,\text{NSE Nifty}_{t-1} + \sum_{i=1}^{m} \beta_{1,3i} \Delta \text{NSE Nifty}_{t-I} + \beta_{1,4} t + u_{1t} \quad \ldots\ldots\text{(i)}$$

$$\Delta \text{Consumer Price Index}_t = \beta_{2,1} + (\beta_{2,2} - 1)\text{Consumer Price Index}_{t-1} + \sum_{i=1}^{m} \beta_{2,3i} \Delta \text{Consumer Price Index}_{t-I} + \beta_{2,4} t + u_{2t} \ldots\ldots\text{(ii)}$$

$$\Delta \text{Yield on Government Bond}_t = \beta_{3,1} + (\beta_{3,2} - 1)\text{Yield on Government Bond}_{t-1} + \sum_{i=1}^{m} \beta_{3,3i} \Delta \text{Yield on Government Bond}_{t-i} + \beta_{3,4} t + u_{3t} \ldots\ldots\text{(iii)}$$

$$\Delta \text{Oil Prices}_t = \beta_{4,1} + (\beta_{4,2} - 1)\,\text{Oil Prices}_{t-1} + \sum_{i=1}^{m} \beta_{4,3i} \Delta \text{Oil Prices}_{t-i} + \beta_{4,4} t + u_{4t} \ldots\ldots\text{(iv)}$$

$$\Delta \text{Index of Industrial Production}_t = \beta_{5,1} + (\beta_{5,2} - 1)\text{Index of Industrial Production}_{t-1} + \sum_{i=1}^{m} \beta_{5,3i} \Delta \text{Index of Industrial Production}_{t-i} + \beta_{5,4} t + u_{5t} \ldots\ldots\text{(v)}$$

$$\Delta \text{ Foreign Exchange}_t = \beta_{61} + (\beta_{62} - 1)\text{ Foreign Exchange}_{t-1} + \sum_{i=1}^{m} \beta_{63i} \Delta \text{ Foreign Exchange}_{t-I} + \beta_{63} t + u_{6t} \ldots\ldots\text{(vi)}$$

(For the equation (i) ; The variable is NSE Nifty. Δ NSE Nifty $_t$ is change in NSE Nifty in period t, $(\beta_{1,2} - 1)$ is the coefficient of the Stationarity for variable whose 't' value is tested against the Null $\beta_{12} = 1$, $\sum_{i=1}^{m} \beta_{1,3i} \Delta$ Nifty $_{t-i}$ denotes change in NSE Nifty in period t-i where 'I' are the no. of lags which go up to 'm' . This denotes the augmented variable and takes care of autocorrelation . It is important to note that the term continues to add up 'm' times till the autocorrelation is removed, $\beta_{1,4} t$ is the trend variable and takes care of deterministic trend in the variable so that only stochastic

trend can be detected, u_{1t} is random error term.)

Using similar methodology we carry out stationarity test for other variables(eq ii to vi)

The testable hypothesis for Stationarity test of our Variable NSE Nifty (eq (i)) would be

$(H_0) : \beta_{1,2} - 1 = 0$ or $\beta_{1,2} = 1$ (the NSE Nifty has a unit root or is not stationary $(H_a): \beta_{1,2} - 1 \neq 0$, (NSE Nifty is stationary)

Establishing a Parsimonious Dynamic OLS Co-integration Model

Under this we make an attempt to establish the Dynamic OLS regression with NSE Nifty Prices as dependent variable and five macro variables namely Consumer Price Index , Yield on Government Bond, Index of Industrial Production, Foreign Exchange Rates and Oil Prices as independent variables

$$\text{NSE Nifty}_t = X_t B' + S_{i=-K}^{+K} \lambda_{2,i} \Delta CPI_{t-I} + S_{i=-K}^{+K} \lambda_{3,i} \Delta \text{Govt.Yield}_{t-i} + S_{i=-K}^{+K} \lambda_{4,i} \Delta IIP30_{t-i} + S_{i=-K}^{+K} \lambda_{5,i} \Delta Forex_{t-i} + S_{i=-K}^{+K} \lambda_{6,i} \Delta Oil_{t-i} + u_t \quad \text{.....(vii)}$$

(Note : In the above equation (vii); X_t =[1, CPI, Govt Yield IIP Forex Oil] & B' = Vector of long run coefficients (β_1, β_2 , β_3 ,β_4, β_5, β_6) , X_t is multiplied with the transpose of B' to get = $1*\beta_1 + \beta_2$ CPI + β_3Govt Yield + β_4IIP + β_5 Forex + β_6 Oil. Further $\lambda_{2,i}$ to $\lambda_{6,i}$ *are the coefficients of first differenced five independent variables, 'K' denotes the no. of lags/leads with a maximum K being '3')*

Short run dynamics and Error Corrective Mechanism (ECM)

$$\text{NSE Nifty}_t = \alpha_1 + \alpha_2 u_{t-1} + S_{i=0}^{n} (a_{3,i} \Delta CPI_{t-1}) + S_{i=0}^{n} (a_{4,i} \Delta Oil_{t-1}) + S_{i=0}^{n} (a_{5,i} \Delta Forex_{t-1}) + S_{i=0}^{n} (a_{6,i} \Delta \text{NSE Nifty}_{t-1}) + e_t \text{.....(viii)}$$

(Note : To begin with we started our ECM equation(eq. viii) with three lags and then arrived at the final equation parsimoniously , u_{t-1} is the first lag of the residuals

obtained by solving the a more general linear model which establishes a long term relation)

The Cause –Effect Relation

We establish a uni-directional cause-effect relation which is moving from each of the five macro variables(*Consumer Price Index, Yield on Government Bond, Index of Industrial Production, Foreign Exchange Rates and Oil Prices*) to NSE Nifty prices . Due to the presence of some of the variables being I(1) Stationary, we shall apply an improved version of causality as given by Toda, H. Y., & Yamamoto, T. (1995) . e.g. let the two variables be NSE Nifty and Consumer Price Index and we are interested in testing uni-directional causality; Consumer Price Index → NSE Nifty , we develop the following two equations : restricted (eq ix) and unrestricted (eq x);

***Restricted Model*:**

$$\textbf{NSE Nifty}_t = \theta_0 + \sum_{j=1}^{Imax} a_j \textbf{Consumer Price Index}_{t-j} + \sum_{i=1}^{H+Imax} b_j \textbf{NSE Nifty}_{t-i} + \textbf{u}_t \text{.....(ix)}$$

***Unrestricted model*:**

$$\text{NSE Nifty}_t = \theta_0 + \sum_{i=1}^{k+Imax} a_j \textbf{Consumer Price Index}_{t-j} + \sum_{i=1}^{H+Imax} b_j \textbf{NSE Nifty}_{t-i} + \textbf{u}_t \text{.....(x)}$$

Null Hypothesis(Ho) : Lagged values of Consumer Price Index do not influence Nifty or $\sum a_j = 0$

$$\text{Mod F}_{\text{'Wald'}} = \frac{(RSS_{rest} - RSS_{unres})/k}{RSS_{unres}/(n-k)}$$

(The Uni-directional Causality for other pair of variables namely Yield on Government Bond→ NSE Nifty, Index of Industrial Production→ NSE Nifty, Foreign Exchange Rates→NSE Nifty & Oil→NSE Nifty is also tested in the similar manner)

EMPIRICAL RESULTS OF THE STUDY AND ITS INTERPRETATION

The empirical results of the study are given in tabular & graphic format in appendices. Appendix I (a) gives the results of our unit root test of all the six variables included in the study and the test applied is ADF Unit root test both at the levels(original prices) and also at 1st difference (Change prices). Appendix I(a) clearly shows that five of our variables (Consumer Price Index, Yield on Government Bond, Index of Industrial Production, Foreign Exchange Rates & Oil Prices) are stationary only at 1st difference which is evident from both computed 't' values (which are higher in absolute terms than the table 't' values in absolute terms) and also the corresponding 'p' values (which are lower than critical value of 0.05) & therefore Null Hypothesis that Variable has a Unit root is rejected for these five variables only at 1st difference.

On the other hand, the variable NSE Nifty appears to be rejecting the Null hypothesis of Unit root at levels (original prices) , its absolute computed 't' > table 't'(absolute) and its 'p' statistics is also very close to the critical value (rejecting the Null at 6 %). Thus this variable is stationary at level or original prices.

Next we move to Appendix I(b) , it has seven tables showing the Statistical Description of all the seven variables under study . The Appendix I(b) also includes histogram of monthly returns for each of the seven variables [Fig(I) to (VII)] . The Appendix I(b) provides information about Mean, Median, Maximum & Minimum Monthly Relative Change / (Return) over the ten year period. It also gives histogram of the monthly return (change) . Coming to the mean of the variables, the three variables; Money Supply, CPI & Indistrial Production would reflect the average monthly change, while the other four variables namely Forex, Nifty, Oil & Govt Bond would signify the average monthly return .

A look at the seven tables given in this Appendix I(b) reveals that mean monthly return of the Nifty is the highest at 0.00765 while that of Govt. Bond is the lowest at 0.000486, although both the average returns are positive. In terms of change in macro

indices, the highest average monthly change is seen in Money Supply while the lowest is for the Index of Industrial Production. The risk of each variable is shown in terms of Standard Deviation, while the Skewness & Kurtosis tell about the normality for each time series variable. The results show that variable Oil has the highest standard deviation of 0.08 which makes it highly risky to invest, while the forex has the lowest risk of 0.02; this is approximatley 1/4rd of the risk associated with investment in Oil.

In terms of the nature of their distribution, all the seven variables have peakedness higher than the normal distribution as given by the kurtosis of each variable's distribution . On the other hand , when we compare the skewness of the variables , the skewness of distribution of CPI , I.P & Forex is positive while rest of the variables are negatively skewed. In terms of their overall distribution , none of the seven variables have distributions close to normal , this is seen when we compare their histograms with histogram of a normal distribution, the same result is also given by JB Statistic (a popular test for normality) and the computed JB of all the seven distributions is much higher than the figure of 5.99 which is JB figure statistic for a normal distribution. Thus in case of all the variables we reject the Null Hypothesis of their Distribution being Normal.

Coming to Appendix II, which gives the results of Co-integration using Dynamic Ordinary Least Squares (DOLS) we find that after parsimonious adjustment only three variables (CPI, Oil & Foreign Exchange) were found to be co-integrated with the dependent variable NSE Nifty as given by their 'p' values. Also since we have used DOLS, it is possible to interpret the coefficients , the results showed that both Oil and Foreign Exchange were negatively correlated with NSE while CPI was positively correlated, however the elasticity of foreign exchange was higher than Oil with respect to NSE Nifty.

Appendix III gives the results of error correction model wherein we established a lagged error correction term whose coefficient showed the dynamics of adjustment towards long run equilibrium. The final ECM model has also been achieved

parsimoniously so that the insignificant lags of the variables are removed from the system. The ECM Model results showed that speed of adjustment between short and long run was negative & statistically significant for India and the ECM (-1) figure was at -0.5137 showing a backward adjustment process which in one period (one month in our case) was approximately 52 %.

Appendix IV gives the results of the uni-directional causality testing of our variables. The approach applied was Toda, H. Y., & Yamamoto, T. (1995) which gives correct causality even when the variables are I(1) Stationary . The uni-directional Causality is seen in three cases ; Foreign Exchange to NSE, Govt. Yield to NSE & Industrial Production to NSE

CONCLUSION AND POLICY IMPLICATIONS

The study made an attempt to investigate the impact of India's macro-economic variables on the India's flagship Stock Index: the NSE Nifty. The variables included were money supply, industrial production, rupee – dollar exchange rate, Oil Prices and Yield on Government Bonds. For financial variables closing monthly prices of NSE Nifty, Oil Prices and rupee-dollar foreign exchange rate were taken and analysis was carried out for a ten year period April 2008 to March 2018. For other macro variables we took closing value of their respective indices. The Dynamic OLS technique of Stock and Watson(1993), a co-integration technique along with ECM Dynamics adjustment was applied in the study. All these two techniques, DOLS and ECM were also adjusted parsimoniously. For stationarity testing of variables, usual ADF test was employed.

To begin with Dynamic OLS was carried out at optimal AIC (Lag Identification criteria) with max of '3' lags and '3' leads . The results of the study showed positive co-integration for only three variables, CPI, Forex and Oil with the dependent variable NSE Nifty Prices. The Parsimonious ECM showed lagged error term was significant and also negative & was correcting @ 51 % per period (backward movement

towards equilibrium in one period) The unit root diagnostic tests confirmed that time series of all the independent variables were stationary only at 1st difference with the dependent NSE Nifty being only variable which was stationary at level .

There can be few policy implications of the study ; since it is now clear that India's Stock Index does have a co-integrating relation with three macro variables viz. Consumer Price Index, Movement of the rupee against dollar and rise & fall of Oil Prices, these macros should be considered more aggressively which framing the broad reformative policies of the government. Further since the direction of the relation between the macros with the Indian stock index is negative for Oil & Forex & positive for CPI, the implications of the same must be clearly spelt out by the policy makers i.e. while Government should keep a close check on prices of oil and exchange rate , indications from the stock markets are that a low to moderate inflation is something not bad for the markets and this can be achieved through limited rise in prices of products which can easily be sustained by the markets. However Government has to be very careful as the rise in prices do not cause inflation spiral but only a controlled level which can be good for the markets so that it is able to build a positive image both amongst domestic and international investing community.

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1. Appendices

Appendix I(a): Results of Unit Root Tests of our variables

Null Hypothesis	Computed 't' value	ADF at 5 % level	Prob.	Result (Null Accepted/ Rejected)
NSE Prices has a unit root	-3.432100	-3.448021	0.0520	Accepted
NSE 1st Difference has a unit root	-5.619263	-3.449020	0.0000	Rejected
CPI Prices has a Unit root	0.320266	-3.450436	0.9985	Accepted
CPI 1st Difference has a Unit root	-7.851654	-3.450436	0.0000	Rejected
Forex Prices has a unit root	-2.419101	-3.450073	0.3678	Accepted
Forex 1st Diff has a unit root	-4.353446	-3.449716	0.0038	Rejected
Yieldon Govt. Bondshas a unit root	-2.695896	-3.448021	0.2403	Accepted
Yield on Govt. Bonds 1st Diff. has a unit root	-12.31380	-3.448348	0.0000	Rejected
Indl. Prod. has a unit root	-2.362138	-3.448681	0.3973	Accepted
Indl. Prod 1st Diffhas a unit root	-10.92200	-3.448681	0.0000	Rejected
Money Supply has a unit root	-1.395492	-3.449716	0.8573	Accepted
Money supply 1st Difference has a unit root	-6.971475	-3.449716	0.0000	Rejected
Oil Prices has a unit root	-2.370213	-3.448348	0.3931	Accepted
Oil 1st Diff has a unit root	-7.325174	-3.448348	0.0000	Rejected

Appendix I(b): Statistical Description of our variables & test for normality

Fig I: Monthly Change in CPI

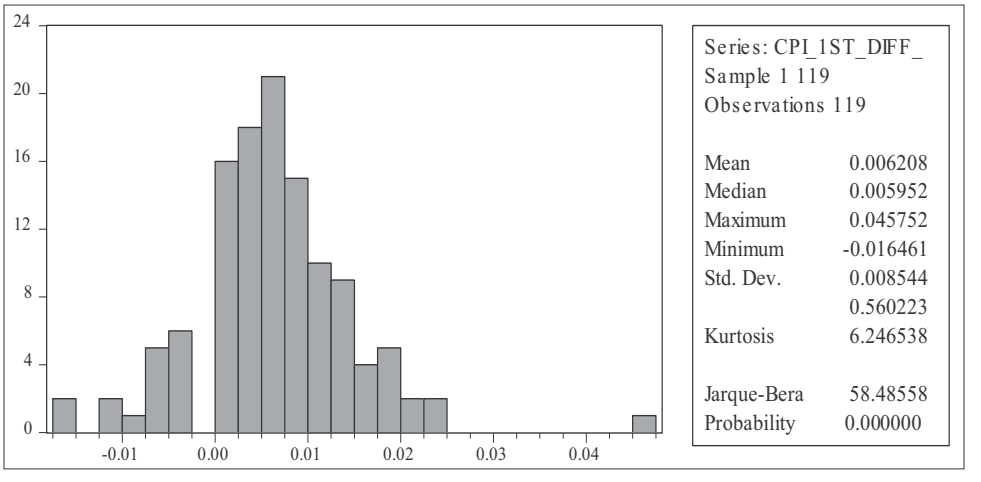


Fig I: Monthly Change in CPI

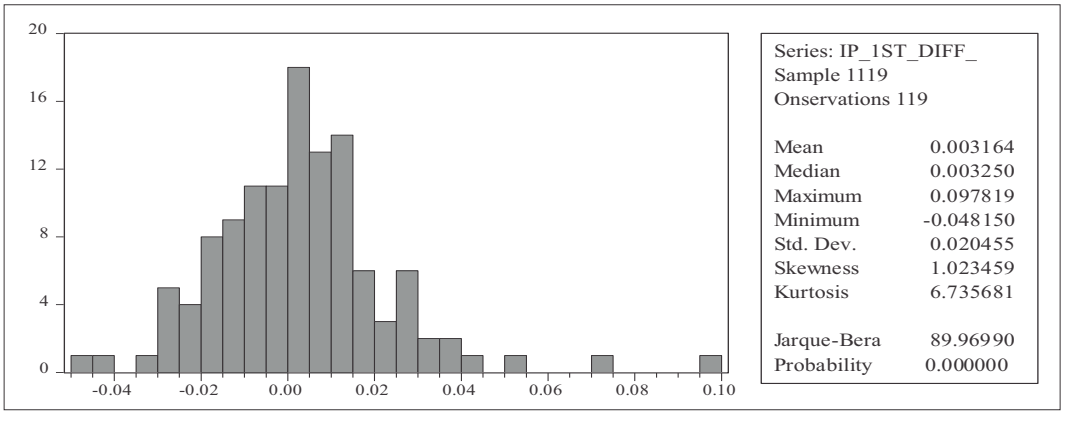


Fig III: Money Supply Change

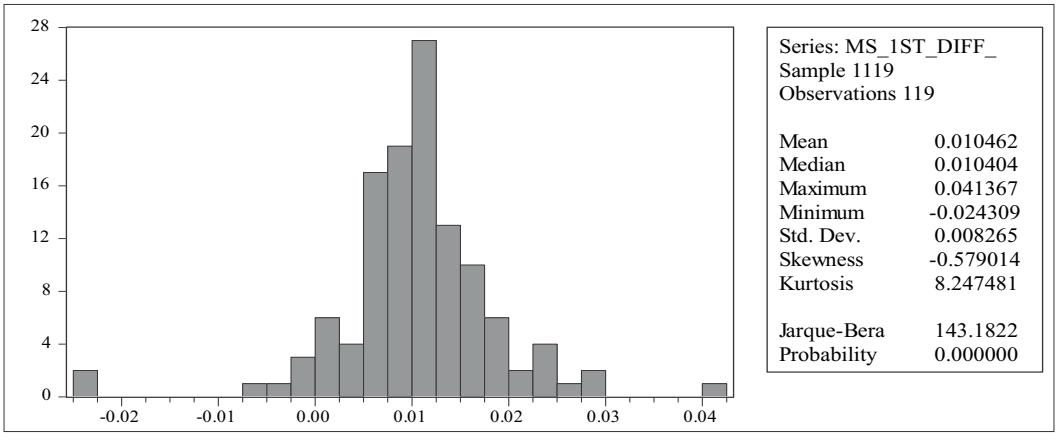


Fig IV: Monthly Return on Oil

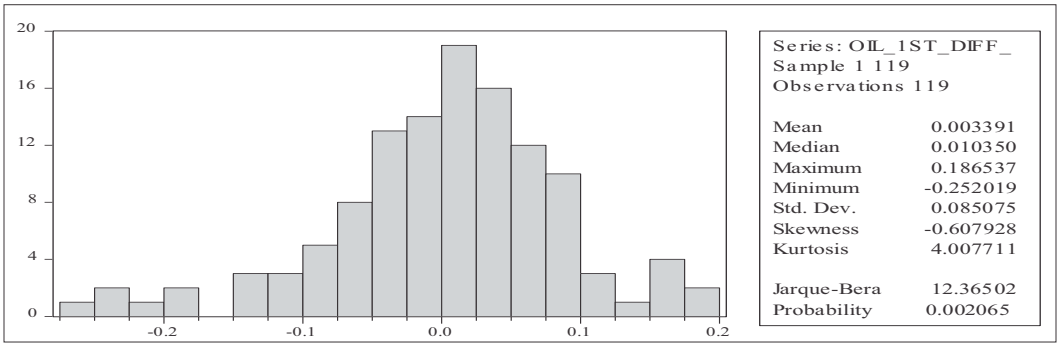


Fig V: Monthly Return on NSE Nifty

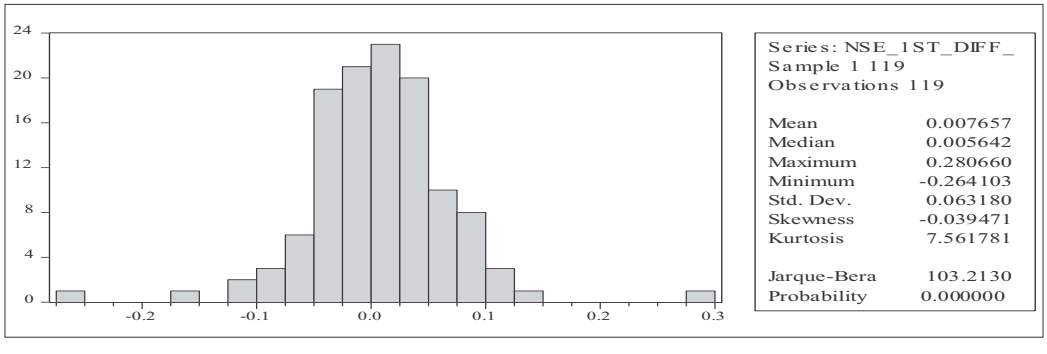


Fig VI: Monthly Return on Forex ($/Rs)

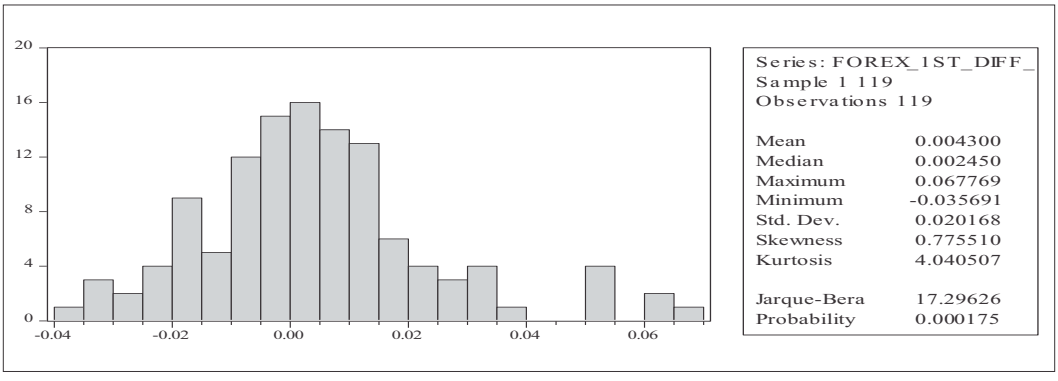
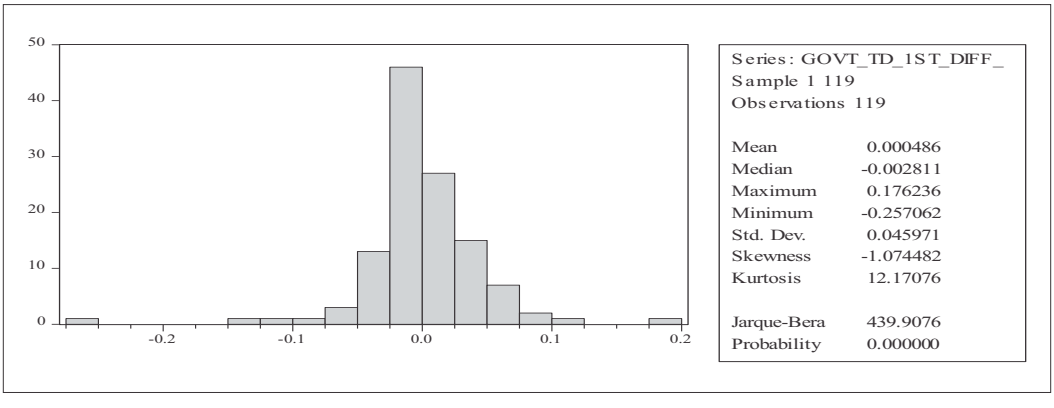


Fig VII: Monthly Return(Yield) on Govt Bond



APPENDIX II : DYNAMIC LEAST SQUARES CO-INTEGRATION

(Dependent Variable Ln NSE)

Variable	Beta Coefficient	Computed 't'	Prob 'p' value
Ln CPI	1.822933	1.210315	0.2306
Ln Govt Yield	-0.194596	-0.616733	0.5396
Ln Forex	-1.126599	-2.035697	0.0459
Ln MS	-0.048306	-0.040779	0.9676
Ln Oil Prices	-0.088837	-1.105211	0.2732
Ln Ind. Prod	0.590651	0.432354	0.6669
Parsimony : 1st Exercise [leaving out Money Supply (MS)]			
Variable	Beta Coefficient	Computed 't'	Prob 'p' value
Ln CPI	1.789791	2.641794	0.0101
Ln Govt Yield	-0.193201	-0.719835	04740
Ln Forex	-1.119874	-2.349464	0.0215
Ln MS			
Ln Oil Prices	-0.088795	-1.159406	0.2501
Ln Ind. Prod	0.590863	0.625707	0.5335
Parsimony : 2rd t Exercise[leaving out Ind. Prod]			
Variable	Beta Coefficient	Computed 't'	Prob 'p' value
Ln CPI	2.159511	10.05703	0.0000
Ln Govt Yield	-0.153590	-0.594094	0.5541
Ln Forex	-1.269844	-4.352527	0.0000
Ln MS			
Ln Oil Prices	-0.155535	-2.161538	0.0336
Ln Ind. Prod			
Parsimony : 3rd Exercise[leaving out Yield on Govt. Bonds]			
Variable	Beta Coefficient	Computed 't'	Prob 'p' value
Ln CPI	2.176311	10.18980	0.0000
Ln Govt Yield			
Ln Forex	-1.263204	-4.398537	0.0000
Ln MS			
Ln Oil Prices	-0.183076	-3.614879	0.0005
Ln Ind. Prod			

Notes

(1) We have followed automatic leads and lags selection based upon AIC Criteria for our variables subject to max of '3' The results given in the table are however for main coefficients only , ignoring the lags and leads of each variable

(2) Three rounds of Parsimony were required to achieve the all significant coefficients of our model

Appendix III: Results of the Error Correction Model (Parsimonious)

Dependent Variable	Independent Variables	ECM(-1) Coeff.	Computed 't' values	Prob 'p'	Parsimonious Adjustment *(Details of Lags of Independent Variables Removed)*
NSE	CPI, Forex & Oil Prices	-0.4827	-1.8292	0.0703	None
NSE	CPI, Forex & Oil Prices	-0.4668	-1.7869	0.0769	Lag(-1) from Oil
NSE	CPI, Forex & OilPrices	-0.4876	-1.8816	0.0627	Lag(-2) from Forex
NSE	CPI, Forex & Oil Prices	-0.5137	-1.9914	0.0491	Lag(-1) from Forex

APPENDIX IV

Type of Relation tested	Obs .	Computed 'F' value	Prob.	Result
FOREX →NSE	110	3.8999	0.0002	Causality
CPI →NSE	110	1.60297	0.1186	No Causality
GOVT.YD →NSE	110	2.93782	0.0031	Causality
IP→ NSE	110	2.45537	0.0122	Causality
MS →NSE	110	0.82497	0.6056	No Causality
OIL →NSE	110	0.58452	0.8226	No Causality