Business Analyst, ISSN 0973 - 211X, 41(1), 55-80, ©SRCC

EMPIRICAL INVESTIGATION OF SELECT NSE SECTOR SPECIFIC INDICES TO ASCERTAIN SEASONALITY & ASYMMETRIES IN THEIR RETURN & VOLATILITY

Rakesh Shahani* and Ananya Sharma**

ABSTRACT

The current study makes an attempt to investigate the month-wise seasonal variation in returns (& also volatility of returns) of four sector specific indices viz. Nifty Auto, Nifty FMCG, Nifty Pharma and Nifty Real Estate of National Stock Exchange for the ten year period April 2009 to March 2019. Besides this, the study would also investigate spill-over of volatility from one sector specific index to another and also ascertain asymmetries in their return and return volatility. The data for the purpose of the study includes log transformed monthly returns of the four sampled sector specific indices. The methodology employed for this purpose include OLS (NW) Regression for testing seasonal impact in returns and GARCH(1,1) framework for ascertaining seasonal impact in return volatility. Further for asymmetry of returns, 'T' GARCH Model has been employed & for spill-over impact, residual squared error terms has been included in the GARCH Model. The results of the study showed that seasonal variation in returns did exist in some of the sector specific indices. In terms of results of asymmetry in volatility, only one index Nifty Auto was found to have asymmetric returns , on the other hand the spill-over impact from one sector to another was not visible from the results. The data was also tested for stationarity using DF-GLS test & all sector specific indices were found to be I(1) stationary.

Keywords: Seasonal Variation, Asymmetry, Dummy , Sector Specific Index, Spill-over

* Associate Professor, Dept. of Business Economics, Dr. Bhim Rao Ambedkar College, University of Delhi, Delhi. E-mail: rakesh.shahani@bramb.du.ac.in.

** CFA Level III Candidate, Also Student BA(H) Business Economics (2015-18) Dr Bhim Rao Ambedkar College, University of Delhi, Delhi, E-mail : ananyasharma1397@gmail.com

INTRODUCTION

Seasonal Movement or Variation in sales, profits, expenses across seasons for different economy sectors is a universal phenomenon. . These seasonal movements are fairly common in agro-based commodities, textiles, consumer durables etc. (Surbhi, et.al 2014), however whether or not the same can be extended to stock markets or more specifically in case of sector specific stock indices is a matter of detailed investigation. This is so because if the stock market is efficient, then sector's sales or profits in all previous years or previous quarters should be incorporated in the current stock prices & this is also true for sector specific indices, would make the specific indices efficient too. This would also imply that if any sector is giving abnormal sales or profits in any quarter of a year, there should not be any impact on the sector's stock prices as sector price indices are efficient.

Seasonal Movement in Stock Indices is usually studied by analysing calendar movements e.g. month of the year or day of the week showing different stock prices movement than other months or other days of the week. Although a lot of literature is available which have tested for stock markets seasonality of different stock indices. (Ignatius, (1998) on NYSE , Marrett, et.al. ,(2011) for Australian Stock Index, Onyuma, S. O. (2009) for Kenyan Indices , Rahman, M. L. (2009) for Dhaka Stock Exchange, F. B., & Joshi, N. K. (2005) on Nepal Stock Exchange and Poshakwale, S. (1996) Kaur (2004) , Bodla and Jindal (2006), Lodha, S., & Soral, G. (2016) , Akhtar et.al (2017) for Indian Stock Markets/Indices. On the other hand only a few studies have gone ahead and tested the same with respect to any sector specific index of the stock market. Some research studies are however available which have tried to link the returns of one sector specific index to another sector specific indices of the same financial market or across different markets. These include study by Balli, F., & Balli, H. O. (2011) where they tried to link different sectors across developed markets, Yilmaz, et.al. (2015) where they focused on sector specific linkages across Islamic countries, Kaltenhauser (2002) who studied industry sectors for linkages across Euro region and so on. Some research studies on sector specific indices have tried to link

their movement with macroeconomic variables. Prominent contributors here include Saji, T. G. (2013); Khan, F., Muneer, S., & Ahmad, A. M. (2013); Husain, F., Mahmood, T., &Azid, T. (1999). Most of these studies have found that although there is positive relation between the macros and sector specific index movement still the impact of these macro variables differed quite significantly from one sector to another.

The above discussion thus makes it clear that the existing research on sector specific indices have pre-dominantly focused either on inter sector linkages or linkages with macro variables with very few studies on testing the sector specific indices for seasonality aspect. Few available research studies on the seasonality in sector returns do reflect some kind of uniformity in terms of their results i.e. most of these studies found that main or prominent index of a stock market did not reflect any seasonal movement, while some amount of seasonality was detected in their sector specific indices movement.

Thus keeping in view the above, it would be therefore interesting to explore whether or not the seasonality exists with respect to sector specific indices pertaining to Indian Stock Market & therefore through the present study an attempt has been made to investigate the seasonal variation in returns (& also volatility of returns) of four different sector specific indices of National Stock Exchange. Attempt has also been made to ascertain asymmetries in their return and return volatility. Further it has also been investigated whether this asymmetry in return or volatility has any relation with seasonal variation. Yet another dimension of the present study has been to examine spill-over of volatility from one sector specific index to another and whether this spill-over too has a relation with the seasonal variation in returns.

The data for the purpose of the study includes log transformed monthly returns of the four major sector specific indices which include Nifty Auto, Nifty FMCG, Nifty Pharma and Nifty Real Estate for the ten year period April 2009 to March 2019(no. of observations included in the study are 120 for each sector index), data for the same has been obtained from websites; www.nseindia.com, &, www.investing.com. The rest of the paper is structured as: Section 2 provides information about the sampled

indices. Section 3 describes the Statistical Description of Data & Diagnostic tests , Section 4 discusses the methodology employed along with hypothesis to be tested Section 5 provides empirical results & findings of the study & its interpretation, Section 6 gives the conclusion & finally Section 7 the policy recommendations of the paper followed by References and Appendices.

ABOUT THE SAMPLED INDICES

The indices which have been included in our study are Nifty Auto, Nifty FMCG, Nifty Pharma and Nifty Real Estate. All the four indices account for approximately 1/4th of all the volumes traded on the National Stock Exchange as on March 31, 2016 (www.nseindia.com). The indices have been selected after analysing the monthly sales of top two companies of each index. It was seen that companies belonging to two of these indices viz. Nifty Pharma and Nifty Auto showed no major deviation in sales from one month to another while on the other hand, the companies from Nifty FMCG and Nifty Real Estate showed considerable variation in monthly sales. Another reason for including these four sectors in our sample was that all the four sectors were mainly determined by a common variable; Per Capita Income. The stock market index specific details of the four indices are given in Table 1 below.

Table 1: Sampled Sector specific NSE Stock Indices included in the study

Particulars	*Nifty Auto*	*Nifty Pharma*	*Nifty FMCG*	*Nifty Reality*
1. Coverage	Cars, motorcycles, heavy vehicles, auto ancillaries, tyres	Pharmaceuticals Health Care	Non-Durable Goods & Products, Mass Consumption Products	Real Estate Companies
2.Market Representation (as a % of free float on NSE on 31st March 2016)	8.6 %	6.1 %	8.6 %	0.4 %
3.Volumes Trade (as a % of all traded stocks on NSE on 31st March 2016)	9.5 %	7 %	4.5 %	1.8 %

Source: www.nseindia.com

A look at the table reveals that out of the four indices chosen, Nifty Auto has the highest share in terms of market capitalization, followed by Nifty Pharma, Nifty FMCG and finally Nifty Reality. A close look at the Nifty Reality reveals that it has a very low market representation as well as low traded volumes as compared to other indices. This is mainly due to listing of limited number of stocks of real estate companies.

DATA DIAGNOSTICS

Under Data Diagnostics, we begin with, statistical description of data which includes computation of mean, standard deviation & variance, range, skewness & kurtosis of all the four sector specific indices under study (see Appendix I). We also carry out test of normality of data (using JB test Statistic see eq. (i) given below) & also perform the test for stationarity of variables using ADF-GLS Methodology *(ADF-GLS Methodology as proposed by Elliott, Rothenberg and Stock (ERS) has been used in the study as it is considered to contain more power that simple ADF unit root test)* (see eq. (ii), (iii), (iv) & (v) given below).

$$JB = \frac{n}{6}\left(S^2 + \frac{1}{4}(K\text{-}3)^2\right) \quad \text{.....(i)}$$

$$\Delta \text{Nifty Reality}_t = a_1 \text{Nifty Reality}_{t-1} + \sum_{i=1}^{m} a_{2,i}\ \Delta \text{Nifty Reality}_{t-i} + u_t \quad \text{.....(ii)}$$

$$\Delta \text{Nifty Pharma}_t = b_1 \text{Nifty Pharma}_{t-1} + \sum_{i=1}^{m} b_{2,i}\ \Delta \text{Nifty Pharma}_{t-i} + v_t \quad \text{.....(iii)}$$

$$\Delta \text{Nifty FMCG}_t = F_1 \text{Nifty FMCG}_{t-1} + \sum_{i=1}^{m} F_{2,i}\ \Delta \text{Nifty FMCG}_{t-i} + e_t \quad \text{.....(iv)}$$

$$\Delta \text{Nifty Auto}_t = g_1 \text{Nifty Auto}_{t-1} + \sum_{i=1}^{m} g_{2,i}\ \Delta \text{Nifty Auto}_{t-i} + w_t \quad \text{.....(v)}$$

{eq.(ii to v) are the equations which test the stationarity of our four indices using ADF-GLS Methodology. Nifty Reality$_t$, Nifty Pharma$_t$, Nifty FMCG$_t$ & Nifty Auto$_t$ are the de-trended variables; α_1, β_1 , Φ_1 & λ_1 are the four coefficients which test for the stationary of our variables. $\sum_{i=1}^{m} \alpha_{2,i}\ \Delta$ Nifty Reality$_{t-i}$ in eq. (ii) denotes the change in Nifty Real Estate index in period t-i & is the augmented

variable which takes care of serial – correlation in our time series. Like wise we include similar terms $\sum_{i=1}^{m}\beta_{2,i}\Delta Nifty\ddot{P}harma_{t-i}$, $\sum_{i=1}^{m}\Phi_{2,i}\Delta Nifty\ddot{F}MCG_{t-i}$ *&* $\sum_{i=1}^{m}\lambda_{2,i}\Delta Nifty\ddot{A}uto_{t-i}$ *for other equations viz. eq. (iii), (iv) and (v).These term sums up 'm' times till the autocorrelation is removed.Further since we are working on de-trended data, intercept & time variable are excluded from the equations}*

RESEARCH METHODOLOGY & HYPOTHESIS TESTING

The study employs the following methodology for this purpose:

Hypothesis testing with Dummy Variable - base incremental regression approach to capture seasonal variation in returns

Here the methodology employed includes running a regression for the sampled period with the return on any sector specific index as dependent variable and eleven dummies *(i=2 to 12)* representing eleven months of the year as independent variables with one particular month as a base for Dummy Variable. If the observation belongs to the month for which dummy has been created, its value is taken as '1' else '0'. The following Models (I, II, III, IV & V) have been developed for return on our four variables viz. (a) Nifty Auto, (b)Nifty FMCG, (c)Nifty Pharma and (d)Nifty Real Estate; the base month dummy variable for all the four models has been kept as April.

Model I

$$\text{Return on Nifty Reality}_t = \gamma_1 + \sum_{i=2}^{12}\gamma_{2,i}D_{i,t} + u_{1t} \quad \text{.....(vi)}$$

Model II

$$\text{Return on Nifty Pharma}_t = \theta_1 + \sum_{i=2}^{12}\theta_{2,i}D_{i,t} + u_{2t} \quad \text{.....(vii)}$$

Model III

$$\text{Return on Nifty Auto}_t = \omega_1 + \sum_{i=2}^{12}\omega_{2,i}D_{i,t} + u_{3t} \quad \text{.....(viii)}$$

Model IV

$$\text{Return on Nifty FMCG}_t = \eta_1 + \sum_{i=2}^{12}\eta_{2,i}D_{i,t} + u_{4t} \quad \text{.....(ix)}$$

Null Hypothesis(H_o) : In-Significant Dummy Coefficient

$\gamma_{2,i} = \theta_{2,i} = \omega_{2,i} = \eta_{2,i} = 0$ *(i=2 to 12)*

Acceptance of Null would imply that the corresponding month against the Dummy variable for the relevant index is not showing any seasonal variation in sector specific stock returns. However if the computed 't' for any of the Dummies is found to be significant, we conclude that seasonal variation in return exists for that particular month of the year for that sector specific index. The above regression exercise has been conducted in above four models (I to IV) by using robust Newey West OLS Regression which takes care of autocorrelation and heteroscedasticity in data.

Hypothesis testing to ascertain seasonal impact on return and return volatility: To capture the seasonal impact in return and return volatility we would be employing GARCH (p,q) framework. The study employs two models/versions of GARCH; first model (given as Model V below) is a simple GARCH (p,q) model where the mean equation is similar to the AR(1) equation *(to keep things simple we have assumed that the variable follows the simple AR(1) Model)* along with eleven dummies signifying the month effect for our sector specific index ; Return on Nifty Reality . The GARCH (p,q) model also has a variance equation which includes a Constant, Square of the error term of previous period & previous period's variance of the error term. The second model under GARCH (p,q) i.e. Model VI also for the same sector specific index i.e. Return on Nifty Reality, incorporates month of the year effect through return as well as variance equations, however the eleven dummies are also included as variance regressors.

MODEL V

$$\text{Ret. on Nifty Reality}_t = \beta_1 + \sum_{i=2}^{12} \beta_{2,i} D_{i,t} + \beta_3 \text{Ret. on Nifty Reality}_{t-1} + u_{5t} \quad \text{.....(x)}$$

$u_{5t} \sim \text{iid. N}(0, \sigma^2 u_t)$

$$h_t = \alpha_1 + \sum_{j=1}^{p} \alpha_{2,j} u^2_{5(t-j)} + \sum_{i=1}^{q} \alpha_{3,i} h_{t-i} \quad \text{.....(xi)}$$

MODEL VI

$$\text{Ret. on Nifty Reality}_t = b_1 + \sum_{i=2}^{12} b_{2,i} D_{i,t} + b_3 \text{Ret. on Nifty Reality}_{t-1} + u_{6t} \quad \text{.....(xii)}$$

$$u_{6t} \sim \text{iid. N}(0, \sigma^2 u_t)$$

$$h_t = \alpha_1 + \sum_{j=1}^{p} a_{2,j} u^2_{6(t-j)} + \sum_{i=1}^{q} a_{3,i} h_{t-i} + \sum_{i=2}^{12} a_{4,i} D_{i,t} \quad \text{.....(xiii)}$$

(In both Models V & VI, b_1 is constant and represents the base month dummy (April) , $\beta_{2,i}$ is the coefficient attached to each dummy variable; 'i' refers to month of the year (i=2 to 12 i.e. 11 months ; May to March) , β_3 is the coefficient of first lag of Return on Nifty Reality. Also in both models V & VI , we have variance equations where α_1 as the constant, α_2 & α_3 represent the ARCH and GARCH terms respectively. Also in the variance equation in Model VI, we have included dummy as variance regressors whose coefficient is $\alpha_{4,i}$ which may be interpreted in same manner as above)

Using the same logic as given in Model V & Model VI, we would be building GARCH (p, q) equations for our other variables namely, Return on Nifty FMCG, Return on Nifty Pharma & Return on Nifty Auto.

Hypothesis testing to detect asymmetries in the return & volatility (T-GARCH Approach)

In Financial Markets, it is usually seen that any bad news is known to have a much higher impact on the volatility of the market than the good news and the behaviour of sector specific indices is no different. In order to incorporate this aspect for our variable sector specific index we have used Threshold GARCH (or 'T' GARCH). Here we have used a Threshold Dummies **D(NR), D(NA), D(NP) & D(NF) ;** one each for our four sector specific indices & the dummies have been added to the squared lagged error term in the variance equation i.e. the ARCH term. Threshold Dummy is expected to take the value of '1', if error term (**u_t) of the relevant sector specific index** is negative and the value shall be '0' if the term is positive. It is important to add that in Model (VII) although we are adding Dummy to the square of the error term, Dummy itself has been created by taking error term values (and not squared values) .

Now if the coefficient of the dummy is significant it would mean that asymmetry works in the relevant sector specific index market or higher volatility is created by bad news than good news. On the other hand if the coefficient of relevant dummy is in-significant, it would imply that the impact of good and bad news is symmetric. Here too we construct two TGARCH (p,q) variants , the first variant (Model VII) includes monthly dummies in mean but not in the variance equation while the second variant (Model VIII) includes monthly dummies in both mean and variance equations. The dependent variable is however same in both models which is return on the sector specific index under consideration. The two Models; Model VII & Model VIII capture the asymmetric return on Nifty Reality and similar methodology has been used to build T-GARCH(p, q) equations for our other variables viz. Return on Nifty FMCG, Return on Nifty Pharma & Return on Nifty Auto. It is to be noted that variance equation for Model VIII has two different type of dummies, D_1 representing month of the year and other Dummy, the Threshold Dummy as **D(NR), D(NA), D(NP) & D(NF);** one dummy each for each of the four sectoral indices, for testing asymmetry.

MODEL VII

$$\text{Ret. on Nifty Reality}_t = b_1 + \sum_{i=2}^{12} b_{2,i} D_{i,t} + b_3 \text{Ret. on Nifty Reality}_{t-1} + u_{7t} \quad \text{.....(xiv)}$$

$$u_{7t} \sim \text{iid. } N(0, \sigma^2 u_t)$$

$$h_t = \alpha_1 + \sum_{j=1}^{p} (a_{2,j} + a_{3,j} D(NR)_{t-j}) u^2_{7(t-j)} + \sum_{i=1}^{q} a_{4,i} h_{t-i} \quad \text{.....(xv)}$$

MODEL VIII

$$\text{Ret. on Nifty Reality}_t = b_1 + \sum_{i=2}^{12} b_{2,i} D_{i,t} + b_3 \text{Ret. on Nifty Reality}_{t-1} + u_{8t} \quad \text{.....(xvi)}$$

$$u_{8t} \sim \text{iid. } N(0, \sigma^2 u_t)$$

$$h_t = \alpha_1 + \sum_{j=1}^{p} (a_{2,j} + a_{3,j} D(NR)_{t-j}) u^2_{8(t-j)} + \sum_{i=1}^{q} a_{4,i} h_{t-i} + \sum_{i=1}^{12} a_{5,i} D_{1_{i,t}} \quad \text{.....(xvii)}$$

(In both Models VII & VIII, b_1 is constant and represents the base month dummy (April) , $\beta_{2,i}$ is the coefficient attached to each dummy variable; 'i' refers to month of the year (i=2 to 12 i.e. 11 months ; May to March) , β_3 is the coefficient of first lag of Return on Nifty Reality. Also in both models VII & VIII, we have variance equations where α_1 as the constant, α_2 & α_4 represent the ARCH and GARCH terms respectively. α_4 is the coefficient of Threshold Dummy of Nifty Reality (NR) which gets added to the GARCH term . Also in the variance equation eq. (xvii) in Model VIII we have included second dummy $D_{1_{i,t}}$ as variance regressors which may be interpreted in same manner as done for mean model i.e. eq. (xvi) above)

1.1 Hypothesis testing to detect asymmetries in the return & volatility (E-GARCH Approach)

Our next Model (Model IX) uses Exponential GARCH which tries to fit an exponential equation to test for asymmetric return in volatility. The Model is an alternative to 'T'GARCH Model which tested for the leverage effect by developing a quadratic variance equation. The EGARCH Model on the other hand, fits an exponential equation thus making leverage effect behave exponentially.

MODEL IX

$$\text{Ret. on Nifty Reality}_t = b_1 + \sum_{i=2}^{12} b_{2,i} D_{i,t} + b_3 \text{Ret. on Nifty Reality}_{t-1} + u_{9t} \quad \text{.....(xviii)}$$

$$u_{9t} \sim \text{iid. N}(0, \sigma^2 u_t)$$

$$\ln.h_{m,t} = a_1 + a_2 \left| \frac{u_{t-1}}{\sqrt{h_{t-1}}} \right| + a_3 \frac{u_{t-1}}{h_{t-1}} + a_4 \ln(h_{t-1}) + u_{m,t} \quad \text{.....(xix)}$$

ASYMMETRY

Eq. (xix) is the log transformation of our exponential model for the variable, Ret. on Nifty Reality and test for asymmetries (leverage effect) is carried out by obtaining the values of parameter a_2. In the above Model IX, Null $= a_2 = 0$ i.e. model is symmetric and if value obtained for $a_2 < 0$, then negative news has higher volatility than positive news. The same procedure is followed for remaining three other sectoral indices)

1.2 Hypothesis testing to detect volatility spill-over from one sector specific index to another

We also develop a model (Model X) to test whether there exists a spill-over of volatility from one sector specific index to another sector specific index. Here we introduce a new variable; square of the residuals of variable's error term which is included into variance equation of another variable. Thus here the variance equation of each sector specific index would include square of the residuals of every other index while mean equation remains the same i.e. AR(1) in all our four sector specific indices . The mean equations for the four sector specific indices have been clubbed together are given as eq. (xx) to eq. (xxiii) as under :-

$$\text{Mean Equation 1: Ret Nifty FMCG}_t = \beta_1 + \beta_2 \text{ Ret Nifty FMCG}_{t-1} + u_t \quad \text{.....(xx)}$$

$$\text{Mean Equation 2: Ret Nifty Auto}_t = \alpha_1 + \alpha_2 \text{ Ret Nifty Auto}_{t-1} + v_t \quad \text{.....(xxi)}$$

$$\text{Mean Equation 3: Ret Nifty Reality}_t = \gamma_1 + \gamma_2 \text{ Ret Nifty Reality}_{t-1} + e_t \quad \text{.....(xxii)}$$

$$\text{Mean Equation 4:Ret Nifty Pharma}_t = \delta_1 + \delta_2 \text{ Ret Nifty Pharma}_{t-1} + w_t \quad \text{..... (xxiii)}$$

$$u_t \sim \text{iid N}(0, \sigma^2 u_t)$$

Similarly the four variance equations (eq. xxiv to eq. xxvii) for our four sector specific indices are given below:

$$\text{Variance Eq.1: } h_t \text{ (Ret on FMCG Nifty)} = \beta_1 + \beta_2 u^2_{t-1} + \beta_3 h_{t-1} + \beta_4 v^2_t + \beta_5 w^2_t + \beta_6 e^2_t \quad \text{...(xxiv)}$$

$$\text{Variance Eq.2: } h_t \text{ (Ret on Nifty Auto)} = \gamma_1 + \gamma_2 v^2_{t-1} + \gamma_3 h_{t-1} + \gamma_4 u^2_t + \gamma_5 w^2_t + \gamma_6 e^2_t \quad \text{.....(xxv)}$$

$$\text{Variance Eq.3: } h_t \text{ (Ret on Nifty Reality)} = \theta_1 + \theta_2 e^2_{t-1} + \theta_3 h_{t-1} + \theta_4 u^2_t + \theta_5 w^2_t + \theta_6 v^2_t \quad \text{....(xxvi)}$$

$$\text{Variance Eq.3: } h_t \text{ (Ret on Nifty Pharma)} = \lambda_1 + \lambda_2 w^2_{t-1} + \lambda_3 h_{t-1} + \lambda_4 u^2_t + \lambda_5 e^2_t + \lambda_6 v^2_t \quad \text{.(xxvii)}$$

(for variance equation of Ret on FMCG Nifty i.e. eq.(xxiv), the first three terms with parameters β_1 , β_2 & β_3 represent a Constant, Square of the error term of previous period & previous period's variance of the error term while the next three terms with parameters β_4 , β_5 & β_6 represent the spill-over effect in the form of square of the residuals of other three indices)

Hypothesis testing to detect volatility spill-over from one sector specific index to another (incorporated in T-GARCH Model)

This model (Model XI) includes spill-over of volatility in our T-GARCH Model i.e. we are considering asymmetric spill-over i.e. spill-over of volatility from one sector specific index to another sector specific index along with asymmetry in return volatility. This is done by incorporating the above variable (square of the residuals of variable's error term) in the T-GARCH Model of another variable. e.g. for our sector specific index Return on Nifty Reality we get the following equations.

$$\text{Ret. on Nifty Reality}_t = b_1 + \sum_{i=2}^{12} b_{2,i} D_{i,t} + \text{Ret. on Nifty Reality}_{t-1} + u_{11t} \quad \text{.....(xxviii)}$$

$$u_{11t} \sim \text{iid. } N(0, \sigma^2 u_t)$$

$$h_t = \alpha_1 + \sum_{j=1}^{p} (a_{2,j} + a_{3,j} D(NR)_{t-j}) u^2_{11(t-j)} + \sum_{i=1}^{q} a_{4,i} h_{t-i} + \sum_{i=1}^{12} a_{5,i} D_{1_{i,t}} + \alpha_6 v^2_t + \alpha_7 W^2_t + \alpha_8 e^2_t \quad \text{(xxix)}$$

(*For variance equation of Ret on FMCG Nifty i.e. eq.(xxix), α_1 is the constant, α_2 & α_4 represent the ARCH and GARCH terms respectively. α_4 is the coefficient of Threshold Dummy of Nifty Reality (NR) which gets added to the GARCH term . We have included A second dummy D_1 as variance regressors which may be interpreted in same manner as done for mean model done earlier, the next terms with parameters α_6 , α_7 & α_8 represent the spill-over effect in the form of square of the residuals of other three indices.)* $_{i,t}$

Similarly we develop and interpret our models on remaining three indices .

RESULTS OF THE STUDY

The results of the study are given in tabular format in appendices. To begin with we discuss the results of different diagnostic tests (Appendix I & II) which includes test

of variable stationarity, normality & statistical description of data. Whereas Appendix–I gives Statistical Description of our four sampled NSE Sector specific indices (at returns) for the period April 2009- Mar 2019, Appendix-II provides the results of stationarity testing of variables using DF-GLS test (trend and intercept)).

Under Appendix-I the computations give the mean, median, standard deviation, skewness and kurtosis of our all the four sector specific indices & the results showed that three of the four indices namely Nifty FMCG, Nifty Pharma & Nifty Auto were giving average positive returns while only Nifty Reality index gave a net negative average return during the ten year period (2009-19). The highest mean return recorded was of Nifty FMCG at 1.465 % p.m or 17.58 % on annualized basis. In terms of risk which was measured by standard deviation, Nifty FMCG enjoys the lowest risk while Nifty Reality had the highest risk which was approximately three times that of Nifty FMCG; index with the lowest risk. If we go by these two parameters i.e. average return and risk , Nifty FMCG becomes the clear winner out of the four sector specific indices. Further, in terms of comparison with that of a normal distribution, two of the sector specific indices viz. Nifty FMCG & Nifty Pharma are found to be normally distributed as given by Jarque-Berra Statistics *(Computed Values were less than Chi Square critical value of 5.99)*. The Kurtosis or (peakedness of the sector specific distribution) was highest in case of Nifty Reality , much higher than that of a normal distribution while Nifty Pharma and Nifty FMCG have kurtosis close to '3' which is also the case with normal distribution.

The next appendix (Appendix-II) gives the results of tests for Stationairty of our four Sector specific Indices using DF-GLS test; the results show that the computed 't' values of three of four sector specific indices; Nifty Auto, Nifty Pharma & Nifty Reality are stationary at 1st difference (or at returns) while Nifty FMCG is stationary at level *[Criteria followed : the absolute computed values must be higher than the 5 % absolute critical value as given by Elliott-Rothenberg DF-GLS Test]*

After diagnostic tests, we next move to the results of Hypothesis testing and first of these results pertain to capturing seasonal variation in returns of sector specific

indices by incorporating dummy variables in Newey West Technique of OLS ;the results are provided in Appendix III. Appendix III table shows eleven dummy variables , each dummy representing one month of the year ;May to March; with the month of April being considered as the base for the dummy variable approach. Appendix III also gives the computed 't' values and the probability 'p' values for all the eleven dummy variables. The results of the regression reveal that in the case of Nifty Auto , the month of January shows significant variation *(at 10 % levels as shown by the respective 'p' values or computed 't' statistics)* , on the other hand significant variation is also seen in the months of January and February for Nifty FMCG at 10 % and 5 % levels respectively . Also Nifty Pharma shows significant variation in the month of August (5 % levels).

Appendix IV (a & b) gives the results of test for seasonal variation in returns and volatility of returns of the four sector specific indices under the GARCH (1,1) framework. The results in this section are divided into two parts, Appendix IV (a) where we include Dummy Variables only in the mean equation based upon Model V, while Appendix IV (b) where these are also included in the variance equation; results based upon Model VI. The results reveal significant variation in returns in mean equation *(at 5 % level)* which was for seven months August-February for Nifty FMCG and for the month of May in case of Nifty Pharma. On the other hand, if we consider the results at 10 % levels of significance , then other two indices also join i.e. Nifty Auto had variation in the month of January while Nifty Pharma in the month of June . No variation in returns was seen for rest of the months for any of the four indices. [See Appendix IV (a)].

When the Dummies were also included as variance regressors significant seasonal variation in volatility of returns was seen in Nifty Reality (August, December & February) & also Nifty Pharma (June & October), however no seasonal variation in volatility was seen in Nifty Auto & FMCG. (see Appendix IV (b)). Thus overall picture which emerges is that seasonal variation in returns exists for some periods in some of the sector specific indices which support other research studies in this area that although the main index of the stock exchange may be efficient in terms of no

seasonal variation, this is not so with sector specific indices from the same stock exchange where some seasonal variations surely exists.

The next set of results given in Appendix V (a & b), detect asymmetries in the return & volatility using T-GARCH Methodology. Appendix V (a) reveal that the coefficient of T-GARCH { (RESID(-1)^2*RESID(-1)<0) }reflecting asymmetric impact on returns ; bad vs. good news impact on sector specific index returns was found to be significant only for NSE Auto. Thus the results make it clear that any bad news about the auto sector specific index has much more impact on volatility than any good news about this sector. However when dummies were also included as variance regressors (See Appendix V (b)), this asymmetry could not be detected showing no asymmetric impact on return volatility. Similar results (at 10 % critical levels) were obtained from E-GARCH Model which assumes exponential relation. Therefore the picture that emerges is that asymmetry exists in NSE Auto in its return and volatility of returns while returns and volatility of returns of other sectoral indices is symmetric. (See Appendix V (c)).

Appendix VI (a & b) pertain to the results of spill-over of volatility from one sectoral index to another and this aspect has been ascertained by including in the variance regressor, squared residuals of the other sectors. Further whereas Appendix VI(a) pertains to the spill-over incorporated in GARCH Model, Appendix VI(b) incorporates spill-over in the T-GARCH framework *(these Appendices shows only spill-over results excluding the other coefficients)*. These results do not indicate any spill-over of volatility from one index to another as all the 'p' values are higher than 0.05 thereby making the relevant coefficient of spill-over as insignificant. *(Null Hyp : No spill-over occurs from one sector to another)*

CONCLUSION AND POLICY RECOMMENDATION

To conclude, the present study made an attempt to investigate the month-wise seasonal variation in returns (& also volatility of returns) of four sector specific indices viz. Nifty Auto, Nifty FMCG, Nifty Pharma and Nifty Real Estate of

National Stock Exchange for the ten year period April 2009 to March 2019. The study also investigated spill-over of volatility from one sector specific index to another and also tried to ascertain asymmetries in their return and return volatility. The data for the purpose of the study included log transformed monthly returns of the four sampled sector specific indices. These results of the study showed that seasonal variation in returns as well as return volatility exists in some of the sector specific indices (especially Nifty FMCG & Nifty Reality) which is in line with other research studies in this area, justifying the stance that although the main index of the stock exchange may be efficient in terms of no seasonal variation , this is not so with sector specific indices of same exchange where some seasonal variations surely exists. In terms of results of asymmetry in return and return volatility, only one index Nifty Auto was found to be giving asymmetric returns , on the other hand the spill-over impact from one sector to another was not visible from the results

The results of the study bring to light some useful information which can be beneficial to the researchers and policy makers. First, the section on Statistical Description revealed that risk is lowest & returns are highest for Nifty FMCG and also this is exactly the opposite for Nifty Reality where the average returns were found to be below zero (negative) for the ten year period. Thus the message is clear for portfolio investors, they would be better off by shifting all their funds from the reality sector index to FMCG sector Index. As a matter of fact, they could also think of excluding Reality Sector altogether from the portfolio. Second, the FMCG sector showed substantial variation in its return month-wise as revealed by significant dummies for the seven months August-February ; one likely reason for variation in returns month-wise in case of FMCG sector could be attributed to change in buying patterns of the consumers who are now making quite a substantial purchases on-line . Now with August-November being an extended festive season in India, there are quite a number of internet sites which give huge discounts on purchases in this season which results in skewed sales on few months of the year of the FMCG Companies. Adding to this the consumers are now seeing more purchasing power in their hands and also most of these purchases are coming from the middle class educated

consumers. The rise in the purchasing power in the hands of the consumer could be attributed to high growth rate which India has achieved during the last decade or so. Again although the effect of these changes (e.g. high growth rate, shift in demographic profile of India) shall have impact on almost all the sectors, the impact is faster in the consumer oriented FMCG sector/segment than other sectors.

The results also showed that auto sector was showing asymmetry of bad and good news, in returns and return volatility; this is probably because this sector is linked to highly volatile energy products (crude oil, gas etc.). Moreover things are moving very fast in this sector especially during the last ten years. Further, auto being a highly capital intensive sector, the impact of any policy decision is quite severe on this sector e.g. a decision to ban all diesel trucks entering a city or scrapping all ten/fifteen year old diesel vehicles would impact the sale of diesel trucks immediately. Such a decision may be taken keeping in view the environmental concerns; but is a severe blow to the auto industry as transforming itself to new (green) technology could be done only gradually in a phased manner. This being the case, the impact of it would be seen both current and future sales of this auto industry.

Further the buyers of vehicles working on their own interests immediately work out their own economies thereby resulting in deferring or postponing their purchase decision and such a trend is already visible in case of vehicular sales in India. Another related reason which is likely to result in asymmetry in returns is the entry of substitutes. The monopoly of this sector is now at stake after the successful entry of Electric Vehicles in the market. This is also another reason why buyers are reluctant to buy existing vehicles for the fear that very soon they would be forced to shift to Electric Vehicles as a policy measure. If this happens it would not only reduce the market value of existing vehicles but might also make them unviable as these might be of no match in terms of cost effectiveness as compared to electric vehicles.

Coming to Reality sector, seasonal volatility in returns of Nifty Reality was seen in the months of August, December & February. The likely reason for this can be due to the fact that a lot of attractive schemes are launched by the real estate developers

during these months. This is a new trend which has emerged in the last few years especially after the fall in the real estate prices especially after 2015, which has kept the buyer away from this market. The variation in August is primarily because of the rise in demand of real estate during the festive season which is traditionally considered most auspicious occasion for buying a real estate. Further during the month of December, the sales are expected to fall as the home buyers would postpone their purchases till new year and finally the volatility in month of February may be due to some sales in this sector because there might be some sops for the real estate sector in the Union Budget which is presented each year in February.

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Appendices

Appendix I: Statistical Description of our four sampled Sector specific indices (at returns) for the period April 2009- Mar 2019

Parameter	NIFTY AUTO Return	NIFTY FMCG Return	NIFTY PHARMA Return	NIFTY REALITY Return
Mean	0.014346	0.014657	0.011462	-0.000404
Median	0.016305	0.012876	0.012274	-0.006362
Standard Deviation	0.067159	0.045174	0.051827	0.120887
Skewness	0.326739	0.154514	-0.204077	0.967411
Kurtosis	4.589564	3.332666	2.821327	6.724792
Minimum	-0.170092	-0.100736	-0.136223	-0.257311
Maximum	0.266830	0.172267	0.128960	0.591211
No. of Observations	119	119	119	119
JB Statistics	14.64566	1.022235	0.984297	87.35399

Appendix II : Testing of the Stationary of Variables : DF-GLS(ERS) Unit root test (Trend + Intercept)

Null Hypothesis	DF-GLS (Computed) Absolute*values*	Test Critical (ERS-DF-GLS): Absolute Values (at 5 %)	*Result (Ho : Null Hypothesis)*
Nifty Auto (Close) has a unit root	1.454235	3.011000	Accepted
Nifty Auto (1st Diff) has a unit root	3.737497	3.015000	Rejected
Nifty FMCG (Close) has a unit root	3.540056	3.011000	Rejected
Nifty FMCG (1st Diff.) has a unit root	9.554757	3.013000	Rejected
Nifty Pharma (Close) has a unit root	1.021618	3.013000	Accepted
Nifty Pharma (1st Diff.) has a unit root	6.803655	3.013000	Rejected
Nifty Reality (Close) has a unit root	2.204470	3.011000	Accepted
Nifty Reality (1st Diff.) has a unit root	3.851698	3.018000	Rejected

Appendix III : The OLS (Newey West Regression) regression results of Month of the year effect on five Sampled Indices using Dummy Approach (with Intercept) with APRIL as BASE DUMMY

	NIFTY AUTO			NIFTY FMCG			NIFTY REALITY			NIFTY PHARMA		
Month of the Year Dummy	Beta Coeff	Computed 't' Values	'p' Values	Beta Coeff.	Computed 't' Values	'p' Values	Beta Coeff	Computed 't' Values	'p' Values	Beta Coeff.	Computed 't' Values	'p' Values
May	-0.0086	-0.2104	0.8337	-0.0062	-0.3064	0.7598	-0.0343	-1.2447	0.2159	0.0212	0.2624	0.7935
June	-0.0255	-1.2068	0.2301	0.0028	0.1282	0.8982	0.0109	0.5604	0.5763	-0.0495	-1.2093	0.2292
July	0.0041	0.1542	0.8777	0.0097	0.4166	0.6778	0.0034	0.1758	0.8608	-0.0162	-0.4136	0.6799
August	-0.0264	-1.2416	0.2171	-0.0314	-1.4357	0.1540	-0.0091	-0.3551	0.7231	-0.0736	-1.9989	0.0482
Sept	-0.0009	-0.0332	0.9735	-0.0268	-1.0999	0.2738	0.00 62	0.2580	0.7969	-0.0147	-0.3087	0.7581
October	-0.0100	-0.4177	0.6770	-0.0177	-0.8814	0.3801	-0.0026	-0.1360	0.8920	-0.0176	-0.4363	0.6635
Nov.	-0.0197	-0.7742	0.4405	-0.0236	-1.1980	0.2336	-0.0372	-1.4142	0.1602	-0.0648	-1.2273	0.2224
December	-0.0228	-1.3463	0.1810	-0.0271	-1.6533	0.1012	-0.0198	-0.9511	0.3437	-0.0287	-0.8455	0.3997
Jan	-0.0566	-1.7993	0.0748	-0.0383	-1.8403	0.0685	-0.0306	-1.2801	0.2032	-0.0447	-0.8148	0.4170
Feb	-0.0343	-1.4314	0.1552	-0.0396	-2.1876	0.0309	-0.0301	-1.2203	0.2250	-0.0580	-1.3074	0.1939
March	-0.0023	-0.0926	0.9263	0.0087	0.4215	0.6742	-0.0084	-0.2802	0.7798	0.0082	0.1527	0.8789

Appendix IV(a): GARCH(1,1) results for seasonal variation in volatility in returns of the four sector specific indices

	NIFTY AUTO		NIFTY FMCG		NIFTY REALITY		NIFTY PHARMA	
	Beta Coeff	'p' Values	Beta Coeff.	'p' Values	Beta Coeff	'p' Values	Beta oeff.	'p' Values
Mean Eq								
Ret(-1)	-0.0247	0.8163	-0.2270	0.0088	0.0092	0.9260	-0.2031	0.0018
May	-0.0357	0.2960	-0.0205	0.2885	-0.0369	0.4865	-0.04611	0.0189
June	-0.0252	0.5141	-0.0141	0.2982	-0.0360	0.5400	0.0140	0.5278
July	-0.0111	0.8066	-0.0036	0.8394	-0.0252	0.6977	0.0042	0.8488
August	-0.0280	0.4404	-0.0345	0.0099	-0.0791	0.2367	0.0037	0.8331
Sept	-0.0075	0.8254	-0.0486	0.0000	-0.0122	0.8159	0.0042	0.8167
October	-0.0063	0.8560	-0.0336	0.0340	-0.0118	0.8481	-6.52E -05	0.9977
Nov.	-0.0237	0.4908	-0.0270	0.0410	-0.0630	0.2084	-0.0259	0.1499
December	-0.0249	0.5528	-0.0383	0.0441	-0.0280	0.6942	-0.0147	0.4376
Jan	-0.0565	**0.0768**	-0.0350	0.0089	-0.0413	0.4020	-0.0401	0.0599
Feb	-0.0366	0.2939	-0.0508	0.0045	-0.0550	0.3303	-0.0284	0.1422
March	-0.0039	0.9074	-0.0029	0.8757	0.0112	0.8230	-0.0120	0.5034
VarEq								
RESID(-1)^2	0.0005	0.9935	-0.1513	0.0000	-0.0084	0.9405	-0.1469	0.0003
GARCH(-1)	0.7628	0.0027	0.9582	0.0000	0.7101	0.2558	0.6046	0.1089

Appendix IV(b): GARCH(1,1) results for seasonal variation in volatility in returns of the four sector specific indices using Dummies in variance regressors

	NIFTY AUTO		NIFTY FMCG		NIFTY REALITY		NIFTY PHARMA	
	Beta Coeff	'p' Values	Beta Coeff.	'p' Values	Beta coeff.	'p' Values	Beta Coeff.	'p' Values
Mean Eq								
Ret(-1)	0.0149	0.8707	-0.1293	0.1632	0.1321	0.2040	-0.0711	0.5062
May	-0.0340	0.2505	-0.008 8	0.4266	-0.0469	0.6201	-0.0332	0.3001
June	-0.0265	0.2233	-0.0050	0.7767	-0.0294	0.7369	0.0020	0.9420
July	-0.0111	0.5478	-0.0023	0.8895	-0.0230	0.7848	0.0136	0.6379
Aug	-0.0278	0.2475	-0.0292	0.1495	-0.0830	0.3116	-0.0160	0.6147
Sept	-0.0085	0.7940	-0.0403	0.0577	-0.0070	0.9377	0.0090	0.7680
Oct	-0.0031	0.8941	-0.0270	0.1169	-0.0336	0.7589	-0.0007	0.9777
Nov.	-0.0260	0.4800	-0.0215	0.1731	-0.0732	0.3895	-0.0370	0.2529
Dec	-0.0245	0.2245	-0.0306	0.0104	-0.0302	0.7170	-0.0246	0.4553
Jan	-0.0569	0.0973	-0.0394	0.0262	-0.0490	0.5689	-0.0239	0.4315
Feb	-0.0357	0.1579	-0.0434	0.0000	-0.0668	0.4342	-0.0329	0.3086
March	-0.0011	0.9659	0.0079	0.7516	0.0020	0.9813	-0.0032	0.9191
VarEq								
RESID(-1)^2	0.0220	0.6791	-0.0708	0.4083	0.1132	0.4499	0.1435	0.3277
GARCH(-1)	0.8019	0.0000	0.6695	0.0015	0.5983	0.1368	0.5932	0.1056
May	0.0045	0.1977	-0.0024	0.4362	-0.0127	0.2085	-0.0019	0.4729
June	-0.0005	0.8808	6.78E -05	0.9784	-0.0115	0.4073	-0.0031	0.0684
July	0.0007	0.7809	-0.0014	0.5167	-0.0125	0.2019	-0.0015	0.3114
Aug	0.0034	0.2373	3.09E -05	0.9918	-0.0100	0.0755	0.0002	0.8538
Sept	0.0041	0.2583	0.0004	0.8796	0.0011	0.8967	-0.0018	0.4732
Oct	0.0001	0.9609	-0.0016	0.5490	0.0015	0.9229	-0.0032	0.0402
Nov.	0.0029	0.5055	-0.0011	0.6743	-0.0146	0.3750	0.0007	0.7121
Dec	-0.0004	0.9049	-0.0020	0.3482	-0.0164	0.0013	-0.0022	0.2719
Jan	0.0073	0.2087	-2.16E -05	0.9922	8.57E -05	0.9914	-0.0015	0.4821
Feb	-0.0013	0.7934	-0.0019	0.3463	-0.0130	0.0825	-0.0012	0.4763
March	0.0027	0.6119	-0.0003	0.8954	-0.0022	0.8574	-0.0011	0.5902

Appendix V(a): T-GARCH results for asymmetric impact of monthly returns of the four sector specific indices on volatility

	NIFTY AUTO		NIFTY FMCG		NIFTY REALITY		NIFTY PHARMA	
	Beta Coeff	'p' Values	Beta Coeff.	'p' Values	Beta Coeff	'p' Values	Beta Coeff.	'p' Values
Mean Eq								
Ret(-1)	-0.0284	0.7647	-0.1731	0.0829	-0.0266	0.7726	-0.1890	0.0463
May	-0.0067	0.7795	-0.0108	0.6198	-0.0592	0.3005	-0.0433	0.0154
June	-0.0290	0.2468	-0.0160	0.2986	-0.0723	0.0893	0.0122	0.5277
July	-0.0041	0.8757	0.0026	0.9007	-0.0314	0.5332	-0.0005	0.9782
August	-0.0295	0.2287	-0.0269	0.0730	-0.0824	0.1509	-0.0066	0.6394
Sept	-0.0099	0.6555	-0.0470	0.0002	-0.0544	0.2697	0.0020	0.9035
October	-0.0039	0.8777	-0.0293	0.1018	-0.0290	0.5646	0.0010	0.9601
Nov.	-0.0128	0.6071	-0.0200	0.2217	-0.0485	0.2550	-0.0365	0.0283
Dec	-0.0169	0.5539	-0.0304	0.1864	-0.0425	0.4730	-0.0128	0.4707
Jan	-0.0730	0.0042	-0.0318	0.0622	-0.0476	0.2950	-0.0337	0.0879
Feb	-0.0406	0.1042	-0.0499	0.0090	-0.0697	0.1291	-0.0372	0.0274
March	-0.0190	0.4141	0.0002	0.9907	-0.0086	0.8323	-0.0151	0.0000
VarEq								
RESID(-1)^2	-0.1339	0.0000	-0.1032	0.1215	-0.1135	0.0812	0.0639	0.7658
RESID(-								
1)^2*(RESID	0.0545	0.0048	-0.0729	0.2125	0.04675	0.6217	-0.2133	0.3071
(-1)<0)								
GARCH(-1)	1.0403	0.0000	0.9478	0.0000	1.0446	0.0000	0.6214	0.0329

Appendix V(b): T-GARCH results for asymmetric impact of monthly returns of the four sector specific indices on volatility with Dummies included as variance regressors

	NIFTY AUTO		NIFTY FMCG		NIFTY REALITY		NIFTY PHARMA	
	Beta Coeff	'p' Values	Beta Coeff.	'p' Values	Beta Coeff	'p' Values	Beta Coeff.	'p' Values
Mean Eq								
Ret(-1)	-0.0139	0.8752	-0.1261	0.1473	0.1737	0.1350	-0.0843	0.4291
May	-0.0375	0.4515	-0.0077	0.6717	-0.0985	0.2626	-0.0331	0.2716
June	-0.0234	0.6331	-0.0021	0.9121	-0.0238	0.7681	0.0021	0.9349
July	-0.0085	0.8510	0.0020	0.9353	-0.0134	0.8573	0.0137	0.6262
August	-0.0224	0.6425	-0.0289	0.1927	-0.0595	0.4139	-0.0184	0.5362
Sept	-0.0059	0.9092	-0.0352	0.0982	-0.0357	0.6661	0.0078	0.8031
October	-5.27E-05	0.9991	-0.0276	0.1899	-0.0275	0.7256	-0.0008	0.9750
Nov.	-0.0236	0.6527	-0.0208	0.2781	-0.0679	0.4345	-0.0375	0.2315
Dec	-0.0198	0.6685	-0.0277	0.1212	-0.0206	0.8653	-0.0254	0.4441
Jan	-0.0512	0.3190	-0.0405	0.0318	-0.0792	0.3131	-0.0233	0.4337
Feb	-0.0280	0.5613	-0.0427	0.0171	-0.0940	0.2087	-0.0359	0.2728
March	-0.0061	0.8957	0.0066	0.7947	-0.0051	0.9466	-0.0020	0.9473
VarEq								
RESID(-1)^2	-0.0237	0.7738	0.0030	0.9832	0.0600	0.5409	0.1668	0.3878
RESID(-1)^2*(RESID(-1)<0)	0.1029	0.3355	-0.0934	0.5554	0.2371	0.3216	0.0099	0.9619
GARCH(-1)	0.7699	0.0000	0.5992	0.0498	0.6157	0.0029	0.5953	0.0947
May	-0.0032	0.5770	-0.0021	0.1167	-0.0129	0.6089	-0.0023	0.1760
June	-0.0047	0.2170	-0.0005	0.6826	-0.0137	0.0244	-0.0031	0.0084
July	-0.0042	0.2124	-0.0007	0.6450	-0.0128	0.4632	-0.0017	0.0289
August	-0.0010	0.7747	-0.0005	0.7933	-0.0113	0.4126	-0.0003	0.8023
Sept	-0.0005	0.9034	-0.0002	0.8837	0.0021	0.8945	-0.0016	0.3474
October	-0.0049	0.0280	-0.0010	0.5414	-0.0155	0.2852	-0.0033	0.0030
Nov.	-0.0012	0.7534	-0.0014	0.2365	-0.0002	0.9874	0.0004	0.7722
Dec	-0.0051	0.2682	-0.0018	0.0722	-0.0057	0.7799	-0.0020	0.3146
Jan	0.0016	0.7584	-0.0006	0.5226	-0.0117	0.4766	-0.0017	0.2629
Feb	-0.0053	0.2725	-0.0015	0.1222	-0.0145	0.3126	-0.0010	0.5535
March	-0.0031	0.4436	-0.0006	0.5879	-0.0028	0.8628	-0.0016	0.3295

Appendix V(c): E-GARCH results for asymmetric impact of monthly returns of the four sector specific indices on volatility

	NIFTY AUTO		NIFTY FMCG		NIFTY REALITY		NIFTY PHARMA	
	Beta Coeff	'p' Values	Beta Coeff.	'p' Values	Beta Coeff	'p' Values	Beta Coeff.	'p' Values
Mean Eq								
Ret(-1)	0.986190	0.0000	0.998296	0.0000	-0.0266	0.7726	0.988966	0.0000
VarEq								
ABS(RESID(-1) /@SQRT(GARCH(-1)))	-0.293665	0.0964	-0.087290	0.6133	-0.195404	0.3423	-0.065068	0.2314
RESID(-1)/@SQRT(GARCH(-1))	-0.27509 8	0.0297	0.117621	0.2716	0.004373	0.9562	0.141086	0.0069
LOG(GARCH(-1))	-0.238364	0.6860	1.011559	0.0000	0.947298	0.0000	0.986682	0.0000

Asymmetry

Appendix VI(a) : Spillover using GARCH Model (results presented here includes statistics pertaining to coefficient of spillover only which is square of the residual of other index)

	NIFTY AUTO		NIFTY FMCG		NIFTY REALITY		NIFTY PHARMA	
	Beta Coeff	'p' Values	eta Coeff.	'p' Values	Beta Coeff.	'p' Values	Beta Coeff.	'p' Values
RESI SQ FMCG	0.082772	0.6354			0.054525	0.9439	-0.000114	0.9993
RESI SQ PHARMA	-0.084986	0.4891	-0.025203	0.6152	-0.156139	0.7120		
RESI SQ REAL ESTATE	0.012882	0.6423	0.023770	0.3241			-0.004352	0.8261
RES SQ AUTO			0.057735	0.5424	0.031812	0.9139	-0.024150	0.5110

Appendix VI(b) : Spillover using T-GARCH Model(results presented here includes statistics pertaining to coefficient of spillover only which is square of the residual of other index)

	NIFTY AUTO		NIFTY FMCG		NIFTY REALITY		NIFTY PHARMA	
	Beta Coeff	'p' Values	Beta Coeff.	'p' Values	Beta Coeff	'p' Values	Beta Coeff.	'p' Values
RESI SQ FMCG	0.072661	0.7234			0.251673	0.7818	-0.016255	0.9315
RESI SQ PHARMA	-0.058449	0.6475	-0.087590	0.4273	0.090356	0.8440		
RESI SQ REAL ESTATE	0.010840	0.6963	0.00019 5	0.9940			-0.005243	0.8485
RES SQ AUTO			0.005419	0.9400	0.180526	0.6673	-0.007936	0.9118