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Heat Waves or Meteor Showers: Empirical Evidence from the Stock Markets

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ABSTRACT

In order to study the volatility spillovers / the transfer of volatilities from spot and futures markets for the period 1st January 2001 to 30th November 2005 with high frequency data i.e., one minute intervals, we have used GARCH models to compute volatilities and VAR models for the returns of different markets and for the volatilities. It is evident that, these VAR models for the volatilities can exhibit the nature of the change in volatility. In a heat wave, the conditional variance of the returns in spot (futures) market depends only upon the past shocks in the given market. For meteor showers, the impact of shocks on spot (futures) markets are transferred from other i.e., futures (spot) markets. With the VAR (1)-GARCH (1,1) analysis, we found that both series are I(1) and that a bi-directional relationship exists between the spot and future market return series. Empirically it is evident that both heat waves and meteor showers exist in Indian spot and futures markets.

JEL Classification: C22, C32, C53, E47, G14, N25, O16, Y1.
Keywords: Volatility Spillovers, Heat Waves, Meteor Showers, Indian Stock Market.

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1 INTRODUCTION

We are living in the most uncertain world i.e., nothing is certain in this world except risk. To make this uncertain to certain we need to provide important shocks and policies to control it. Risk is a major factor, which influences the human activity through different ways and forms. But, a man acts as a rational behavior and always tries to minimize the risk, which improves the return predictability by using optimizing techniques and tools. The risk can be classified into three categories such as risk lover, risk averter and risk neutral.

Essentially risk is the probability of outcome which may be damaging and result in a loss. In the presence of risk, outcomes of an event are thrown open to uncertainty. Uncertainty is unavoidable in the stock market, which demonstrates through information. In the analysis of markets, risk plays a major role for the players (such as arbitragers, hedgers and speculators and regulators) in the market. To minimize risk, players will adopt new techniques which help to analyze and to suggest possible outcomes. In order to analyze uncertainty in the Indian stock market we have chosen high frequency data.

According to Engle et al (1990), heat wave is the conditional variance of the returns in one market depends only upon the past shocks in the market. The heat wave hypothesis is consistent with the view that major sources of disturbances are changes in spot market–specific fundamentals, and that one large shock increases the volatility in spot only. The large shocks can be due to new pieces of information (Engle, Ito, Lin (1990) and Engle (1993), for instance the central bank raising or lowering the interest rates. The heat wave hypothesis is equivalent to a zero coefficient in the futures market term. The meteor shower is equivalent to a zero coefficient on the spot market term. This process of transfer of volatilities from one market to another can be studied through careful investigation.

Since the last decade, as most economies in the world including India, deregulated their capital markets, removed barriers and welcome the international investments, and improved the accessibility to information, investors in many countries have adopted a global view. To study the Indian stock markets and its subsequent spillover between spot and futures markets, we use GARCH models to compute volatilities and VAR models for the returns of different markets for the volatilities (which may be expressed as squared returns). As mentioned by several authors (Chowdhury et. al (1997), these VAR models for the volatilities can show the nature of the change in volatility; when the impact of a shock coming from the same market is much bigger than the impact of shock transferred from other markets, as a "heat wave". When the impact of shock on one market is transferred from other markets, they call it a "meteor shower".

This work deals with volatility spillover or volatility contagion between spot and futures market in the National Stock Exchange (NSE), India. NSE commenced trading in index futures on June 12, 2000. The index futures contracts are based on the popular market benchmark S&P CNX Nifty index, which is a diversified of 23 sectors representing the Indian Economy. NSE defines the characteristics of the futures contract such as the underlying index, market lot, and the maturity date of the contract. The futures contracts are available for trading from introduction to the expiry date.

In India, derivatives mainly introduced with view to increase liquidity which may in turn curb the increasing volatility of the asset prices in financial markets and to introduce sophisticated risk management tools leading to higher liquidity by reducing risk and transaction costs as compared to individual financial assets. Though the onset of derivative trading has significantly altered the movement of stock prices in Indian spot market, it is yet to be proved whether the derivative products has served the purpose as claimed by the Indian regulators.

The basic data proposed to be used in this study consist of intraday price histories from January 2001 to November 2005 for the nearby contract of nifty index futures, nifty spot index. The required intra-day data will be obtained from NSE Research Initiative and then we construct one-minute intervals (based on Frank de Jong et. al (1997) methodology) for both Nifty spot and futures indices.

This paper proceeds as follows: section 2 deals with extensive review, section 3 discusses the methodology that is used to reach the objective of the paper, in section 4 we present and discuss the results and finally we arrive at conclusions.

2 REVIEW OF LITERATURE

Engle et. al (1990), argued that shocks are transmitted as meteor showers rather than heat waves. The heat waves hypothesis assumes that volatility has only country-specific autocorrelation. An innovation in a particular market will persist only in that market and will not have a spillover effect on other markets. The meteor shower hypothesis asserts that innovations are transmitted from one market to others.

Volatility is definitely an important economic phenomenon. Such questions as which markets are more volatile? Do the stock prices follow the same volatility patterns? Does the volatility of one market (i.e., spot) correlate with volatility of other market (i.e., futures)? Does the volatility reflect the impact of economic fundamentals of cast-of-carry model? Such issues demand proper empirical investigation.

Accurate estimation of volatility in financial markets is very important and plays vital role for the players. Price fluctuations are connected with appearance of information flow even at an intraday level. During recent years financial markets are characterized by increasing international integration, which indicates that information from one market "spills over" to other markets.

As Cox (1976) argues that futures trading can be alter the available information and thus spot market volatility for two reasons: First, futures attract additional traders to a market. Second, as transactions costs in the futures market are lower than with reference to spot market, new information may be transmitted to the futures market more quickly. Now, the question is how the rate of information flow related to spot price volatility. This issue addressed by Ross (1989). Thus, if the derivative trading increases the flow of information, then in the absence of arbitrage opportunity, the volatility of the spot price must change.

The volatility is often used as a measure of the total risk of financial assets and is measured through the standard deviation or variance of the return. The hypothesis of heat-wave was based on assumption that expected volatility would follow the same intraday pattern with only regionally specific autocorrelation in fluctuations. But this skeleton does not give the explanation why volatility transmits across different markets. The explanation of autocorrelation-across-regions volatility was based on meteor shower effect, that is, the public information appeared at any point of time is followed with some lag from one place to other.

To obtain the above objective, paper summarizes and considered two hypotheses:

Volatility in spot (futures) prices is fully determined by domestic influence which is consistent with heat wave hypothesis

Volatility in spot (futures) prices is also influenced by future (spot) prices which are consistent with meteor shower hypothesis.

3 METHODOLOGY

Since the stock market index is adjusted every minute there are no missing data points on the index unless the frequency at which the data are analyzed is even higher than one minute. In this paper, we would like to present the volatility spillover between Indian Stock markets i.e., spot index and Index futures price (lag Returns) values. To study the interdependence, we have used a multivariate VAR (1)-GARCH (1, 1) model, as the correlations are high for contemporary returns on financial markets, and we will concentrate on the BEKK methods.

The development of multivariate generalized autoregressive conditionally heteroscedastic (MGARCH) models from the original univariate specifications represented a major step forward in the modeling time series. MGARCH models permit time-varying conditional covariances as well as variances, and the former quantity can be of substantial practical use for both modeling and forecasting, especially in Finance. Brooks, et al (1998) employed the benchmark for evaluating the accuracy of the parameter estimates in the estimates in the context of univariate GARCH models and stressed the importance of the development of benchmarks for other non-linear models, including other models in the GARCH class. However, there are currently no benchmarks developments for multivariate GARCH models. Several different multivariates GARCH model formulations have been proposed in the literature, and the most popular of these are the VECH, the diagonal VECH and the BEKK models. Each of these is discussed briefly in turn below; for a more detailed discussion, see Kroner et al (1992).

Introducing some notation, let H_t denote a NxN conditional variance-covariance matrix, Ξ_i an Nx1 vector of innovations, Ψ_{i-1} represent the information set at time t-1, then the conditional variance-covariance equations of the unrestricted VECH model may be written

$$VECH(H_t) = C + A\,VECH(\Xi_{t-1}\Xi'_{t-1}) + B\,VECH(H_{t-1}),\ \Xi_i \big/ \Psi_{i-1} \sim N(0, H_i)$$

Where C is an (N(N+1)/2)x1 vector containing the intercepts in the conditional variance and covariance equations. A and B are

(N(N+1)/2)x(N(N+1)/2) matrices containing the parameters on the lagged disturbance squares or cross-products and on the lagged variances or covariance's respectively. The term "VECH" arises from the use of the VECH (.) column-stacking operator applied to the upper triangle of the symmetric matrix.

A potentially serious issue with the unrestricted VECH model described above is that it requires estimation of a large number of parameters. This over-parameterization led to the development of the simplified diagonal VECH model by Bollerslev, Engle and Wooldrige (1988), where the A and B matrices are forced to be diagonal, resulting in a reduction of the number of parameters in the variance and covariance equations.

In order of an estimated multivariate GARCH model to be plausible, H_i is required to be positive definite for all values of the disturbances, but even checking this condition is a non-trivial issue for VECH or diagonal VECH models of moderate size or larger. To circumvent this problem, Engle and Kroner (1995) proposed a quadratic formulation for the parameters that ensured positive definiteness and this became known as the "BEKK" model.

In order to simplify matters as much as possible, we employ only the diagonal VECH representation, and we estimate only a bivariate system. This model is still probably more widely employed than the BRKK, and the parameters of the former model are more easily interpreted.

Let S_t and F_t denote the spot (i.e., cash index) and futures prices respectively, the return series are denoted by lower case letter and are calculated as $s_t = \log(S_t / S_{t-1}) * 100$ and $f_t = \log(F_t / F_{t-1}) * 100$ in the usual fashion. The conditional mean equations for the model that we estimate can be written as

$$Y_i = M + \Xi_i\ ,\ \ \Xi_i \sim N(0, H_i)$$

Where $Y_i = \begin{bmatrix} s_t \\ f_t \end{bmatrix}$, M is a 2 x1 vector of intercepts in the conditional mean $\left(M = \begin{bmatrix} \mu_s \\ \mu_f \end{bmatrix} \right)$, and with the conditional variance-covariance equations being given by (1) using diagonal forms for A and B. The conditional variance-covariance matrix, H_t, will comprise the elements $h_{s,t}$ and $h_{f,t}$ on the leading diagonal and $h_{s,f,t}$ as both of the off-diagonal terms. For clarity, the conditional mean equations can be written out separately as

$$s_t = \mu_s + \varepsilon_{s,t}$$
$$f_t = \mu_f + \varepsilon_{f,t}$$

With the conditional variance and covariance equations as

$$h_{s,t} = c_1 + a_1\varepsilon^2_{s,t-1} + b_1 h_{s,t-1}$$
$$h_{f,t} = c_2 + a_2\varepsilon^2_{s,t-1} + b_2 h_{s,t-1}$$
$$h_{s,f,t} = c_3 + a_3\varepsilon_{s,t-1}\varepsilon_{f,t-1} + b_3 h_{s,f,t-1}$$

Bid and Ask of future contracts provides a method for hedging exposures to movements in the price of the underlying asset. In the present context, estimating an optimal hedge ratio would be involved in determining the optimal number of futures contracts that should be sold per holding of the spot asset. Many studies have compared the performance of time-varying hedge ratios estimated using multivariate GARCH models with those of naïve or time-invariant hedge rations estimated using OLS regressions. The majority of the studies have preferred the time-varying approach on the grounds that they provide slightly more accurate hedge ratio estimation leading to portfolio returns with lower variances. Given the coefficients and fitted values from the estimated model, it is possible to show that the optimal hedge ratio will be given by the negative of the ratio of the one-step-ahead forecast of the covariance between the spot and future returns to the one-step-ahead forecast of the future return variance: $\beta^*_{t-1} = -\frac{h_{s,f,t}}{h_{f,t}}$

When the hedge ratio is expressed in this way, the returns to the hedged portfolio can be written as $r_{p,t} = s_t + \beta^*_{t-1} f_t$. It is also possible to express the variance of the returns to the hedged portfolio as $\mathrm{var}(r_{p,t}) = h_{s,t} + \beta^*_{t-1} h_{f,t} - 2\beta^*_{t-1} h_{s,f,t}$.

3.1 VAR (1) – GARCH (1,1) model using BEKK method

As proposed by Isakov and Perignon (2000), Bollerslev et al (1998), a diagonal vector (d vec) model where the elements of the lower half H_t

matrix are vectorized. The size of the matrices A and B was 3x3 for the 2 dimensional models, due to the coefficient for the covariance. They proposed to make the A and B matrices diagonal. This specification removes the potential interaction between the variances of two markets. On the other hand, the BEKK kind of multivariate GARCH models (Engle and Kroner, 1995) allows these interactions. This is useful to know that the volatility transfers from one market to another. Moreover, the BEKK kind of multivariate GARCH can be used in association with a VAR specification, allowing a computation of VAR- coefficients that are efficient and consistent, even in the residuals of the classical VAR where a Gaussian distribution and a constant variance is not present.

We consider a VAR (1)-GARCH (1, 1) model in a BEKK form. The order one is chosen because the influence of one market on the other often lasts not more than one minute.

The mean equation is the following: $y_t = k + \beta y_{t-1} + \varepsilon_t$, for t=1,2…….,T

With $\varepsilon_t \sim N(0, H_t)$, where $H_t = C'C + A_1'(\varepsilon_{t-1}\varepsilon'_{t-1})A_1 + B_1'H_{t-1}B_1$

where the matrices C, A_1, B_1 are of dimension dxd (C is higher triangular), with d equal to the number of equations. Because of paired matrices, symmetry and non negative definiteness of the conditional variance matrix H_t is assured (see Engle and Kroner, 1993, 1995).

In the case with 2 dimensions, we have

For the mean equation:

$$y_t = \begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix}, \quad \mathrm{k} = \begin{pmatrix} \mathrm{k}_1 \\ \mathrm{k}_2 \end{pmatrix}, \quad \beta = \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix}, \quad \varepsilon_t = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}$$

Where β is a 2x2 matrix of coefficients (not symmetric or diagonal), ε_t is a 2x1 vector of estimated residuals in the mean equation (1)

For the variance equation (2).

$$A_1 = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}, \quad B_1 = \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \text{ and } \mathrm{C} = \begin{pmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{pmatrix}$$

We note that in this BEKK model, a_{12} and a_{21} are different from each other, as are b_{12} and b_{21}.

The variance system has 11 parameters for two equations. The parameters of the mean and the variance equation are estimated by using maximum likelihood.

We estimated the model above either for the spot or the futures index and one other market each time. In a series of bivariate models based on the equations 1 and 2 above in order to show the links existing either between the spot and future returns. If we develop the equations 1 and 2 above, we find

$$y_{1t} = \mathrm{k}_1 + \beta_{11} y_{1t-1} + \beta_{12} y_{2t-1} + \varepsilon_{1t}$$
$$y_{2t} = \mathrm{k}_2 + \beta_{21} y_{2t-1} + \beta_{22} y_{2t-1} + \varepsilon_{2t}$$

3.2 The volatility transfers

To explain the volatility transfers between markets in the framework a BEKK-kind of VAR(1)-GARCH(1,1) model for 2 variables, we consider the following variance equations:

$$h_{11t} = a_{11}(a_{11}\varepsilon^2_{1t-1} + a_{21}\varepsilon_{1t-1}\varepsilon_{2t-1}) + a_{21}(a_{11}\varepsilon_{1t-1}\varepsilon_{2t-1} + a_{21}\varepsilon^2_{2t-1})$$
$$+b_{11}(b_{11}h_{11t-1} + b_{21}h_{21t-1}) + b_{21}(b_{21}h_{12t-1} + b_{21}h_{22t-1}) + c^2_{11}$$

$$h_{12t} = a_{12}(a_{11}\varepsilon^2_{1t-1} + a_{21}\varepsilon_{1t-1}\varepsilon_{2t-1}) + a_{22}(a_{11}\varepsilon_{1t-1}\varepsilon_{2t-1} + a_{21}\varepsilon^2_{2t-1})$$
$$+b_{12}(b_{11}h_{11t-1} + b_{22}h_{21t-1}) + b_{22}(b_{12}h_{12t-1} + b_{21}h_{22t-1}) + c_{11}c_{12}$$

$$h_{21t} = a_{11}(a_{12}\varepsilon^2_{1t-1} + a_{22}\varepsilon_{1t-1}\varepsilon_{2t-1}) + a_{21}(a_{12}\varepsilon_{1t-1}\varepsilon_{2t-1} + a_{22}\varepsilon^2_{2t-1})$$
$$+b_{11}(b_{12}h_{11t-1} + b_{22}h_{21t-1}) + b_{21}(b_{12}h_{12t-1} + b_{22}h_{22t-1}) + c_{11}c_{12}$$

$$h_{22t} = a_{12}(a_{12}\varepsilon^2_{1t-1} + a_{22}\varepsilon_{1t-1}\varepsilon_{2t-1}) + a_{22}(a_{12}\varepsilon_{1t-1}\varepsilon_{2t-1} + a_{22}\varepsilon^2_{2t-1})$$
$$+b_{12}(b_{12}h_{11t-1} + b_{22}h_{21t-1}) + b_{22}(b_{12}h_{12t-1} + b_{22}h_{22t-1}) + c^2_{22}$$

We are interested first of all in the impact of the squared residuals ε^2_{1t} and ε^2_{2t} on the 2 variances h_{11t} and h_{22t}, and the covariance. The volatility transfers are indicated in bold characters. Note that h_{12t} and h_{21t} are equal on the assumption that they were equal for the previous observation at time t-1 and so on until the beginning of the series. Using the BEKK modeling, we can show how far these squared residuals will lead to a strong change in h_{ijt}. We are aware that, Isakov and Perignon (2000, p.133) in their model, by using the Hadamard product $B\Theta H_{t-1}$ instead of $B^{'}H_{t-1}B$, they constrain the volatility transmission mechanism. It is true that in this case, the only possible way for a market's volatility to influence another market's volatility is through shocks. However, it is not always sure that B will remain non negative definite or that H_t will have only positive elements on the main diagonal in all possible cases, in any probable situation. Further, the $B^{'}H_tB$ term in the BEKK model involves the presence of h_{11t-1} in the equation for h_{22t} and the presence of h_{22t-1} in the equation for h_{11t}. However, as h_{11t-1} and h_{22t-1} do not increase very fast, the main element of influence remains the squared residuals ε_{1t}^2 and ε_{2t}^2. The volatility spillover, the coefficient a_{21}, will be relevant for measuring the effect of the spot markets volatility (h_{22t}) on futures markets volatility (h_{11t}). The coefficient a_{12} will be relevant for measuring the effect of futures market volatility on the spot market volatility. Moreover, the increase in volatility due to h_{t-1} takes two steps: a shock happens in t-2, h_{t-1} increases at time t-1 only because of the shock in ε_{1t} or ε_{2t} at time t-2 and the increase in h_{t-1} will further increase h as late as in h_t. As we are interested in the mean impact of a shock after one period (independently from the shock that happened two periods before) and not only in the impact of one precise shock, ε_1 or ε_2 are the only important indicators for the volatility increase in the next period.

4 RESULTS DISCUSSION

As it is evident from the literature, we have the following common features of stock market indices. Linear structural (time series) models cannot explain a number of important features:

Leptokurtosis.

Volatility clustering or volatility pooling (large changes tend to be followed by large changes of either sign).

Leverage effects (tendency for changes in stock prices to be negatively correlated with changes in volatility).

Table 1, provides the possible explanation about the common features of the indices, kurtosis in raw series exhibit mesokurtic (i.e., 0.588, 0.59

for spot and futures respectively), where as for the return series it is significantly evident that both series are leptokurtic (excess kurtosis i.e., 1666.867, 96.466 for spot and futures respectively). With the band-width of spot and futures raw (33.43, 33.28) and returns of spot and futures (0.0024, 0.0037) evident that the return series are acute peak in the mean and fatter tails i.e., super Gaussian distribution (from figure 2). Correlation between raw prices is high (0.999) and returns is low (0.148). So, for the further analysis we have used return series. Jarque-Bera statistics and corresponding *p-value* used to test the null hypotheses that the one minute of returns are normally distributed. With all *p-value* equal to zero at the six decimal places, we reject the null hypothesis that returns for spot and futures markets are well approximated by normal distribution.

Table 1. Descriptive statistics for price and return series

	Price Series		Rerun Series	
	Spot Price	Futures Price	Spot returns	Futures returns
Mean	1490.097	1486.455	7.86E-05	0.0002
Median	1362.724	1363.45	0.000634	0
Maximum	2726.3	2732.65	4.050147	7.945603
Minimum	850.5019	852	-10.413	-11.7748
Std. Dev.	483.9538	481.9016	0.071084	0.22831
Skewness	0.588971	0.591021	-12.4517	-0.46034
Kurtosis	2.125595	2.131483	1666.867	96.46614
Std. Dev.	483.9538	481.9016	0.07108389	0.2283104
Variance	234211.3	232229.1	0.005052919	0.05212562
Jarque-Bera	33692.47	33683.26	4.34E+10	1.37E+08
ADF stats	0.470371	0.562873	-244.308	-306.606
Observations	375729	375729	375729	375729
Correlation	0.999		0.148	
Covariance	233186.0		0.002403045	

Before estimating the system, we have checked whether the two return time series are cointegrated in order to be certain that a VAR model is appropriate. If the series appear to be cointegrated an error correction term should be included in the mean equations. We first test for stationarity of the logarithm of stock indices and of the returns using an augmented DICKEY-FULLER (1979, 1981) test with trend and four lags. Table 1 indicates the raw series of stocks indices can be considered as I(1) because the raw series of indices are non-stationary but the returns (the first difference of the logs) are stationary.

As illustrated in Table 1 the volatility (measured by standard deviation) for the index returns series of spot and futures evidence that futures returns are more volatile than spot.

We have found the enough evidence of volatility clustering in both return series i.e., for large changes in the series followed by large changes of either sign with the help of returns series (figure 1), also residuals and squared residuals series of returns (figure 4). Correlogram (ACF and PACF) of the spot and futures returns helped us to identify the randomness of the returns (figure 3)

Hence, in the presence of above common features violates assumption of regression and estimates are no longer BLUE. Need to apply, GARCH family techniques which help us to modeling time-varying-volatility and also facilitates linking information and volatility

We have used VAR (1)-GARCH (1, 1) model in a BEKK form. The order one is chosen because the influence of one market on the other often lasts not more than one minute.

The mean equation is the following: $y_t = k + \beta y_{t-1} + \varepsilon_t$, for t=1,2…….,T

With $\varepsilon_t \sim N(0, H_t)$, where $H_t = C^{'}C + A_1^{'}(\varepsilon_{t-1}\varepsilon^{'}_{t-1})A_1 + B_1^{'}H_{t-1}B_1$

where the matrices C, A_1, B_1 are of dimension dxd (C is higher triangular), with d equal to the number of equations. Because of paired matrices, symmetry and non negative definiteness of the conditional variance matrix H_t is assured (see Engle and Kroner, 1993, 1995). We note that in this BEKK model, a_{12} and a_{21} are different from each other, as are b_{12} and b_{21}. The variance system has 11 parameters for two equations.

The value for C, A & B matrices are available on Table 2 in the while Figure 5 simulates the previous equations as variance and covariance for the two markets. It is obvious from the behavior of conditional covariances that the correlation between the returns for spot and futures are not constant over the study period. These mean that all the estimated figures of covariance's and variances have significant autocorrelation.

Figure 1. Spot and Index Futures (prices and return) series

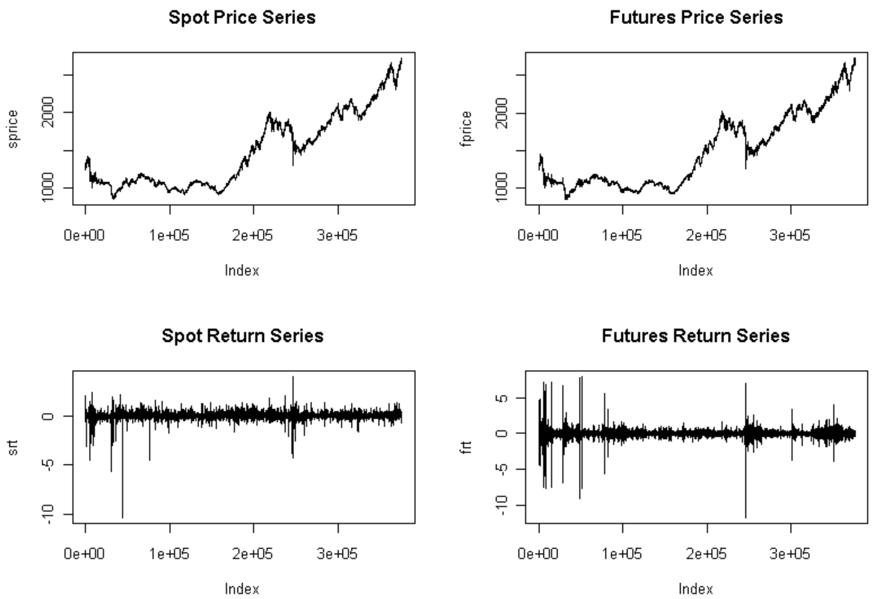


Figure 2. Density diagrams for spot and future series

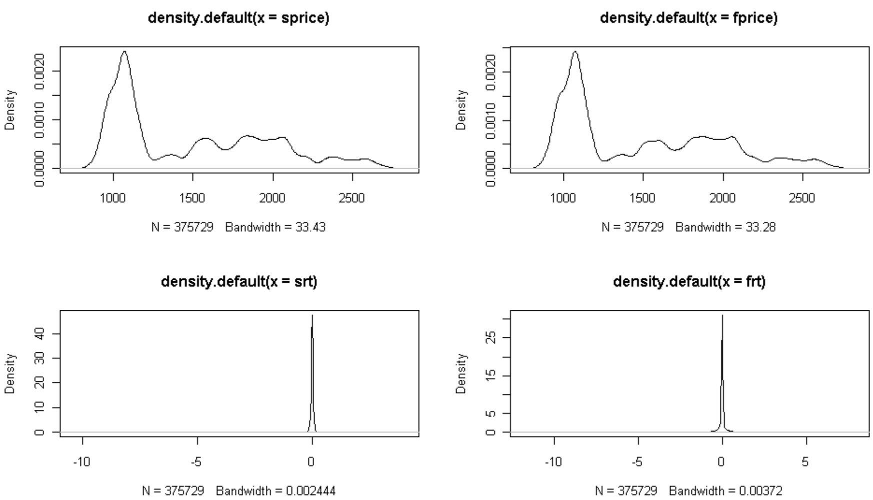


Figure 3. ACF and PACF of the spot and futures return series

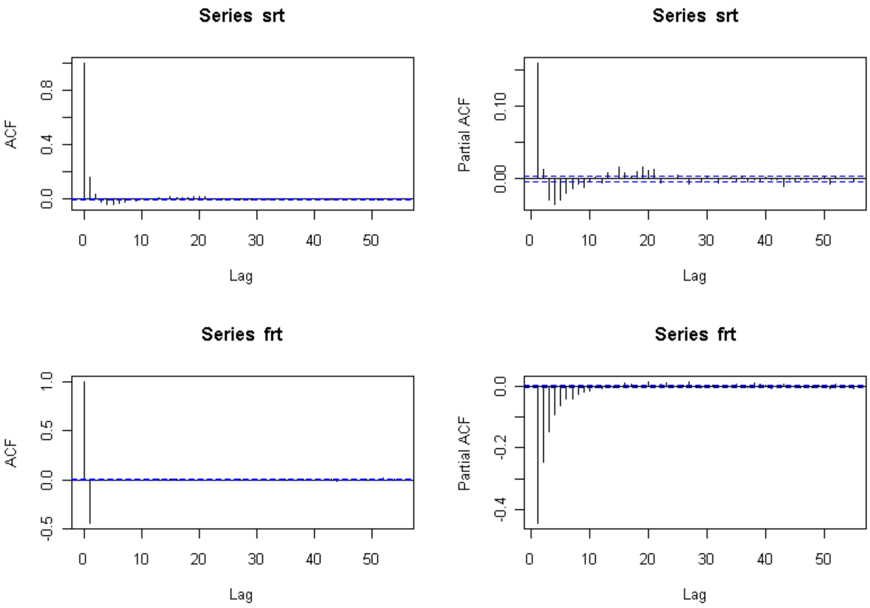


Figure 4. Residuals and squared residuals of spot, futures return series

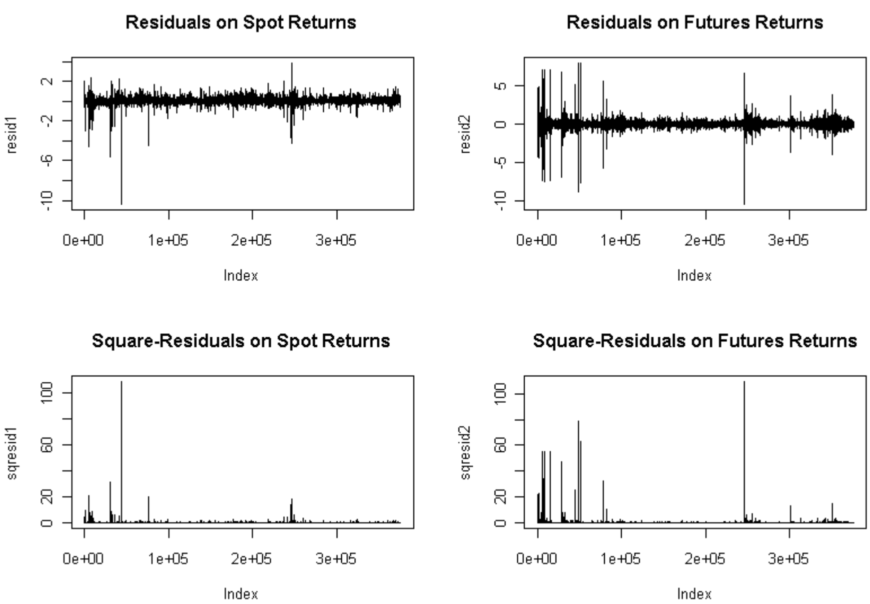
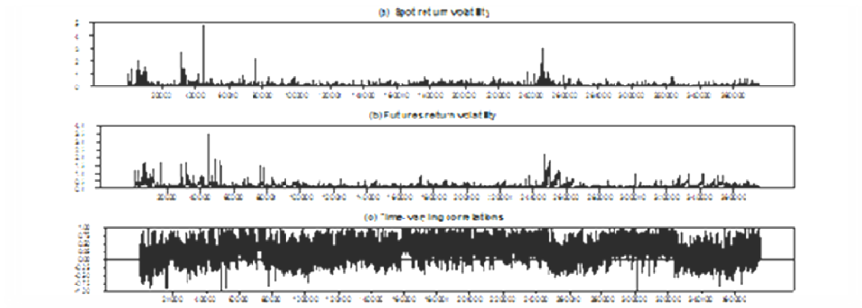


Figure 5. The analysis and estimate volatilities and time-varying correlations



Further more, it has been observed in the multivariate model estimation that the volatility for the four markets is changing over. It is noticeable that the volatility futures are more volatile over the study period.

Table 2. Estimates of VAR-GARCH (1, 1) - BEKK model

Mean, Variance and Covariance Variables	Coefficient	Standard error	T-stat
Mean (1)	-0.00069864	0.000058694	-11.90328
Mean (2)	-0.00071787	0.000121151	-5.92543
C(1,1)	0.003739686	0.000076138	49.11733
C(2,1)	0.006616032	0.000057646	114.77043
C(2,2)	0.000003409	0.000656475	0.00519
A(1,1)	0.468035609	0.001681575	278.33170
A(1,2)	0.334969189	0.001802161	185.87089
A(2,1)	0.018679749	0.000253779	73.60639
A(2,2)	-0.16687012	0.000736187	-226.66803
B(1,1)	0.920780821	0.000475085	1938.14032
B(1,2)	-0.03361499	0.000417550	-80.50528
B(2,1)	0.002686126	0.000046992	57.16110
B(2,2)	0.987206931	0.000104047	9488.08765
Multivariate Q(10)	2610.61432		
Significance Level as Chi-Squared(40)	0.00000		
Multivariate Q(10)	113.92911		
Significance Level as Chi-Squared(40	5.04586e-09		

5 CONCLUSIONS

We have use MGARCH models, because of the limitation of the univariate volatility models have a limitation such as a) there may be "volatility spillovers" between markets so the univariate model might be mis-specified, and b) the covariance's between series are of interest. As it is discussed, uncertainty (risk) is a key role for the market players. Particularly, in order to analyze uncertainty (volatility spillovers) in Indian Stock market we have chosen high frequency data i.e., one minute interval.

In India, derivatives mainly introduced with view to increase liquidity which may in turn curb the increasing volatility of the asset prices in financial markets and to introduce sophisticated risk management tools leading to higher liquidity by reducing risk and transaction costs as compared to individual financial assets. Though the onset of derivative trading has significantly altered the movement of stock prices in Indian spot market, it is yet to be proved whether the derivative products has served the purpose as claimed by the Indian regulators. In an efficient capital market where all available information is fully and instantaneously utilized to determine the market price of securities, prices in the futures and spot market should move simultaneously without any delay. However, due to market frictions such as transaction cost, capital market microstructure effects etc., significant volatility spillovers between the two markets has been observed.

An important finding of the study is that conditional co-variances show significant changes over time for markets. Thus, we conclude that these models overcome the usual concept of the time invariant correlation coefficient. The overall result showed that the model perform well statistically. The main findings is that the market one minute returns have the indication of volatility clustering and Leverage effects since the relation between the spot market and the futures markets

We could establish that the empirical evidence also supports and explains that, both markets such as spot and futures markets in India, has both heat waves and meteor showers. The risk and uncertainty is prevalent during the observed period in Indian Stock market. Hence the volatility in the stock market is due to heat waves and also due to meteor showers presence in Indian Stock market.

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