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EXAMINING VOLATILITY IN MID CAP SECTORS: A STUDY OF BSE

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ABSTRACT

The study investigated the stock market volatility in the S&P CNX BSE Mid Cap of Bombay Stock Exchange of India using daily closing price from January 1, 2010 to July 4, 2014. The finding indicate that the stock market exhibits the persistence of volatility, mean reverting behavior and volatility clustering. The results reveal that the GARCH(1,1) model successfully captures volatility clustering.

JEL CLASSIFICATION

G14, C32

KEYWORDS

Volatility clustering, GARCH.

1. INTRODUCTION

Volatility in equity market has become a matter of mutual concern in recent years for investors, regulators and brokers. Stock return volatility hinders economic performance through consumer spending[1]. Stock Return Volatility may also affect business investment spending[2]. Further the extreme volatility could disrupt the smooth functioning of the financial system and lead to structural or regulatory changes.

Volatility of stock returns in the developed countries has been studied extensively. After the seminal work of Engle(1982) on Autoregressive Conditional Heteroscedasticity (ARCH) model on UK inflation data and its Generalized form GARCH(Generalized ARCH) by Bollerslev (1986), much of the empirical work used these models and their extensions (See French, Schwert and Stambaugh 1987, Akgiray 1989, Schwert, 1990, Chorhay and Tourani,1994, Andersen and Bollerslev, 1998) to model characteristics of financial time series.

Starting with the pioneering work of Mandelbrot (1963) and Fama (1965), various features of stock returns have been extensively documented in the literature which are important in modeling stock market volatility. It has been found that stock market volatility is time varying and it also exhibits positive serial correlation (volatility clustering). This implies that changes in volatility are non-random. Moreover, the volatility of returns can be characterized as a long-memory process as it tends to persist (Bollerslev, Chou and Kroner, 1992). Schwert (1989) agreed with this argument. Fama (1965) also found the similar evidence. Baillie and Bollerslev (1991) observed that the volatility is predictable in the sense that it is typically higher at the beginning and at the close of trading period. Akgiray (1989) found that GARCH (1, 1) had better explanatory power to predict future volatility in US stock market. Poshakwale and Murinde (2001) modeled volatility in stock markets of Hungary and Poland using daily indexes. They found that GARCH(1,1) accounted for nonlinearity and volatility clustering. Poon and Granger (2003) provided comprehensive review on volatility forecasting. They examined the methodologies and empirical findings of 93 research papers and provided syneptic view of the volatility literature on forecasting. They found that ARCH and GARCH classes of time series models are very useful in measuring and forecasting volatility.

There is relatively less empirical research on stock return volatility in emerging markets. In the Indian Context, Roy and Karmakar (1995) focused on the measurement of average level of volatility as the standard deviation in the Indian Stock Market and examined that volatility was highest in the year 1992. Goyal (1995) examined the nature and trend of the stock return volatility in the Indian Stock Market and assessed the impact of 'carry forward facility' on the level of volatility. Reddy (1997) analyzed the establishment of NSE and introduction of BSE online trading (BOLT) on the stock market volatility as sample standard deviation. Kaur (2002) analyzed the extent and pattern of stock market volatility, modeled the volatility during 1990-2000 and examined the effect of company size, FII, day of the week effect on volatility. Ajay Pandey (2002) modeled the volatility of S & P CNX Nifty using different class of estimators and ARCH /GARCH class of models.

Foregoing discussion suggests that the modeling of the stock markets volatility is of great importance to academics, policy makers, and financial markets participants. High levels of volatility in a stock market can lead to a general erosion of investors' confidence and an outflow of capital from stock markets, volatility has become a matter of mutual concern for government, management, brokers and investors. BSE introduced S&P BSE MID Cap index to track the performance of companies with relatively smaller market capitalization. It represents more percentage of companies in listed universe. Therefore, it is representative of investors. High volatility retards investment and discourages growth. It is therefore necessary for us to explore a model of stock market volatility that can measure and estimate volatility in mid cap

The rest of the paper is organized as follows. Section 2 provides research design used in the study. Empirical results are discussed in Section 3. Section 4 summarizes.

2. RESEARCH DESIGN

PERIOD OF STUDY

We collected data on daily closing price of S&P CNX Mid Cap of Bombay Stock Exchange from January 1, 2010 to July 4, 2014. It consists of 1127 observations. The data are collected from www.bseindia.com

METHODOLOGY

Daily returns are identified as the difference in the natural logarithm of the closing index value for the two consecutive trading days.

Volatility is defined as;

$$\sigma = \sqrt{1/n-1\sum_{t=1}^{n}(R_t-\bar{R})^2}$$

Equation 1

where $\bar{R}$ = Average return(logarithmic difference) in the sample.

In comparing the performance of linear model with its nonlinear counterparts, we first used ARIMA[3] models. Nelson (1990b) explains that the specification of mean equation bears a little impact on ARCH models when estimated in continuous time. Several studies recommend that the results can be extended to discrete time. We follow a classical approach of assuming the first order autoregressive structure for conditional mean as follows:

[1] Garner A.C., 1988, Has Stock Market Crash Reduced Customer Spending? Economic Review, Federal Reserve Bank of Kanas City, April, 3-16.

[2] Gertler, M. and Hubbard, R.G.,1989, Factors in Business Fluctuations, Financial Market Volatility, Federal Reserve Bank of Kanas City, 33-72.

[3] A process that combines Autoregressive process (AR) and Moving Average terms (MA) terms. AR process where the present observations depend on the previous observations and MA is a weighted average of the present and the recent past observations of a process.

$$R_t = a_0 + a_1 R_{t-1} + \varepsilon_t$$

Equation 2

where R_t is a stock return, $a_0 + a_1 R_{t-1}$ is a conditional mean and ε_t is the error term in period t. The error term is further defined as:

$$\varepsilon_t = \upsilon_t \sigma_t$$

Equation 3

where υ_t is white noise process that is independent of past realizations of ε_{t-i}. It has zero mean and standard deviation of one. In the context of Box and Jenkins (1976), the series should be stationary. Therefore, Augmented Dickey Fuller test (ADF) is used to test for stationarity of the return series. It is a test for detecting the presence of stationarity in the series. The early and pioneering work on testing for a unit root in time series was done by Dickey and Fuller (1979 and 1981). If the variables in the regression model are not stationary, then it can be shown that the standard assumptions for asymptotic analysis will not be valid. ADF tests for a unit root in the univariate representation of time series. For a return series R_t, the ADF test consists of a regression of the first difference of the series against the series lagged k times as follows:

$$\Delta r_t = \alpha + \delta r_{t-1} + \sum_{i=1}^{p} \beta_i \Delta r_{t-i} + \varepsilon_t$$

Equation 4

$$\Delta r_t = r_t - r_{t-1}; r_t = \ln(R_t)$$

The null hypothesis is H_0: $\delta = 0$ and H_1: $\delta < 1$. The acceptance of null hypothesis implies nonstationarity. We can transform the nonstationary time series to stationary time series either by differencing or by detrending. The transformation depends upon whether the series is difference stationary or trend stationary.

One needs to specify the form of the second moment, variance, σ_t^2 for estimation. ARCH and GARCH models assume conditional heteroscedasticity with homoscedastic unconditional error variance. That is, the changes in variance are a function of the realizations of preceding errors and these changes represent temporary and random departure from a constant unconditional variance. The advantage of GARCH model is that it captures the tendency in financial data for volatility clustering. It, therefore, enables us to make the connection between information and volatility explicit since any change in the rate of information arrival to the market will change the volatility in the market. In empirical applications, it is often difficult to estimate models with large number of parameters, say ARCH (q). To circumvent this problem, Bollerslev (1986) proposed GARCH (p, q) models. The conditional variance of the GARCH (p,q) process is specified as

$$h_t = \alpha_0 + \sum_{j=1}^{q} \alpha_j \varepsilon_{t-j}{}^2 + \sum_{i=1}^{p} \beta_i h_{t-i}$$

Equation 5

with $\alpha_0>0$, $\alpha_1, \alpha_2, \ldots\ldots \alpha_q \geq 0$ and $\beta_1, \beta_2, \beta_3, \ldots\ldots, \beta_p \geq 0$ to ensure that conditional variance is positive. In GARCH process, unexpected returns of the same magnitude (irrespective of their sign) produce same amount of volatility. The large GARCH lag coefficients β_i indicate that shocks to conditional variance takes a long time to die out, so volatility is 'persistent.' Large GARCH error coefficient α_j means that volatility reacts quite intensely to market movements and so if α_j is relatively high and β_i is relatively low, then volatilities tend to be 'spiky'. If $(\alpha + \beta)$ is close to unity, then a shock at time t will persist for many future periods. A high value of it implies a 'long memory.' The model is then tested for ARCH effect using ARCH-LM test to judge model adequacy. If ARCH-LM test results are statistically insignificant, the model will be adequate.

3. EMPIRICAL RESULTS

The descriptive statistics for the return series include mean, standard deviation, skewness, kurtosis, Jarque-Bera and Ljung Box. ARCH-LM statistics are also exhibited in the Table 1.

TABLE 1: DESCRIPTIVE STATISTICS OF DAILY RETURNS

Statistic	BSE Mid Cap
Mean	0.000299
Standard deviation	0.010354
Skewness	-0.432474
Kurtosis	4.044739
Jarque-Bera Statistics	86.31(0.000)
$Q^2(12)$	140.90(0.00)
ARCH LM statistics (at Lag =1)	25.52(0.000)
ARCH LM statistics (at Lag =5)	65.42(0.000)

Notes: ARCH LM statistic is the Lagrange multiplier test statistic for the presence of ARCH effect. Under null hypothesis of no heteroscedasticity, it is distributed as $\lambda^2(k)$. $Q^2(K)$ is the Ljung Box statistic identifying the presence of autocorrelation in the squared returns. Under the null hypothesis of no autocorrelation, it is distributed as $\lambda^2(k)$.

The mean returns for all the stock indices are very close to zero indicating that the series are mean reverting. The return distribution is negatively skewed, indicating that the distribution is non-symmetric. Large value of Kurtosis suggests that the underlying data are leptokurtic or thick tailed and sharply peaked about the mean when compared with the normal distribution. Since GARCH model can feature this property of leptokurtosis evidence in the data.

The Jarque-Bera[4] statistics calculated and reported in the Table-1 to test the assumption of normality. The results show that the null hypothesis of normality in case of both the stock markets is rejected.

The Ljung-Box LB^2 (12) statistical values of all the series respectively rejects significantly the zero correlation null hypothesis. It suggests that there is a clustering of variance. Thus, the distribution of square returns depends on current square returns as well as several periods' square returns, which will result in volatility clustering.

Stationarity condition of the Bankex daily return series were tested by Augmented Dickey-Fuller Test (ADF). The results of this test are reported in the Table 2.

[4] The B-J teat statistic is T[skewness^2/6+(kurtosis-3)^2/24].

TABLE 2: UNIT ROOT TESTING OF DAILY RETURNS OF BANKEX: AUGMENTED DICKEY-FULLER TEST

Stock markets	Log Level	First Difference of Logarithmic series
LBSEIT	-0.552 (0.878)	-27.10 (0.000)

ADF statistics in level series shows presence of unit root in the stock markets as their Mackinnon's value do not exceed the critical value at 1% level. It suggests that the price series is nonstationary. It is, therefore, necessary to transform the series to make it stationary by taking its first difference. ADF statistics reported in the Table 2 show that the null hypothesis of a unit root is rejected. The absolute computed values for the index is higher than the MacKinnon critical value at 1% level. Thus, the results of the indices show that the first difference series is stationary.

To test for heteroscedasticity, the ARCH-LM test is applied to the series. The results are reported in Table 1. The ARCH-LM test at lag length 1 and 5 indicate presence of ARCH effect in the residuals in both the stock markets. It implies clustering of volatility where large changes tend to be followed by large changes, of either sign and small changes tend to be followed by small changes (Engle, 1982 and Bollerslev, 1986). To explore the nature of volatility, GARCH (1,1) model is applied in the stock markets. The results of the estimated model are reported in Table 3. The GARCH model is tested for their fitness and adequacy using ARCH-LM test. The results are also presented in the Table 3. The findings indicate that there is no ARCH effect left after estimating the models because the results of ARCH-LM test statistics at lag length 5 reported in the Table 3 are statistically insignificant as its probability value is higher than 0.05. It, therefore, suggests that the estimated models are better fit and successfully account for time varying volatility.

TABLE 3: COEFFICIENTS OF GARCH MODEL

	BSE Mid Cap
Coeffiecients	GARCH(1,1)
α_0	0.000(0.000)
α_1	0.106(0.000)
β_1	0.836(0.000)
α_1+ β_1	0.942
ARCH-LM test	2.17(0.83)

Note: Figures in the parenthesis indicate probability Value.

The parameters estimates of the GARCH (1, 1) models in Tables 3 are all statistically significant. The estimates of β_1 are always markedly greater than those of α_1 and the sum α_1+ β_1 is very close to but smaller than unity. It is observed that α_1+ β_1 is equal to 0.942. This is less than unity indicating stationarity condition is not violated. It indicates a long persistence of shocks in volatility in Mid Cap. As the lag coefficient of conditional variance β_1 is higher than the error coefficient α_1 implying that volatility is not spiky in all the stock markets. It also indicates that the volatility does not decay speedily and tends to die out slowly.

4. SUMMARY

The volatility in the BSE Mid Cap exhibits the persistence of volatility, mean reverting behavior and volatility clustering. The study used more than five years of recent daily data on Mid Cap to illustrate these stylized facts, and the ability of GARCH(1,1) to capture these characteristics. Daily returns in the stock markets exhibit volatility clustering which are satisfactorily captured by the GARCH models. In the stock market, volatility tends to die out slowly. Results suggest that the volatility is persistent.

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