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Measurement of Stock Market Volatility through ARCH and GARCH Models: A Case Study of Karachi Stock Exchange

[1]Hakim Ali Kanasro, [2]Chandan Lal Rohra, [3]Mumtaz Ali Junejo

[1]Institute of Commerce, University of Sindh, Jamshoro. Sindh, Pakistan.
[2]Department of Business Administration, Shah Abdul Latif University, Khairpur, Sindh, Pakistan.
[3]Department of Commerce, Shah Abdul Latif University, Khairpur, Sindh, Pakistan.

Abstarct: This paper examines the presence of volatility at the Karachi Stock Exchange (KSE) through the use of Autoregressive Conditional Heteroskedacity (ARCH) and Generalized Autoregressive Conditional Heteroskedacity (GARCH) models introduced by Engle (1982), Bollerslev (1986) and Nelson (1991). The data has been acquired from the website of KSE and State Bank of Pakistan and analysis is with the use of Minitab, Excel and other computer packages. In this paper, a long-time series data analysis of two Indexes namely;'KSE-100 Index' and 'All shares index' has been used first time in this emerging stock exchange. The empirical result confirms the presence of high volatility at Karachi Stock Exchange through- out the study period.

Key words: Volatility, Autoregressive conditional heteroskedasticity, Market Capitalization, Leptokurtosis, Indexes

INTRODUCTION

The developing economies are facing many impediments in their financial markets, and with many other factors, high volatility in prices which also considered as high risk or uncertainty is a major factor of erosion of capital from markets. As due to this the investors becomes fearful and run away from the market. Though it is not the sign of inefficiency of market but it poses a threat to 'crash' the market due to high volatility. High volatility creates a high uncertainty in a stock market and individual security prices and these may curtail down the prices and associated return.

What are the causes of high volatility in the stock market is a long discussion amongst the market experts and academicians. Fama (1965) & French (1980) investigated and concluded that; volatility caused by trade it self. It means greater the level of trade volume, greater the price movements. Bessembinder and Seguin (1993) find that an asymmetrical volatility is due to response between volume and price. French & Roll (1986) studied volatility and their results show that volatility is higher during trading hours. It is also argued that volatility is driven by trading volume followed by arrival of new information regarding new floats, or any kind of private information that incorporate into market stock prices. The stock market volatility caused by number of factors such as; credit policy, inflation rate, interest, financial leverage, corporate earnings, dividends yield policies, bonds prices and many other macroeconomic, social and political variables are involved.

Madhavan (1992) defines volatility in terms of price variance. Low volatility is preferred as it reduces unnecessary risk borne by investors thus enables market traders to liquidate their assets without large price movements. Glen (1994) defines volatility as the frequency and magnitude of price movements and comparing the various microstructure attributes argues that liquid and efficient markets have less volatility than illiquid and inefficient markets.

Amihud *et al.* (1997) find reduced volatility in the Tel Aviv market as the market adopted a more continuous trading system.

Amongst the literature of most relevance to the whole volatility issues is 'Market Volatility' of Robert Shiller (1990). Shiller is a firm advocate of the popular model explanation of stock market volatility. The popular models are a qualitative explanation of price fluctuations. In short, it proposes that investor reactions, due to psychological or sociological beliefs, exert a great influence on the market than good economic sense arguments.

Corresponding Author: Hakim Ali Kanasro, Institute of Commerce, University of Sindh, Jamshoro, Sindh, Pakistan.
Mob: +92 0301 3500809, E-mail: hkanasro@hotmail.com

For regulatory issues and volatility Jamshed and Mangla (2006) have examined the regulatory effectiveness in two emerging markets in South Asia India and Pakistan. And they concluded that bullish sentiments, speculations and volatility at Karachi Stock Exchange are continued despite of measures taken by the regulators (SECP)

Portfolios are composed of many individual security stocks and investors in portfolio owns more than a few securities and bonds, so they always consider watching behavior or trend of an individual stocks with aggregate market. Therefore, it is believed that if overall market rises it also increases value of stocks in portfolio and when there is a decrease in market indices it means that the value of individual stock may also come down. For this purpose, investors use market indicator series (Frank K. Reilly 2003).

The analysis focuses on the Karachi Stock exchange and the data of two indices viz; 'KSE-100 index' and; 'All shares index' are used along with the daily percent changes in 'KSE-100 index' and daily percent changes in 'All shares index' are also used in the analysis from the period from January 2003 to December 2008.

Karachi Stock Exchange KSE-100 is market indices along with three other market indices namely; All Share index, 30-index and newly introduced KMI-30 Index.

KSE-100 index is representative sample of common stocks that traded on Karachi Stock Exchange. The KSE-100 index comprises of top 100 stocks, having largest market capital which place in descending order. It is designed to provide the investors a sense that how equity market is performing. KSE-100 index represents more than 80 percent of total market capitalization. In simplest words, the KSE-100 index is a benchmark by which the stock price performance of 100 stocks is put in to a moving average over a period of time or a base period. On 1st November 1991, the total market value of top 100 stocks (Number of shares outstanding X current market price of each share) was indexed as these were assigned 1000 pints. It is technically a market –value-weighted series.

The purpose of this paper is: to explain volatility using an updated daily data of KSE-100 Index, All Share Index, and the daily changes in both indexes.

The organization of this paper is as follow: section II is based on data information

II DATA:

We included the data for analysis from KSE-100 Index, All Share Index, and the daily changes in 'KSE-100 Index' and daily changes in 'All Share Index'. The data period is from 1st January 2003 to 30th December 2008. However two other time series data viz; Interest rate spread and Inflation rate from macroeconomic variables are also used in the analysis. The data sources of KSE-100 Index, All Index Share, Changes of KSE-100 Index, and Changes in All Share Index were obtained from official web site of Karachi Stock Exchange.

III Methodology:

Volatility is a statistical measure of the dispersion of return for a security or index. The statistical devices such as; the standard deviation or variances are used to measure the variance between index and return that is called volatility or in other words it is referred as uncertainty or risk in the securities value. The unexpected return due to unexpected events, the price movements may become volatile and with non-constant variance, the financial markets develop an unexpected behavior which may confuse the investors very much.

The variance are measured by some financial econometrics tools, as; Engle (1982) introduced the model of autoregressive conditional heteroskedacity (ARCH) and it was extended by Bollerslev (1986) and Nelson (1991) as generalized autoregressive conditional heteroskedacity (GARCH) model to study the volatility, which is considered as basics tools for studying and analyzing the time series data of finance and financial markets. Through the literature it is learnt that many scholars have used the ARCH and GARCH models to study the stock price behavior with use of different variables to study the volatility.

The GARCH model estimator uses estimation of mean and conditional variance equations. GARCH (1,1) model stated as follow;

$$Y_t = X_t\sigma + \epsilon_t$$ ……(Conditional mean equation)….. "" "0." "" "0."1)

Where the conditional variance with mean equation with x_t being the vector exogenous variable be rewritten as;

$$\sigma_t^2 = \omega + \alpha\epsilon_t^2 + \beta\sigma_{t-1}^2$$ …..(conditional variance equation)..... "" "0." "" "0."2)

Where w (omega) is a constant term, αe^2_t ARCH and βs^2_{t-1} being the GARCH terms.

The volatility is measured with use of different methods by extending the basic equations are discussed above. As financial data series includes the characteristic like kurtosis, volatility clustering, long memory and leverage effects. So we have considered the GARCH type models, as Bollerslev (1986) given as GARCH (p,q) model, i,e.,

$$R_t = \mu + \epsilon_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{"" "0." "" "0."3)}$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{"" "0." "" "0."4)}$$

Where q is order of ARCH process and p is the order of GARCH process. The R_t is return on day t and we expect the mean value of m to be positive and small. Error e_t is assured to be normally distributed to be positive and small, and expected value of w to be small. Expression $a+b$ is suppose to be less than zero and it show unity with $b > a$. The volatility be measured as lag of the squared residual from the mean equation (ARCH term) $a_i s^2_{t-i}$ or q when new information is arrived and the estimates of p or $\beta_j s^2_{t-j}$ shows the impact of old news or information on volatility.

IV Empirical Results:

First of all we examine the conditional mean structure by estimating ARCH and GARCH process under the GARCH (p,q) models. The result from mean equation shows the significant value of both indices. Further we present seven statistics by using in full sample of four variables. The results calculated using the full observations are: mean, median, standard deviation skewness, kurtosis, minimum and maximum parameters (see Descriptive Statistics in Table-1)

Table 1: Descriptive Statistics

Variables	Number of Observation (Days)	Mean	Median	Standard Deviation	Skewness	Kurtosis	Minimum	Maximum
KSE-100 Index	1517	8611.5	9182.19	3624.3	0.04	-1.14	2356.5	15676.3
Change	1517	-1.93	10.28	236.93	-20.07	622.38	-7385.00	960.5
All Share Index	1517	5867.7	6281.2	2647.0	0.13	-1.10	1473.2	11148.7
Change	1517	2.29	6.810	94.39	-0.45	5.33	-487.56	663.720

Both KSE-100 Index and All Share Index have positive skewness depicting that in both series distribution is relative to the long right tail. On contrary Change (of KSE-100 Index) and Change-1 (of All Share Index) show negative skewness showing that the distribution has relatively long left tail in their characteristics.

The modality of the distribution is shown in the Figure-1 and Figure-2 represents the histogram of summary for KSE-100 Index and Figure-2 represents the histogram of summary of 'All Shares Index'. Both figure shows multimodal character because there more than two major peaks in histogram and both are flatter. Therefore, there characteristic are platykurtic as both kurtosis are lower than 3 (both are less than -1.1) The values of Kurtosis in both series are negative and distributions are flat which is showing abnormality, so the distribution is significantly non-normal or platykurtic and it is flatter than normal bell curve (see Figure-1 and Figure-2).

The emphasis of this paper is on the measurement of the volatility in the Karachi Stock Exchange's both Indices which is analyzed and the empirical results are shown in Figure-3 and Figure-4. The empirical results confirm a high volatility presence at Karachi Stock Exchange during the study period from January1, 2003 to December 31, 2008. The unit of time we used in this analysis is a daily data of both Indexes.

Figure-3 shows high volatility in clustering manner. The results of GARCH analysis is presented if Figure-4 which shows a random-walk (stochastic) behavior so market can be termed as very uncertain and very risky for short-term and medium-term investors.

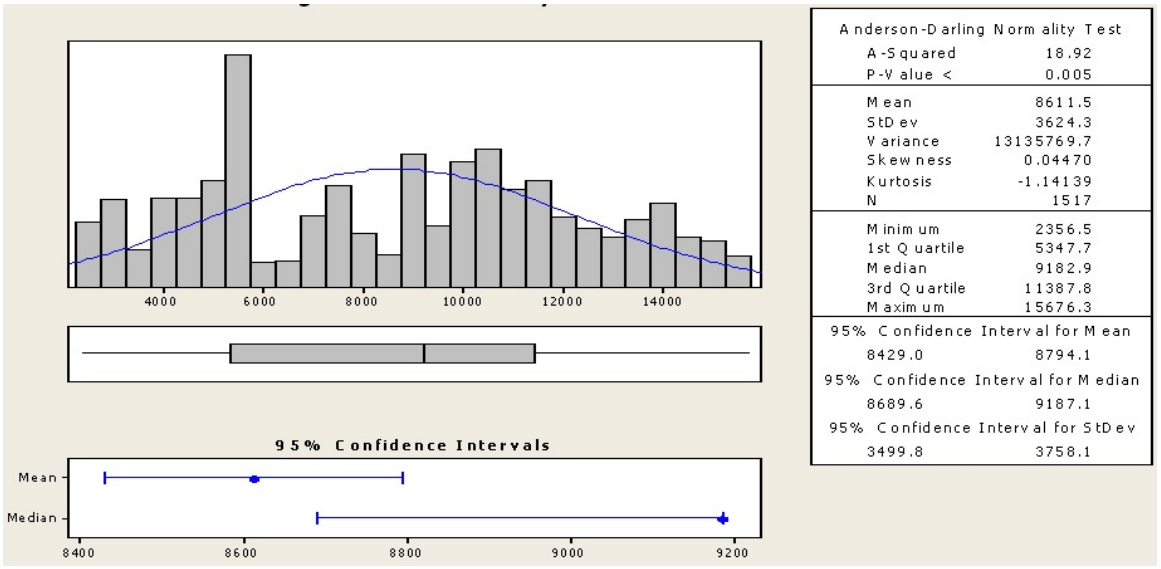

Fig. 1: Summary for KSE 100 index

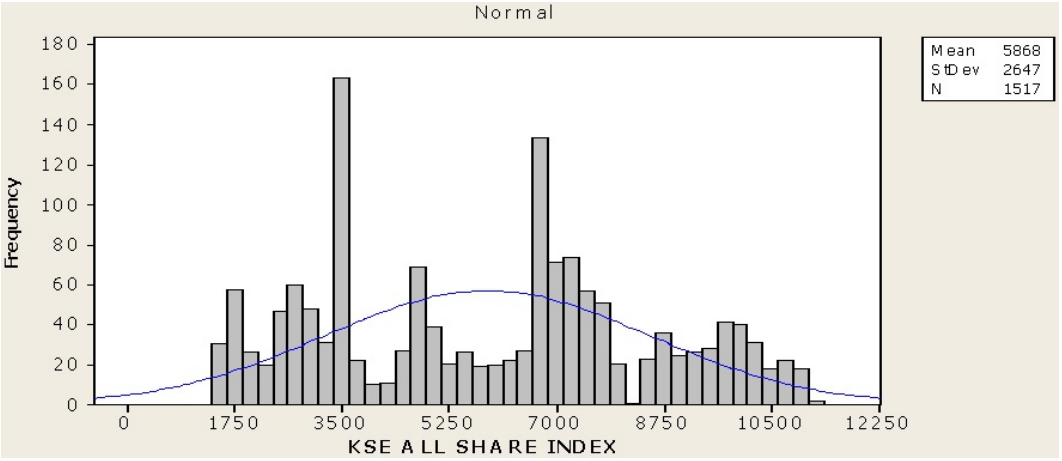

Fig. 2: Summary of KSE all share index.

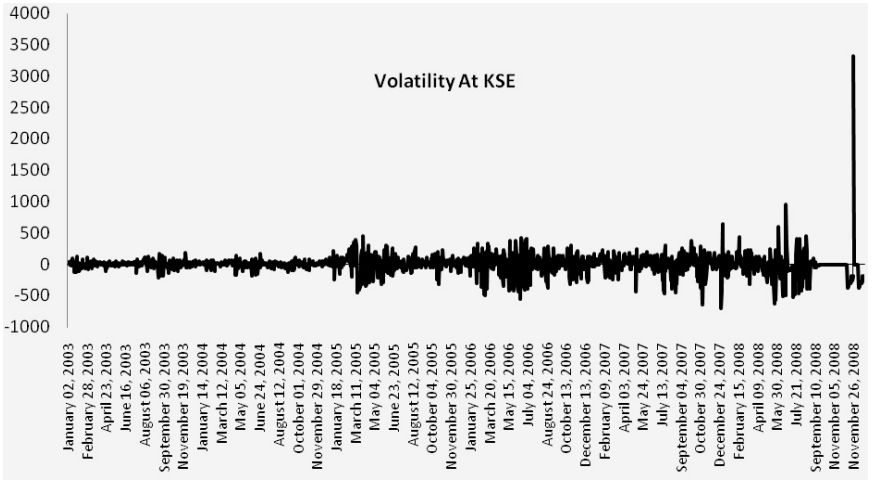

Fig. 3: volatility at karachi stock exchange

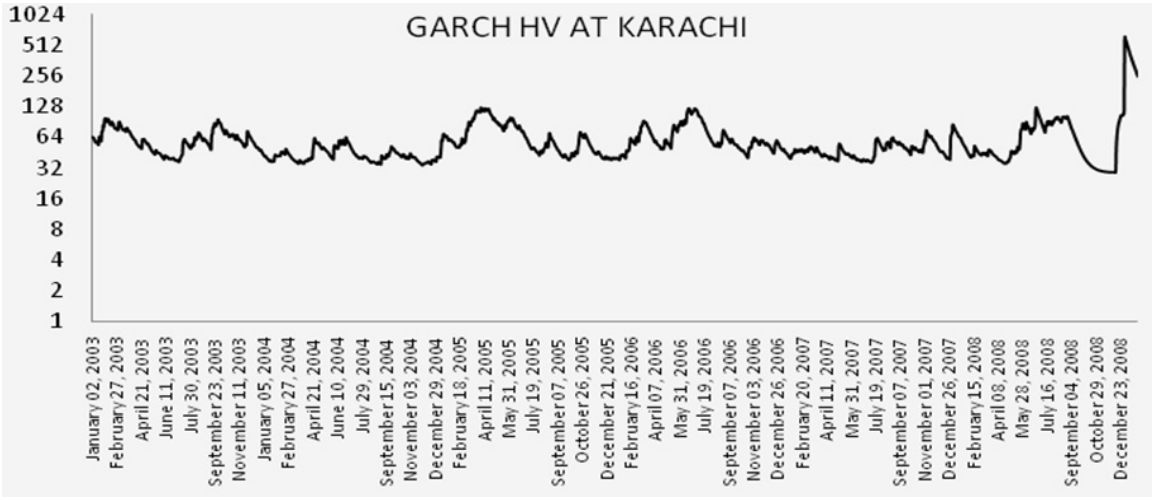

Fig. 4: garch at karachi stock excange

V Conclusion:

In this paper the empirical research work is based on using the historical data of Karachi Stock Exchanges. The empirical research resulted that there is high volatility found in the Karachi stock Exchange during the observed period from January 1, 2003 to December31, 2009 in both Indexes. The volatility is found in clustering manner and stochastic. The ARCH and GARCH models have confirmed the presence of high volatility in the given period. This high volatility deters the new risk-averse investor to inter in business of security. It is concluded that high volatility creating high risk which creating negative effects on the market stock's return and overall business of the market.

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