ASA University Review, Vol. 5 No. 2, July–December, 2011

The Volatility of Dhaka Stock Exchange (DSE) Returns: Evidence and Implications

Mohammed Abu Rayhan*
Shah Md. Al-Emran Sarker**
Sheikh Mohammad Sayem***

Abstract

The main focus of the study is on detecting the pattern and reasons behind the volatility of the monthly stock returns of the DSE and to search the possible solutions thereto. The *data set consists of monthly DSE General Index (DSE-GEN) which covers the twenty- three-year-long period commencing from January 1987 to March 2010. Unit Root test especially Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test are used in this study to check the stationarity. These tests revealed that monthly DSE price index follows random walk but monthly DSE returns don't follow it. The study also revealed that monthly DSE returns follow Generalized Autoregressive conditional Heteroskedasticity (GARCH) properties. Though volatility is a common phenomenon in the capital market, the study recommends careful monitoring of volatility by the concerned authority, if necessary. It also recommends making available all relevant information, to ensure adequate supply of stock through active participation of the government and giant national and multinational companies, and asset securitization, and to establish proper risk-return relationship and so forth.*

Keywords: Return, Volatility, Stationarity, GARCH.

1. Introduction

Dhaka Stock Exchange (hereafter, DSE) is the country's leading stock exchange. On April 28, 1954, the DSE was first incorporated as the East Pakistan Stock Exchange Association Limited. However, formal trading began in 1956 with 196 securities listed on the DSE with a total paid-up capital of about Taka 4 billion (Chowdhury, 1994). On June 23, 1962, it was renamed as Dhaka Stock Exchange (DSE) Limited. Since 1971 till 1976, the trading activities of the Stock Exchange remained suppressed due to the liberation war and the economic policy pursued by the then government. The trading activities resumed in 1976 with only 9 companies listed having a paid up capital of Taka 137.52 million on the stock exchange (Chowdhury, 1994). As of August, 2010 there were 450 Securities listed on the DSE with a market capitalization of $ 50.28 billion which is 43.65% of GDP (GDP projected 6, 90,000 crore Taka at the end of the fiscal year (2009-10). DSE is registered as a public limited company and its activities are regulated by its Articles of Association and its own rules, regulations, and by-laws along with the Securities and Exchange

*Former Lecturer, Dept. of Business Administration, ASA University Bangladesh
**Assistant Professor, Dept. of Business Administration, ASA University Bangladesh
***Lecturer, Dept. of Agriculture Statistics, Bangladesh Agricultural University

Ordinance, 1969; the Companies Act, 1994; and the Securities and Exchange Commission Act, 1993 (DSE, 1999). As per the DSE Article 105B, its management is separated from the Council. The executive power of the DSE is vested with the Chief Executive Officer (CEO). The CEO is appointed by the Board with the approval of the SEC. DSE is a self regulated non-profit organization. It has provisions for 500 members though at present the number of members is 238. Membership is open to the foreigners as well. The Exchange has 2 Boards of Detectors', of which 12 are elected from the members and the other 12 are nominated by different organization. Trading is done through automated on-line system every day except Friday, Saturday and other government holidays. There are four markets in the system: (1) **Public Market**: Only trading of market lot share is done here through automatic matching. (2) **Block Market**: A place where bulk quantities of shares are traded through pick and fill basis. (3) **Odd Lot Market**: Odd lot scripts are traded here based on pick and fill basis. (4) **OTC Market**: Dhaka Stock Exchange (DSE) has launched the over-the-counter (OTC) market-a separate trading floor-- to facilitate trading of the non-listed and the de-listed companies. The shares of companies that have been de-listed from the premier bourse will be placed on the OTC market in the first phase. In the next phase, shares of non-performing and non-operational companies that will be removed from the main board will be traded on the new OTC floor.

Over the passage of time some significant developments took place in DSE. One important development in the capital market in January, 2004 was the initiation of electronic settlement through the Central Depository System (CDS). In order to prevent market manipulation by the in-house officials of the listed companies, SEC banned the purchasing or selling of shares of a company by its owners during an interim period (from the date of the financial year closure to the day of approval of accounts by the company's board). De-listing of 13 companies in August 2004 by DSE due to their repeated failure in complying with the listing rules was also an important step towards bringing discipline in the stock exchange. The trading of Bangladesh Government Treasury Bonds (BGTBs) started in DSE from January 2005. In order to temper the rising trend of stock index and control excess liquidity in the capital market, SEC temporarily suspended the credit facility extended by the brokers to their clients. At the same time, SEC also increased the members' trade margin requirements by reducing the free trading limit from Tk. 10 million to Tk. 5 million. All the market barometers significantly rose during 2010 reflecting regained investors' confidence after 1996 stock market bubble. The increasing trend of DSE General Index in January 2007 crossed the 3,000 mark for the first time and it crossed 8187 points for the first time by the end of 2010. Two DSE branch offices were established at Chittagong and Sylhet. The members from these two branches are getting facility of full redundant connectivity using BTTB DDN and Ranks-ITT. DSE has already established two network hub rooms (DSE POP) in Dhanmondi and Uttara.

In view of the rapidly increasing role of the stock market, volatility in stock prices can have significant implications on the performance of the financial sector as well as the entire economy. There exists important link between stock market uncertainty and public confidence in the financial market. The policy makers usually rely on the market estimate of volatility as the barometer of the vulnerability of the stock market. Stock return volatility represents the

variability of day-to-day stock price changes over a period of time, which is taken as a measure of risk by the relevant agents. High volatility, accompanied by any change in the real situation, may lead to a general erosion of investors' confidence in the market and redirect the flow of capital away from the stock market. Excessive volatility also reduces the usefulness of stock price as a reflector of the real worth of the firm. Volatility, however, is not an evidence of irrational market behavior or inefficient markets. Stock return volatility is usually asymmetric in its response to past negative price shocks compared with the positive shocks, but what factors drive volatility over time is not clear. Moreover, increase in firm-specific risk appears to adversely affect its stock valuation.

This study aims at examining the volatility of stock returns of the DSE. It also scrutinizes why volatility exists and its magnitude and impact over the DSE return, and what the different sets of policies adopted by the policy makers to address the volatility are. In this regard, this paper is organized as follows: Section 2 highlights the findings of the research on the volatility and its effect on the asset returns in the context of the DSE. Section 3 provides an introduction about the statistical and econometrical terms and the methodology of the study. Section 4 analyzes the empirical findings and section 5 concludes the paper with policy implications and possible remedial measures to develop the market as a whole.

2. Literature Review

A number of papers (Haque and Hassan, 2000; Harvey, 1995a, b: Harvey and Bekaert, 1995; Bekaert, 1995; Bekaert and Harvey, 1997; Kim and Singal, 1999; Choudhury, 1996; Lee and Ohk, 1991; Claessens, Dasgupta and Glen, 1995) examined the return-volatility behavior of a number of emerging market economies dotting in the global landscape.

Poterba and Summers (1998) conducted an extensive study using various frequencies of data from the New York stock Exchanges (NYSE) and 17 other equity markets. Their study consistently shows that returns are positively correlated over longer periods. In addition, Poterba and Summers found that for the long horizon, a mean reverting component of stock prices could explain a large portion of variations in stock returns.

Applying weekly data of the NYSE during 1962-1985, Lo and MacKinlay (1998) examined whether stock prices followed the random walk pattern. They found strong evidence of positive dependence in successive differences of weakly stock price index and individual securities. They rejected the null hypothesis of random walk both for the value and equally weighted portfolios.

Hung (1996) used the variance ratio test to examine the random walk hypothesis for 9 Asian countries, namely, Hong Kong, Indonesia, Japan , Korea, Philippines, Singapore, Thailand, Malaysia and Taiwan. Using weekly stock price data from January 1988 to June 1992 of the nine countries, Hung applied both the hetroskedasticty unadjusted and the hetroskedasticty adjusted variance ratio test to the data. He found that the stock prices of Malaysia and Korea showed

positive serial correlation for all the holding periods whereas, the stock of Hong Kong, Singapore, and Thailand showed positive serial dependence for some of the holding periods.

Haque et al (1998) examined whether the introduction of automated trading along with the changes in regulatory measures changed the risk return composition and thus improved the market efficiency of the DSE. They conclude that the DSE at best can be considered as weak-form efficient and the automation & other regulatory measures have done little or nothing at all to change the risk return composition of the market.

Bekaert and Harvey (1995) test a variety of sophisticated models of conditional volatility and find that volatility is difficult to model in emerging markets. They find evidence, however, that the importance of world factors in emerging market volatility may be increasing, and that volatility tends to decrease following market liberalization.

Kim and Singal (1993) suggest that there has been no increase in volatility over time, and that volatility has tended to decrease following market liberalization.

Richards (1996) used three different methodologies and two sets of data to estimate volatility of emerging markets. A common claim of all these studies is that the proposition that liberalization increases volatility is not supported by empirical evidence.
However, Levine and Zervos (1995) suggest that volatility may increase after liberalization.

Bekaert *et al.* (2003) and A. Ng (2000) find that equity return volatility follows univariate GARCH processes with asymmetry in emerging markets.
Batra, A. (2004) examines the time variation in volatility in the Indian stock market during 1979-2003. Using monthly data and asymmetric GARCH methodology augmented by structural change analysis, the paper reveals that the period around the BOP crisis and the subsequent initiation of economic reforms in India is the most volatile period in the stock market. Stock return volatility in India seems to be influenced more by domestic political and economic events rather than by global events. The analysis in the paper also reveals that stock market cycles in India have not intensified after financial liberalization. A generalized reduction in stock market instability is observed in the post- reform period in India.

3. Statistical Terms and Methodology of the Study

A time series is a sequence of data points, measured typically at successive times spaced at uniform time intervals. To develop more accurate time series and forecasting model, first of all, we need to find out whether the data are stationary or not. Line charts or time series plots are particularly effective for business and economic data because we can show the change or trends in a variable over time.

Weekly stationary can be tested by the **correlogram** of a time series, which is a graph of autocorrelation at various lags. For stationary time series, the correlogram tapers off quickly,

whereas for non-stationary time series it dies off gradually. For a purely random series, the autocorrelation at all lags 1 and greater are zero. Stationary can also be checked by finding out if the time series contains a **unit root.** The **Dickey-Fuller (DF)**, **augmented Dickey-Fuller (ADF) tests, and Phillips-Perron (PP) test** can be used for this purpose. If the time series contain a **unit root,** the data may follow **random walk** model. Random walk is a motion of a 'particle' that moves the discrete jumps with certain probabilities from point to point.

Suppose u_t is a white noise error term with mean zero and variance σ^2. Then the series Y_t is said to be **random walk** if

$$Y_t = Y_{t-1} + u_t .$$

Anderson-Darling test is a test in which a given sample of observations arises from some specified theoretical probability distribution. For testing the normality of the data, the test statistic is

$$A_n^2 = -\frac{1}{n}\left[\sum_{i=1}^{n}(2i-1)\{\log z_i + \log(1-z_{n+1-i})\}\right] - n$$

Where $x_{(1)} \le x_{(2)} \le \cdots \le x_{(n)}$ are the ordered observations, s^2 is the sample variance and $z_i = \Phi\left(\frac{x_{(i)} - \bar{x}}{s}\right)$ Where $\Phi(x) = \int_{-\alpha}^{x} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2} du$. The null hypothesis of normality is rejected for 'large' values A_n^2. Critical values of the test statistic are available.

Cramer-von Mises test is a test of whether a set of observations arises from a normal distribution. The test statistic is

$$W_2 = \sum_{i=1}^{n}\left[z_i - \frac{(2i-1)^2}{2n}\right] + \frac{1}{12n}$$

Where the z_i are found from the ordered sample values $x_{(1)} \le x_{(2)} \le \cdots \le x_{(n)}$ as $z_i = \int_{-\alpha}^{x_{(i)}} \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} dx$. Critical values of W_2 can be found in many sets of statistical tables.

Jarque-Bera (JB) test of normality is an asymptotic, or large-sample, test. The test statistic is

$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right]$$

Where $n =$ sample size, $S =$Skewness coefficient, and $K =$Kurtosis coefficient. The JB test of normality is a test of the joint hypothesis that S and K are 0 and 3. Under the null hypothesis, the test statistic follows chi-square distribution with 2 degrees of freedom.

.

Shapiro-Wilk W **test** is a test of whether a set of random variables arises from a specified probability distribution. It is most commonly used to test for departures from the normal distribution and the exponential distribution. The test statistic is

$$W = \frac{n}{n-1} \frac{(\overline{x} - x_{(1)})^2}{\sum_{i=1}^{n} (x_{(i)} - \overline{x})^2}$$

where $x_{(1)} \leq x_{(2)} \leq \cdots \leq x_{(n)}$ are the ordered sample values and $\overline{x}$ is their mean. Critical values of W based on the simulation studies are available in many statistical tables.

Autoregressive model (AR) is a model used primarily for the analysis of time series in which the observation, Y_t, at time t, is postulated to be a linear function of previous values of the series. The first order autoregressive model is of the form

$$Y_t = \phi Y_{t-1} + u_t .$$

Autoregressive Conditional Heteroskedasticity (ARCH) models are specifically designed to model and forecast conditional variance. The variance of the dependent variable is modeled as a function of past value of the dependent variable. ARCH model is introduced by Engle (1982). ARCH model is especially useful in analyzing financial time series, such as stock prices, inflation rates, and exchange rates. A distinguishing feather of this model is that the error variance may be correlated over time because of the phenomenon of volatility clustering. We can try **Generalized Autoregressive Conditional Heteroskedasticity** ((**GARCH**) (***p,q***)) model to have a parsimonious parameterization of a high order ARCH process. To identify the best model, we used AIC (Akaike Information criterion), SBC (Shwartz Bayesian Criterion), and LR (log-likelihood ratio).

In this study, stock return is defined as the difference in the logarithm of prices, that is, $r_t = \ln p_t - \ln p_{t-1}$, where In pt and In pt-1 are current period and one-period lag log prices respectively. Stock returns defined above are nominal only, and it doesn't take into account the effects of dividends, inflation and exchange rates. The data set used in this study consists of twenty three-year-long period commencing from January 1987 to March 2010, obtained from various issues of the DSE monthly bulletin, national dailies and internet.

4. Empirical Findings

In order to test the volatility in the monthly return data, the study selected two common and popular statistical techniques: Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test to find out whether the data sets satisfy stationarity or not.

Before testing the presence of stationarity, the study examines various descriptive statistical properties (i.e. mean, variance, skewness, kurtosis, normality and so forth) of the monthly DSE

return series. Table 2 shows that overall monthly DSE mean return is positive. Sample estimates of skewness and excess kurtosis for monthly DSE returns are both large and positive. This indicates that more returns have mass in the tail (positively skewed) than that of normal distribution. In symmetric distribution the value of skewness and kurtosis are 0 and 3 respectively. But in figure 2, time series plot suggests that monthly DSE Returns contain a large number of outliers especially during the period of Hubble, 1996. So the distribution of the DSE monthly returns is fat or heavy-tailed. The value of Kuiper (V), Cramer-von Mises (W2), Watson (V2), Anderson-Darling (A2), and Jarque-Bera normality statistics are significantly indicating that the monthly DSE Price Index is not normally distributed which is shown in table 3.

From the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test (table 4), there is enough evidence to conclude that monthly DSE Price Index, (January 1987-March 2010) follows random walk (that is, data series are not stationary) whereas Monthly DSE Returns (January 1987-March 2010) does not follow random walk.

Therefore, Autoregressive (AR) model is applicable to monthly DSE returns for prediction. However, we need to justify that the error variances are correlated over time because of the phenomenon of volatility clustering. That's why, autoregressive conditional Heteroskedasticity (ARCH) test is more appropriate for the data set rather than conventional Autoregressive model. In table 5, ARCH LM test suggests that ARCH effect exists in the data set. Based on model selection criteria such as AIC, SBC, and LR, we choose GARCH (1,2) as our volatility model which is exhibited in table 6. So we can conclude that monthly DSE returns satisfy Generalized Autoregressive Conditional Heteroskedasticity (GARCH) properties. GARCH models have shown the ability to capture the heteroskedastic nature of the returns data, which has not previously been taken care by the autoregressive models. We have found that variance is predictable from information about past variance. Since risk-return relation is absent, such variance predictability comes to no use to the investors.

5. Conclusions and Policy Implications

The above analysis shows that the stock market volatility changes significantly over time. The volatility of stock return is determined by the fluctuations in monthly stock index. Fluctuation in the stock index also depends on the demand for and supply of securities traded in the stock exchange. Sometimes the stock return volatility is driven by trading volume following new information and by the process that incorporates new information into market prices. At the aggregate level, stock return volatility rises more sharply during stock price declines following bad news than that in periods of stock price increase following good news. While relating changes in stock market volatility with a number of economic factors, such as financial leverage, corporate bond yields, corporate earnings and dividend yields, stock trading activity, volatility of interest rates, bond prices, and other macroeconomic variables, Schewert (1987) concludes that "none of these factors … plays a dominant role in explaining the behavior of stock volatility over time".

Volatility in stock prices is a common phenomenon in the equity market. Individual stock price undergoes ups and downs which is a regular feature of an efficient stock market. In the absence of price volatility, potential investors lose interest to participate in the stock market. However, careful monitoring of volatility by the concerned authority is needed in DSE which is yet to achieve maturity especially when high volatility exists in the market. If necessary, there should be effective intervention when the market experiences excess volatility. During unpredictable movements of individual stock prices, it would be useful for the authority to identify the factors behind such price movements and quickly disseminate information to interested stakeholders. In addition, the authority may take measures to make available all relevant information relating to real worth of the companies experiencing exceeds volatility in stock prices, especially to the investors. It is also important to ensure adequate supply of stocks through active participation of the government in the capital market particularly to dampen the excess demand. The endeavor should be to make the market more liquid, and the government can directly contribute to this by floating more treasury bonds. The availability of risk-free instruments would allow the investors to diversify their portfolios that carry lower risks. Of course, greater awareness and the development of stock market infrastructure are essential to stock market development. In addition, it is necessary to ascertain enforceable regulations that would ensure financial transparency, stop financial malpractice, and prevent any form of market manipulation. Capital market participation, in the form of floating debt and equity or asset securitization, remains the acceptable options of financing and materializing these options. As a financial product, securitization has gained popularity in Bangladesh for providing a method of issuing bonds that ensure maximum safety for investors. Most importantly, securitization addresses the fundamental asset liability maturity mismatch problem by providing true long-term funds.

The policy makers should ensure the proper risk-return relation because without it educated and institutional investors will keep on turning away from capital market. Even if they participate, they will resort to other sources of profit-making opportunities like inside information, fixed transactions, behavioral transactions, and other unethical ways. Moreover, due to information asymmetry the foreign investors obviously avoid DSE. Market should be such that fundamentals are the basis of asset valuation and information and the market is efficiently disseminated so that investors cannot make abnormal gains. Due to inefficient banking system, political interference and loan default culture, cost of capital of bank loan is less than that of share issue, which encourages investors to stay away from capital market.

For the improvement of the market, good shares are of utmost importance because they provide more liquidity to the market. This in turn reduces irregular trading, attracts investors, and increases general investors' confidence as a whole. Regulators/policy makers should force directly (such as compulsory listing when authorized capital passes certain limit) or persuade (such as tax benefit) to ensure the participation of reputed firms apart from off-loading government shares so that the market depth (liquidity) is increased.

For example, Grameen Phone is the leading mobile phone company in Bangladesh that has recently enlisted in stock market and raises the depth of the market significantly. In the same manner there are many reputed Bangladeshi and multinational companies whose shares and bonds can be brought to the market. Small participation of these reputed firms through IPO (initial public offer) can attract institutional as well as foreign investors and raise the depth (liquidity) of the market, which can ultimately change the overall scenario of the capital market.

References

Bekaert, G. and C. R. Harvey (1995), "Emerging Equity Market Volatility," NBER Working Paper No. 5307, Cambridge, Massachusetts: National Bureau of Economic Research.

Bekaert, G., C. R. Harvey and A. Ng (2003), "Market Integration and Contagion," *Journal of Business*, Forthcoming.

Batra, A (2004), *"Stock return volatility patterns in India",* Working paper No. 124, Indian Council for Research on International Economic Relations.

Chowdhury, A. R. (1994), "Statistical Properties of Daily Return from the Dhaka Stock Exchange", *Bangladesh Development Studies,* Vol. XXII, No. 4.

Campbell, J Y, Lo, A W and MacKinaly, A C, (1997), "The Econometrics of Financial Markets", Princeton University Press, Princeton, New Jersey

DSE annual report 2008-2009

Engle, R, (1982), "Autoregressive conditional heteroscedasticity with estimates of the variance of UK inflation", Econometrica, 50, 987-1007

Fama, E, (1965), "The behavior of stock market prices", Journal of Business, 38, 34-105

_____,(1970), "Efficient capital markets: a review of theory and empirical works", Journal of Finance, 25, pp 383-417

Gujarati, D. N. (2003). *Basic Econometrics*, 4th ed., McGraw Hill, New York.

Haque, MS, Eunus, R, and Ahmed, M, (1998), "Risk return and market efficiency in a capital market under distress: Theory and evidence from DSE, Bangladesh", Journal of Business Administration, 24, July-October, 1-31

Huang, Bwo-Nung, (1995), "Do Asian stock market prices follow random walks? Evidence from the Variance ratio test", Applied Financial Economics, 5, 251-256

Johnston, J., and Dinardo, J. (1997). *Econometric methods*, 4th ed., McGraw Hill, New York.

Koutsoyiannis, A. (1996). *Theory of Econometrics*, 2nd ed., Macmillan Press Ltd., Hampshire.

Kim, E. H., and V. Singal (1993), "Opening Up of Stock Markets by Emerging Economies: Effect on Portfolio Flows and Volatility of Stock Prices," in *Portfolio Investment in Developing Countries*, edited by S. Claessens and S. Gooptu, World Bank Discussion Paper No. 228, Washington: World Bank, pp. 383-403.

Lo, Aw and Mackinlay, A C, (1998), "Stock market prices do not follow random walks: Evidence from a simple specification test", Review of financial studies, 1, 41-66.

Levine, R., and S. J. Zervos (1995), Capital Control Liberalization and Stock Market Performance, (unpublished; Washington: World Bank)

Poterba, J M and summers, LH, (1990), "Mean reversion in stock returns: Evidence and implications", Journal of Financial Economics, 22, 27-59.

Shleifer, A and Summers, L H, (1990), "The noise traders approach to Finance", Journal of economic perspective, vol.4, Spring, 19-33.

Schwert, G. W. and R. Stambaugh (1987), "Expected Stock Returns and volatility", *Journal of Financial Economics,* No. 19.

www.wikepedia

www.dsebd.org

www.secbd.org

Appendices A

Fig (1): Monthly DSE Price Index (January 1987-March 2010)

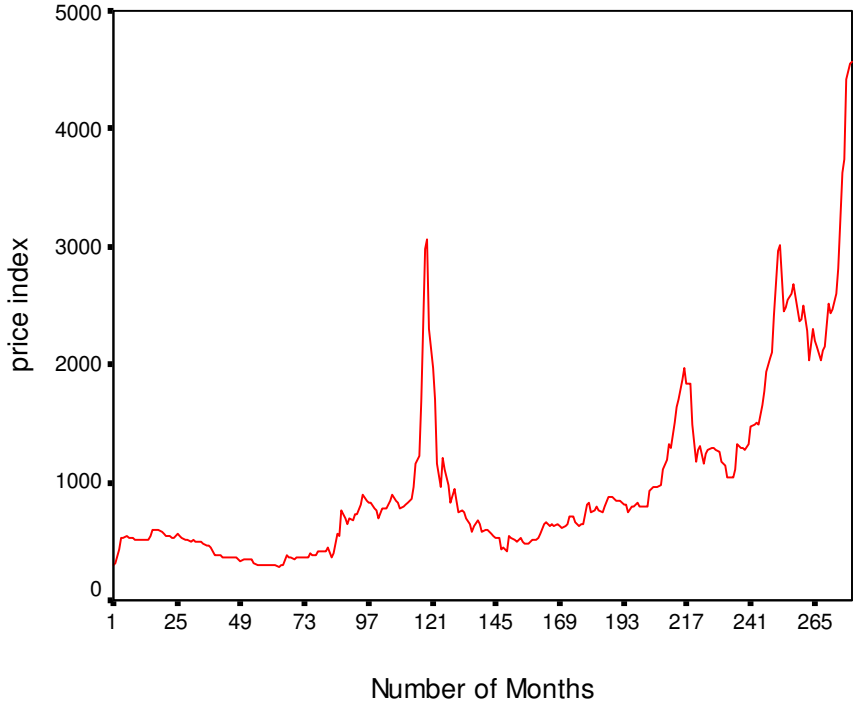
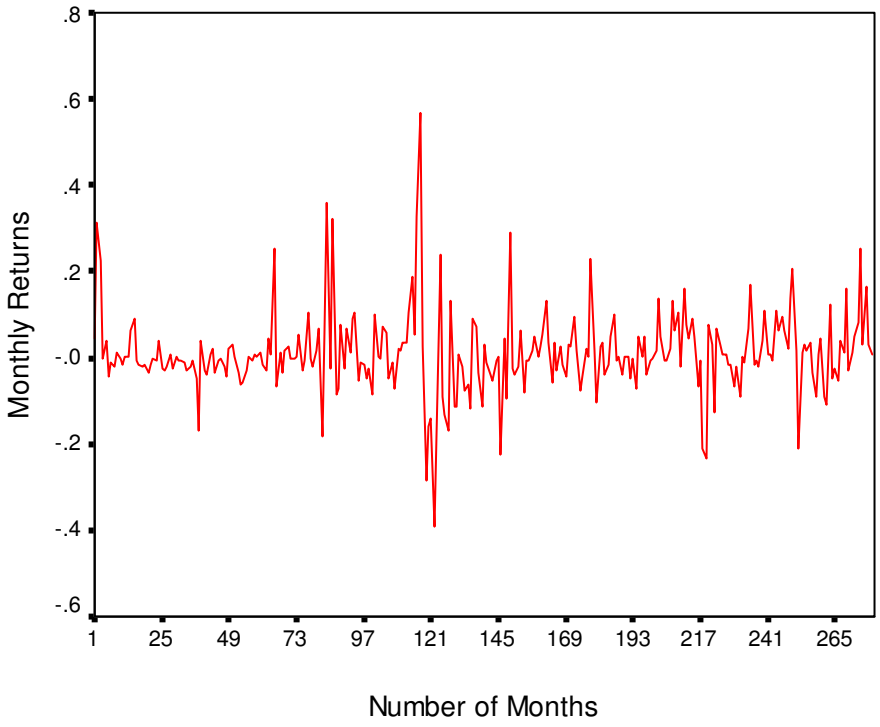


Fig (2): Monthly DSE Returns (January 1987-March 2010)



Appendices B

Table 1: DSE market highlights (As on 31st March, 2010)

Indicators	DSE
No. of companies	240
No. of mutual funds	23
No. of Debentures	8
No. of treasury bonds	164
No. of corporate bonds	2
Total No. of listed Securities	437
	(Fig. in Million)
No. of shares of all listed companies	4336
No. of certificates of all listed mutual funds	945
No. of debentures of all listed debentures	0.41
No. of all listed Govt T-bond	3.85
No. of all listed Corporate bonds	4.34
Total No. of tradeable securities	5290

	(Fig. in Million Taka)
Issued Capital of all companies	166,577.00
Issued Capital of all Mutual funds	9,766.00
Issued debentures	140.00
Total Issued capital	566,632.00
Total market capitalization	2,275,558.00
All share price index	4573.81

Table 2: Descriptive Statistics of Monthly DSE returns, $r_t = \ln p_t - \ln p_{t-1}$.

Number of observations	278
Mean	0.01
Standard Deviation	0.096329
Skewness	0.970662 (0.146911)
Kurtosis	6.495657 (0.293821)
Maximum	0.57
Minimum	-0.39

Table 3: Normality test of Monthly DSE returns $r_t = \ln p_t - \ln p_{t-1}$.

Method	Value	Probability
Kuiper (V)	0.790443	0.0000
Cramer-von Mises (W2)	18.37295	0.0000
Watson (U2)	18.36884	0.0000
Anderson-Darling (A2)	88.04601	0.0000
Jarque-Bera	511.4173	0.0000

Table 4: The Unit root test of Monthly DSE Price Index and Monthly DSE Returns, (January 1987-March 2010)

Variables	Augmented Dicky-Fuller (ADF) Tests (Constant)			Phillips-Perron (PP) Tests (Constant)		
	Statistics	P-values	Unit Root	Statistics	P-values	Unit Root
Price Index	0.306623	0.9783	Yes	0.691828	0.9918	Yes
Monthly Returns	-13.48429	0.0000	No	-13.46871	0.0000	No

Table 5: Autoregressive Conditional Heteroskedasticity test of Monthly DSE Returns (January 1987-March 2010)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNDSE(-1)	0.212229	0.058801	3.609270	0.0004

ARCH Test:			
F-statistic	12.67432	Probability	0.000437
Obs*R-squared	12.20239	Probability	0.000477

Table 6: Regression Results of Autoregressive Conditional Heteroskedasticity model of Monthly DSE Returns (January 1987-March 2010)

Model Type	Coefficients							AIC	SBC	LR
	α_0	α_1	α_2	α_3	α_4	β_1	β_2			
ARCH(1)	0.0063 (0.000)	0.3666 (0.000)						-1.9453	-1.9192	272.41
ARCH(2)	0.0035 (0.000)	0.3320 (0.000)	0.3521 (0.000)					-2.1296	-2.0904	299.012
ARCH(3)	0.0034 (0.000)	0.2751 (0.000)	0.3000 (0.000)	0.0732 (0.1148)				-2.1264	-2.0742	299.58
ARCH(4)	0.0036 (0.000)	0.2697 (0.000)	0.3083 (0.000)	0.072594 (0.1208)	-0.034 (0.1097)			-2.1254	-2.0602	300.44
GARCH(1,1)	0.0019 (0.000)	0.3537 (0.000)				0.4486 (0.000)		-2.1151	-2.0760	297.00
GARCH(1,2)	0.0014	0.2571				1.0054	-0.3983	-2.1335	-2.0813	300.56
GARCH(2,1)	0.0029 (0.000)	0.2655 (0.000)	0.2511 (0.000)			0.1746 (0.000)		-2.1211	-2.0558	299.83
GARCH(2,2)	0.0032 (0.000)	0.3083 (0.000)	0.3140 (0.0033)			0.1710 (0.2465)	-0.0880 (0.3267)	-2.1200	-2.0548	299.69