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# Time-varying volatility and equity returns in Bangladesh stock market

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This article empirically examines the time-varying risk return relationship and the impact of institutional factors such as circuit breaker on volatility for the emerging equity market of Bangladesh [namely The Dhaka Stock Exchange (DSE)] using daily and weekly stock returns. The DSE equity returns show negative skewness, excess kurtosis and deviation from normality. The returns display significant serial correlation suggesting stock market inefficiency. The results also show a significant relationship between conditional volatility and stock returns, but the risk-return parameter is found to be sensitive to choice of samples and frequencies of data. Overall, the coefficient of the risk-return parameter is negative and statistically significant. While this result is not consistent with the portfolio theory, it is possible theoretically in emerging markets as investors may not demand higher risk premia if they are better able to bear risk at times of particular volatility (Glosten *et al*., 1993). While lock-in did not have any overall impact on stock volatility, the imposition of a circuit breaker has contributed significantly to the volatility of realized returns. As a policy to improve the operation of capital market timely disclosure and dissemination of information to the shareholders and investors on the performance of listed companies should be emphasized.

## I. Introduction

While empirical tests of return-volatility behaviour are plentiful for developed stock markets, the focus on developing and emerging stock markets has only begun in recent years. The interest in these emerging markets has arisen from the increased globalization and integration of the world economy in general and that of financial markets in particular. The globalization and integration of these markets has created enormous opportunities for domestic and international investors to diversify their portfolios across the globe. As a result, rigorous empirical studies examining the efficiency and other characteristics of these markets would be of great benefit to investors and policy makers at home and abroad.

A number of articles, Poshakwale and Murinde (2001), Siourounis (2002), Bologna and Cavallo (2002) and Gonzalez *et al*. (2003), have examined the return-volatility behaviour of a number of

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emerging market economies.[1] Poshakwale and Murinde (2001) examine the stock market volatility of two emerging stock markets (Hungary and Poland) using daily indexes. Using generalized autoregressive conditional heteroskedasticity (GARCH)-M technique, the authors find that volatility is roughly persistent in both markets although it declined after 1995 for Poland due to improved market integration with the UK and German stock markets. Siourounis (2002) empirically examines the efficiency of Athens stock exchange using daily returns data. Using various GARCH type models he finds that the market is not efficient and factors such as political instability influences the price behaviour of the stock. Bologna and Cavallo (2002) apply the GARCH technique to examine the relationship between stock index futures and stock market volatility for the Italian stock exchange. Using daily returns data the authors find that stock index futures contribute to significant reduction in the stock market volatility. Gonzalez *et al.* (2003) fit a GARCH(1,1) model to study the Mexican market volatility using weekly equity returns. Results show that volatility in equity returns is primarily explained by the presence of the statistical outlier in the data.

While the relationships between volatility and return has been examined for a number of emerging markets, very little has been done for a frontier capital market like Bangladesh, primarily because of lack of data. Hassan and Maroney (2004) examined the issue of nonlinearity and thin trading as a test for market efficiency in the context of Bangladesh [i.e., Dhaka Stock Exchange (DSE)]. The authors fit a cubic function of stock return and an AR(1) return process, respectively, for nonlinearity and thin trading using daily return data over the period September 1986 through November 1999. Results show that the evidence of nonlinearity cannot be rejected even after correcting for thin trading in the sample. While the Hassan and Maroney (2004) study is important in determining market efficiency, the questions of stock market volatility, persistence of volatility and risk premia in the stock market have not been addressed in their study.

The aim of this article is two-fold. First, we examine the return distributions and stochastic processes of such distributions in the stock market of Bangladesh following the deregulation and opening up of its capital market to foreign investors in the 1990s. Second, we examine the impact of institutional factors such as circuit breakers and lock-ins on stock market volatility. In particular, the article examines the time-varying risk return relationship for this emerging equity market using a data set of daily and weekly returns. This long data series allows us to examine the impact of capital market opening on the volatility of the Bangladesh stock market, the associated risk premia and the persistence of shocks to stock market volatility before, during and after the capital market liberalization that began in 1990. We use GARCH-type models introduced by Engle *et al.* (1987) and Bollerslev (1986) to examine the time-varying risk–return relationship. The GARCH models are capable of incorporating a number of widely observed behaviours of stock prices such as leptokurtosis, skewness and volatility clustering.

This study is important for a number of reasons. First, to the best of our knowledge, this is the first study of this kind for the Bangladesh stock market. Second, it utilizes a unique daily and weekly data series, which have not been utilized in previous studies. Third, the results of this study will be of interest to academics, policy makers and investors both at home and abroad. Finally, it may also be useful for international organizations (such as the World Bank) and foreign governments who are interested in the development of capital markets in emerging countries.

The rest of the article is organized as follows. Section II provides a brief overview of the DSE. Section III discusses methodology and sources of data. Section IV discusses the statistical properties of the stock prices and returns in the DSE. Section V analyses the empirical findings of time-varying risk-return behaviour of stock prices and returns using GARCH-type framework. Section VI concludes the article.

## II. The DSE: A Brief Description

On 28 April 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 23 June 1962 it was renamed as Dhaka Stock Exchange (DSE) Limited. After 1971, the trading activities of the Stock Exchange remained suppressed until 1976 due to the liberation war and the economic policy pursued by the ruling government. The trading activities resumed in 1976 with

[1] Other important contributions include Haque *et al.* (2001), Harvey (1995a, b), Bekaert (1995), Bekaert and Harvey (1995) and Choudhry (1996), to mention a few.

**Table 1. DSE market highlights**

| Indicators | DSE (As on June 2003) |
|---|---|
| No. of companies | 241 |
| No. of mutual funds | 10 |
| No. of debentures | 9 |
| *Total no. of listed securities* | 260 |
| | (Fig. in million) |
| No. of shares of all listed companies | 972.72 |
| No. of certificates of all listed mutual funds | 72.25 |
| No. of debentures of all listed debentures | 0.635 |
| *Total no. of tradable securities* | 1045.60 |
| | (Fig. in million US$) |
| Issued capital of all companies | 608 |
| Issued capital of all mutual funds | 5 |
| Issued debentures | 9 |
| *Total issued capital* | 622 |
| Total market capitalization | 1259 |
| Weighted average share price index | 823.14 |

*Source*: SEC (2003).

only nine companies listed having a paid up capital of only US$20 million (Chowdhury, 1994). As of 30 June 2003, there were 260 securities listed on the DSE with a market capitalization of US$1.25 billion (see Table 1).

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 Bangladesh Securities and Exchange Ordinance, 1969; the Companies Act, 1994; and the Securities and Exchange Commission (SEC) Act, 1993. As per the DSE Article 105B, its management is separated from the Council which consists of 24 members of which 12 are elected from the members and the other 12 are nominated as nonmembers from different apex bodies (SEC, 2003). 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. At present, the DSE has a staff of 115 people. The DSE is a self regulated nonprofit organization. It has provisions for 500 members though at present the number is 195. Membership is open to foreigners as well.

Trading is done through an automated on-line system every day except Friday 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) Spot Market: spot transactions are done here through automatic matching which must be settled within 24 h. (3) Block Market: a place where bulk quantities of shares are traded on a pick and fill basis. (4) Odd Lot Market: odd lot scripts are traded here based on a pick and fill basis. All the transactions of a day in public market are settled after netting and cleared through the DSE Clearing House on the 3rd and 5th working day, respectively, calculated from date of trading. Members shall be allowed to carry out transactions of foreign buyers and/or sellers involving a custodian bank to be settled directly between the member through the custodian bank within the fifth day subsequent to the trading day, i.e., $T+5$ in respect of the transactions carried out on each trading day with intimation to the clearing house.

## III. Methodology and Data

### Methodology

The study examines the distribution of equity returns by dividing the sample period into two sub periods; periods before and after the market was opened to international investors. Return distributions are studied by comparing the descriptive statistics of the Dhaka Stock Exchange Index (DSEI). In order to examine the stochastic process over the study period, we employ models of conditional variances using the generalized GARCH formulation. The GARCH approach allows for an empirical assessment of the relationship between risk and returns in a setting that is consistent with the characteristics of leptokurtosis and volatility clustering observed in emerging stock markets. Moreover, conclusions regarding the predictability of returns based on the significance of autocorrelation coefficients are valid only after controlling for the autoregressive conditional heteroskedasticity (ARCH) effects (Errunza, *et al*. 1994).

The ARCH model introduced by Engle (1982) allows the variance of the error term to vary over time, in contrast to the standard time series regression models which assume a constant variance. Bollerslev (1986) generalized the ARCH process by allowing for a lag structure for the variance. The generalized ARCH models, i.e. the GARCH models, have been found to be valuable in modelling the time series behaviour of stock returns (French *et al*., 1987, Akgiray 1989, Baillie and DeGennaro 1990, Koutmos 1992 and Koutmos *et al*., 1993). Bollerslev (1986) allows the conditional variance to be a function of the prior period's squared errors as well as of its past conditional variances.

The GARCH model has the advantage of incorporating heteroscedasticity into the estimation procedure. All GARCH models are martingale difference implying that all expectations are unbiased. The GARCH models are capable of capturing the tendency for volatility clustering in financial data. Volatility clustering in stock returns implies that large (small) price changes follow large (small) price changes of either sign. Engle *et al.* (1987) provide an extension to the GARCH model where the conditional mean is an explicit function of the conditional variance. Such a model is known as the GARCH in the mean or GARCH-M model. Following Chowdhury (1994) and Mecagni and Sourial (1999), stock returns can be represented by the GARCH $(p, q)$-M model as follows:

$$y_t = u_t + \delta_1 h_t^{1/2} + \varepsilon_t, \quad (1)$$

$$\frac{\varepsilon_t}{\psi_{t-1}} \sim N(0, h_t) \quad (2)$$

$$h_t = \omega + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{j=1}^{q} \alpha_j (\varepsilon_{t-j})^2 \quad (3)$$

where $y_t$ is the stock return, $u_t$ is the mean of $y_t$ conditional on past information $(\Psi_{t-1})$ and the following inequality restrictions $\omega > 0$, $\alpha_j \geq 0$, $\beta_j \geq 0$ are imposed to ensure that the conditional variance $(h_i)$ is positive. The presence of $h_t^{1/2}$ in Equation 1 provides a way to directly study the explicit trade off between risk and expected return. According to Chou (1988), the GARCH-M model provides a more flexible framework to capture various dynamic structures of conditional variance and it allows simultaneous estimation of parameters of interest and hypotheses. The size and significance of $\alpha_j$ indicates the magnitude of the effect imposed by the lagged error term $(\varepsilon_{t-1})$ on the conditional variance $(h_t)$. In other words, the size and significance of $\alpha_j$ implies the existence of the ARCH process in the error term (volatility clustering).

The economic interpretation of the ARCH effect in stock markets has been provided within both micro and macro frameworks. According to Bollerslev *et al.* (1992, p. 32) and other studies, the ARCH effect in stock returns could be due to the clustering of trade volumes, nominal interest rates, dividend yields, money supply, oil price index, etc. The significant influence of volatility on stock returns is captured by the coefficient of $h_t^{1/2}(\delta_1)$ in Equation 1. In other words, the coefficient $\delta_1$ represents the index of relative risk aversion (time-varying risk premium). A significant and positive coefficient $\delta_1$ implies that investors trading stocks were compensated with higher returns for bearing higher levels of risk. A significant negative coefficient indicates that investors were penalized for bearing risk. According to Bollerslev *et al.* (1992), the GARCH-M model provides a natural tool to investigate the linear relationship between the return and variance of the market portfolio provided by Merton's (1973, 1980) intertemporal Capital Asset Pricing Model (CAPM).

Engle and Bollerslev (1986), Chou (1988), Bollerslev *et al.* (1992) show that the persistence of shocks to volatility depends on the sum of the $\alpha + \beta$ parameters. Values of the sum lower than unity imply a tendency for the volatility response to decay over time. In contrast, values of the sum equal (or greater) than unity imply indefinite (or increasing) volatility persistence to shocks over time. However, a significant impact of volatility on the stock prices can only take place if shocks to volatility persist over a long time (Poterba and Summers, 1986).

The GARCH $(p, q)$-M model is estimated for DSEI using the Berndt *et al.* (1974) maximum likelihood method (henceforth, BHHH), as in other studies based on the same modelling methodology. First, we select a simple autoregressive specification of the $u_t$ based on the sequence of past stock returns. The Box–Jenkins method based on sample autocorrelations and partial autocorrelations and sensitivity tests suggest a simple first-order autoregressive process AR(1) is a reasonable and parsimonious specification for the DSEI daily index. Second, we examine the residuals from the conditioning AR(1) specification for the presence of GARCH effects based on a general-to-specific modelling strategy. This involves re-estimating jointly the AR(1)-GARCH $(p, q)$-M model by the BHHH algorithm, starting from a GARCH (3,3) specification and eliminating insignificant $(p,q)$ terms sequentially, in order of least significance. We employ both Ljung–Box and Breusch–Godfrey likelihood ratio tests to check the specification of GARCH-M (1,1) model in this article.

In a GARCH(1,1)-M model, the series $\varepsilon_t$ is covariance stationary if the sum of $\alpha$ and $\beta$ is significantly less than unity. As the sum of $\alpha$ and $\beta$ approaches unity, the persistence of shocks to volatility is greater. A GARCH-M(1,1) of the following form is used in this study:

$$Y_t = u_t + \delta_1 h_t^{1/2} + \varepsilon_t \quad (4)$$

$$\varepsilon_t | \psi_{t-1} \sim N(0, h_t) \quad (5)$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad (6)$$

In order to examine the impact of circuit breakers and lock-ins on volatility, we estimate a GARCH(1,1) model so that the risk–return trade-off coefficient of GARCH-M model cannot influence the direction of volatility after the impositions of circuit-breakers and lock-ins. Consequently, we introduced the dummy of circuit-breakers and lock-ins directly in the conditional variance equation (Equation 7) as an exogenous variable. The GARCH(1,1) model uses the form of Equations 4–7 with a value of the risk-return trade-off coefficient, $\delta_1$, equal to zero.

### *Data*

Daily closing prices from the Dhaka Stock exchange are used for the period beginning 1 September 1986 to 30 January 2002. The data are collected from two sources: data for the period 1 September 1986 to 31 December 1993 were extracted from the various monthly bulletin of DSE (1993), while data for the period 1 January 1994 to 30 January 2002, were obtained electronically from Union Capital Limited,[2] an investment company based in Dhaka, Bangladesh. In order to examine whether our results are sensitive to the frequency of data, we used a 5-day average of the daily data to construct weekly data. The DSEI index is composed of all traded stocks (value weighted) in the exchange. The index includes dividends.

## IV. Statistical Properties of the DSE Daily Returns

Tables 2 and 3 provide the statistical characteristics of DSE for daily and weekly returns, respectively. We ran a Chow test to ascertain the actual break in the data set and the Chow *F*-test result confirms 30 December 1990 as a structural break in the data set. We divided the sample into two sub-periods: the pre-financial liberalization (September 86 to January 2002) and the post-financial liberalization (January 1991 to January 2002) periods. The mean of the returns is negative in all periods and increases over time, but the mean in the second period is higher than the mean in the first period. However, the SD (as a measure of risk) does not decrease significantly; it in fact increases. The period January 1991 to January 2002 displays a higher mean return, but with a higher level of SD (risk) for both daily and weekly data.

With the inauguration of a new government on 24 June 1996, the stock market started rising without any connection to company fundamentals. The DSEI index grew from 804 on 31 May 1996 to an all time high of 3596 on 17 November 1996 and then fell to 622.28 on 16 April 1998. In order to exclude 'irrational exuberance' from the DSE data during the speculative run-up of the DSE index, we omit the data from 1 July 1996 to 31 December 1996 and ran all descriptive statistics again. For both daily and weekly data, the exclusion of this period increases the SD of the second and the total period, but it does not affect the mean return for that period.

The distribution of the stock returns is skewed to the left for both frequencies of data. The exclusion of the period (1 July 1996 to 31 December 1996) creates a large left skewness in the data. Further, a large excess (positive) kurtosis is found for the full and sub samples. The returns in DSE index have much thicker distribution tails than the normal distribution. This kurtosis becomes larger when we exclude the abnormal period.

Thus, the Dhaka Stock Exchange Index (DSEI) shows negative skewness, excess kurtosis and deviation from normality, which are consistent with the findings of other countries. Fama (1965) shows that the distribution of both daily and monthly returns of Dow Jones and NYSE indices depart from normality and are skewed, leptokurtic and volatility clustered. Campbell *et al.* (1997) conclude that daily US stock indices show negative skewness and positive excess kurtosis. Bekaert *et al.* (1998) provide evidence that 17 out of 20 emerging countries examined (the sample does not include Bangladesh) have positive skewness and 19 of 20 have excess kurtosis, so that normality was rejected for a majority of the sample countries.

## V. Time Varying Risk–Return Behaviour of DSE

### *Autocorrelation and nonsynchronous trading*

Table 3 presents the empirical results of the volatility of stock returns. The equity return is calculated as the log difference of the DSE stock price index: $R_t = \ln(P_t) - \ln(P_{t-1})$. The AR(1) coefficient in Table 3 shows mixed results. For the daily returns, the AR(1) coefficients are negative and statistically insignificant at the 5% level when used the pre-financial liberalization samples (columns 2 and 6).

[2] Formerly Peregrine Capital Limited (PCL), Bangladesh Branch. This is an investment firm in Bangladesh and engaged in stock trading and portfolio management services. The data is available from the corresponding author upon request.

**Table 2. Unconditional distribution statistics for DSE daily returns**

| | With period July 1996 to December1996 | | | | Excluding period July 1996 to December 1996 | | | |
|---|---|---|---|---|---|---|---|---|
| | DLDSEI (September 1986 to January 2002) | | DLDSEI (January 1991 to January 2002) | | DLDSEI (September 1986 to January 2002) | | DLDSEI (January 1991 to January 2002) | |
| Mean (in %) | −0.031 | | −0.028 | | −0.032 | | −0.029 | |
| SD (in %) | 1.554 | | 1.651 | | 2.076 | | 2.323 | |
| Skewness (*t*-statistics)[a] | −1.648 | (−43.27*) | −0.714 | (−15.95*) | −22.076 | (−569.14*) | −21.628 | (−471.20*) |
| Kurtosis (*t*-statistics)[b] | 71.125 | (933.81*) | 57.904 | (647.06*) | 968.12 | (12479.6*) | 860.19 | (9370.4*) |
| Jarque–Bera[c] (*p*-value) | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| ADF unit root test[d] (*p*-value) | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| Observation (*N*) | 4137 | | 2997 | | 3988 | | 2848 | |

*Notes*: * indicates significance at the 1% level.
[a] $t = (S' - 0)/\text{se}(S')$, where $\text{se}(S') = \text{square root}(6/N)$.
[b] $t = (K' - 3)/\text{se}(K')$, where $\text{se}(K') = \text{square root}(24/N)$.
[c] Under the null hypothesis of a normal distribution, the Jarque–Bera statistic is distributed as $\chi^2$ with 2 degrees of freedom. The *p*-values indicate rejection of the null hypothesis, hence deviation form normality.
[d] Under the null hypothesis of a unit root, for the ADF test, the lag length has been chosen using Akaike Information Criterion. *P*-values are calculated based on MacKinnon (1996). The results indicate that the weekly equity return is stationary.

**Table 3. Unconditional distribution statistics for DSE weekly returns**

| | With period July 1996 to December 1996 | | | | Excluding period July 1996 to December 1996 | | | |
|---|---|---|---|---|---|---|---|---|
| | DLDSEI (September 1986 to January 2002) | | DLDSEI (January 1991 to January 2002) | | DLDSEI (September 1986 to January 2002) | | DLDSEI (January 1991 to January 2002) | |
| Mean (in %) | −0.163 | | −0.149 | | −0.169 | | −0.156 | |
| SD (in %) | 3.637 | | 3.939 | | 4.553 | | 5.111 | |
| Skewness (*t*-statistics) | −1.839 | (−21.04*) | −1.704 | (−16.60*) | −10.173 | (−114.49*) | −9.922 | (−94.47*) |
| Kurtosis (*t*-statistics) | 18.192 | (86.94*) | 16.977 | (68.11*) | 194.14 | (1075.6*) | 170.714 | (798.47*) |
| Jarque–Bera (*p*-value) | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| ADF unit root test (*p*-value) | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| Observation (*N*) | 786 | | 570 | | 760 | | 544 | |

*Notes*: See Table 2.

For the post-liberalization samples (columns 4 and 8), the AR(1) coefficients are positive and statistically significant at 1% level. The results are consistent across samples for the daily returns and in all cases the Ljung-Box test indicates that the residuals are not free of autocorrelation. As for the weekly data, three out of four cases produce statistically insignificant AR(1) coefficients at the 5% level. The AR(1) coefficient is negative when we exclude the observations from July 1996 through December 1996 and is positive otherwise.

The different sign of the AR(1) coefficients for different samples can be attributed to the spurious effects associated with nonsynchronous trading. As explained in Campbell *et al.* (p. 129, 1997), the presence of nonsynchronous trading induces geometrically declining negative serial correlation in observed individual security returns that have nonzero means. In contrast, nonsynchronous trading that produces positive serial correlation in observed portfolio returns, yield an AR(1) for the observed return process. These serial autocorrelations (negative and positive) are induced by nonenforcement of regulation and weak supervision of the stock exchange. Moreover, there are a large number of nonactively traded shares in the stock market. Finally, the supply of securities is also very limited. Only recently has the government allowed the issuance of mutual funds by private investment houses. The observed time dependence of stock returns in Bangladesh may be the result of a lack of merchant and investment banks, which tend to promote equity research and increase the speed of adjustment to new information.

**Table 4. Estimates for AR(1)-GARCH(1,1)-M models for daily and weekly returns**

| | With period July 1996 to December 1996 | | | | | | | | Excluding period July 1996 to December 1996 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DLDSEI (September 1986 to January 2002) | | | | DLDSEI (January 1991 to January 2002) | | | | DLDSEI (September 1986 to January 2002) | | | | DLDSEI (January 1991 to January 2002) | | | |
| | Daily[1] (2) | | Weekly (3) | | Daily (4) | | Weekly (5) | | Daily (6) | | Weekly (7) | | Daily (8) | | Weekly (9) | |
| AR(1) | −0.062 | (−0.495) | 0.235 | (1.880***) | 0.187 | (5.436*) | 0.054 | (0.331) | −0.011 | (−0.602) | −0.296 | (−1.169) | 0.167 | (3.733*) | −0.364 | (−1.470) |
| $\delta_1$ | 0.028 | (0.278) | −0.305 | (−1.576) | 0.047 | (0.494) | −0.185 | (−1.026) | −0.065 | (−2.673*) | 0.001 | (0.019) | 0.028 | (0.099) | −0.018 | (−0.312) |
| $\alpha_0$ | 1.07e-05 | (2.980*) | 5.18e-05 | (1.474) | 5.85e-05 | (2.382**) | 6.45e-05 | (2.523**) | 0.0003 | (5.626*) | 4.64e-05 | (5.576*) | 0.000 | (2.682*) | 6.23e-05 | (2.157**) |
| $\alpha_1$ | 0.277 | (3.516*) | 0.601 | (2.876*) | 0.306 | (2.834*) | 0.976 | (4.383*) | 4.500 | (1.188) | 2.555 | (3.582*) | 0.192 | (1.867***) | 3.204 | (3.209*) |
| $\beta_1$ | 0.797 | (18.77*) | 0.567 | (5.034*) | 0.523 | (10.082*) | 0.425 | (6.565*) | −0.018 | (−5.547*) | 0.220 | (3.216*) | −0.017 | (−0.455) | 0.145 | (2.504**) |
| $\alpha_1 + \beta_1^2$ | 1.074 | (390.96*) | 1.168 | (76.62*) | 0.829 | (95.21*) | 1.401 | (66.44*) | 4.482 | (1.401) | 2.775 | (18.265*) | 0.175 | (1.826***) | 3.349 | (12.492*) |
| SE of reg.[3] | 0.015 | | 0.035 | | 0.016 | | 0.040 | | 0.021 | | 0.049 | | 0.023 | | 0.056 | |
| Normality test of residuals[4] | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 | |
| ARCH LM test[5] | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | |
| Ljung–Box Q test[5] | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | | Insignificant | |
| Observations | 4136 | | 785 | | 2997 | | 569 | | 3987 | | 759 | | 2847 | | 543 | |

*Notes*: Values in parenthesis are test statistic. *, **, *** denote significance at the 1, 5 and 10% level, respectively.
[1]For all cases, heteroskedasticity consistent covariance and SE are computed using the methods describes by Bollerslev and Wooldridge (1992).
[2]$\chi^2(1)$ test value.
[3]SE of regression.
[4]*P*-value of Jarque–Bera test of normality of standardized residuals.
[5]Both tests use squared standardized residuals with a lag up to 120 for daily returns (and 36 for weekly returns). The LM test statistic is asymptotically $\chi^2(q)$ distributed. $Q$ test statistic is asymptotically distributed as a $\chi^2$ with degrees of freedom equal to the number of autocorrelations.

*Volatility and returns in DSE*

We present the results for volatility and risk in Table 3. We divide the sample into the pre- and post-liberalization sub-periods and also report results after excluding the 1 July 1996 to 31 December 1996 period (see Section IV). The hypothesis that volatility is a significant determinant of stock returns is not confirmed as the parameter $\delta_1$, capturing the influence of volatility on stock returns, is mostly statistically insignificant at the 10% level for both daily and weekly returns. For daily returns, the risk-return coefficient is mostly positive, while it is mostly negative for weekly returns. The regression coefficient of the risk-return parameter is found significant only for the pre-liberalization sample with daily returns (column 6). Empirical applications to data found mixed results regarding the sign and statistical significance of the risk-return parameter. Elyasiani and Mansur's (1998) estimates on US data were negative and significant. Chou (1988) and Poterba and Summers (1986) document that excess returns on the daily S&P index, weekly NYSE returns and UK stock indices were positive and significant. For emerging markets, Thomas (1995) finds a positive but insignificant risk-return parameter for the Bombay Stock Exchange and Mecagni and Sourial (1999) find a positive and significant risk-return parameter for Egyptian stock markets.

Engle *et al*. (1987) and Bollerslev *et al*. (1992) state that the sign and magnitude of the risk-return parameters depend on the investor's utility function and risk preference and the supply of securities under consideration. Glosten *et al*. (1993) discuss special circumstances that would make it possible to observe a negative correlation between current returns and current measures of risk. Investors may not demand high risk premia if they are better able to bear risk at times of particular volatility. Moreover, if the future seems risky investors may want to save more in the present thus lowering the need for larger premia. And, if transferring income to the future is risky and the opportunity of investment in a risk-free asset is absent, then the price of a risky asset may increase considerably, hence reducing the risk premium. According to Glosten *et al*. (1993), both positive and negative relationships between current returns and current variances (risk) are possible.

The significance of $\alpha_1$ parameters in the model indicates the tendency of the shocks to persist. For the daily returns the measure of volatility persistence, $\alpha_1 + \beta_1$, coefficient is greater than unity and statistically significant for the pre-liberalization samples implying nonstationarity of conditional variance which might have resulted due to the presence of serial correlation in the returns (Bera and Higgins, 1993). However, when regressed for the post-financial liberalization period (January 1991 to January 2002), the sum of the ARCH and GARCH coefficient, $\alpha_1 + \beta_1$, turns out to be less than unity and statistically significant at 1% level. When observations for the period July 1996 through December 1996 are excluded the volatility of stock returns for both daily and weekly data increases. This is consistent with the findings of Section IV (see Tables 2 and 3). In contrast, the sum of ARCH and GARCH coefficient always exceeds unity for weekly returns suggesting higher volatility associated with low frequency of the data.

The above results indicate that the tendency for a volatility response to shocks displays a long memory. These results confirm the time varying risk in the daily stock returns in Bangladesh. The conditional variance changes over time. These results show that periods of relatively high (or low) volatility are found to be time-dependent. The opening up of the stock market neither reduces time-varying risk nor reduces volatility persistence over time.

*Lock-in, circuit breaker and stock market volatility*

In order to curb speculation in the equity market, the government introduced a system of lock-in for primary securities on 11 February 1995. Under this lock-in provision, foreign investors are not allowed to trade in initial public offering[3] for a year. However, this lock-in system was abolished on 8 July 1996 to encourage foreign investment in the equity market. Under this new rule, foreign investors do not face any lock-in period either for primary or secondary shares. However, the Bangladeshi sponsors face a 3-year lock-in period in sponsor's equity, while foreign investors do not face such a lock-in period. For secondary shares, an investor has to register with the SEC if he acquires at least 10% of any publicly listed company equity.

The circuit breaker system was introduced within 3 months of the stock market bubble in 1996. The circuit breaker system is explained in Appendix A. Daily price limits may truncate the distribution of price changes for individual stocks and produce irregularly observed or missing data as the equilibrium price is no longer observable when the

[3] On average about 8–10 new shares are introduced in the Dhaka Stock Exchange through initial public offering (IPO) each year.

price limit becomes binding. Price limits may represent a barrier to market clearing and prevent, rather than enhance, the price discovery process by delaying price changes that are the result of development of underlying stock fundamentals. Price limits may also create liquidity problems, to the extent that buyers (sellers) are unwilling to enter the market as a result of further anticipated price decreases (increases). The distortions may also make price limits self-fulfilling. For instance, the fears of illiquidity or of remaining locked into an investment position may increase early trading, as participants recognize the risk of being unable to trade when prices move closer to the limit. Trading on the other hand may be impaired if market participants act to prevent the limit from being hit, for instance as they recognize that their ability to trade or modify their positions could then be adversely affected. However, price limits may provide markets with a cooling off period preventing investors from panicking and favouring a substantial reduction in volatility, particularly in periods of significant uncertainty that may lead to market overreaction to news (see Ma *et al*., 1989; Lauterbach and Ben-Zion, 1993 and Chowdhury and Nanda, 1998).

In order to test the impact of circuit-breakers and lock-ins on volatility, we estimate a GARCH(1, 1) model so that the effect can be tested directly. Consequently, we introduce a dummy variable for circuit-breakers and lock-ins as an exogenous variable in the conditional variance equation by modifying Equation 6:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \delta_{Di} + \varepsilon_t \qquad (7)$$

where $D_i$ is zero-one dummy representing the exogenous variables. We first examine the imposition (11 February 1995) and then the repeal (8 July 1996) of lock-in period for foreign investors on the volatility of the DSE returns. Then we examine the impact of the imposition of the circuit breaker in two phases- first a 10% and second a 5% on the conditional volatility of stock returns. The results are reported in Tables 5–8. For both daily and weekly returns the dummy variable D1 (Lock-in vs. Lock-out) is found to have a negative effects in most cases but statistically insignificant at the 5% level. When the exuberance observations are excluded from the full sample (Table 7), the coefficient of D1 becomes positive for both daily and weekly returns. Besides, the presence of dummy variable D1 produces the sum of ARCH and GARCH coefficients to be greater than unity for weekly returns in all cases and two out of four cases for the daily returns. Both ARCH-LM and Ljung–Box test indicate that the residuals are not free from autocorrelations.

The dummy variable D2 (introducing the first circuit breaker of 10%) is found to have both positive and negative effects for daily returns and mostly positive effects for weekly returns. For the daily returns the coefficient of D2 is positive and significant at the 10% level for the post-financial liberalizations sample (Table 6) implying that the volatility increases with the imposition of this restriction. However, for both daily and weekly returns, when the exuberance observations are excluded from the sample, the regression coefficient of D2 becomes negative but statistically significant at 1% level indicating that volatility decreases with the imposition of this restriction. The result is quite consistent in the sense that the restriction (D2) has significant impact on volatility (positive and negative) for the post-liberalization period.

The dummy variable D3 (introducing the second circuit breaker of 5%) is found to have a significant negative effect in three out of four cases for the daily returns and only one case for weekly returns, implying that the imposition of this restriction reduces volatility of the realized returns significantly. The dummy variable D4 (the third circuit breaker of 10%) has no significant impact on the weekly returns, but its effect on daily returns is found negative and significant in two out of four cases. The regression coefficient of D4 consistently influences (downward) the volatility of the pre-liberalization samples. Finally, the dummy variable D5 (introducing the different circuit breakers, thus giving combined effect) echoes the results of D4. It too has no effect on weekly returns, but affects significantly the pre-liberalization samples of daily returns.

In summary, although lock-in did not have any significant impact on stock volatility, circuit breakers seem to have some influences on the volatility of both daily and weekly returns for both pre- and post-liberalization samples. The results are quite consistent across samples and sign of coefficients. All dummy variables seem to affect the volatility of realized returns negatively and the results are quite robust for daily returns.

## VI. Summary and Policy Implications

This article has empirically investigated the return behaviour of the Dhaka Stock Exchange Index (DSEI), the time-varying risk-return relationship within a GARCH-type framework and the

**Table 5. Estimates for AR(1)-GARCH(1, 1) model for daily and weekly returns (with lock-in, withdraw of lock-in and circuit breaker of 10 and 5% multiplicative dummies)**

| | D1[1] | | D2[2] | | D3[3] | | D4[4] | | D5[5] | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dummy → | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly |
| AR(1) | −0.069 | 0.290 | −0.073 | 0.278 | −0.074 | 0.293 | −0.031 | 0.301 | −0.034 | 0.301 |
| | (−0.550) | (2.729*) | (−0.564) | (3.397*) | (−0.564) | (2.852*) | (−0.295) | (3.099*) | (−0.297) | (3.100*) |
| $\delta^{Di}$ | −2.45e−06 | 6.47−e06 | −1.46e−05 | 0.001 | −2.26e−05 | −0.001 | −9.06e−06 | −2.37e−05 | −9.05e−06 | −2.37e−05 |
| | (−0.305) | (0.120) | (−0.093) | (0.231) | (−0.331*) | (−0.408) | (−1.698***) | (−0.835) | (−1.691***) | (−0.834) |
| $\alpha^0$ | 1.03e−05 | 3.98e−05 | 1.02e−05 | 4.24e−05 | 1.01e−05 | 3.97e−05 | 1.14e−05 | 4.26e−05 | 1.14e−05 | 4.26e−05 |
| | (2.980*) | (0.987) | (3.075*) | (1.177) | (3.087*) | (0.965) | (2.831*) | (1.060) | (2.830*) | (1.060) |
| $\alpha^1$ | 0.278 | 0.477 | 0.278 | 0.445 | 0.279 | 0.474 | 0.272 | 0.465 | 0.272 | 0.465 |
| | (3.479*) | (1.731***) | (3.457*) | (1.917***) | (3.477*) | (1.748***) | (3.798*) | (1.764**) | (3.806*) | (1.765***) |
| $\beta^1$ | 0.801 | 0.664 | 0.802 | 0.699 | 0.802 | 0.667 | 0.801 | 0.669 | 0.802 | 0.669 |
| | (19.110*) | (3.357*) | (19.305*) | (4.695*) | (19.351*) | (3.380*) | (21.42*) | (3.483*) | (21.47*) | (3.483*) |
| $\alpha^1 + \beta^1$ | 1.079 | 1.142 | 1.081 | 1.145 | 1.082 | 1.142 | 1.074 | 1.135 | 1.075 | 1.135 |
| | (347.66*) | (76.95*) | (357.78*) | (84.39*) | (355.09*) | (79.66*) | (434.54*) | (86.41*) | (434.01*) | (86.42*) |
| SE of reg. | 0.015 | 0.034 | 0.015 | 0.034 | 0.015 | 0.034 | 0.015 | 0.034 | 0.015 | 0.034 |
| Normality test of residuals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ARCH LM test | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant |
| Ljung–Box $Q$ | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Significant |
| Observations | 4136 | 785 | 4136 | 785 | 4136 | 785 | 4136 | 785 | 4136 | 785 |

*Notes*: Sample: September 1986 to January 2002. See Table 5.
[1]The dummy D1 (represents Lock-in vs. Lock-out) assumes value equal to 1 from 11 February, 1995 till 8 July, 1996; and zero otherwise.
[2]The dummy D2 (introducing first Circuit breaker of 10%) assumes value equal to 1 from 8 October 1996 till 5 November 1996; and zero otherwise.
[3]The dummy D3 (second Circuit breaker of 5%) assumes value equal to 1 from 6 November 1996 to 31 December 1996; and zero otherwise.
[4]The dummy D4 (representing the third Circuit breaker of 10%) assumes value equal to 1 from January 1997 till 15th of November 1999; and zero otherwise.
[5]The dummy D5 (represents all Circuit breaker) assumes value equal to 1 from 8 October 1996 till 15 November 1999; and zero otherwise.

**Table 6. Estimates for AR(1)-GARCH(1,1) model for daily and weekly returns (with lock-in, withdraw of lock-in and circuit breaker of 10 and 5% multiplicative dummies)**

| | D1 | | D2 | | D3 | | D4 | | D5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dummy → | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly |
| AR(1) | 0.182 | 0.271 | 0.184 | 0.257 | 0.180 | 0.261 | 0.146 | 0.281 | 0.127 | 0.281 |
| | (5.134*) | (2.358**) | (5.203*) | (2.116**) | (4.954*) | (2.175**) | (2.465**) | (2.760*) | (2.043**) | (2.761*) |
| $\delta^{Di}$ | −3.08e−05 | −2.31e−05 | 0.0002 | 0.004 | 8.27e−05 | −0.001 | −3.35e−05 | −5.47e−05 | −2.59e−05 | −5.46e−05 |
| | (−1.074) | (−0.434) | (1.851***) | (0.757) | (1.020) | (−0.365) | (−1.566) | (−1.314) | (−1.569) | (−1.313) |
| $\alpha^0$ | 6.44e−05 | 6.71e−05 | 5.79e−05 | 6.41e−05 | 5.74e−05 | 6.11e−05 | 4.82e−05 | 7.37e−05 | 3.55e−05 | 7.36e−05 |
| | (2.289**) | (0.981) | (2.472**) | (0.960) | (2.441**) | (0.891) | (2.314**) | (1.167) | (2.200**) | (1.167) |
| $\alpha^1$ | 0.314 | 0.410 | 0.289 | 0.417 | 0.295 | 0.425 | 0.344 | 0.397 | 0.281 | 0.397 |
| | (2.951*) | (1.343) | (2.667*) | (1.301) | (2.680*) | (1.373) | (3.654*) | (1.444) | (3.774*) | (1.445) |
| $\beta^1$ | 0.508 | 0.684 | 0.533 | 0.679 | 0.530 | 0.683 | 0.611 | 0.690 | 0.696 | 0.690 |
| | (9.398*) | (2.905*) | (9.475*) | (2.820**) | (9.345*) | (2.867*) | (12.91*) | (3.227*) | (14.07*) | (3.228*) |
| $\alpha^1 + \beta^1$ | 0.822 | 1.095 | 0.822 | 1.096 | 0.826 | 1.109 | 0.955 | 1.087 | 0.978 | 1.088 |
| | (97.12*) | (72.44*) | (102.50*) | (61.25*) | (101.01*) | (66.22*) | (262.18*) | (93.27*) | (596.60*) | (93.24*) |
| SE of reg. | 0.016 | 0.037 | 0.016 | 0.037 | 0.016 | 0.037 | 0.016 | 0.037 | 0.016 | 0.037 |
| Normality test of residuals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ARCH LM test | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant |
| Ljung–Box *Q* | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant |
| Observations | 2997 | 570 | 2997 | 570 | 2997 | 570 | 2997 | 570 | 2997 | 570 |

*Notes*: Sample: January 1991 to January 2002. See Table 5.

**Table 7. Estimates for AR(1)-GARCH(1,1) model for daily and weekly returns (with lock-in, withdraw of lock-in and circuit breaker of 10 and 5% multiplicative dummies)**

| | D1 | | D2 | | D3 | | D4 | | D5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dummy → | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly |
| AR(1) | −0.139 | 0.164 | 0.198 | −0.293 | 0.178 | −0.294 | −0.137 | −0.297 | −0.132 | −0.297 |
| | (−0.814) | (0.922) | (4.432*) | (−1.183) | (4.251*) | (−1.194) | (−2.198**) | (−1.228) | (−0.354) | (−1.229) |
| $\delta^{Di}$ | 0.000 | 0.003 | 2.74e−05 | 0.002 | −0.0008 | 4.79e−05 | −0.0001 | 2.03e−05 | −5.17e−05 | 2.05e−05 |
| | (0.930) | (0.914) | (0.075) | (0.493) | (−3.532*) | (−0.024) | (−2.009**) | (0.508) | (−3.649*) | (0.513) |
| $\alpha^0$ | 8.68e−05 | 4.00e−05 | 0.001 | 4.59e−05 | 0.001 | 4.54e−05 | 0.0001 | 4.20e−05 | 5.02e−05 | 4.20e−05 |
| | (3.095*) | (1.194) | (4.680*) | (2.448**) | (4.700*) | (2.431**) | (2.291**) | (2.210**) | (3.546*) | (2.213**) |
| $\alpha^1$ | 0.315 | 0.613 | 0.139 | 2.555 | 0.167 | 2.558 | 6.733 | 2.588 | 0.533 | 2.589 |
| | (3.234*) | (2.289**) | (1.864**) | (3.534*) | (2.342**) | (3.544*) | (1.233) | (3.621*) | (4.404*) | (3.620*) |
| $\beta^1$ | 0.802 | 0.609 | −0.037 | 0.221 | −0.027 | 0.223 | 0.017 | 0.219 | 0.800 | 0.219 |
| | (20.25*) | (3.787*) | (−1.785***) | (3.303*) | (−1.834***) | (3.353*) | (0.549) | (3.341*) | (48.55*) | (3.341*) |
| $\alpha^1 + \beta^1$ | 1.117 | 1.223 | 0.101 | 2.777 | 0.140 | 2.781 | 6.750 | 2.807 | 1.334 | 2.808 |
| | (199.38*) | (63.94*) | (1.306) | (17.66*) | (3.046***) | (17.75*) | (1.540) | (18.437*) | (119.52*) | (18.41*) |
| SE of reg. | 0.021 | 0.045 | 0.020 | 0.049 | 0.020 | 0.049 | 0.021 | 0.049 | 0.021 | 0.049 |
| Normality test of residuals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ARCH LM test | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant |
| Ljung–Box $Q$ | Insignificant | Significant | Insignificant | Significant | Insignificant | Significant | Insignificant | Significant | Insignificant | Significant |
| Observations | 3987 | 759 | 3987 | 759 | 3987 | 759 | 3987 | 759 | 3987 | 759 |

*Notes*: Sample: September 1986 to January 2002 (excluding July 1996–December 1996 observations). See Table 5.

**Table 8. Estimates for AR(1)-GARCH(1,1) model for daily and weekly returns (with lock-in, withdraw of lock-in and circuit breaker of 10% and 5% multiplicative dummies)**

| | D1 | | D2 | | D3 | | D4 | | D5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly | Daily | Weekly |
| AR(1) | 0.090 | −0.360 | 0.128 | 0.269 | 0.157 | 0.343 | 0.167 | 0.095 | 0.166 | 0.096 |
| | (1.589) | (−1.577) | (2.698*) | (2.590*) | (3.068*) | (4.019*) | (3.169*) | (1.101) | (3.316*) | (1.091) |
| $\delta^{Di}$ | −0.0003 | −7.78e−06 | −0.001 | −0.003 | −0.0008 | −0.004 | 4.78e−05 | −6.66e−05 | −0.0002 | −4.97e−05 |
| | (−1.126) | (−0.140) | (−3.910*) | (−3.465*) | (−2.487**) | (−3.021*) | (0.037) | (−0.102) | (−0.320) | (−0.123) |
| $\alpha^0$ | 0.0004 | 7.38e−05 | 0.001 | 0.003 | 0.001 | 0.005 | 0.001 | 7.35e−06 | 0.001 | 7.50e−06 |
| | (1.157) | (2.055*) | (4.103*) | (3.361*) | (3.638*) | (3.264*) | (3.785*) | (1.588) | (3.409*) | (1.317) |
| $\alpha^1$ | 0.492 | 3.071 | 0.083 | 0.024 | 0.136 | 0.064 | 0.100 | −0.003 | 0.129 | −0.003 |
| | (5.248*) | (3.106*) | (1.043) | (0.710) | (1.402) | (0.782) | (1.064) | (−0.365) | (1.266) | (−0.329) |
| $\beta^1$ | 0.258 | 0.158 | −0.027 | 0.432 | −0.027 | −0.096 | −0.034 | 1.005 | −0.028 | 1.004 |
| | (1.595) | (2.643*) | (−1.007) | (5.906*) | (−1.214) | (−1.921***) | (−1.141) | (56.25*) | (−1.306) | (50.35*) |
| $\alpha^1+\beta^1$ | 0.750 | 3.229 | 0.056 | 0.456 | 0.109 | −0.032 | 0.066 | 1.001 | 0.101 | 1.001 |
| | (38.61*) | (11.91*) | (0.300) | (40.66*) | (0.937) | (0.173) | (0.313) | (11941.8*) | (0.730) | (8326.08*) |
| SE of reg. | 0.023 | 0.056 | 0.023 | 0.051 | 0.023 | 0.052 | 0.023 | 0.051 | 0.023 | 0.051 |
| Normality test of residuals | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ARCH LM test | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant |
| Ljung–Box $Q$ | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant | Insignificant |
| Observations | 2847 | 543 | 2847 | 543 | 2847 | 543 | 2847 | 543 | 2847 | 543 |

*Notes*: Sample: January 1991 to January 2002 (excluding July 1996–December 1996 observations). See Table 5.

persistence of shocks to volatility. The Bangladesh capital market has gone through major changes since the 1990s during which the stock market was opened to foreign investment.

The DSE returns show negative skewness, excess kurtosis and deviation from normality. The DSE volatility tends to change over time and is serially correlated. In addition, the DSE returns display significant serial correlation indicating stock market inefficiency. The results also show a significant relationship between conditional volatility and the DSE stock returns, but the risk-return parameter is found to be both negative and positive. While the negative sign of risk-return coefficient is not consistent with portfolio theory, it is theoretically possible in emerging markets as investors may not demand higher risk premia if they are better able to bear risk at times of particular volatility (Glosten *et al.*, 1993). While the lock-in did not have any overall impact on stock volatility, the imposition of the circuit breakers seems to have significant influence over the volatility of realized returns.

The negative risk-return relationship in the DSEI may result from the additional tax treatment of interest income and dividend income and weak corporate profit performance. Besides, information asymmetry may play a crucial part in influencing the distribution of returns among investors. Also, a number of companies do not hold annual general meetings as stipulated in company guidelines, nor they do declare regular dividends or invest the retained earnings in value maximizing investments.

The processing of new information in Bangladesh is rather weak and may result from the persistently large number of nonactively traded shares and the limited role of mutual funds and professionally managed investment and broker houses. To improve the operation of capital market the government should emphasize a policy of timely disclosure and dissemination of information to the stockholders and investors on the performance of listed companies.

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## Appendix A: The Circuit Breaker System in Bangladesh

The unusual and abnormal price fluctuation raised the Price Index to unprecedented heights. In 1996 the Securities and Exchange Commission, in order to protect the interest of the investors, introduced Circuit Breaker System. The guidelines of Circuit Breaker System are given below:

(1) Standard upward and downward price limits over the previous days' market price applicable for each market day are as follows:

(2) In case of new issue, free trade may be allowed for first 5 (five) consecutive market days and after that above limit will be applicable.

(3) In case of receipt of any price sensitive information like right issues, bonus issue and dividend from the listed company, free trade may be allowed for subsequent 3 (three) consecutive market days and after that above limits will be applicable.

(4) In case securities not traded for previous consecutive 30 market days, free trade may be allowed for subsequent 3 (three) consecutive market days and after that above limits will be applicable.

| Previous day's per share market price | Limits |
|---|---|
| (1) Up to Taka 200 | 20% (Twenty percent) but not exceeding Taka 35 |
| (2) Taka 201 to Taka 500 | 17.5% (Seventeen Point Five Percent) but not exceeding Taka 75 |
| (3) Taka 501 to Taka 1000 | 15% (Fifteen Percent) but not exceeding Taka 125 |
| (4) Taka 1001 to Taka 2000 | 12.5% (Twelve Point Five Percent) but not exceeding Taka 200 |
| (5) Taka 2001 to Taka 5000 | 10% (Ten Percent) but not exceeding Taka 375 |
| (6) Taka 5001 and above | 7.5% (Seven Point Five Percent) but not exceeding Taka 600 |