Market Efficiency, Time-Varying Volatility and Equity Returns in Bangladesh Stock Market

M. Kabir Hassan, Ph.D.
University of New Orleans

Anisul M. Islam, Ph.D.
University of Houston-Downtown

Syed Abul Basher
York University

Contact Author

M. Kabir Hassan, Ph.D.
Associate Professor of Finance
Associate Chair
Department of Economics and Finance
University of New Orleans
New Orleans, LA 70148
Phone: 504-280-6163
Fax: 504-280-6397
Email: mhassan@uno.edu

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Abstract

This paper empirically examines the issue of market efficiency and time-varying risk return relationship for Bangladesh, an emerging equity market in South Asia. The study utilizes a unique data set of daily stock prices and returns compiled by the authors which was not utilized in any previous study. The Dhaka Stock Exchange (DSE) equity returns show positive skewness, excess kurtosis and deviation from normality. The returns display significant serial correlation, implying stock market inefficiency. The results also show a significant relationship between conditional volatility and the stock returns, but 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, Jagannathan and Runkle, 1993). While circuit breaker overall did not have any impact on stock volatility, the imposition of the lock-in period has contributed to the price discovery mechanism by reverting an overall negative risk-return time-varying relationship into a positive one. As a policy to improve the capital market efficiency, the timely disclosure and dissemination of information to the shareholders and investors on the performance of listed companies should be emphasized.

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1. Introduction

While empirical tests of return-volatility behavior are plentiful for developed stock markets, the focus on developing and emerging stock markets has begun in recent years. The interest in these emerging markets has arisen from the increased globalization and integration of the world economies in general and that of the 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 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. Fama (1965) has found that large (small) changes in stock prices follow by large (small) changes in either signs and stock prices exhibit fatter tails than a normal distribution. While the relationship between volatility and return, and capital market efficiency have been examined for some emerging markets, it has not been examined for a frontier capital market like Bangladesh. The questions of stock market volatility, persistence of volatility, and risk premia in the stock market are relevant for Bangladesh as the country wants to achieve higher rates of savings, investment and economic growth.

Stock markets tend to be very efficient in the allocation of capital to its highest-value users. These markets also help increase savings and investment, which are essential for economic development. An equity market, by allowing diversification across a variety of assets, helps reduce the risk the investors must bear, thus reducing the cost of capital, which in turn spurs investment and economic growth. However, volatility and market efficiency are two important features which will ultimately determine the effectiveness of the stock market in economic development. For example, in a stock market which is informationally inefficient, investors face difficulty in choosing the optimal investment as information on corporate performance is slow or less available. The resulting uncertainty may induce investors either to withdraw from the market until this uncertainty is resolved or discourage them to invest funds for long term. Moreover, if investors are not rewarded for taking on higher risk by investing in the stock market, or if excess volatility weakens investor's confidence, they will not invest their savings in the stock market, and hence deter economic growth. The emerging stock markets offer an opportunity to examine the evolution of stock return distributions and stochastic processes in response to economic and political changes in these emerging economies. Such changes are occurring in a magnitude and direction in these countries which are not typically observed in the developed stock markets.

The focus of this study is to examine the return distributions and stochastic processes of such distributions in the stock market of Bangladesh following the deregulating and opening up of its capital market to foreign investors in the 1990's. In particular, it examines the issue of market efficiency and the time-varying risk return relationship for this emerging equity market using a data set which was not utilized in any previous study. This unique data set consisting of daily stock prices and returns dating back to 1986 was compiled by the authors. Further, this long data series allows us to examine the impact of capital market opening on the efficiency and volatility of Bangladesh stock market, the associated risk premia, and the persistence of shocks to stock market volatility before, during, and after of capital market liberalization that began in 1990. We used the Generalized Autoregressive Condtional Heteroskedasticity in the mean (GARCH-M) introduced by Engle et. al (1987) and Bollerslev (1992) to examine the time-varying risk-return relationship. The GARCH models are capable of incorporating a number of widely observed behavior of stock prices such as leptokurtosis, skewness, and volatility clustering.

This study is useful for a number of reasons. Firstly, to the best of our knowledge, this is the first known study of this kind for the Bangladesh stock market. Secondly, It utilizes a unique daily data series which were not utilized in previous studies. Thirdly, the results of this study will be of great 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 the emerging countries.

The paper is divided into five sections. Following the introduction in section 1, section 2 provides a brief overview of the Dhaka Stock Exchange. Section 3 discusses data and methodology. Section 4 discusses the statistical properties of the stock prices and returns in the Dhaka Stock Exchange. Section 5 analyzes the empirical findings of time-varying risk-return behavior of stock prices and returns within a GARCH-M framework. Section 6 concludes the paper.

2. The Dhaka Stock Exchange (DSE): A Brief Description

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. 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 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 30th June, 1999 there were 230 Securities listed on the DSE with a market capitalization of Taka 50,748 million. In the FY 1998-99, the total issued capital and

debentures of all listed Securities with the Dhaka Stock Exchange was Taka 28,684 million compared to Taka 30,211 million in the FY 1997-98.

The Dhaka Stock Exchange (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 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. At present, the DSE has a staff consisting of 115 people. The Dhaka Stock Exchange is a self regulated non-profit organization. It has provisions for 500 members though at present the number of members is 195. Membership is open to the foreigners as well. The Exchange has a 24 member Council, of which 12 are elected from the members and the other 12 are nominated as non-member from different apex bodies.

Trading is done through 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 hours. (3) **Block Market:** A place where bulk quantities of shares are traded through pick and fill basis. (4) **Odd Lot Market:** Odd lot scripts are traded here based on pick and fill basis. All transactions in public market of a day, after netting, are settled and cleared through the DSE Clearing House due on 3rd and 5th working day respectively, calculated from date of trading. Members shall be allowed to carry out transaction of foreign buyers and/or seller 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.

Currently there are 230 issues listed securities in the DSE, which is 2.68% higher than that of the previous year (see Table 1). However, the growth of mutual funds and debentures is constant. No new issues of mutual funds or debentures were issued during the period of 1998-99. Table 1 reveals that the performance of DSE during the 1998-99 period has been mixed. The total number of tradable securities increased by 1.97 % but the issued capital of all listed securities declined by 5% during this period. However, both total turnover of securities and total traded amount of securities has increased enormously compared to that of the previous year.

The total Market Capitalization of all listed Securities in the DSE amounted to US$ 1046.36 million in 1999 compared to US$ 1283.79 million in 1998 representing a decline in market capitalization by 22%. The Market Capitalization declined during the period of 1998-99 due to the following reasons: i) listing of lesser number of new Issues, ii) absence of rights and bonus issues, and iii) impact of decrease

in all share price index (SEC, 1999). The all share price index of the DSE declined from 676.47 to 546.79 during this period.

It is to be noted here that special incentives are provided to encourage nonresident Bangladeshis to invest in the capital market. The nonresident Bangladeshis were to enjoy facilities similar to those of the foreign investors. Moreover, they can buy newly issued shares/debentures of Bangladeshi companies and can maintain foreign currency deposits (styled as NFCD[1] account) in special accounts for up to five years. A quota of 10% reserved for nonresident Bangladeshis in primary shares (IPO) has also been initiated. Table 2 shows the portfolio investment by the non-residents (Securities and Exchange Commission, 1999).

3. Methodology and Data:

The study examined the distribution of equity returns by dividing the sample period into two subperiods; 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). Market efficiency is examined with reference to the structure of autocorrelation (ARCH) in returns. In order to examine the stochastic process over the study period, we employed models of conditional variances using the Generalized Autoregressive Conditional Heteroskaedasticity (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 predictability of returns based on the significance of autocorrelation coefficients are valid only after controlling for the ARCH effects (Errunza et al., 1994).

The Autoregressive Conditional Heteroskedasticity (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 modeling the time series behavior of stock returns (Baillie and DeGennaro, 1990; Akgiray, 1989; French et al. 1987; Koutmos, 1992; Koutmos et al. 1993). Bollerslev (1986) allows the conditional variance to be a function of 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

[1] Non-resident Foreign Currency Account

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 Choudhury (1994) and Mecagni and Sourial (1999), stock returns can be represented by the GARCH*(p,q)*-M model as follows:

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

(2) $\varepsilon_t / \Psi_{t-1} \sim N(0, h_t)$

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

where y_t is the stock return, u_t is the mean of y_t conditional on the past information (Ψ_{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_t) is positive. The presence of $h_t^{1/2}$ in (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 α_j indicates the magnitude of the effect imposed by the lagged error term (ε_{t-1}) on the conditional variance (h_t). In other words, the size and significance of α_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 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 (1). In other words, the coefficient δ_1 represents the index of relative risk aversion (time-varying risk premium). A significant and positive coefficient δ_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 CAPM. The use of the GARCH(*p,q*)-M in testing for stock market volatility is also advocated by Engle (1990).

Engle and Bollerslev (1986), Chou (1988), Bollerslev, Chow and Kroner (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).

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

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

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

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

The parameters are estimated using nonlinear estimation techniques based on the Berndt-Hall-Hall-Hausman algorithm, which involves recursive calculation of the variance, h_t. In a GARCH(p,q) model, the order of p and q can be identified by following the Box and Jenkins identification techniques to the time series and examining the autocorrelations and partial autocorrelations for the squared residuals. The primary specification test for a lack of serial correlation in the residuals is Ljung-Box statistics which is asymptotically chi-square distributed. Likelihood ratio can be employed to test the descriptive validity of the model.

We start with identifying the ARMA(p,q) process for modeling the autocorrelation structure of the stock returns for the pre-opening and post-opening periods, as well as the overall period under study. GARCH-M(1,1) is employed to control for the autoregressive conditional heterskedasticity. The residuals from the GARCH-M(1,1) model are then used in the ARMA(p,q) models. After accounting for the GARCH-M effects, if the ARMA coefficients remain significant, the stock returns could then be considered predictable.

4. Statistical Properties of the DSE Daily Returns

Table 3 provides the statistical characteristics of Dhaka Stock exchange daily returns. We ran a Chow test to ascertain the actual break in the data set, and the Chow F-test result confirms December 30, 1990 as a structural break in the data set. By applying the Perron (1997) test for structural break, we found that the date October 31, 1996 is the another point of structural break in the data set.

We divided the sample into two sub-periods: the pre- and the post-financial liberalization periods. The mean of the returns is positive in all periods, and declines over time, but the mean in the second period is less than the mean in the first period. However, the standard deviation (as a measure of risk) does not decrease significantly; it in fact increases. The period Sep.1986-Dec.1990 displays a higher mean return with a lower level of standard deviation (risk).

In order to exclude "irrational exuberance" from the DSE data during the speculative run-up of the DSE index, we omitted the data during July 1, 1996 through December 31, 1996, and ran all descriptive statistics again. The exclusion of this period increased the standard deviation of the second and the total period, but, it did not affect the mean return for that period. However, we couldn't depend on the standard deviation as a measure of risk during those periods since it is insignificantly different from zero.

The skewness of the stock returns changes from excessive right skewness in the first period to a left skewness in the second period. However, the total sample showed that the distribution of the stock returns is skewed to the right. The exclusion of the period (July, 1st 1996-Dec.31,1996) creates a large right skewness in the data. Further, a large excess (positive) kurtosis is found for the full sample and the two sub-periods. The returns in DSE index have a much thicker distribution tails than the normal distribution. This kurtosis becomes bigger when we exclude the abnormal period.

Thus, the Dhaka Stock Exchange Index (DSEI) shows positive skewness, excess kurtosis and deviation from normality, which are consistent with the findings of other countries. Fama (1965) showed 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, Lo and Mackinlay (1997) concluded that daily U.S. stock indexes 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) had positive skewness and 19 of 20 had excess kurtosis, so that normality was rejected for majority of the sample countries.

5. Time Varying Risk-Return Behavior of the DSE Returns:

5.1. Autocorrelation, Non-Synchronous Trading and Capital Market Efficiency:

Table 4 presents the empirical results of volatility of stock returns and market efficiency tests. 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 hypothesis of linear independence of successive price changes was rejected in all tests and for the whole data set (1986-1999). Since it showed a significant first order auto-correlation [AR(1)], the returns are predictable on the basis of past returns. Accordingly, we reject the Efficient Market Hypothesis. For the period (1991-1999), we could not reject the hypothesis that the returns are serially dependent, however,

we could reject the efficient market hypothesis based on the Ljung-Box Q test that showed the residuals are serially correlated.

The departure from the efficient market hypothesis of DSEI suggests that relevant market information is only gradually reflected in stock price changes. They may arise from frictions in the trading process, limited provision of information of firm's performance to market participants as most firms fail to hold regular annual general meetings and provide audited financial statements on time to its shareholders. Moreover, there is a lack of professional financial community who can analyze stock market data for the investors. These findings necessitate the need for the modernization of stock exchanges to improve the trading system, and increase the disclosure requirements of listed companies to the market on a timely fashion.

One may argue that the DSE market inefficiency may result from nonsynchronous or nontrading effects, which imply that information in the stock market is processed with a lag as price adjustments are limited only to traded stocks. However, the presence of AR(1) in DSEI cannot be attributed to spurious effects associated with nonsynchronous trading. As explained in Cambell, Lo and MacKinlay (1997), nonsynchronous trading would imply negative autocorrelation in portfolio returns, but we observe postive autocorrelation in Dhaka stock exchange. This positive autocorrelation is induced by non-enforcement of regulation and weak supervision of the stock exchange. Moreover, there are a large number of nonactively traded shares in the stock market. Out of 222 listed shares in the DSE, only 40 shares are regularly traded in the market. Finally, the observed positive serial autocorrelation also stems from the limited development of specialized financial institutions such as the merchant banks and the investment brokerages houses which promote equity research and increase the speed of adjustment to new information. The supply of securities is also very limited. Only recently the Government has allowed the issuance of mutual funds by private investment houses.

5.2. Volatility and Returns in the Dhaka Stock Exchange

We present the results for volatility and risk in Table 4. We divided the sample into the pre- and post liberalization sub-periods, and also reported results after excluding the July 1, 1996 through December 31, 1996 period. The hypothesis that volatility is a significant determinant of stock returns is confirmed as the parameter $\delta_{1,}$ capturing the influence of volatility on stock returns, is negative and statistically significant. Instead of observing a positive risk-return which is a basic postulate of portfolio theory, we observe a negative relationship between risk and return. Empirical applications to data found mixed results regarding the sign and statistical significance of the risk-return parameter. Elyasiani and Mansur (1998) estimates on U.S. data were negative and significant. Chou (1988) and Poterba and Summers (1986) estimates on excess returns on daily S&P index, weekly NYSE returns and U.K stock indices were positive and significant. For emerging markets, Thomas (1995) found positive but insignificant risk-

return parameter for Bombay Stock Exchange, and Mecagni and Sourial (1999) found positive and significant risk-return parameter for Egyptian stock markets.

Engle, Lilien and Robins (1987), and Bollerslev, Chou and Kroner (1992) state that the sign and magnitude of the risk-return parameter depends on the investor's utility function and risk preference, and the supply of securities under consideration. Glosten, Jagannathan and Runkle (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 the investors may want to save more in the present thus lowering the need for larger premia. And, if transferring income to 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.

5.3. ARCH and GARCH Effects and Volatility Persistence:

The significance of α parameters in the model indicates the tendency of the shock to persist. The measure of volatility persistence $\alpha+\beta$ coefficients is greater than or almost equal to unity. This indicates that the tendency for a volatility response to shocks to display a long memory. These results confirm the time varying risk in the stock returns in Bangladesh. The conditional variance changes over time. These results show that periods of relatively high (or lows) volatility are found to be time-dependent. The opening up of the stock market did neither reduce time-varying risk nor reduce volatility persistence over time.

5.4. Lock-in, Circuit Breaker, and the DSE Return Volatility

In order to curb speculation in the equity market, the Government introduced a system of lock-in for primary securities on February 11, 1995. Under this lock-in provision, no investors, whether local or foreign, are allowed to trade in IPO's for a year. However, this lock-in system was abolished on July 11, 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, but foreign investors do not face such a lock-in period. For secondary shares, an investor has to register to the Securities and Exchange Commission if he acquires at least 10% of any publicly listed company equity.

The circuit breaker system was introduced within three months during the stock market bubble in 1996. The circuit breaker system is explained in appendix B. 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 price limit becomes binding. Price limit may represent a barrier to market clearing, and prevent, rather than enhance, the price discovery process by delaying

price changes that are 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. On the other hand, however, price limits may provide markets with a cooling off period preventing investors from panicking, and favoring a substantial reduction in volatility, particularly in periods of significant uncertainty that may lead to market overreaction to news. (Cox, 1998; Ma, Rao and Sears, 1989; Lauterbach and Ben-Zion, 1993; Chowdhury and Nanda; Koders, 1993).

We estimated the GARCH-M by allowing additional multiplicative dummy variables to test for the time invariance of the slope parameter of $\delta_{1.}$ The stock return with dummy variables can, therefore, be written as

(7) $$Y_t = u_t + \delta_1 h_t^{1/2} + \delta_{Di}[\, D_i h_t^{1/2}\,] + \varepsilon_t$$

We examined first the imposition (February 11, 1995) and then repeal (July 8, 1996) of lock-in period for foreign investors on the volatility of the DSE returns. Then we examined the impact of imposition of the circuit breaker in two phases-first a 10% and second a 5% on the conditional volatility of stock returns. We reporte the results again by dividing the data into two sub-periods in Table 5. The two sub-periods are: January 1991 - November 1999 and September 1986 - November 1999). The dummy variable D1 (Lock-in versus Lock-out) is found to have a positive effect in all cases. The positive coefficient of D1 will reduce the absolute value of the risk-return parameter $\delta_{1.}$

The dummy variable D2 (introducing first the circuit breaker of 10%) is found to have a positive effect in all cases. The positive coefficient of D2 will reduce the absolute value of the risk-return parameter $\delta_{1.}$ The dummy variable D3 (introducing the second circuit breaker of 5%) is found to have a negative effect in all cases. The effect of this sign will increase the absolute value of risk-return parameter $\delta_{1.}$ The dummy variable D4 (the third circuit breaker of 10%) is found to be insignificant, and finally the dummy variable D5 (introducing the different circuit breakers, thus giving combined effect) is found to be insignificant in both periods.

We find a positive impact of the imposition of lock-in period on stock return variability. If we add the coefficient of this dummy variable (D1) with coefficient of $h^{1/2}$, the absolute value becomes positive (-.122+.195=0.073). One interpretation of this finding may be that the lock-in period helped stabilize the volatility of the DSE market during February 11, 1995 through July 8, 1996. The run-up of IPO share prices was, to a degree, contained during this time period by the imposition of the lock-in period.

Similar interpretation may be given for the first circuit breaker dummy variable (D2). If we add the coefficient of $h^{1/2}$ with the coefficient of D2, the overall coefficient value becomes positive, suggesting that a loose circuit breaker help the process of price discovery and establish a positive liquidity premium in the market. However, if we look at the final dummy, combining all three circuit breakers, we see that the imposition and the subsequent repeal of circuit breaker does not have any impact on the Dhaka stock market volatility.

6. Summary and Policy Implications

The purpose of this paper has been to investigate empirically the return behavior of Dhaka Stock Exchange (DSE), the informational efficiency of the DSE, the time-varying risk-return relationship within a GARCH-M framework, and the persistence of shocks to volatility. The Bangladesh capital market has gone through major changes over the 1990-1999 period. During this time period, the stock market was opened to the foreign investment.

The DSE returns show positive 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, implying stock market inefficiency. The results also show a significant relationship between conditional volatility and the DSE stock returns, but the risk-return parameter is negative and statistically significant. While this result is not consistent with 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, Jagannathan and Runkle, 1993). While the circuit breaker overall did not have any impact on stock volatility, the imposition of the lock-in period has contributed to the price discovery mechanism by reverting an overall negative risk-return time-varying relationship into a positive one.

The negative risk-return relationship in DSE may result from the tax treatment of interest income and dividend income, and weaker corporate profit performance. Moreover, the stock market has been generally bearish, except speculative run-up for six months during the later part of 1996, and the companies do not hold annual general meetings as stipulated in company guidelines, nor they do declare 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 persistent large number of non-actively traded shares, and the limited role of mutual funds and professionally managed investment and broker houses. As a policy to improve the capital market efficiency, the timely disclosure and dissemination of information to the shareholders and investors on the performance of listed companies should be emphasized.

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Table 1: DSE Market Highlights, June 1998 to June 1999

Indicators	As on June 1999	As on June 1998	Change (+/-)
Total Number of Listed Securities	230	224	2.68%
Number of Listed Companies	210	204	2.94%
Number of Mutual Funds	9	9	0%
Number of Debentures	11	11	0%
Total Number of Tradable Securities (In Million)	533.53	523.21	1.97%
Issued Capital of All Listed Securities (Million Taka)	28,684	30,211	-5.05%
Total Market Capitalization (Million Dollar)	1,046.36	1,336.15	-21.69%
Total Turnover of Securities (Million, from July 98 to June 99)	1,331.25	98.29	1,254.41%
Total Amount Traded (Million Dollar, from July 98 to June 99)	1,069.97	270.75	295.19%
All Share Price Index (Point)	**546.79**	**676.47**	**-19.17%**

Note: 1 US Dollar as on 30th June, 1999 = Taka 48.50
Source: SEC annual reports, 1998-99

Table 2: Portfolio Investment by the Non Residents (million Taka)

Period	Deposit in NRITA[a]	Investment in Security Purchased	Amount Sold	Purchase Price of the Sold Share	Capital Gain/Loss	Dividend Excluding Capital Gain	Outflow of Sold Amount
April 92 – June 92	57.3	50.8	-	-	-	-	-
July 92 – June 93	316.9	387.5	81.2	35.4	5.8	3.3	38.6
July 93 – June 94	3196.6	3101.8	965.1	510.5	404.6	17.6	918.4
July 94 – June 95	3094.4	2982.7	1334.2	928.1	406.1	92.7	1388.9
July 95 – June 96	738.5	716.8	1877.1	1893.4	(16.3)	146.8	1972.0
July 96 – June 97	527.8	518.0	6186.8	3443.4	2743.4	122.9	6332.1
July 97 – June 98	309.8	316.0	517.5	693.1	(175.6)	97.1	601.8
July 98 – June 99	95.1	95.6	410.7	531.6	(109.3)	43.4	451.1

Note: a. NRITA – Non-resident Investment Taka Account
b. 1 US Dollar as on 30th June, 1999 = Taka 48.50
Source: SEC annual reports, 1998-99

Table 3. Unconditional Distribution Statistics for Dhaka Stock Exchange Daily Returns.

	DLSEI (Sep.1986-Dec.1990)	DLSEI (Jan.1991-Nov.1999)	DLSEI (Sep.1986-Nov.1999)
Mean (In percent)	0.04	0.02	0.02
Std. Dev. t-statistics	0.01 (1.03)	0.02 (0.46)	0.02 (0.89)
Skewness[1] t-statistics[2]	6.94 (95.64*)	-1.35 (-26.00*)	0.11 (2.58*)
Kurtosis[3] t-statistics[4]	143.9 (NA)[5]	31.29 (281.97)	49.66 (NA)[5]
No. of observation	1139	2384	3524
Excluding the period July1,1996-December 31 1996.			
	DLSEI (Sep.1986-Dec.1990)	DLSEI (Jan.1991-Nov.1999)	DLSEI (Sep.1986-Nov.1999)
Mean (In percent)	0.04	0.02	0.02
Std. Dev. t-statistics	0.01 (1.03)	0.02 (0.32)	0.02 (0.65)
Skewness[1] t-statistics[2]	6.94 (95.64*)	22.05 (425.67*)	22.93 (544.07*)
Kurtosis[3] t-statistics[4]	143.9 (NA)[5]	839.48 (NA)[5]	992.65 (NA)[5]
No. of observation	1139	2237	3378

- Significant at 1 percent level,

1/ The value of the skewness coefficient for normal distribution is equal to zero. The distribution of returns skews to left if it has negative value and to the right if it has positive value.
2/ t=(S'-0)/SE (S') where SE (S')= square root (6/n).
3/ The value of the kurtosis coefficient for normal distribution is equal to 3.
4/ t=(K'-3)/SE (K') where SE (K')= square root (24/n).
5/ The significance level of this t-statistics is not applicable.

Table 4. Estimates for AR (1)-GARCH (1,1)-M Model for Dhaka Stock Exchange Daily Returns (Sample period; Sep.1986-Nov. 1999 and the two Sub-periods)

The whole Sample Period Sep.1986-Nov. 1999 and the Subperiods			
	Sep.1986-Dec.1990	Jan.1991-Nov.1999	Sep.1986-Nov.1999
(p,q)	(1,1)	(1,1)	(1,1)
AR(1) Coefficient	-0.19 (-5.51*)	0.02 (0.53)	-0.07 (-2.77*)
δ_1	-0.25 (-10.31*)	-0.08 (-4.52*)	-0.1072 (-6.89*)
α_0	1.09e-7 (1.04)	1.63e-005 (8.51*)	8.02e-006 (14.14*)
α_1	0.19 (12.23*)	0.31 (10.58*)	0.30 (14.73*)
β_1	0.90 (181.1*)	0.72 (42.84*)	0.78 (87.31*)
$\alpha_1+\beta_1$[1 2]	1.09 (52.76*)	1.03 (2.08)	1.08 (27.39*)
$I(\theta)$[3]	4882.69	9135.54	13945.26
S.E.E[4]	0.01	0.02	0.02
Regression Coefficient Of actual on predicted	1.02 (0.17)	1.00 (10.67*)	0.79 (10.11*)
Jarque-Berra test of normality of residuals	1370900	618514.5	3312758
Brench-Goldfry LM test[5]	Significant	Significant	Significant
Ljung-Box Q test[5]	Significant	Significant	Significant
Number of observations	1139	2383	3524

Table 4 (Continued)

With exclusion of the period July,1,1996-Dec.31,1996			
	Sep.1986-Dec.1990	Jan.1991-Nov.1999	Sep.1986-Nov.1999
(p,q)	(1,1)	(1,1)	(1,1)
AR(1) Coefficient	-0.19 (-5.51*)	-0.32 (-9.89*)	-0.32 (-13.19*)
δ_1	-0.25 (-10.31*)	-0.19 (-23.84*)	-0.19 (-25.07*)
α_0	1.09e-7 (1.04)	0.00 (14.24)	0.00 (21.46*)
α_1	0.19 (12.23*)	5.40 (18.00*)	4.45 (21.20*)
β_1	0.90 (181.1*)	0.10 (8.02*)	0.13 (9.64*)
$\alpha_1+\beta_1$[1] [2]	1.09 (52.76*)	5.51 (232.36*)	4.58 (303.11*)
$I(\theta)$[3]	4882.69	7827.93	12393.17
S.E.E[4]	0.01	0.02	0.02
Regression Coefficient Of actual on Predicted	1.02 (0.17)	1.00 (3.16*)	1.00 (3.46*)
Jarque-Berra test of normality of residuals	1370900	3.43e+8	8.92e+8
Brench-Goldfry LM test[5]	Significant	Significant	Significant
Ljung-Box Q test[5]	Significant	Significant	Significant
Number of Observations	1139	2237	3377

*indicates statistical significance at 1 percent level.

1/ The Sum of $\alpha_1+\beta_1$ represents the change in the response function of shocks to volatility per period. If $\alpha_1+\beta_1=1$, a current shock persists indefinitely in conditioning the future variance. If $\alpha_1+\beta_1>1$ then the response function of volatility increases with time. If $\alpha_1+\beta_1<1$ this means that shocks decay with time, the closer to unity value of the persistence measure, the slower is the decay rate. In all periods, $\alpha_1+\beta_1$ is significantly greater than 1, However, it is not too far from unity, which means that the volatility increases over time. However the exclusion of the period July1, 1996-Dec.31, 1996 extremely increased the summation of α_1 and β_1 which make the volatility extremely increasing over time. Except this change(and the change of the sign of the AR(1) in the second period), the exclusion of the period July1, 1996-Dec.31, 1996 does not affect the results.

2/ Chi-Squared (1) test value.

3/ Indicates the estimated maximum likelihood function values.

4/ Standard Error of the regression.

5/Tests for autocorrelation of residuals up to 120 lags for the first period and 320 lags for the second and the total data set.

Table 5. Estimates for AR (1)-GARCH (1,1)-M Model for Dhaka Stock Exchange Daily Returns (With Lock-in, Withdraw of lock-in, and Circuit breaker of 10% and 5% Multiplicative Dummies)

Panel 1 (Sample period; January 1991-November 1999)					
Dummy	D1[1]	D2[2]	D3[3]	D4[4]	D5[5]
(p,q)	(1,1)	(1,1)	(1,1)	(1,1)	(1,1)
AR(1) Coefficient	6.58e-003 (0.201)	0.01 (0.33)	0.02 (0.51)	0.02 (0.66)	0.03 (0.66)
δ_1	-0.12 (-5.33*)	-0.09 (-4.52*)	-0.08 (-3.77*)	-0.06 (-2.14**)	-0.06 (-2.13*)
δ_{Di}	0.19 (4.00*)	0.53 (3.26*)	-0.43 (-3.32*)	-0.06 (-1.34)	-0.06 (-1.42)
α_0	1.59e-005 (8.15*)	1.61e-005 (7.85*)	1.68e-005 (7.44*)	1.72e-005 (6.79 *)	1.73e-005 (6.78*)
α_1	0.33 (10.18*)	0.32 (9.96 *)	0.31 (10.02*)	0.31 (9.84 *)	0.31 (9.77*)
β_1	0.72 (38.81*)	0.72 (39.54*)	0.72 (37.78*)	0.72 (36.43*)	0.72 (36.71*)
$\alpha_1+\beta_1$[5] [6]	1.05 (422.23*)	1.04 (462.6*)	1.03 (490.81*)	1.03 (490.01*)	1.03 (487.46*)
I(θ)[7]	9143.20	9140.36	9139.65	9136.51	9136.49
R^2-corrected	0.04	0.04	0.04	0.04	0.04
	618514.5	618514.5	618514.5	618514.5	618514.5
S.E.E[8]	0.02	0.02	0.02	0.02	0.02
Regression Coefficient of Actual on Predicted	1.00 (10.67*)	1.005 (10.67*)	1.005 (10.67*)	1.005 (10.67*)	1.00 (10.67*)
Jarque-Berra test of normality of residuals	618514.5	618514.5	618514.5	618514.5	618514.5
Brench-Goldfry LM test[9]	Significant	Significant	Significant	Significant	Significant
Ljung-Box Q test[9]	Significant	Significant	Significant	Significant	Significant
Number of observations	2384	2384	2384	2384	2384

Table 5: (Continued)

Panel 2 (Sample Period: September 1986 - November 1999)					
Dummy	D1[1]	D2[2]	D3[3]	D4[4]	D5[5]
(p,q)	(1,1)	(1,1)	(1,1)	(1,1)	(1,1)
AR(1) Coefficient	-0.06 (-2.73*)	-0.08 (-2.87*)	-0.07 (-2.91*)	-0.07 (-2.56*)	-0.07 (-2.74*)
δ_1	-0.19 (-8.03*)	-0.11 (-7.42*)	-0.10 (-6.90*)	-0.11 (-6.42*)	-0.11 (-6.40*)
δ_{Di}	0.19 (4.08*)	0.54 (3.71*)	-0.32 (-2.77*)	7.47e-003 (0.22)	0.01 (0.34)
α_0	8.04e-006 (14.56*)	7.98e-006 (14.23*)	8.07e-006 (14.25 *)	8.00e-006 (14.28*)	7.99e-006 (14.15*)
α_1	0.30 (14.96*)	0.30 (14.59*)	0.30 (15.59*)	0.30 (14.70*)	0.30 (15.34*)
β_1	0.78 (92.55*)	.78 (87.20*)	0.78 (92.25 *)	0.78 (84.96*)	0.78 (91.05*)
$\alpha_1+\beta_1$[6] [7]	1.08 (1234.97*)	1.08 (1202.26*)	1.08 (1362.73*)	1.08 (1222.44*)	1.08 (1332.29*)
I(θ)[8]	13953.37	13950.84	13948.14	13945.28	13945.31
R^2-corrected	0.03	0.03	0.03	0.03	0.03
F-Test, Structural Change[9]	27.19 Unstable	27.19 Unstable	27.19 Unstable	27.19 Unstable	27.19 Unstable
S.E.E[10]	0.02	0.02	0.02	0.02	0.02
Regression Coefficients of actual on predicted	0.79 (10.12*)	0.79 (10.12*)	0.79 (10.12*)	0.79 (10.12*)	0.79 (10.11*)
Jarque-Berra test of normality of residuals	3312758	3312758	3312758	3312758	3312758
Brench-Goldfry LM test[11]	Significant	Significant	Significant	Significant	Significant
Ljung-Box Q test[11]	Significant	Significant	Significant	Significant	Significant
Number of observations	3524	3524	3524	3524	3524

* indicates statistical significance at 1 percent level.

1/ The dummy D1 (represents Lock-in versus Lock-out) assumes value equal to 1 from Feb. 11, 1995 till July 7, 1996; and zero otherwise.

2/ The dummy D2 (introducing first Circuit breaker of 10%) assumes value equal to 1 from October 8, 1996 till Nov. 5, 1996; and zero otherwise.

3/ The dummy D3 (second Circuit breaker of 5%) assumes value equal to 1 from Nov. 6, 1996 through Dec. 31, 1996; and zero otherwise.

4/ The dummy D4 (representing the third Circuit breaker of 10%) assumes value equal to 1 from Jan. 1997 till 15th of Nov. 1999; and zero otherwise.

5/ The Dummy D5 (represents all Circuit breaker) assumes value equal to 1 from October 8, 1996 till Nov. 15, 1999; and zero otherwise.

6/ The Sum of $\alpha_1+\beta_1$ represents the change in the response function of shocks to volatility per period. If $\alpha_1+\beta_1=1$, a current shock persists indefinitely in conditioning the future variance. If $\alpha_1+\beta_1>1$, then the response function of volatility increases with time. If $\alpha_1+\beta_1<1$ this means that shocks decay with time, the closer to unity value of the persistence measure, the slower is the decay rate. In all periods, $\alpha_1+\beta_1$ is significantly greater than 1, However, it is not too far from unity, which means that the volatility increases over time.

7/ Chi-Squared (1) test value.

8/ Indicates the estimated maximum likelihood function values.

9/ F- test is conducted to test the stability of the series before and after Dec. 30 1990.

10/ Standard Error of the regression.

11/Tests for autocorrelation of residuals up to 120 lags for the data in the first panel and up to 320 lags for the data in the second panel.

Appendix A : Highlight of Bangladesh Stock Exchanges

Bangladesh has two Stock Exchanges, Dhaka Stock Exchange (DSE), established in 1954 where trading is conducted by Computerized Automated Trading System and Chittagong Stock Exchange (CSE), established in 1995 which is also conducted by Computerized Automated Trading System. All exchanges are self-regulated, private sector entities which must have their operating rules approved by the SEC. Some of the basic data of the two stock exchanges are shown below.

Trading Characteristics	**Dhaka Stock Exchange**	**Chittagong Stock Exchange**
Date of incorporation	April 28, 1954	April 01, 1995
Previous name	East Pakistan Stock Exchange Ltd.	None
Commencement of formal trading	1956	October 10, 1995
Trading suspended	1971 during and after liberation war	Not Applicable
Trading resumed	1976 with 9 listed companies	Not Applicable
Number of members	195	124
Active Securities	Average 150	Average 124
Percentage of brokerage	1% (Maximum)	1% (Maximum)
Operation time	10:30 a.m. to 5:00 p.m. [weekdays]	10:30 a.m. to 5:00 p.m. [weekdays]
Trading method	Trading at DSE is done on an Automated Order Matching System	Trading at CSE is done on an Automated Order Matching System
Types of securities traded	Shares, debentures and mutual funds	Shares, debentures and mutual funds
Taxes on transactions	None	None
Number of listed securities		
1990	134	-
1991	138	-
1992	149	-
1993	153	-
1994	166	-
1995	201	72
1996	205	117
1997	222	138
Market Capitalization	**in US $ million**	**in US $ million**
1990	287	-
1991	260	-
1992	308	-
1993	453	-
1994	1044	-
1995	1413	596
1996	4003	1301
1997	1569	1228
All Share Price Index		
1990	293	-
1991	296	-
1992	369	-

Trading Characteristics	Dhaka Stock Exchange	Chittagong Stock Exchange
1993	392	-
1994	846	-
1995	835	-
1996	2300	1157
1997	757	333
Average Trading Volume (number of share in million)		
1993-94	0.04	October 95 – 0.004
1994-95	0.09	June 96 – 0.12
1995-96	0.19	
1996-97	0.42	
Average Trading Value (Million Taka)		
1993-94	8.7	October 95 – 0.74
1994-95	17.4	June 96 – 30.49
1995-96	34.89	
1996-97	126.03	
Netting	Allowed	Allowed
Number of Share Holders	300,000 (approx.)	-

Note: 1 US Dollar as on 30th June, 1999 = Taka 48.50
Source: SEC annual reports, 1998-99

Appendix B: 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 is given below:

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

Previous day's per share market price	**Limits**
1. Upto 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

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.