

VOLATILITY NEXUS BETWEEN STOCK MARKET AND MACROECONOMIC VARIABLES IN BANGLADESH: AN EXTENDED GARCH APPROACH

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Abstract

This paper examines the volatility of the Bangladesh stock market returns in response to the volatility of the macroeconomic variables employing monthly data of general index of Dhaka Stock Exchange (DSE) and four macroeconomic variables (Call Money Rate, Crude Oil Price, Exchange Rate and SENSEX of Bombay Stock Exchange) from January 2001 to December 2015. The results of GARCH-S models reveal that the volatility of DSE return is significantly guided by the volatility of macroeconomic variables, such as, exchange rate and SENSEX. Specifically, volatility of the DSE is expected to 19% increase by 1% increase of exchange rate. Moreover, the volatility of the Bangladesh stock market returns is expected to dampen down by 2% with an increase in the volatility of Indian stock market of 1%. Thus, we can comment that adding exchange rate or stock returns of India in the GARCH model provides significant knowledge about the behaviour of the DSE volatility.

Keywords: Stock Market, Macroeconomic Variables, Volatility, GARCH

JEL classification: C32, C58, G10, G12

1. INTRODUCTION

Volatility has become an important issue since financial and economic theory introduce the notion that consumers are risk averse. As a result, increased risk should realize a reduced level of participation and investment in the stock market activity. Nevertheless, the investors of the stock markets are generally liked to adopt more risk in order to earn more return. So, it goes without saying that a little bit volatility of stock prices is a good sign of any stock market. But the problem is that the stock market of Bangladesh is an up-and-coming market. Bangladesh has two stock exchanges: Dhaka Stock Exchange (DSE) and Chittagong Stock Exchange (CSE). Dhaka Stock Exchange is the oldest and largest stock exchange in Bangladesh. The radical unpredictable nature of DSE is the focal dilemma. The

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stock markets of Bangladesh have been progressed accompanied by the overall economy after the process of liberalization in early 1990s. Besides, the stock market crashes in 1996 and 2011 have been enlightened that it is important to protect the stock market from drastic fluctuations. General Index (DGEN) of DSE dropped to 700 points in November 1997 from its highest 3600 points in November 1996 (Alam, 2012). As a result, regulators taken hundreds of steps to stabilize the market. But once again, the market crashed heavily in 2010-11. The DGEN of DSE fallen to 3616 points in early February 2012 from 8918 points in December 2010 (Alam, 2012). This abnormal phenomenon may prevent the smooth functioning of stock markets of Bangladesh and adversely affect the performance of the economy. Previous studies, like Fama (1981, 1990), Chen *et al.* (1986), Oluseyi (2015), among others, investigate that price volatility in stock market increases owing to the movement of economic variables. Theoretically, the stock market should be closely related to real economic variables of the country. Based on a simple discount model, the fundamental value of a corporate stock is equal to the present value of expected future dividends, thus the future dividends must eventually reflect the real economic activity. So, information on the connection between economic variables and stock prices is decisive to the investors in the equity market as well as to the policy makers. Hasan (2015) argues that Dhaka Stock Exchange is inefficient in weak form as historical stock prices can be used to achieve superior gains. In addition, if the connection between stock prices and economic variables exist, the stock market of Bangladesh will lose its informational efficiency in semi-strong form and will become more volatile.

Hossain and Kamal (2010) and Mazumder (2015) reveal that the stock market strongly influences the economic growth in Bangladesh. Thus, stock market might be one of the leading driving forces of country's economy and prerequisite for development as Bangladesh aspires to be a high-income country by 2041. However, this expected pace of development should not be hindered owing to any false movements in the stock market. Thus, the policy makers of Bangladesh should have sound knowledge about the reasons of stock market volatility and the stock market should be handled with care such that crashes like 1996 and 2011 will not be repeated. Motivated by the importance of this matter, this research is to investigate the volatility of stock market returns in response to the volatility of the macroeconomic variables. There is not a sufficient amount of empirical study worldwide based on macroeconomic approach to test volatility of stock markets (Khan, 2013). Most existing literatures focus on determinants of stock price or stock returns, and not their volatility. Most of studies on Bangladesh stock market use only historical data of stock index to test efficiency and volatility. Macroeconomic approach to test volatility of stock markets for Bangladesh stock market has scarcely done so far. This study is an endeavor to fill this void in literatures by giving trustworthy answer to the following question: Does the volatility of macroeconomic variables influence the stock return volatility? This research is expected to add several primary contributions to the existing literature because a special set of macroeconomic variables is preferred based on reasons rather than randomly selected variables. Moreover, this study would widen the existing literature as local and global macroeconomic variables are used to predict whether the volatility of Bangladeshi stock market is motivated mainly by domestic macroeconomic factors, or global stock markets have some influence on it. Though, Bangladesh capital market is one of the smallest in Asia, it is the third largest one within the south Asian region. Thus, discovering the issue of volatility of the stock market in Bangladesh employing monthly data of domestic and global macroeconomic variables may be helpful to the stakeholders and policy makers of Bangladesh and other emerging markets.

2. LITERATURE REVIEW

Volatility nexus between macroeconomic variables and stock returns is a high flying topic, but we are unable to trace back too much studies on this topic in context of Bangladesh.

[Schwert \(1989\)](#) explores the relationships between the U.S. stock market volatility and real and nominal macroeconomic volatility using monthly data from 1857 to 1987. This research is regarded as one of the pioneer studies in the area. He concludes that macroeconomic volatility (changes in real output and inflation) do not help to predict stock and bond return volatility. However, [Schwert](#), provides evidence that the volatility of financial assets helps to predict future macroeconomic volatility. The study also reveals that financial leverage affects stock volatility and there is a relation between trading activity and stock volatility. So, the overall findings support his claim that the prices of speculative assets should react quickly to new information about economic events. [Chiang and Doong \(1999\)](#) test the relation between stock excess returns and macroeconomic factors volatility of the Taiwan industrial data covering from January 1987 to December 1996 employing the traditional GARCH (1, 1)-M model. The results reject the hypothesis that stock excess returns are independent of the volatility of macroeconomic factors. The study also reveals that the real output volatility is more dominant in explaining the excess returns, although other sources of volatility also have some explanatory power, while the macro volatilities are divided into real (domestic output) and financial (exchange rate) components. [Oseni and Nwosa \(2011\)](#) examine the relationship between the stock market volatility and volatility in macroeconomic variables such as the real GDP, inflation, and interest rate for the periods 1986 to 2010 in Nigeria. By means of AR (k)-EGARCH (p, q) and LA-VAR Granger Causality test, the analysis suggests that there is a bi-causal relationship between stock market volatility and real GDP volatility, while no causal relationship between interest rate and inflation volatility, and stock market volatility. [Parvez and Basak \(2012\)](#) observe the volatility switching of Dhaka stock exchange by transition probability and limiting probability using DSE 20 index data for January 2001 to October 2010. The Limiting Probability or LR Probability is used as an expectation of future manner of the stock market, i.e., how to move or fluctuate in future. From the long run probability, they conclude that Dhaka stock exchange will retain 54% of time in Low Volatility, 35% of time in Medium Volatility and 11% of time in High Volatility. So, the limiting probability alerts about the future investment risk in DSE because the stock markets 11% of time in high volatility state and 35% of time in medium volatility state. [Zakaria and Shamsuddin \(2012\)](#) inspect the relationship between stock market returns volatility in Malaysia with five selected macroeconomic volatilities (IPI proxy for GDP, CPI proxy for INF, ER, IR and M2) based on monthly data from January 2000 to June 2012 using GARCH (1, 1) models and bivariate, and multivariate VAR Granger causality tests along with regression analysis. The results from bivariate VAR Granger causality tests show that only volatility in CPI and IR are significantly Granger caused the volatility in stock market returns. The result from both tests reveal that the volatilities of macroeconomic variables as a group also does not Granger cause volatility in stock market returns. The result from regression analysis shows that only money supply volatility is significantly related to stock market volatility. [Oluseyi \(2015\)](#) investigates the link between stock market prices volatility and macroeconomic variables (IPI, CPI, M2, ER and interest rate) volatility in Nigeria using monthly data for a period of January 1990 to December 2014. The results from bivariate VAR Granger causality tests and regression analysis show that volatility in ER and CPI significantly Granger-cause the volatility in stock market prices. GARCH (1,1) model reveals that volatility

in exchange rate, interest rate and money supply influenced the volatility in stock market prices in Nigeria.

3. METHODOLOGY

3.1 Variable selection and justification

A special set of macroeconomic variables is chosen for this study based on logics rather than randomly selected variables. This study uses monthly data of DSE General Index (DGEN) as a proxy of stock prices, Call Money Rate (CM) as a proxy of interest rate, Crude Oil Price (OP), Exchange Rate (ER) and Bombay (Indian) Stock Exchange index (SENSEX) covering the period from January 2001 to December 2015 (180 monthly observations). The data are collected from secondary sources, such as, the central library and official website of Dhaka Stock Exchange, Monthly Economic Trend issued by Bangladesh Bank (BB), and official website of Bombay Stock Exchange. The analysis is done by using the EViews 9.1 econometric software packages.

Dhaka Stock Exchange is the country's leading stock exchange and benchmark index of DSE covers majority of the stocks in the country. Before 28 January 2013, DSE used three indices named All Share Index (DSI), General Index (DGEN) and DSE-20 Index where DGEN was treated as a benchmark. However, on January 28, 2013, DSE has been introduced two new indices which are known as the DSE Broad Index (DSEX) and DSE 30 Index (DS30) based on free float and S&P methodology. Now, DSEX is considered as the benchmark index in DSE. Since, DGEN calculation has been stopped from August 2013, this study uses DSEX for the period of August 2013 to December 2015. The benchmark index (DGEN or DSEX) perfectly reflects the behavior of the overall stock market of Bangladesh as well as of different portfolios. Other than money supply, interest rate is the most used macroeconomic factors to determine the stock returns. This study uses call or notice money rate as a proxy of interest rate. The economic theories assert that there is an inverse relationship between share price and interest rate. It is often argued that the price of oil must be incorporated in any list of systematic factors that influence stock market prices (Chen, Roll and Ross 1986). Rising oil prices results lower corporate sales and profits that directly dampens stock prices through dividends. Foreign Exchange Rate (ER) is the dominant macroeconomic variable that is extensively used to find impacts on a domestic stock market. The study uses monthly average Taka (Bangladesh currency) per U.S dollar exchange rate as foreign exchange rate. The flow or traditional approach concentrates on the trade balance and asserts that a depreciation improves country's external competitiveness and thus its trade balance, and ultimately real output. As a result, the profitability and expected cash flows of firms will increase and thus stock returns. Dekker *et al.* (2001) argue that markets with strong economic ties and close geographic proximity are more closely linked than the isolated market. That is why this study selects SENSEX from Bombay Stock Exchange (BSE) of Indian stock market. The BSE is the oldest stock exchange in Asia and premier stock exchange in India. The measurement procedure of the variables for the univariate and multivariate volatility models are stated in Table no. 1.

Table no. 1 – Measurement procedure of the variables

Variables Name	Symbol	Monthly Returns/Changes
General index of DSE (Proxied for Share Prices of Bangladesh Stock Market)	DGEN	$LNDGEN_t - LNDGEN_{t-1}$
Call Money Rate (Proxied for Interest Rate)	CMR	$LNCMR_t - LNCMR_{t-1}$
Crude Oil Price	OP	$LNOP_t - LNOP_{t-1}$
Exchange Rate	ER	$LNER_t - LNER_{t-1}$
Bombay Stock Exchange Index (Proxied for Share Prices of Indian Stock Market)	SENSEX	$LNSENSEX_t - LNSENSEX_{t-1}$

3.2 Research methods

This subsection discusses the methodological procedures that are applied in this study. Descriptive statistics are operated to provide a general understanding of the empirical features of the variables. Moreover, the leptokurtosis characteristics of the variables can be also noticed through the kourtosis value. In addition, the rejection of the normality test based on Jaque-Bera test gives evidence for the existence of GARCH effects ([Kirchgässner and Wolters, 2007](#)).

Since, GARCH procedures are stationary processes, we have to make sure that both the return series are stationary. Thus, we have applied two extensively used unit root test, namely Augmented Dickey Fuller (ADF) and Phillips-Peron (PP) test. The ADF test is performed using the following equation:

$$\Delta Y_t = \alpha + \beta T + \gamma Y_{t-1} + \delta_i \sum_{i=1}^m \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

where α is a intercept (constant), β is the coefficient of time trend T , γ and δ are the parameters where, $\gamma = \rho - 1$, ΔY is the first difference of Y series, m is the number of lagged first differenced term, and ε is the error term. The test for a unit root is conducted on the coefficient of Y_{t-1} in the regression.

The PP test is modified from Dickey-Fuller test so that serial correlation does no longer affect their asymptotic distribution. The PP test test is performed using the following equation:

$$\Delta Y_t = \alpha + \beta T + \gamma Y_{t-1} + \varepsilon_t \quad (2)$$

where α is a constant, β is coefficient of time trend T , γ is the parameter and ε is the error term.

In order to estimate whether the volatility of the macroeconomic variables incorporated in this study have any impact on stock market volatility in Bangladesh, the multivariate GARCH-S(1,1) model is used in this study as [Bollerslev \(1986\)](#), [Engle \(1993\)](#) and [Brooks and Burke \(1998\)](#) argue that standard GARCH (1,1) model is sufficient to capture all of the volatility clustering that is present from the data. Volatility is one of the most important concept in the finance and economics as measured by the standard deviation or variance of return. Financial and economic time series usually exhibits some peculiar characteristics, such as, leptokurtosis and volatility clustering. These characteristics cannot be explained with linear models. The most popular non-linear financial models are the autoregressive

conditional heteroskedasticity (ARCH) and generalized ARCH (GARCH) models used for modeling and forecasting volatility. The ARCH model is developed by Engle (1982) in order to account for a time-varying variance that is usually associated with high frequency financial and economic data. The study pays no attention to ARCH (p) model as the model fits financial time series well only with a large number of lags. The study employs an extended version of ARCH model named, GARCH model (Bollerslev, 1986) in view of the fact that GARCH is a parsimonious representation of higher order ARCH model. Moreover, Alexander (2001) argues that ARCH models are not often used in financial markets because the simple GARCH models perform so much better.

One of the extended versions of GARCH-X model, GARCH-S model is used to examine the impact of each individual macroeconomic variable included in this study on the stock market return volatility. Lee (1994) provides an extension of the standard GARCH model linked to an error-correction model of cointegrated series to the conditional variance equation. This model is known as the GARCH-X model. According to Lee (1994), the GARCH-X model is useful for examining how the short run disequilibrium affects uncertainty in predicting cointegrated series. The conditional variance equation of GARCH-X model can be expressed mathematically as follows:

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

where λ_n measures the effect of short run deviations from the long run relationship of the cointegrated variables.

As like Alshogheathri (2011), we use GARCH-S model (an extended versions of GARCH-X model) in order to examine the impact of individual macroeconomic variable on the stock market return volatility by substituting the first difference of each macroeconomic variable, ΔX_{nt-1} as a replacement for Z_{t-1}^2 term. The GARCH-S model can be expressed mathematically as follows:

$$h_t^2 = \omega + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j h_{t-j}^2 + \lambda_n \Delta X_{nt-1} \quad (4)$$

where S represents ΔX_{t-1} , and parameter λ_n is expected to account for the previous impact of the explanatory variables on the movements of the stock returns.

Equations 5-8 register the four GARCH-S (1,1) models to account the volatility of DGEN (Bangladesh stock market returns) for the impact of logged first differences of the independent variables namely, CMR, OP, ER, and SENSEX respectively. Thus, the variance equations of the four model takes the following form:

$$h_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}^2 + \lambda \Delta CMR_t \quad (5)$$

$$h_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}^2 + \lambda \Delta OP_t \quad (6)$$

$$h_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}^2 + \lambda \Delta ER_t \quad (7)$$

$$h_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}^2 + \lambda \Delta SENSEX_t \quad (8)$$

The performance of the estimated GARCH models is evaluated by using Ljung-Box test statistics, for instance $Q(p)$ and $Q^2(P)$. These tests examine the null hypothesis of no autocorrelation and homoscedasticity in the estimated residuals and squared standardized residuals up to a specific lag respectively. ARCH LM test is also used to test the null hypothesis of no remaining ARCH effects up to a specific order.

4. EMPIRICAL RESULTS

Table no. 2 covers basic descriptive statistics that reveals that DGEN and SENSEX grew a faster rate than other variables with at an average of 1.1% and 1% per month respectively over the period studied. Looking at the standard deviation of the growth series, it is obvious that CMR remained more volatile than other variables. The returns of the stock markets (DGEN and SENSEX) yielded both profits and losses to investors, while unconditional standard deviations show that returns of DGEN was more volatile than SENSEX. The P-values associated with Jarque-Bera statistics indicate that none of the variables are normally distributed. The kurtosis of all the variables are more than 3 suggesting that the returns of DGEN and SENSEX, and growth of macroeconomic variables exhibit leptokurtosis, a well-known stylized fact in the finance literature. Since the variables not normally distributed, we should follow a GARCH process to model our time series. Table no. 3 reports the results of ADF and PP unit root tests which reveal that the null hypothesis of unit root is strongly rejected at one percent significant level for all of the variables. It confirms that all of the return series are stationary. Since, all of the series are stationary, we can follow GARCH processes.

Table no. 2 – Summary statistics

	DGEN	CMR	OP	ER	SENSEX
Mean	0.011112	-0.003742	0.006451	0.002110	0.010044
Median	0.007601	-0.004115	0.016185	0.000000	0.011157
Maximum	0.264057	1.798494	0.344259	0.052644	0.248851
Minimum	-0.363546	-1.404510	-0.336056	-0.024133	-0.272992
Std. Dev.	0.077248	0.343757	0.086617	0.008966	0.069079
Skewness	-0.438645	0.236849	-0.708515	2.704325	-0.531839
Kurtosis	6.600119	9.106098	6.035687	15.33463	4.894444
Jarque-Bera	102.4066	279.7533	83.70763	1352.916	35.20578
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	179	179	179	179	179

Table no. 3 – ADF and PP unit root test results of the variables

Variables	ADF		PP		Remarks
	Intercept	Trend & Intercept	Intercept	Trend & Intercept	
DGEN	-13.10903*	-13.17986*	-13.10871*	-13.17990*	No Unit Root
CMR	-16.57956*	-16.53868*	-16.57956*	-16.53868*	No Unit Root
OP	-9.174711*	-9.170989*	-8.922804*	-8.890375*	No Unit Root
ER	-10.78297*	-10.84293*	-10.78297*	-10.84718*	No Unit Root
SENSEX	-11.98445*	-11.95296*	-12.07898*	-12.04653*	No Unit Root

Note: * indicates significance at 1% percent level based on MacKinnon 1% critical values.

Table no. 4 reports the results of variance equations of the four GARCH-S (1,1) models. The study reveals that the constant term ' ω ' of model 2, 3 and 4 are positive and significant at 1% level. Both ' α ' and ' β ' are not significant for model 1 (or model 2) indicate that including changes in the CMR (or OP) in the variance equation does not produce the appropriate model to account volatility on the Bangladesh stock market. The λ associated with CMR and OP suggest that changes in interest rate and oil price had no significant impact on the volatility of the DSE returns over the sample period.

Table no. 4 – Impact of macroeconomic variables volatility on the volatility of DSE returns

Coefficients	Model 1	Model 2	Model 3	Model 4
ω	0.004413 (0.0684)	0.005394 (0.0159)	0.002077 (0.0013)	0.002930 (0.0001)
α	0.099020 (0.2634)	0.093080 (0.2737)	0.024207 (0.5760)	0.045867 (0.3353)
β	0.163135 (0.7074)	0.003043 (0.9937)	0.576054 (0.0000)	0.523436 (0.0000)
$\alpha + \beta$	0.26	0.10	0.60	0.57
$\lambda \Delta \text{CMR}$	-0.002301 (0.0688)	-	-	-
$\lambda \Delta \text{OP}$	-	0.005822 (0.3477)	-	-
$\lambda \Delta \text{ER}$	-	-	0.190365 (0.0001)	-
$\lambda \Delta \text{SENSEX}$	-	-	-	-0.018449 (0.0000)
Q(1)	(0.410)	(0.428)	(0.253)	(0.378)
Q(6)	(0.654)	(0.724)	(0.572)	(0.423)
Q(12)	(0.533)	(0.495)	(0.428)	(0.426)
Q2(1)	(0.949)	(0.856)	(0.521)	(0.726)
Q2(6)	(0.998)	(0.997)	(0.923)	(0.933)
Q2(12)	(0.549)	(0.681)	(0.9607)	(0.743)
ARCH LM (1)	(0.9499)	(0.8579)	(0.5284)	(0.7285)
ARCH LM (6)	(0.9987)	(0.9974)	(0.9315)	(0.9381)
ARCH LM (12)	(0.5552)	(0.6330)	(0.9827)	(0.5785)
AIC	-2.261443	-2.249492	-2.290691	-2.239899
SIC	-2.190217	-2.178265	-2.219464	-2.168672
LL	206.3992	205.3295	209.0168	204.4710

Note: P-values are in brackets, For the parameters, P-values are associated with Z-statistics, and for diagnostic fitting, P-values are associated with Q and chi-square statistics.

The GARCH term ' β ' are highly significant for model 3 and 4. Thus, models 3 and 4 are the appropriate models to account volatility on the DSE returns and that volatility in the present period also influences volatility in the next period. The sum of the ARCH and GARCH coefficients is less than one which implies that the unconditional variance of ε_t or h_t^2 is stationary. The sum of the ARCH and GARCH coefficients also measures the persistence of volatility and this is not very close to 1 means that a shock to the Bangladesh stock market volatility does not last a long time. Model 3 estimates the impact of exchange rate volatility on the volatility of Bangladesh stock market returns. A highly significant λ associated with ER suggests that changes in exchange rate had a positive impact on the

volatility of the DSE returns over the sample period. This result indicates that the volatility of the Bangladesh stock market returns is expected to increase by 19% with an increase in the exchange rate of 1%. Model 4 presents the GARCH-S (1,1) estimation to account the impact of Indian stock market volatility on the volatility of Bangladesh stock market returns. A highly significant λ associated with SENSEX implies that Bombay stock index's volatility had a negative impact on the volatility of the DSE returns over the sample period. Thus, the volatility of the Bangladesh stock market returns is expected to dampen down by 2% by an increase in the volatility of Indian stock market of 1%. Thus, the volatility spillover effect appears between Indian and Bangladesh stock market.

It is found that predicting the Bangladesh stock market returns volatility greatly depends on the changes that appear in the domestic and international macroeconomic factors specifically, exchange rates, call money rate and the Indian stock market index. A positive and statistically significant relationship exists between exchange rate and stock returns implying that higher volatility in exchange rate increases the stock return volatility in Bangladesh. The result supports the traditional approach which states that depreciation improves country's trade balance and finally real output. As a result, the profitability and expected cash flows of firms increase and thus stock returns. Call money rate and stock returns of India have the inverse and statistically significant relationship with stock returns of Bangladesh, it means that rise in the volatility of call money rate leads towards decrease in stock market volatility. Specifically, the results suggest that a rise in interest rate dampens the stock market activities as people generally switch their capital from stock market to banks when interest rate rises. Finally, the volatility spillover effects become visible between Indian and Bangladesh stock market due to the increasing trade relations and financial flows between the two nations.

The estimated models meet conditions of the GARCH theory based on Ljung -Box Q statistics and ARCH-LM tests up to lags 12 as Ljung-Box Q and Q^2 suggest that DSE returns do not suffer from autocorrelation and its squared residuals show no independence. Moreover, ARCH tests proof that the models remove conditional heteroskedasticity up to 12 lags.

5. CONCLUSIONS

In this study, we employ four GARCH-S (1,1) models to examine the effects of macroeconomic variables on stock return volatility in Bangladesh using monthly data from January 2001 to December 2015. The descriptive statistics show that all of the variables do not follow normal distribution and the variables exhibit leptokurtosis. The ADF and PP test results show that the monthly return series of all variables are stationary. Thus, we then proceed an extended version of GARCH-X model named GARCH-S model. The results of four GARCH-S models indicate that including one exogenous macroeconomic variable such as ER or SENSEX in the variance equation produces significant GARCH parameters. The sum of α and β is not close to one implies that the time-varying volatility of the DSE returns is moderately persistent including ER or SENSEX in the variance equation. In terms of diagnostic fit, the estimated models satisfy conditions of the GARCH theory based on Ljung -Box Q and Q^2 statistics and ARCH-LM tests up to 12 lags.

This study reveals that there is a significant positive relationship between the changes in exchange rate and the volatility of DSE returns. This result indicates that with an increase in the exchange rate of 1%, the volatility of the Bangladesh stock market returns is expected to increase by 19%. This result is in the line with the flow or traditional approach, which

asserts that a depreciation improves country's external competitiveness and thus its trade balance, and ultimately real output. As a result, the profitability of firms increases with an increase in the exchange rate or depreciation and thus volatility of DSE stock returns increases. This result also implies that international trade plays an important role in Bangladesh and specifically for the companies listed on the stock market. Finally, we find that there is a significant negative relationship between the volatility of Indian stock market (SENSEX) and the volatility of Dhaka stock exchange returns. This result suggests that with an increase in the volatility of Indian stock market of 1%, the volatility of the Bangladesh stock market returns is expected to dampen down by 2%. Thus, the volatility spillover effect is present between Indian and Bangladesh stock market, and it agrees with the common notion that the financial markets are highly interdependent with each other because of rapid globalization and liberalization. The implication of these results is that adding ΔER or $\Delta SENSEX$ in the GARCH model provides significant knowledge about the behavior of the DSE volatility. It is concluded that predicting the Bangladesh stock market returns volatility heavily depends on volatility of exchange rate and Indian stock market returns. Therefore, policymakers may need to take these macroeconomic variables into account when formulate policies to develop a less volatile securities markets.

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