CIU Journal | 2(1) 19–38

An Empirical Study of Volatility in Chittagong Stock Exchange

Emon Kalyan Chowdhury [1]

Abstract

The Main objective of this study is to exhume the nature of volatility in Chittagong Stock Exchange (CSE). It also aims to measure the impact of selective macro-economic factors on volatility. For this study, data have been collected from the websites of CSE and The World Bank from 2009 to 2018. To test the volatility and the impact of macro-economic variables, Generally Autoregressive Conditional Heteroscedasticity (GARCH) and Vector Autoregression (VAR) have been applied. The stationarity of the data has been verified with Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. This study finds that both GARCH (1,1) and VAR models can successfully forecast the volatility movement in CSE. Although inflation, money supply, and flow of remittance have significant and positive impact on the volatility, the interest rate has negative and significant impact on volatility in CSE. It is also observed that residuals are conditionally heteroskedastic. Shocks on macro-economic variables have direct influence on volatility. Appropriate implementation of recommended policies can turn this highly potential market in to a strong platform for economic growth of this nation.

Keywords

ARCH, GARCH, stock market, VAR, volatility

Introduction

Stock market plays a significant role in the development of trade and economy of a country. People invest in the stock market intending to earn return. They invest in different stocks to diversify the risk of overall investment. The average return of the portfolio is known as expected return. On the other hand, the return of the overall industry or market portfolio is known as market return. The variation between expected return and market return is known as dispersion. The measure of dispersion of stock return is known as volatility. This stock market volatility has long been a research topic to many researchers in

[1] Associate Professor, CIU Business School, Chittagong Independent University, Chattogram, Bangladesh.

Corresponding author:
Emon Kalyan Chowdhury, Associate Professor, CIU Business School, Chittagong Independent University, Chattogram, Bangladesh.
Email: emonkalyanchy@ciu.edu.bd

the world. Both policy makers and market practitioners are very concern about stock market volatility. Policy makers emphasize on the impact of different factors on the volatility and its spillover effect, whereas market practitioners want to know the impact of volatility on the stock prices and hedging of stock market instruments (Corradi, Distaso, & Mele, 2012). Heston (1993) observed that stock market volatility derives from the correlation between exogenous unobservable factors and the asset returns. Market becomes highly volatile during boom economy and less volatile during recession (Hamilton & Lin, 1996). Engle (1982) developed Autoregressive Conditional Heteroscedasticity (ARCH) model which allows the difference of the error term to vary over time opposite of standard time series regression. Bollerslev (1986) contributed to the development of Generalized ARCH (GARCH) which eases the modelling of financial econometrics. It can explain time wavering volatility over long periods and therefore can provide a highly acceptable sample estimate (Franses & Dijk, 1996). Floros (2008), Kim and Kon (1994), and Sentana and Wadhwani (1992) found that ARCH and GARCH models are successful in clarifying the volatility of mature stock markets. Contrary, for structural inference and policy analysis, the VAR model is used. Structural analysis is conducted considering the specific assumptions of the variables. Impulse response function indicates the reaction of any dynamic system against the selective external forces and forecasts error variance decompositions. Campbell, Lo, and MacKinlay (1997); Tsay (2002); and Mills and Markellos (2008) provided necessary guidelines on the VAR model. They successfully applied the model to forecast stock market volatility using financial data. There is nothing to argue that, existence of efficient capital market gears up the economic progress of a country. Two major crashes in Bangladesh within one and half decades clearly indicate that Bangladesh capital market is not stable and efficient. The recent catastrophe in the capital market has distraught the whole country as millions of people became insolvent within a very short span of time (Star, 2019).

Chittagong Stock Exchange

CSE is one of the important stock exchanges in Bangladesh. Official trading in CSE began on October 10, 1995. Earlier, the trading procedure in CSE was manual. It was known as cry-out system. However, CSE converted its manual transaction process to automation on June 2nd, 1998. Recently, CSE has become a demutualized exchange. It is a proud partner of United Nation's sustainable stock exchange initiative. Total capitalization of CSE is over 30 billion US dollars. CSE has 311 listed companies spreading over twenty different sectors (Chittagong Stock Exchange, 2018). CSE introduced CSE Selective Categories' Index (CSCX) back in 2004. This index is highly representable and excludes securities which remain suspended for more than six months to ensure the stability of index. CSE authority reviews this index every six months (CSE Selective Categories' Index, 2017).

Problem Statement

Bangladesh, with high population density and very limited natural resources, is going ahead with an envying economic growth rate of more than 7 percent. She has ensured the highest economic growth among the 26 countries in the last 10 years. On the other hand, the stock index has dipped below 5000 points leaving the general investors wrinkled (Star, 2019). Bangladesh Equity Market is also expanding in terms of listing of companies and investors. The volatile nature of stock market is a serious concern for investors, policy makers, regulatory bodies, government and other related parties. Investors earn abnormal returns when market tends to fly high and lose significant portion when it tends to decline. In this situation, knowing the nature of stock market volatility and the influence of different macro-economic factors on the volatility has become a serious concern for all. This study will test whether the volatility of CSE is predictable or not and to what extent the selective macro-economic factors influence the volatility.

Research Questions

This research will find the answers to the following questions

a) Does volatility of one period spillover following periods?
b) Do macro-economic factors influence the volatility in CSE?
c) Can GARCH and VAR models estimate the volatility in the CSE?
d) Does shock on external factors influence the volatility in CSE?

Literature Review

Although volatility is a great challenge for the sustainable development of the stock markets, there are many countries which are doing extremely good despite having volatile stock market. The absence of rigorous control over the securities market and business operations is mainly responsible for not having a sound securities market (Wei, 2005). Islam and Chowdhury (2015) observed that Bangladesh stock market has two-fold problems. In one side, most of the investors do not have necessary stock market literacy, so they aspire huge profits within fortnight and do not stay for long time and thus make the market volatile. On the other side, absence of proper monitoring, bureaucratic tangles of stock exchanges and controlling authorities discourage reputed companies to raise required capital from stock market. Being a rumor driven stock market, few people gain significant margin through stock price manipulations (Star, 2019, p. B1). Both financial and economic theories postulate that the relation between stock market volatility and macro-economic variables diverges for many reasons.

Consumer Price Index (CPI) measures the price fluctuation of market basket of consumer goods and services of households. CPI has direct impact on stock market trading. The relation can properly be explained by developing stochastic approach. When economy of a country turns down, the company's business also turns down and earning per share becomes low and the stock

price falls down and vice-versa. Schwert (1981) found negative impact of CPI on S&P composite portfolio, Pearce and Roley (1985) found no association between CPI and stock market reaction, whereas Subhani, Guland Osman (2010) found significant association between CPI and KSE-100 index trading volume in Pakistan.

Monetary authority in an economy controls the supply of money by applying different methods like changing reserve requirements, interest rates, and buying and selling government securities. Increase in money supply results in inflation and it increases the rate of return. The high expected rate of return decreases the value of firm; therefore, decreases the share prices and vice versa. Hsing (2011) examined the impact of money supply on US and South Africa's stock market and found positive relation between them. Ogbulu and Uruakpa (2011) also found the same positive impact of money supply on Nigerian stock market.

Commercial deposit rates and the stock market movement are very important factors of economic growth of a country. The relation between interest rates and stock market movement is highly influenced by government policy, monitory policy, financial securities valuation, and risk management practices. Uddin and Alam (2010) found significant negative correlation between interest rate and share price in Dhaka Stock Exchange.

Stock price movement is also influenced by the flow of remittances. Remittance is the transfer of monetary items by immigrants to their home country (Azeez & Begum, 2009). It plays a significant role in the economic development of a country (Aggarwal, Demirguc, & Peria, 2006). If financial system is developed and works out properly, it ensures more remittances (Acosta, Baerg, & Mandelman, 2009).

There are very few studies found in Bangladesh measuring the impact of macro-variables on the volatility and no study was found on the impact of inflation, money supply, interest rate and flow of remittances on the volatility in CSE. Rahman and Hossain (2008) examined the nature of volatility in Dhaka Stock Exchange. They found that excessive volatility and fluctuations in stock price do not indicate the real financial position of a company and the frequent price variations discourage investors to participate in the market. Islam and Ahmed (2015) measured the impact of stock market crush on the volatility of Dhaka Stock Exchange using GARCH-M (1,1). They found negative correlation between risk and return. The model exhibited the presence of influence of stock market crush on the volatility. Roni, Wu, Jewel, and Wang (2017) applied GARCH model to measure volatility on Dhaka Stock Exchange and observed that the index volatility characteristics are changeable over time and a risky stock gives a very low return. They noticed irrational behavior of investors in this stock market. However, they observed efficient applicability of GARCH model in forecasting the stock market volatility in Dhaka Stock Exchange.

The above analysis postulates that the volatility in stock market depends on behavior of different macro-economic factors. The behavior pattern of macro-economic factors varies from place to place so does its impact on the

volatility (Flannery & Protopapadakis, 2002). This study will give an in-depth idea about the nature of volatility in CSE and will measure the impact of four factors namely Consumer Price Index (CPI), Broad Money Supply (BMS), Deposit Interest Rate (DIR), and Flow of Remittances (FOR) on volatility. The outcome of this study will add significant value to the existing literature and undoubtedly benefit the concerned stakeholders at both micro and macro levels.

Data and Methodology

To conduct this study, ten years' weekly data set of CSCX Index, Consumer Price Index, Broad Money Supply, Deposit Interest Rate, and Flow of Remittances have been considered from 2009 to 2018. Data have been collected from the websites of CSE and The World Bank. The objective of this study is to test the applicability of GARCH and VAR to forecast volatility and to measure the impact of macro-economic variables on the volatility in CSE. It also aims to verify the impact of shocks on different variables towards the volatility. The justification for choosing the variables has been stated below:

CSCX	This index includes stocks belonging to all the sectors and the authority reviews the selection process twice in a year thus ensures appropriate representation and effectiveness.
CPI	Inflation erodes the purchasing capacity of investors. It accentuates variation in the stock market return. Growing inflation removes capital from stock market to money market as interest rates increase due to inflation.
BMS	Excessive supply of money results in inflation and thus negatively effects the stock return.
DIR	Interest rate has significant impact on stock exchange. It plays vital role in framing monitory policy, risk management practices, financial securities valuation and government policy towards financial markets.
FOR	Higher flow of remittance enhances the demand for stocks. It has positive impact on the stock index movement. If flow of remittance decreases, people try to fill the gap by taking away the funds from the stock market thus decrease the index.

Both Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) Unit Root tests have been applied to check the stationarity of the data. To check the volatility spillover, ARCH has been used, whereas GARCH and VAR models have been used to check the impact of macro-economic factors on the stock return. To check the stability of the results of GARCH model, correlogram

squared residual, Jarque-bera statistics and heteroskedasticity tests have been used, whereas for that of VAR, LM autocorrelation test, normality test, and residual heteroskedasticity test have been applied. Finally, to check the impact of shocks on the variables toward the volatility in CSE, impulse response function has been used.

Results and Discussion

Empirical Results

All the variables have been examined to check whether they have unit root or not. After applying ADF and PP unit root tests, the following results have been obtained for each variable:

Table 1. Data Stationarity Test Result

Test Statistic	Stationarity at	CSCX	BMS	CPI	DIR	FOR
ADF	level		-5.35633			
	1st diff.	-8.71475		-8.34373	-27.9935	-5.32226
	Prob.	0.000	0.000	0.000	0.000	0.000
PP	level		-5.39402			
	1st diff.	-22.1502		-24.545	-27.9935	-21.3262
	Prob.	0.000	0.000	0.000	0.000	0.000

All data have been found stationary at first difference except BMS under ADF and PP test statistics. Therefore, further analysis is possible converting selective data into first difference. Both GARCH (1,1) and VAR have been applied using the data below.

GARCH model (1,1)

In (1,1) model, first one is ARCH term and second one is GARCH term. It has two equations. For this study, the equations have been developed as follows:

Mean Equation: To construct the equation, CSCX index and CPI for 10 years ranging from 2009 to 2018 has been considered.

$$CSCX = C_1 + C_2 * CPI + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

CSCX: CSE Selective Categories' Index

C_1: Constant

C_2: Coefficient of CPI

CPI: Consumer Price Index

ε: Residual

Mean equation (1) generates the following residuals of CSCX:

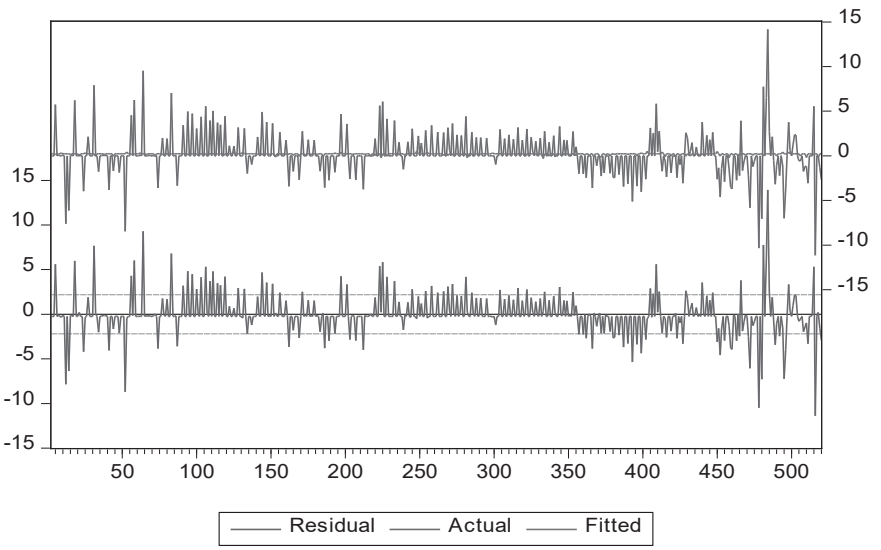

Figure 1. Residuals of CSCX index

Figure 1 indicates that a small volatility causes another small volatility and a big volatility causes another big volatility in the long-run. This nature of volatility allows to introduce ARCH and GARCH model. The market was normal from 70th week to 460th week and was volatile before and after that period. The reason behind this volatility was political unrest in Bangladesh. State of emergency was declared and military took power of the country in 2007. The inflow of foreign remittance increased. Investors tried to find alternative investment sectors to invest their savings and found stock market as an attractive alternative. Total number of Beneficiary Owners (BO) account holders on 20th December, 2010 was 3.21 million; in contrast, it was 1.25 million in December 2009. Total 238 brokerage houses were operating with 590 branches at 32 districts. Banks and other financial institutions of Bangladesh had a lot of excess liquidity due to less business opportunities in the recession period of 2009-10. To minimize the cost of bearing excess liquidity, the financial institutions and its officials took loan and invested in the share market. This made a huge influx of liquidity in the share market. Khaled (2011) observed that the weekly transaction in the share market was on an average from Taka 20,000 to 30,000 million in 2010 and the figure was double comparing to 2009. To grow the economy of Bangladesh by 7% to 8% per year Bangladesh Bank, adopted accommodative monetary policy during the high inflation periods to support investment. Although the policy increased exports, the investment was misguided and ended up blowing the mother of all bubbles. Then government permitted whitening of black money through tax breaks and schemes. Bangladesh Security and Exchange Commissions (BSEC) was not capable to monitor the market conditions properly. Due to the poor monitoring and market surveillance share prices of Z Category Companies and small companies increased dramatically. As the institutions and banks started selling

their shares in 2010, the turnovers at both the bourses reached at the highest level in the history (Raisa, 2011). However, it is observed that low volatility is followed by low volatility and high volatility is followed by periods of high volatility. This suggests that residual or error is conditionally heteroskedastic and it can be represented by ARCH and GARCH model.

Variance Equation: Residual derived from equation (1.1) is used to construct variance equation. Variance repressors such as BMS, DIR and FOR are considered as volatility contributors. The variance equation is stated as follows:

$$GARCH\ (H_t) = C_3 + C_4 * H_{t-1} + C_5 * e^2_{t-1} + C_6 * CPI + C_7 * BMC + C_8 * DIR + C_9\ FOM \quad \text{.....(1.2)}$$

Where,

H_t : Variance of the residual (error term) derived from equation (1.1). It is also known as current day's variance of CSCX or volatility.

C_3 : Constant

H_{t-1} : Previous day's residual variance or volatility of CSCX. It is known as GARCH term.

e^2_{t-1} : Previous period's squared residual derived from equation 1.1. It is also known as previous day's CSCX index information about volatility. It is ARCH term.

CPI : Consumer Price Index

BMS: Broad Money Supply

DIR : Deposit Interest Rate

FOR : Flow of Remittances

Equation (1.2) is a GARCH (1,1) model that refers to first order of ARCH term and first order of GARCH term. Higher order GARCH (2,1) can be applied, but many experts and econometricians prefer to use GARCH (1,1) for modeling the volatility of stock index. Both mean equation (1.1) and variance equation (1.2) have been applied under normal gaussian distribution, student's t with fixed degree of freedom and generalized error distribution assumption as below:

Table 2. GARCH (1,1) Results

*GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*BMS + C(7)*DIR + C(8)*FOR*

	Normal Gaussian Distribution				Student's t with Fixed Degree of Freedom				Generalized Error Distribution			
Variable	Coeff	SE	z-Stat	Prob.	Coeff	SE	z-Stat	Prob.	Coeff	SE	z-Stat	Prob.
C	0.000	0.000	4.237	0.000	0.000	0.000	4.310	0.000	0.000	0.000	3.522	0.000
RESID(-1)^2	1.143	0.175	6.523	0.000	1.151	0.158	7.293	0.000	1.332	0.297	4.492	0.000
GARCH(-1)	0.090	0.058	-1.568	0.000	0.088	0.041	-2.125	0.000	0.068	0.076	-0.885	0.000
BMS	1.767	0.005	337.659	0.000	1.773	0.004	396.366	0.000	1.767	0.003	546.857	0.000
DIR	-1.096	0.013	-86.895	0.000	-1.093	0.013	-86.621	0.000	-1.098	0.011	-103.036	0.000
FOR	0.242	0.010	23.446	0.000	0.240	0.011	21.391	0.000	0.242	0.012	19.921	0.000

(Table 2 Continued)

(Table 2 Continued)

	Normal Gaussian Distribution	Student's t with Fixed Degree of Freedom	Generalized Error Distribution
R-squared	0.87	0.87	0.86
Adjusted R-squared	0.869	0.869	0.859
S.E. of regression	0.198	0.198	0.205
Durbin-Watson stat	0.016	0.016	0.015
Mean dependent var	8.9	8.9	8.9
S.D. dependent var	0.547	0.547	0.547
Akaike info criterion	-1.679	-1.611	-2.085
Schwarz criterion	-1.621	-1.554	-2.02
Hannan-Quinn criter.	-1.656	-1.589	-2.06

In Table 2, it is clearly observed that under three distributions, both ARCH and GARCH are significant. It means that previous day's CSCX volatility information can influence next day's CSCX volatility. The ARCH and GARCH are internal shock that influence the volatility of CSE. It is also observed that both BMS, FOR and DIR have significant impact on the volatility. Since, CSCX index can be best explained by CPI, BMS and FOR properly, it may be recommended to follow GARCH (1,1) under the above distribution to forecast CSCX stock returns if the model satisfies the following conditions:

a) the data distribution should be free from serial correlation,
b) residuals should have normal distribution, and
c) data should be free from arch affect

Serial correlation has been tested using correlogram squared residual, normality of data distribution through Jarque-bera statistics and arch affect through heteroscedasticity test. The results are summarized in Table 3, Table 4 and Figure 2.

Table 3. Correlogram Squared Residual

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|. |	.|. |	1	0.013	0.013	0.0834	0.773
.|. |	.|. |	2.0000	-0.0060	-0.0060	0.1021	0.9500
.|* |	.|* |	3.0000	0.1050	0.1050	5.8816	0.1180
.|. |	.|. |	4.0000	0.0260	0.0240	6.2384	0.1820
.|. |	.|. |	5.0000	0.0050	0.0060	6.2530	0.2820

Table 4. Heteroscedasticity Test: ARCH

F-statistic	0.08248	Prob. F(1,516)	0.7741
Obs*R-squared	0.082787	Prob. Chi-Square(1)	0.7736

Mean	0.0532	Skw	0.03378
Median	-0.019	Kut	8.828
Max	5.4091	JB	734.74
Min	-4.4321	Prob.	0.0000
Std. Dev	0.94153		

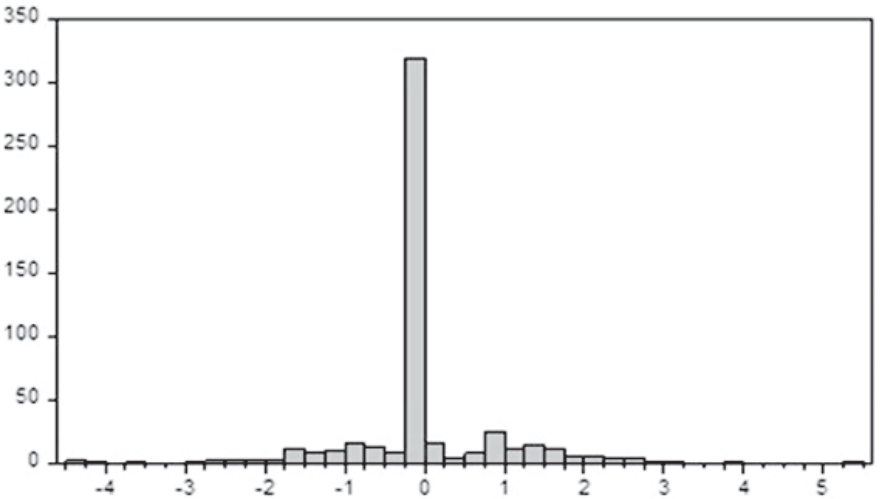

Figure 2. Jarque-Bera Statistics

The above results indicate that there is no serial correlation as the probability values are more than 5%. The heteroscedasticity test results indicate that the GARCH (1,1) model has no ARCH affect as the p-values are more than 5%. However, the Jarque-Bera statistics indicate that residuals are not normally distributed as the p-values are less than 5%. Although the residuals are not normally distributed, the model is acceptable as the estimators are consistent and this may be applied for forecasting.

VAR model

First of all, the prime objective is to find out the appropriate lag order for the model, so that the estimation is accurate and free from errors related to auto-correlation. Although there are many statistical criteria for selecting lag length, Akaike Information Criterion (AIC) has been applied and it suggests that the lag order is 6 as shown in Table 5. Considering lag 6, a VAR model has been identified as exhibited in Table 6. To check the robustness of the model, LM autocorrelation test, normality test, and heteroscedasticity test of VAR residuals have been applied and shown in Table 7, Table 8 and Table 9 respectively. Table 10 shows stability test of roots of characteristic polynomial of estimated VAR model. All the results ensure the stability of the model.

Table 5. Test Statistics and Choice Criteria for Selecting the Order of the VAR Model

Lag	LogL	LR	AIC
0	-5582.4	NA	21.86851
1	-3534.76	4047.199	13.9521
2	-3496.01	75.8412	13.89826
3	-3457.77	74.07482	13.84647
4	-3379.85	149.4328	13. 63935
5	-3330.54	93.61911	13.54417
6	-3305.11	47.75612*	13.54252*
7	-3292.72	23.05096	13.59184
8	-3276.21	30.36557	13.62508

LR: sequential modified LR test statistic (each test at 5% level), AIC: Akaike Information Criterion

Table 6. Vector Autoregression Estimates

	CSCX	CPI	DIR	BMS	FOR
	0.014	0.001	0.003	0.074	0.024
	-0.046	-0.001	-0.008	-0.545	-0.013
CSCX(-1)	[0.30869]	[1.30112]	[0.33604]	[0.13493]	[1.83540]
	0.122	-0.001	-0.015	0.109	0.015
	-0.046	-0.001	-0.008	-0.547	-0.013
CSCX(-2)	[2.67970]	[-0.92453]	[-1.75709]	[0.19991]	[1.18915]
	0.204	-0.001	-0.001	0.233	0.010
	-0.046	-0.001	-0.008	-0.548	-0.013
CSCX(-3)	[4.44593]	[-0.84206]	[-0.08472]	[0.42409]	[0.74098]
	-0.010	0.000	-0.005	0.047	0.000
	-0.046	-0.001	-0.008	-0.549	-0.013
CSCX(-4)	[-0.21965]	[0.41518]	[-0.60165]	[0.08555]	[0.01798]
	-0.051	0.000	0.007	0.104	0.000
	-0.047	-0.001	-0.008	-0.557	-0.013
CSCX(-5)	[-1.08684]	[0.39200]	[0.87813]	[0.18692]	[-0.03182]
	-0.027	0.000	-0.006	-0.138	0.017
	-0.047	-0.001	-0.009	-0.562	-0.013
CSCX(-6)	[-0.57312]	[-0.35882]	[-0.66225]	[-0.24550]	[1.30658]
	-0.363	-0.109	0.454	-41.157	0.313
	-2.019	-0.045	-0.368	-24.187	-0.571
CPI(-1)	[-0.17995]	[-2.41625]	[1.23384]	[-1.70167]	[0.54863]
	-1.284	-0.128	1.093	-11.088	0.150
	-2.033	-0.045	-0.370	-24.355	-0.575
CPI(-2)	[-0.63150]	[-2.81896]	[2.95195]	[-0.45524]	[0.26157]
	1.127	0.082	0.090	6.439	0.896
	-2.011	-0.045	-0.366	-24.091	-0.569
CPI(-3)	[0.56056]	[1.82196]	[0.24552]	[0.26726]	[1.57508]

(Table 2 Continued)

(Table 2 Continued)

	CSCX	CPI	DIR	BMS	FOR
	-0.743	0.288	-0.331	9.689	0.620
	-2.008	-0.045	-0.366	-24.054	-0.568
CPI(-4)	[-0.36994]	[6.41650]	[-0.90386]	[0.40281]	[1.09218]
	0.842	0.047	-0.100	32.072	-0.028
	-2.074	-0.046	-0.378	-24.839	-0.587
CPI(-5)	[0.40617]	[1.01678]	[-0.26473]	[1.29121]	[-0.04856]
	-2.699	0.132	-0.748	8.591	-0.499
	-2.058	-0.046	-0.375	-24.650	-0.582
CPI(-6)	[-1.31174]	[2.87791]	[-1.99688]	[0.34851]	[-0.85798]
	0.239	-0.004	-0.284	5.190	-0.082
	-0.245	-0.005	-0.045	-2.940	-0.069
DIR(-1)	[0.97446]	[-0.73465]	[-6.35277]	[1.76531]	[-1.18595]
	-0.183	-0.006	-0.131	0.140	-0.108
	-0.239	-0.005	-0.044	-2.868	-0.068
DIR(-2)	[-0.76250]	[-1.10998]	[-2.99770]	[0.04892]	[-1.60023]
	-0.223	0.004	0.182	3.195	0.075
	-0.218	-0.005	-0.040	-2.608	-0.062
DIR(-3)	[-1.02257]	[0.73421]	[4.59900]	[1.22527]	[1.22531]
	0.047	0.002	0.405	0.925	0.077
	-0.219	-0.005	-0.040	-2.618	-0.062
DIR(-4)	[0.21578]	[0.43873]	[10.1632]	[0.3533+7]	[1.24146]
	-0.228	0.005	0.359	4.823	0.092
	-0.235	-0.005	-0.043	-2.814	-0.066
DIR(-5)	[-0.96945]	[1.03596]	[8.39715]	[1.71429]	[1.39172]
	-0.104	0.006	0.153	-0.169	0.029
	-0.243	-0.005	-0.044	-2.906	-0.069
DIR(-6)	[-0.43067]	[1.02555]	[3.47129]	[-0.05819]	[0.42402]
	0.000	0.000	0.000	0.887	0.001
	-0.004	0.000	-0.001	-0.045	-0.001
BMS(-1)	[-0.07196]	[0.59673]	[-0.39450]	[19.6886]	[0.59642]
	-0.003	0.000	0.000	-0.026	-0.001
	-0.005	0.000	-0.001	-0.060	-0.001
BMS(-2)	[-0.59197]	[-0.97221]	[0.05356]	[-0.43517]	[-1.04837]
	0.001	0.000	0.002	0.004	0.003
	-0.005	0.000	-0.001	-0.060	-0.001
BMS(-3)	[0.21957]	[0.70663]	[2.16332]	[0.07442]	[2.42180]
	-0.002	0.000	0.000	0.003	-0.002
	-0.005	0.000	-0.001	-0.060	-0.001
BMS(-4)	[-0.33865]	[1.20298]	[-0.33638]	[0.05296]	[-1.41974]
	0.004	0.000	-0.002	0.017	-0.001
BMS(-5)	-0.005	0.000	-0.001	-0.060	-0.001
	0.000	0.000	0.000	0.108	0.000
	-0.004	0.000	-0.001	-0.045	-0.001
BMS(-6)	[-0.02621]	[1.00138]	[0.27765]	[2.38008]	[0.45009]
	0.079	-0.004	0.029	3.744	0.068
	-0.163	-0.004	-0.030	-1.947	-0.046
FOR(-1)	[0.48591]	[-1.22914]	[0.98761]	[1.92268]	[1.47837]

(Table 2 Continued)

(Table 2 Continued)

	CSCX	CPI	DIR	BMS	FOR
	-0.127	-0.002	-0.040	-2.697	0.168
	-0.163	-0.004	-0.030	-1.947	-0.046
FOR(-2)	[-0.77976]	[-0.68115]	[-1.33543]	[-1.38493]	[3.64516]
	-0.079	0.000	0.011	-0.123	0.126
	-0.161	-0.004	-0.029	-1.931	-0.046
FOR(-3)	[-0.48725]	[0.00208]	[0.36297]	[-0.06345]	[2.76343]
	0.085	0.001	0.033	-1.276	0.170
	-0.161	-0.004	-0.029	-1.926	-0.045
FOR(-4)	[0.52656]	[0.20176]	[1.11830]	[-0.66214]	[3.74745]
	-0.144	-0.002	-0.013	-3.190	0.125
	-0.161	-0.004	-0.029	-1.928	-0.046
FOR(-5)	[-0.89753]	[-0.44597]	[-0.43558]	[-1.65432]	[2.74388]
	0.290	0.002	-0.017	4.786	-0.021
	-0.162	-0.004	-0.030	-1.943	-0.046
FOR(-6)	[1.78752]	[0.67682]	[-0.57422]	[2.46366]	[-0.44878]
	1.004	-0.006	-0.083	54.598	-0.012
	-0.529	-0.012	-0.096	-6.333	-0.150
Constant	[1.89900]	[-0.53852]	[-0.86161]	[8.62072]	[-0.07983]
R-squared	0.096	0.154	0.336	1.000	0.212
Adj. R-squared	0.039	0.102	0.294	1.000	0.163
Akaike AIC	4.422	-3.179	1.016	9.388	1.896
Schwarz SC	4.678	-2.923	1.272	9.644	2.152

Note: Sample (adjusted): 8, 520 included observations: 513 after adjustments, Standard errors in ( ) & t-statistics in [ ]

Table 7. LM Autocorrelation Test

Lag	LRE* stat	Df	Prob.	Rao F-stat	df	Prob.
1	22.82892	25	0.5876	0.9131	(25, 1758.6)	0.5876
2	24.79758	25	0.4738	0.992394	(25, 1758.6)	0.4738
3	32.61847	25	0.1409	1.308279	(25, 1758.6)	0.1409
4	38.45909	25	0.0417	1.545093	(25, 1758.6)	0.0517
5	47.56288	25	0.0042	1.915778	(25, 1758.6)	0.0042
6	22.5488	25	0.6039	0.901824	(25, 1758.6)	0.6039

Table 7 indicates that the errors are not serially correlated as p-values are more than 5%.

Table 8. Normality Test

Component	Skewness	Chi-sq	df	Prob.*
1	0.284671	6.928702	1	0.0085
2	1.50584	193.8758	1	0
3	0.080592	0.555334	1	0.4561
4	2.098757	376.6089	1	0
5	2.787045	664.1313	1	0
Joint		1242.1	5	0

(Table 8 Continued)

(Table 8 Continued)

Component	Kurtosis	Chi-sq	df	Prob.
1	9.750962	974.1761	1	0
2	7.456869	424.5862	1	0
3	7.008254	343.4129	1	0
4	7.403284	414.4379	1	0
5	39.26446	28110.5	1	0
Joint		30267.11	5	0
Component	Jarque-Bera	df	Prob.	
1	981.1048	2	0	
2	618.462	2	0	
3	343.9682	2	0	
4	791.0468	2	0	
5	28774.63	2	0	
Joint	31509.21	10	0	

Table 8 shows that the estimated residuals which have been generated from multivariate normal distribution, have probability value less than 5%, and therefore these are statistically significant at 5% level of significance.

Table 9. VAR Residual Heteroscedasticity Tests

Chi-sq	df	Prob.
1139.213	900	0.000

Table 9 exhibits that the estimated results are not affected by heteroscedasticity problem and calculated value of Chi-sq is 1139.213 with 900 df and statistically significant at 5% level of significance.

Table 10. Stability Test of Roots of Characteristic Polynomial of Estimated VAR Model

Root	Modulus
0.995926	0.995926
0.948132	0.948132
0.877448	0.877448
0.081073 + 0.832049i	0.835989
0.081073 - 0.832049i	0.835989
0.827889	0.827889
-0.77281	0.772806
-0.645484 + 0.353843i	0.7 36108
-0.645484 - 0.353843i	0.736108
0.488668 - 0.530219i	0.72106
0.488668 + 0.530219i	0.72106

(Table 10 Continued)

(Table 10 Continued)

Root	Modulus
-0.235223 - 0.680012i	0.719546
-0.235223 + 0.680012i	0.719546
-0.327498 - 0.633257i	0.71293
-0.327498 + 0.633257i	0.71293
0.136040 + 0.690616i	0.703887
0.136040 - 0.690616i	0.703887
-0.427937 + 0.530799i	0.681819
-0.427937 - 0.530799i	0.681819
0.618600 - 0.250706i	0.667473
0.618600 + 0.250706i	0.667473
-0.620823 + 0.119436i	0.632207
-0.620823 - 0.119436i	0.632207
-0.63066	0.630661
-0.023746 + 0.615116i	0.615574
-0.023746 - 0.615116i	0.615574
0.186511 + 0.520439i	0.552849
0.186511 - 0.520439i	0.552849
-0.065182 + 0.339294i	0.345498
-0.065182 - 0.339294i	0.345498

Table 10 shows that no root lies outside the unit circle and VAR satisfies the stability condition. Therefore, it might be free from outliers and extreme values. In order to validate the dynamics of the variables, the impulse response analysis has been applied. Figure 2 shows the combined graph of the response of CSCX to selective macro factors. It is observed that CSCX has immediate effect on CPI, DIR, BMS and FOM. A shock to CPI decreases the CSCX for the first 3 weeks and it starts to increase till 4th week and again starts declining. However, more shocks on CPI indicates systematic ups and down to the CSCX. The same reaction is observed in other factors as well. It is clearly noticeable that a shock in BMS consistently has negative response to CSCX for the whole period. Thus, the results indicate that innovations or shocks have direct impact on the volatility and it is very much similar to the discussion in the literature review section.

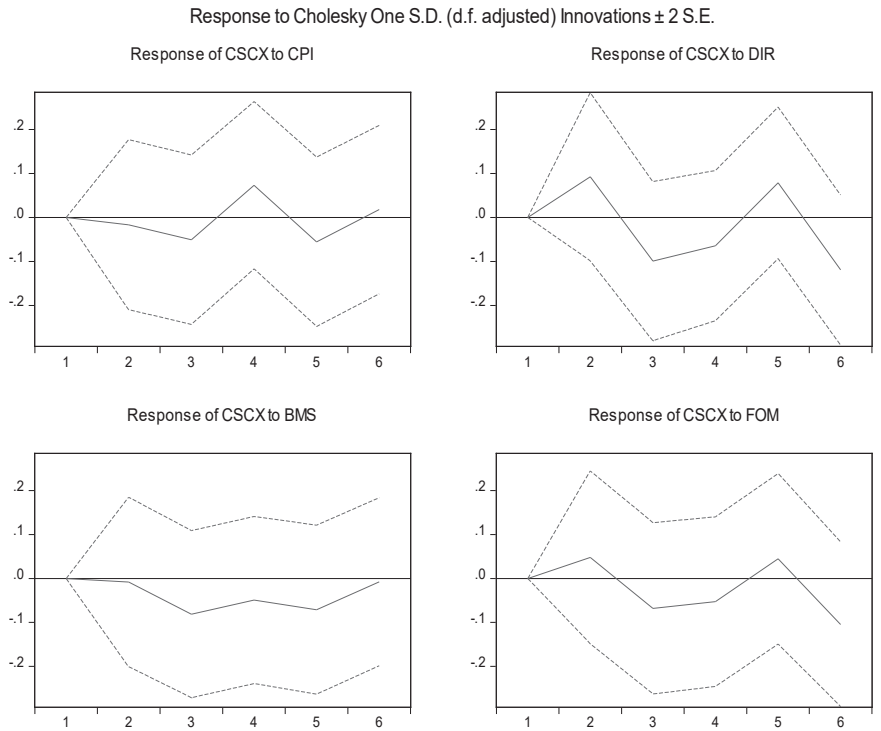

Figure 3. Impulse Response Functions

Therefore, it may be concluded that the above estimates can clearly predict the stock market volatility in CSE.

Discussion and Policy Implications

An efficient and stable stock market significantly contribute to the overall socio-economic development of a country. Bangladesh stock market is a weak-form inefficient market (Hassan & Chowdhury, 2008). Government and regulatory authority jointly tried to stabilize the market but it miserably failed, and the confidence level of investors has gone down to the bottom level (Alam, 2012). Bangladesh stock market has become more unstable over the last decade and the regulators failed to control the volatility (Chowdhury, 2017). Regulators need to take few bold steps to restore the lost confidence of general investors. The portion of IPO for the general investors should be increased at least to fifty percent. Irregularities in the approval of IPO and private placement should be eradicated entirely. This initiative will encourage more potential investors to come to this sector. Mutual funds should not be allowed to give bonus shares to the investors. The lock-in period of sponsors' shares should be increased to keep the market stable. State run companies should be enlisted in the bourses to ensure transparency and accountability. Bangladesh Bank should take stern actions to ensure holding of

excellent quality of assets by its schedule banks so that banks do not pose any threat to the stock market due to liquidity crisis. To avoid such crisis and to keep the portion of non-performing loan at the bottom level, banks are expected to be more careful and strict while providing loans to its clients. To attract more companies with outstanding financial track records, tax gap between listed and non-listed companies should be increased. At the same time, BSEC should remain cautious so that financially weak companies cannot be listed easily. Multiple margins for different sectors will ensure justification. Government can also initiate pro-active role in ensuring a stable market through tapping the growing interest of general people in the market by increasing supply of shares. BSEC itself should be strengthen both in terms of number of manpower and quality of professionals. It should be in a position to conduct high quality independent research to strengthen monitoring capacity and to take effective regulatory decisions in collaboration with different advisory committees, consultation with the representatives from chambers of commerce, stock exchanges, intermediary associations, investors' associations and others related parties to avoid any unexpected conflicts and to achieve the desired goals. To make stock specific information reliable, BSEC should strictly monitor the quality of audited reports so that audit firms are bound to ensure utmost accountability and transparency. Considering the growing interest and demand of general public, facilities of share business should be expanded all over the country and internet based trading facility should be made free of cost to attract more and more young and potential investors. If these suggestions can properly be implemented, the capital market of Bangladesh will not only become a safe investment base for general investors, it will also be a strong and integral part of overall economic development of Bangladesh.

Conclusion

Volatility of stock return in financial market slows down the economic growth of a nation. Being an emerging economy, Bangladesh ensures more than six percent economic growth. Since capital market plays a significant role in gearing up the economic growth of a nation, the market requires to be stable and efficient. It is to be recalled that an efficient and stable stock market keeps the economy free from financial debacles (Lim & Kim, 2008). From this study, it is observed that important factors which are considered to be volatility drivers of any stock markets have significant influence on the volatility in CSE. Mukherjee and Goswami (2017) also observed the similar impact of macro-economic factors on the gold future markets in India. In CSE, previous day's volatility information and index influence the next day's volatility. Shocks on dependent variables have direct impact on the volatility in CSE. Inflation, money supply, interest rates and flow of remittance have significant influence on the index movement. In CSE, GARCH (1,1) and VAR models can successfully estimate the volatility. This research considered only a few selective variables, further studies may be conducted considering other important variables like monetary policy, industrial productions, fiscal policy, inflation, and GDP growth.

References

Acosta, P. A., Baerg, N. R., & Mandelman, F. S. (2009). Financial development, remittances, and real exchange rate appreciation. *Economic Review, Federal Reserve Bank of Atlanta, 94*, 1-15.

Aggarwal, R., Demirguc-Kunt, A., & Martinez Peria, M. S. (2006). Do workers' remittances promote financial development? *World Bank Publications, 3957*(1), 1-41.

Alam, S. G. S. (2012). *Recent trends in capital market of Bangladesh: Critical evaluation of regulation.* (Masters Dissertation, Asian Institute of Technology, MS. Thailand): Asian Institute of Technology. Retrieved from http://www.bankingandfinance.ait.asia/sites

Azeez, K. A., & Begum, M. (2009). International remittances: A source of development finance. *International NGO Journal, 4*(5), 299-304.

Bollerslev, T. (1986). Generalized auto regressive conditional heteroskedasticity. *Journal of Econometrics, 31*(3), 307-327.

Campbell, J. Y., Lo, A. W., & MacKinlay, A. C. (1997). *The econometrics of financial markets. Princeton,* NJ: Princeton University press.

Chittagong Stock Exchange (2018, April 10). Retrieved from http://www.cse.com.bd/historical_market.php

Chowdhury, E. K. (2017). Measuring the effect of macroeconomic variables on the stock market return: Evidence from Chittagong Stock Exchange. *AU-International e-Journal of Interdisciplinary Research, 2*(2), 1-10.

Corradi, V., Distaso, W., & Mele, A. (2012). Macroeconomic determinants of stock market volatility and volatility risk-premiums. *Swiss Finance Institute Research Paper Series* (12-18), (12-18).

CSE Selective Categories' Index, (2017, March 20). Retrieved from http://www.cse.com.bd/share-price-index.php.

Engle, R. F. (1982). Auto regressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. *Econometrica: Journal of the Econometric Society,* 987-1007.

Flannery, M., & Protopapadakis, A. (2002). Macroeconomic factors do influence aggregate stock returns. *The Review of Financial Studies,15*(3), 751-782. Retrieved from http://www.jstor.org/stable/2696720

Floros, C. (2008). Modelling volatility using GARCH models: Evidence from Egypt and Israel. *Middle Eastern Finance and Economics,* (2), 31-41.

Franses, P. H., & Van Dijk, D. (1996). Forecasting stock market volatility using (non-linear) GARCH models. *Journal of Forecasting, 15*(3), 229-235.

Hamilton, J. D., & Lin, G. (1996). Stock market volatility and the business cycle. *Journal of Applied Econometrics,* 573-593.

Hassan, M. K., & Chowdhury, S. S. H. (2008). Efficiency of Bangladesh stock market: Evidence from monthly index and individual firm data. *Applied Financial Economics, 18*(9), 749-758.

Heston, S. L. (1993). A closed-form solution for options with stochastic volatility with applications to bond and currency options. *The Review of Financial Studies, 6*(2), 327-343.

Hsing, Y. (2011). The stock market and macroeconomic variables in a BRICS country and policy implications. *International Journal of Economics and Financial Issues, 1*(1), 12-18.

Islam, A., & Chowdhury, E. K. (2015). Investors' attitude toward stock market risk-a Chittagong perspective. *Portfolio,* (Special Issue), 58-73.

Islam, K. M., & Ahmed, S. F. (2015). Stock market crash and stock return volatility: Empirical evidence from Dhaka Stock Exchange. *Bangladesh Development Studies, 38*(3), 25-34.

Khaled, K. I. (2011). Investigation report of Probe Committee. <https://www.thedailystar.net/news-detail-180800>

Kim, D., & Kon, S. J. (1994). Alternative models for the conditional heteroscedasticity of stock returns. *Journal of Business,* 563-598.

Lim, K. P., Brooks, R. D., & Kim, J. H. (2008). Financial crisis and stock market efficiency: Empirical evidence from Asian countries. *International Review of Financial Analysis, 17*(3), 571-591.

Mills, T. C., & Markellos, R. N. (2008). *The econometric modelling of financial time series.* New York: Cambridge University Press.

Mukherjee, I., & Goswami, B. (2017). The volatility of returns from commodity futures: Evidence from India. *Financial Innovation, 3*(1), 1-23.

Ogbulu, O. M., & Uruakpa, P. C. (2011). Monetary policy and stock prices in Nigeria: A cointegration and error correction approach. *ABSU Journal of Arts, Management, Education, Law and Social Sciences (JAMELSS), 1*(1), 60-85.

Pearce, D. K., & Roley, V. V. (1985). Stock prices and economic news. *Journal of Business, 58*(1), 49-67.

Rahman, M. H., & Hossain, M. S. (2008). Volatility of stock return in the Dhaka Stock Exchange. *The Bangladesh Bank, 38*(3), 25-34.

Raisa, A. (2011, January 21). Behind the scenes the stock market saga. *The Daily Star.* Retrieved from [Internet] <http://www.thedailystar.net/magazine/2011/01/03/cover.htm>[Accessed April 22, 2012].

Roni, B., Wu, C., Jewel, R. K., & Wang, S. (2017). A Study on the volatility of the Bangladesh Stock Market-—based on GARCH type models. *Journal of Systems Science and Information, 5*(3), 193-215.

Schwert, G. W. (1981). The adjustment of stock prices to information about inflation. *The Journal of Finance, 36*(1), 15-29.

Sentana, E., & Wadhwani, S. (1992). Feedback traders and stock return autocorrelations: Evidence from a century of daily data. *The Economic Journal, 102*(411), 415-425.

Star Business Report. (2019, September 3). GDP growth tops 26 countries. *The Daily Star.* Retrieved from https://www.thedailystar.net

Star Business Report. (2019, May 21). Stocks back in red upon rumour. *The Daily Star.* Retrieved from https://www.thedailystar.net

Subhani, M. I., Gul, A., & Osman, A. (2010). Relationship between consumer price index (CPI) and KSE-100 index trading volume in Pakistan and finding the endogeneity in the involved data. *Iqra University Research Centre (IURC),* 1-12.

Tsay, R. S. (2002). *Analysis of financial time series.* Canada: John Wiley & Sons.

Uddin, G. S., & Alam, M. (2010). The impacts of interest rate on stock market: Empirical evidence from Dhaka Stock Exchange. *South Asian Journal of Management Science, 4*(1), 21-30.

Wei, Y. (2005). Development of the securities market and regulation in China. *Loyola of Los Angeles International and Comparative Law Review, 27*(3), 479-514.