Stock Market Crash and Stock Return Volatility: Empirical Evidence from Dhaka Stock Exchange

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This paper empirically investigates the impact of stock market crash on the volatility of Dhaka Stock Exchange stock return of Bangladesh with GARCH-type framework by using data of daily closing stock price indices of (DSE General Index) over the period from 9 November 2004 to 31 July 2013. The results of GARCH-M (1,1) model conclude that conditional standard deviation is negatively related to the level of returns. While this result is not consistent with the theory of a positive risk premium on stock indices, in special circumstances investors may not claim higher risk premium if they are competent enough to bear risk at times of specific volatility. Moreover, the model also confirms that stock market crash affected the volatility of DSE General Index return and there is a propensity for the volatility to erode over time.

Keywords: Dhaka Stock Exchange, Volatility, Crash, GARCH, Bangladesh
JEL Classification: C22, C52, G12, E32

I. INTRODUCTION

Stock market crash is an intense and unanticipated decline of stock market prices for a short period of time which makes market participants panicked and causes significant investment losses to investors. A stock market crash has unpleasant impact on capital which may have long term or permanent effect on the investment climate of the country. It may erode public confidence gradually to invest in stock market. When stock markets crash, everyone becomes very worried, everyone wants to sell and nobody wants to buy in anticipation of further fall in prices. At the individual level, many investors may remain under constant panic and a sense of severe anguish may work in them. When an investor observes that her portfolio has dropped in value, she may decide to pull

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out of stocks altogether and focus on safer, lower-risk investment securities like bonds and notes commonly known as fixed income securities.

Ahmed, Uchida and Islam (2012) state that Bangladesh has experienced two major stock market crashes – one in 1996 and the other in 2010. There was a big bubble in 1996 followed by a catastrophic crash. The index point of Dhaka Stock Exchange (DSE) jumped from about 800 points in June 1996 to around 3,600 points in November 1996. After that, the index began to fall. Large investors left the market with huge profit, leaving the small investors in the situation of sharp price fall with many losing their capital. The burst of the stock market bubble in 1996 created a negative impression in the mind of investors. The market witnessed another severe bout of decline in 2010 that resulted in wiping out even the initial capital investment made by thousands of wretched and ill-fated investors. The aftershocks from the market crash of late 2010 continued to be felt with the index point falling 3,032 points in 2011 and a further 1,038 points in 2012.

Figure 1: DSE daily DGEN index between October 2010 to February 2011
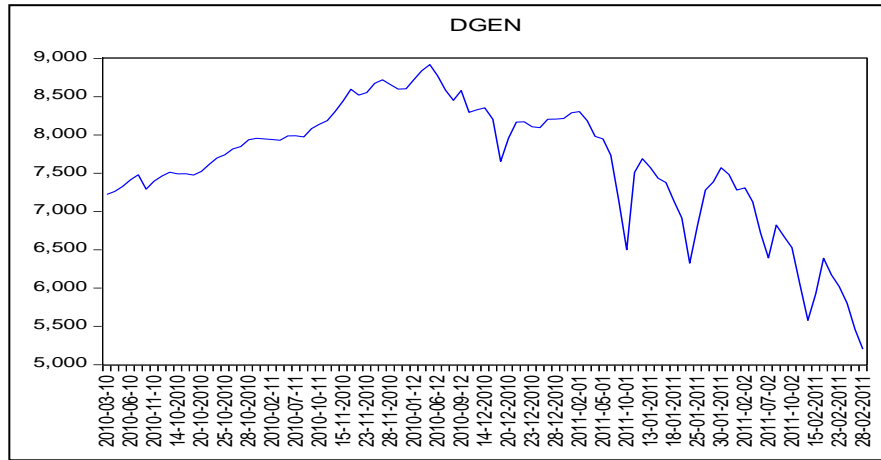
On 5th December 2010, DSE General Index (DGEN) reached its all-time high of 8,918.51 points following a sharp rise in October-November 2010. Subsequently, the DSE witnessed a dramatic decline.

Choudhury (2013) pointed out that lack of restriction on opening beneficiary owner (B/O) accounts, speculation through omnibus accounts, wrong placement of IPOs, violation of banking act, rumour spread by the brokers and the dealers, wrong method used in face value determination and lack of monitoring in the

share market were behind the stock market crash in Bangladesh. In the wake of the dramatic crash of December 2010, a committee commonly known as "*The Probe Committee*" (Khaled 2011) was formed to investigate the stock market scam. The committee accused 60 influential individuals to be responsible for the crash. It found an array of irregularities, including the existence of omnibus accounts that allowed key market players to make excessive profits at the cost of the retail investors.

In Bangladesh, a few studies (Choudhury 2013, Ahmed, Uchida and Islam 2012) have been conducted to explore the reasons and consequences of stock market crashes. Empirical studies on the relationship between stock market crash and stock price volatility is scarce. In this context, the present study aims to answer the following research question: Does stock market crash cause stock price volatility? Using daily data of closing stock price indices of DSE for the period from 9 November 2004 to 31 July 2013, this paper investigates the impact of the stock market crash on the volatility of DSE stock market returns in Bangladesh. This is the first study of its kind for the Bangladesh stock market and we expect that the results of the study will be of interest to investors, policymakers and academics.

II. LITERATURE REVIEW

A number of studies have been conducted around the world regarding stock market crash and stock market return. Choudhry (1996) investigated the volatility of stock markets of Argentina, Greece, India, Mexico, Thailand and Zimbabwe by using monthly data ranging from January 1976 to August 1994. Using GARCH-M model, the study found differences in the ARCH parameter, risk premium and existence of volatility before and after the 1987 crash. The study concluded that the changes vary from market to market.

According to Mishkin and White (2002), stock markets infrequently experience strong and sudden fall of prices, which may take place after a period of strong stock price increases. Their study concluded that the key reasons behind the stock market crash are illogical market behaviour, failure of regulatory authority to supervise the market suitably, excessive liquidity in the market, defective listing system, issuance of right shares and preference shares at high price, stock manipulations by insider trading, lack of knowledge of the investors about the market, avoidance of company basics by the investors and excessive greed of investors to make profit in short duration of times.

Using the daily data of S&P 500 index (closing prices) (American Stock Market Index) which is based on the market capitalisation of 500 large companies having common stock listed on the NEW York Stock Exchange (NYSE) or National Association of Securities Dealers Automated Quotations (NASDAQ) of the period ranging from 4 January 1928 to 13 March 2009, Nikolaos and Scharler (2009) observed a move into high volatility quite some time before the crash, which persists for a considerable period of time even after the crash.

Singh and Makkar (2014) examined the relationship between the financial crisis and stock returns volatility of the Indian banking sector by using daily data of closing stock prices spanning from January 1, 2004 to December 31, 2012. They applied a GARCH model to capture the impact of the crisis on the volatility of banks. Their results found significant impact of crisis on the stock volatility of the Indian banking sector and they claimed that stock return volatility has significantly changed during the pre- and post- crisis period.

Kishor and Singh (2014) examined the impact of the news of the US stock market on the stock returns volatility of the BRICS stock markets through a GARCH model by using daily data of the period starting from 1 January 2007 to 31 December 2013. Based on the estimated results, the authors deduced that the news of the US stock market has significantly affected some of the BRIC countries (e.g., India and South Africa).

Some studies found significant impact of stock market crash on stock return volatility while others highlighted the importance of favourable economic conditions in relation to the stock market crash. Some studies even concluded that news about the stock market significantly affect the stock return volatility. In this backdrop, the present study attempts to empirically investigate the impact of market crash on the volatility of DSE stock market return in Bangladesh.

III. DATA AND EMPIRICAL MODEL

Daily closing stock price indices of DSE in terms of DSE General Index (DGEN) for the period from 9 November 2004 to 31 July 2013 consisting of total observations of 2,074 are used in the study. After reaching the all-time highest point (8,918.5135) on 5 December 2010, DSE General Index (DGEN) witnessed successive falls of index points in later periods (Bhuiyan, 2011). So, the period from 6 December 2010 to 31July 2013 has been considered as crash period. The stock market return (RDGEN) is calculated as the natural log difference of

DGEN: $R_t = \ln\left(\dfrac{PI_t}{PI_{t-1}}\right) \times 100$, where PI_t is the price index at time t and PI_{t-1} is the price index at time *t-1*. The data of DGEN have been collected from different publications of DSE.

This paper examines the impact of stock market crash on the volatility of stock market return of DSE. We employ a model of variances using the generalised ARCH (GARCH) formulation for the study. Bollerslev (1986) introduced the GARCH model that considers the conditional variance as a function of the preceding period's squared errors and conditional variances to explain the volatility evolution of stock-return series. The GARCH models can recognise the tendency for volatility clustering in financial data. Volatility clustering in stock return indicates that large price changes are followed by large price changes and small price changes are followed by small price changes (Brooks 2008).

GARCH-M model, introduced by Engle, Lilien and Robins (1987), allows the conditional mean to depend on its own conditional standard deviation. Therefore, the GARCH-M (1,1) model has the following form:

Mean Equation: $r_t = \mu + \lambda \sigma_t + u_t$ (1)

Variance Equation: $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \delta D_i$ (2)

where, r_t = Index return on day *t*;

σ_t^2 = Variance of the error term;

u_{t-1}^2 = Previous period's volatility (the ARCH term);

σ_{t-1}^2 = Previous period's variance (the GARCH term);

D_i = Dummy variable equal to 1 for observation during crash period and 0 for the rest of the period. This dummy variable for stock market crash is added as an explanatory variable in the conditional variance equation to investigate the impact of stock market crash on the volatility of the DSE stock market return (RDGEN).

The presence of σ_t in equation (1) helps us to study the trade-off between risk and expected return. The coefficient of σ_t, λ, helps to capture the influence of volatility on stock returns. The coefficient, λ, represents the risk premium parameter. A significant positive coefficient, λ, indicates that the investors are

rewarded with higher returns for bearing higher risks (Brooks, 2008). Conversely, a significant negative coefficient, λ, indicates that the investors are penalised for taking risks. Glosten, Jagannathan and Runkle (1993) stated that both positive and negative relationships between current returns and current risks are possible.

From equation (2), it can be said that the current fitted variance, σ_t^2, is a weighted function of a long-term average value (reliant on α_0), information about volatility during the prior period ($\alpha_1 u_{t-1}^2$), the fitted variance from the model during the prior period ($\beta_1 \sigma_{t-1}^2$) and crash dummy (δD_i).The constraints on the coefficients $\alpha_1 \geq 0$ and $\beta_1 \geq 0$ are imposed to make sure that the conditional variance σ_t^2 is positive (Poon 2005).

IV. EMPIRICAL FINDINGS

Table I provides the results of the descriptive statistics of the variables used in the study. From Table I, it is evident that the average daily return for RDGEN is 0.044% during sample period, which is 0.113% before crash period and -0.113% during crash period. The return ranges from -9.33% to 20.38% during sample period, from -7.36% to 20.38% before crash period and from -9.33% to 14.48% during crash period. The risk (standard deviation) per day for RDGEN is 1.71% during sample period, 1.33% before crash period and 2.35% during crash period. RDGEN has positive skewness with test statistic of 0.80 during sample period, 2.32 before crash period and 0.20 during crash period.

TABLE I
DESCRIPTIVE STATISTICS OF RDGEN

Statistics	RDGEN (Full sample period)	RDGEN (Before crash period)	RDGEN (During crash period)
Mean (%)	0.044319	0.113142	-0.113521
Maximum (%)	20.38212	20.38212	14.47989
Minimum (%)	-9.329968	-7.358857	-9.329968
Std. Dev. (%)	1.709637	1.326891	2.353077
Skewness	0.803177	2.316673	0.203167
Kurtosis	18.19833	41.94951	6.895813
Jarque-Bera[a] (*p*-value)	0.0000	0.0000	0.0000
Observation	2,074	1440	634

Note: [a]Under the null hypothesis of a normal distribution, the *p*-values indicate rejection of the null hypothesis, hence deviation from normality.

The test statistic of kurtosis of RDGEN is 18.20 during the sample period, 41.95 before the crash and 6.89 during the crash period (which exceed the benchmark of 3). The Jarque-Bera test shows deviations from normality in all cases.

In order to detect the stationarity of the variable, RDGEN, two popular unit root tests, namely the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, have been applied. The results are presented in Table II.

TABLE II
**THE AUGMENTED DICKEY-FULLER (ADF) AND
PHILIPS-PERRON (PP) TESTS RESULTS**

Variable	ADF Test (Level)		PP Test (Level)		Stationary
	Drift	Drift and Trend	Drift	Drift and Trend	
RDGEN	-44.5586***	-44.5558***	-44.5586***	-44.5558***	Yes

Note: ***Denotes the rejection of null hypothesis that the time-series is non-stationary at 1% significance level.

Both ADF test and PP test confirm that RDGEN is stationary in level at 1% significance level. This means that the variable is suitable for the analysis.

TABLE III
ARCH-LM TEST

Variable	Obs*R-squared	p-value	ARCH effect
RDGEN	85.8859***	0.0000	Yes

Note: *** denotes the rejection of null hypothesis of no ARCH effect at 1% significance level

The ARCH-LM test of RDGEN (see Table III) to detect the ARCH effect in the residuals of mean equation confirms that there exist ARCH effects in the residuals of RDGEN.

Figure 2: Residuals of RDGEN
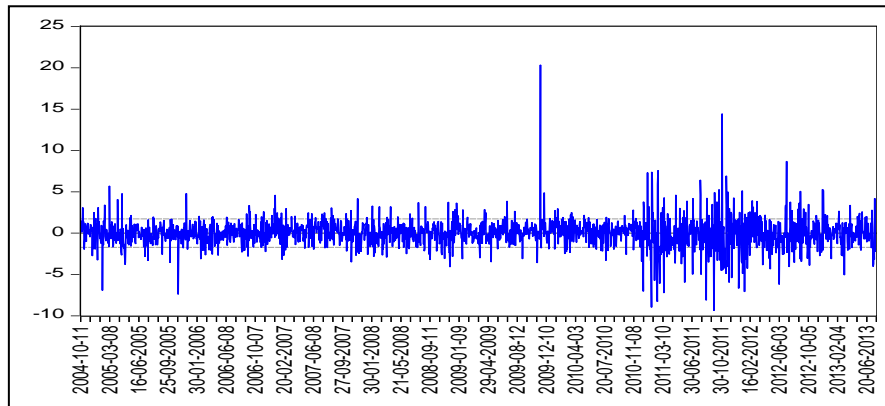
From Figure 2, it is apparent that there is presence of volatility clustering, which indicates that the current level of volatility tends to be positively correlated with its level during the immediate preceding periods. Further, there exist several spikes with high volatility which persist for a number of periods.

The results of GARCH-M (1,1) model are presented in Table IV. The estimated coefficient of conditional standard deviation term on the mean equation is found to be negative and statistically significant at 1% significance level, which indicates that conditional standard deviation used as a proxy for risk of return is negatively related to the level of returns. This result is not consistent with the theory of a positive risk premium on stock indices (Brooks 2008). One plausible explanation of such finding is that in special circumstances investors may not claim higher risk premium if they are better able to bear risk at times of specific volatility. This result is similar to what Glosten *et al.* (1993) reported in their study.

TABLE IV
RESULTS OF GARCH-M (1,1) MODEL ON RDGEN

	GARCH-M(1,1)
Mean Equation	
C	$0.4558 \ (0.0790)^a$
RDGEN(-1)	$0.1423^{***}(0.0228)^a$
λ	$-0.2956^{***} \ (0.0617)^a$
Variance Equation	
C	$0.2659 \ (0.0468)^a$
α_1	$0.2844^{***} \ (0.0418)^a$
β_1	$0.6005^{***} \ (0.0415)^a$
δ	$0.2939^{***}(0.1065)^a$
Diagnostic Checking	
ARCH LM test	$0.0701[0.7912]^b$
Normality test of residuals	51897.35 $(0.000)^b$
Ljung-Box Q Statistic	Significant[**]
Observations	2,074

Notes: [a]Standard errors are in parentheses; [b]*p*-values are in brackets; [**] and [***] denote significance at 5% level and 1% level respectively.

Moreover, the presence of dummy variable in the conditional variance equation is statistically significant and positive by which one can conclude that stock market crash affected the volatility of DSE General Index return. Besides

this, the coefficients on both the lagged squared residual and lagged conditional variance terms in the conditional variance equation are highly statistically significant. The results show that the sum of the estimated coefficients on the lagged squared error and lagged conditional variance (approximately 0.88) is lower than unity which implies a tendency for the volatility response to erode over time. The LM test confirms that there is no ARCH effect after GARCH-M (1,1) estimation as the null hypothesis of no ARCH effect cannot be rejected at 5% level of significance. The normality test of residuals indicates that residuals are not normally distributed and the Ljung-Box Q statistic test confirms that residuals are not free from serial correlations.

V. CONCLUSION AND POLICY IMPLICATIONS

This paper has empirically investigated the impact of stock market crash on stock return volatility of Dhaka Stock Exchange with GARCH-type framework and the persistence of shocks to volatility based on daily closing stock price indices of DSE (DSE General Index) over the period from 9 November 2004 to 31 July 2013. The results of GARCH-M (1,1) model conclude that conditional standard deviation used as a proxy for risk of return is negatively related to the level of returns. One plausible explanation of such finding is that in particular conditions investors may not claim higher risk premium if they are capable enough to tolerate risk at times of specific volatility. Moreover, the presence of dummy variable in the conditional variance equation is statistically significant, which indicates that stock market crash affected the volatility of DSE General Index return and there is a tendency for the volatility response to erode over time.

The implication of this study is that the regulatory authorities such as Bangladesh Securities and Exchange Commission may actively monitor the reasons for stock market crash in Bangladesh and formulate and implement rules and regulations to avoid such collapse in future. The stock market crash destituted a large number of ill-fated small investors who lost almost whole of their investment. Proper remedial incentives to the affected investors and strict legal actions against the convicted people behind the crash may recover the fragile confidence of the investors about stock market.

The study focused on the co-movement of stock market volatility and stock market crash with limited dataset of about ten years only. The analysis relied on only one variable like stock index price, while there are many other factors that may have profound influence on volatility of stock market. Future research may be conducted applying co-integration test and granger causality test to identify

the relationship between stock market volatility and stock market crash along with some additional explanatory variables like political instability, strikes, liquidity crisis and other macroeconomic variables that are likely to influence stork price volatility.

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