“Impact of return on long-memory data set of volatility of Dhaka Stock Exchange market with the role of financial institutions: an empirical analysis”

AUTHORS	Muhammad Mahboob Ali Aviral Kumar Tiwari Naveed Raza

ARTICLE INFO	Muhammad Mahboob Ali, Aviral Kumar Tiwari and Naveed Raza (2017). Impact of return on long-memory data set of volatility of Dhaka Stock Exchange market with the role of financial institutions: an empirical analysis. *Banks and Bank Systems*, *12*(3), 48-60. doi:10.21511/bbs.12(3).2017.04
DOI	http://dx.doi.org/10.21511/bbs.12(3).2017.04
RELEASED ON	Tuesday, 29 August 2017
RECEIVED ON	Thursday, 20 October 2016
ACCEPTED ON	Wednesday, 21 June 2017

JOURNAL	"Banks and Bank Systems"
ISSN PRINT	1816-7403
ISSN ONLINE	1991-7074
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
38	4	3

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10, Sumy,
40022, Ukraine

www.businessperspectives.org

Muhammad Mahboob Ali (Bangladesh), **Aviral Kumar Tiwari** (India),
Naveed Raza (Malaysia)

IMPACT OF RETURN ON LONG-MEMORY DATA SET OF VOLATILITY OF DHAKA STOCK EXCHANGE MARKET WITH THE ROLE OF FINANCIAL INSTITUTIONS: AN EMPIRICAL ANALYSIS

Received on: 20th of October, 2016
Accepted on: 21th of June, 2017

Muhammad Mahboob Ali, Ph.D., Post Doctorate, Professor, Dhaka School of Economics, Bangladesh.

Aviral Kumar Tiwari, Assistant Professor, Faculty of Management, IBS/IFHE Hyderabad, India.

Naveed Raza, Universiti Malaysia Terengganu, Malaysia.

Abstract

The current study intends to empirically test a relationship between long-memory features in returns and volatility of Dhaka Stock Exchange market. As such, the study uses the ARFIMA-FIGARCH and FIPARCH structure for the daily data ranging from 15 December 2003 to July 31, 2013 of Dhaka Stock Exchange market index, i.e., DSE General Index (DGEN). The observed indication assembled from long-memory tests supports the occurrence of long memory in Bangladesh stock returns. The study aims at doing research work with long-memory data set, as it provides a superior strategy, as well as gives real picture with short-memory data set. Moreover, the backup indication for existence of long memory in both return and volatility denies the efficient market hypothesis of Fama (1970) that the future return and volatility values are unpredictable. Extra measures ought to be given for the smooth functioning of the Dhaka Stock Exchange market so that both individual and institutional investors can get congenial atmosphere to invest. Authors' suggested that Bangladesh Bank must play vital role as share market of Bangladesh is dominated by banking shares and in case of other listed shares of the Dhaka Stock Exchange, market authority should deal with transparently and fairly so that the market can be transformed into strong efficient market. This requires suitable directives, groundwork, removing malpractices and also implementation of investors' friendly decisions. Further, fiscal policy of the country should be pro investor friendly, as well as monetary policy should work as complementary towards investment at stock exchange market as suggested by the authors.

Keywords Bangladesh Bank, returns, volatility, Dhaka Stock Exchange, long run memory, monetary policy, fiscal policy

JEL Classification C22, E44, E52, E58

INTRODUCTION

J. M. Keynes argued that strongly suit the capital market must be interlinked with monetary policy where monetary and rate of interest, information symmetry, excessive saving to invest, corporate taxes and exchange rates wholly back by the strengthening process of the capital markets as mentioned by Siegel, 1965. Dhaka Stock Exchange market needs to identify whether there is any linkage with Keynes's view and real life portfolio management by considering long memory data set on volatility.

Stiglitz (2013) argued that monetary policy is of such importance in part, because the financial sector is so important: the financial sector has been likened to the brain of an economy, and if the financial sector does not work well, the economy does not work well. Long-memory data set of return and volatility in stock exchange market over the time period plays imperative part in the economy of the country, especially risk analysis and management, capital investment and situation of market efficiency. Granger (1998) commented that the long-memory finding for volatility does not go against any major financial theory and does not need an explanation. Evans and Speight (2007) opine that the complexity of the volatility response to individual macroeconomic announcements can be assessed through volatility response functions rather than the significance of simple dummy variables for categories of announcement type. Tan and Khan (2010) depicted that the long-memory property exists in both the return and volatility, with and without incorporating the crisis impact. They observed that among the various GARCH type models with different innovation distributions, the Student t-distribution provides better specifications in terms of the long-memory volatility processes. Positive character is that long-lasting financial structures and capital market can simultaneously play in beneficial the modern economic advancement of countries for which financial institutions play harmonizing protagonist of stock market. Chowdhury and Shimon (2008) observed "before crash (1996) bid firms produced almost twice as average return as small firms at the cost of about 2% additional standard deviation. After the crash, the scenario has changed so much that large firms produce higher negative return than small firms". Islam et al. (2015) argued "Debt holders' control of firms with covenants in their indentures may impair the aggressive strategies of the management that ultimately contributes positively to ensure financial excellence".

The total number of listed securities at Dhaka Stock Exchange has increased from 536 in June, 2014 to 555 in June, 2015. At the end of June, 2015 total issued capital of all listed securities stands at Tk. 1, 09,195.35 crore, which was Tk. 1,03,207.64 crore in June, 2014 , registering 5.80 percent growth. Total market capitalization of all listed securities was Tk. 2, 94,320.23 crorein June, 2014, which stands at Tk. 3,24,730.63 crore in June, 2015, representing 10.33 percent increase. DSE introduced its new index benchmark; DSE board Index (DSEx) on January 28, 2013 where the first day closing was 4,090.47 points. DSEx has increased from 4,480.52 points in June, 2014 to 4,583.11 points in June, 2015, showing 2.29 percent up (Bangladesh Bank, 2015–2016). For a developing country like Bangladesh, the importance of sound development of the market cannot be undermined. Although the SEC has been trying to maintain a continuous flow in the market, very often its role meets the broad economic objectives. In order to make the market less volatile, SEC itself should be strengthen both in terms of number of manpower and quality of the professionals involved with special focus on independent research, monitoring mechanism and prompt decision making (Rahman & Moazzem, 2011). Nature of share market of Dhaka Stock Exchange is predominant by banking investment. Moreover, still the capital market of the country is underdeveloped, since no sub sector like debt market and derivatives markets in the country has been yet developed. For long-term financing, in most cases, entrepreneurs need to depend on money market. Fiscal policy is able to influence directly on the share market.

Mukit and Shafiullah (2012) found that Granger causality analysis was unidirectional causality from inflation to DGEN index and money supply to DGEN index. The market was trying to recapture its stable condition by employing different policies since the crash occurred. Of these policies, the use of monetary policy instruments affects the performance of the stock market significantly. The Central Bank influenced stock market performance by targeting monetary policy properly and especially by targeting money supply which was a better predictor of market performance rather than other monetary variables.

As such, monetary policy may have important role. It may be noted that crash of stock exchange market in 2010 at Bangladesh raises the question of the role of the Central Bank's monetary policy. Now we shall see Dhaka Stock Exchange performance from 1990 to 2017 in Figure 1.

Source: http://www.tradingeconomics.com/bangladesh/stock-market (accessed on May 25, 2017).

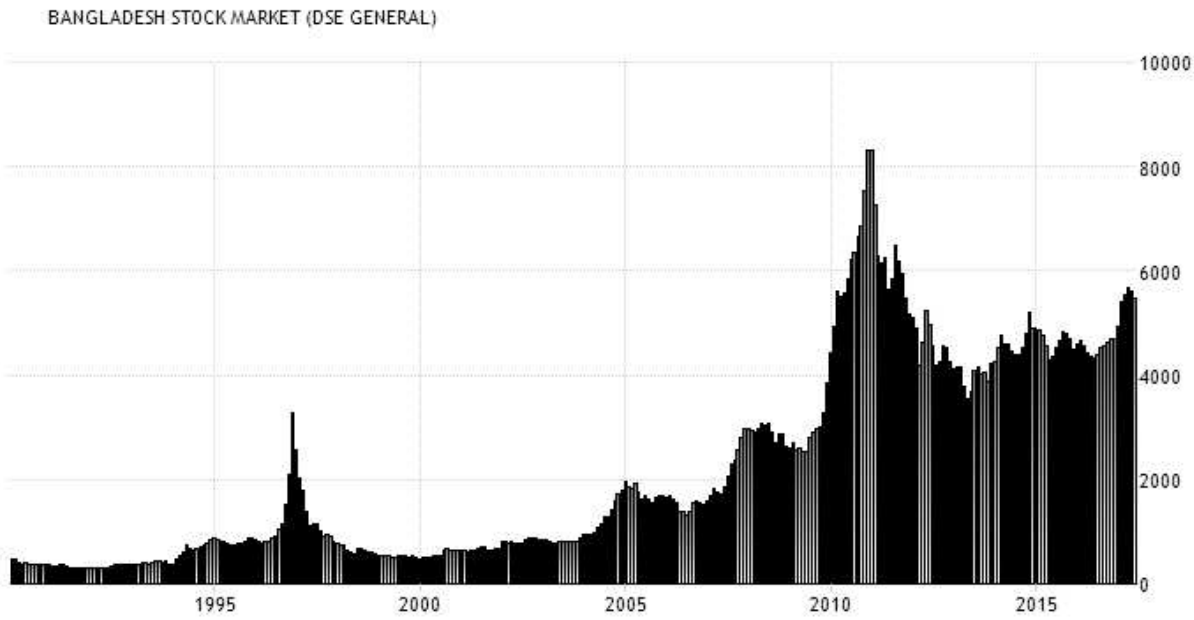

Figure 1. Dhaka Stock Exchange performance from 1990 to 2017

As such, research question of the study is whether testing the long memory data in return and volatility of Dhaka Stock Exchange prevails? This paper also aims to test the long-memory features in return and volatility of DSE General Index (DGEN) with regard to the simultaneous accumulation consequences. The study also tried to see the effect of financial sector with special role of Bangladesh Bank (Central Bank of Bangladesh).

Objectives of the study are given below:

- to observe presence of intermediate memory and whether there is a warning sign for investors to keep these investments in the long run;
- to evaluate long-memory volatility process;
- to examine how predicting the one-step-ahead volatility to measure and manage investment risk;
- to evaluate role of financial institutes through fiscal policy and complementary monetary policy.

The study aims at doing research work with long-memory data set, as it provides a superior strategy, as well as gives real picture with short-memory data set.

The remainder of the paper is organized as follows: section 1 will depict literature review, section 2 will consist of methodology of the study and data analysis. In section 3, estimation of the results will be given. The section 4 reports the discussions, conclusions and implication of the study, while in last section, we will discuss future research direction.

1. LITERATURE REVIEW

Lillo and Farmer (2004) observed that fluctuations in order signs are compensated for by anti-correlated fluctuations in transaction size and liquidity, which are also long-memory processes that act to make the returns whiter. They show that some institutions display long-range memory and others don't.

Ahmed et al. (2006) wrote that "a contractionary monetary policy shock, measured by increase in the short-term policy interest rate, has small negative effect on the stock price index and the effect do not persist for long".

Conrad and Haag (2006) derived necessary and sufficient conditions for the non-negativity of the conditional variance in the fractionally integrated generalized autoregressive conditional heteroskedastic (p,d,q) (FIGARCH) model of the order $p \leq 2$ and sufficient conditions for the general model.

Siddik (2011) depicted that "it would not be wise to label it as inefficient, because market efficiency changes over time and capital market is subject to be tested continuously".

Moazzem and Rahman (2012) described a number of those measures were taken at the behest of major market players, which was unlikely to have long-term implications for the market. A major 'faulty' initiative would be providing financial support to small investors who lost their equity capital in the market.

Rahman and Moazzem (2011) depicted that the vibrant nature of the capital market in 2010–2011 might be due to the increased interest in the market by a large number of individual investors which has been influenced by the government's decision to reduce the bank interest rates for its different types of savings instrument. But the perturbing aspect of this sharp rise is the accompanying increase of "price earnings (P/E) ratio", which is making investment in the capital market risky over time. During July-September 2011–2012, depression strikes again, as SEC step out to take legal action against the suspected investors, weakening financial system, liquidity shortage. Investors protested against it and it results in the relaxation of adjustment timeline for single borrower exposure of merchant bankers (Sarker et al., 2012).

Rayhanet al. (2011) argued that due to inefficient banking system, political interference and loan default culture, cost of capital of bank loan is less than that of share issue, which encourages investors to stay away from capital market.

Contreras-Reyes and Palma (2012) argued that several time series exhibit long-range dependence or persistence in their observations, leading to the development of a number of estimation and prediction methodologies to account for the slowly decaying autocorrelations. The autoregressive fractionally integrated moving average (ARFIMA) process is one of the best-known classes of long-memory models.

Muktadir-Al-Mukit (2013) found that money supply, inflation and T-bill rate have a positive impact, where repo rate has a negative impact on the market index.

Maheshchandra (2014) commented that the long-memory property of volatility in the BSE market is revealed to be much stronger than SSE. The evidence of long memory in volatility, however, shows that uncertainty or risk is an important determinant of the behavior of daily stock data in India and China.

Turkyilmaz and Balibey (2014) observed that weak-form efficient market hypothesis in Pakistan supports that asset prices reflect all available information. In case of long memory, returns are not independent over time and future returns can be predicted by using past prices.

Assaf (2015) confirmed that the long memory in volatility is real and not caused by shifts in variance for all markets. He found that market participants in the REITs markets, whose success depends on the ability to forecast and model REITs price movements.

Christensen and Varneskov (2015) argued that consistency and asymptotic normality of the medium band least squares (MBLS) estimator were established, a feasible inference procedure is proposed, and rigorous tools for assessing the co-integration strength and testing MBLS against the existing narrow band least squares estimator were developed.

Taslim (2015) described that the market has undergone some major downward market corrections and the DSEX index is now at about the value that correctly reflects the underlying fundamentals. If the latter happens to be the case, and Bangladesh Bank (BB Central Bank) were to intervene by reducing the interest rates, a bubble will be in the making. It may gain momentum to become a full-blown bubble in future. The very forces that persuaded BB to reduce interest rates arguing that the market was depressed ought to be able to also persuade it not to hike rates when the market is buoyant. The bubble will eventually burst with all the attendant problems, and BB will be held culpable.

Sochi (2015) observed that "DSE has a long negative memory resulting in an abnormally higher number of negative long runs than a random walk price model with an equal probability of success".

Dissanayake (2016) commented that theoretical aspects of standard fractionally differenced processes with long memory and related state space modelling will be discussed. An efficient mechanism based on theory to estimate parameters and detect optimal lag order in minimizing processing speed and turnaround time is introduced subsequently.

Litimi, Ben Saïda, and Bouraoui (2016) commented that trading volume turnover and investors' sentiment are ubiquitous factors besides market return to fuel herding movement in most sectors. Granger causality test shows that herding is a vital ingredient to increasing bubbles in some sectors, but not all.

Tamilselvan and Vali (2016) found that the volatility shocks are quite persistent. The study disclosed that the volatility is highly persistent and there is asymmetrical relationship between return shocks and volatility adjustments and the leverage effect is found across all flour indices.

Kononovicius (2017) revealed that the power-law exponents of the obtained probability density functions are close to 3/2, which is a characteristic feature of the one-dimensional stochastic processes. This is in good agreement with earlier proposed model of absolute return based on the non-linear stochastic differential equations derived from the agent-based herding model.

Korolev (2017) proposed an approach which was based on a multidimensional interpretation of the volatility of one-dimensional processes. The foundation of this approach was a model based on the limit theorems for compound doubly stochastic Poisson processes, in which the distributions of the increments of financial index logarithms are represented in the form of mixtures of normal laws.

Masa and Diaz (2017) found long-memory processes in ETNs; however, dual long-memory process in returns and volatilities is not verified. The research also posed a challenge to the weak-form efficiency hypothesis of Fama (1970), because lagged changes determine future values, especially in volatility. They show that differences in the characteristics of commodity, currency and equity ETNs are not concluded because of similarities in ETN traits and several insignificant results.

Norwood and Killick (2017) proposed a model with certain structural features have been known to have similar properties to other models as mentioned by them according to Granger and Hyung (2004). This overlap will be here referred to as an 'ambiguity' between the models. This is such that either model may appear similar to one another in some metrics, but provide very different interpretations on the data generating process, and lead to different predictions into the future.

Wikipedia (accessed on March 3, 2017) depicted that in statistics, autoregressive fractionally integrated moving average models are time series models that generalize ARIMA (autoregressive integrated moving average) models by allowing non-integer values of the differencing parameter. These models are useful in modelling time series with long memory, that is, in which deviations from the long-run mean decay more slowly than an exponential decay. The acronyms "ARFIMA" or "FARIMA" are often used, although it is also conventional to simply extend the "ARIMA (p,d,q)" notation for models, by simply allowing the order of differencing, d, to take fractional values.

Hossain and Hossain (2017) commented "Then investors of stock market should know the behaviour of the individual stock of minimizing the risk".

From the aforesaid literature review, we found that relationship between long-memory data set in return and volatility of Dhaka Stock Exchange market need to be tested. As such, we intended to test relationship between return on long-memory data and volatility of Dhaka Stock Exchange market.

2. METHODOLOGY OF THE STUDY AND DATA ANALYSIS

In the light of literature review, we develop the framework of methodology of the study.

2.1. Autoregressive fractional integrated moving average (ARFIMA) model

Masa and Diaz (2017) argued that commodity, currency and equity ETNs as data samples, and examines the performance of the three combinations of long-memory models, that is, autoregressive fractionally integrated moving average and generalized autoregressive conditional heteroskedasticity (ARFIMA-GARCH), autoregressive fractionally integrated moving average and fractionally integrated generalized autoregressive conditional heteroskedasticity (ARFIMA-FIGARCH) and autoregressive fractionally integrated moving average and hyperbolic generalized autoregressive conditional heteroskedasticity (ARFIMA-HYGARCH), and three forecasting horizons, that is, 1-, 5- and 20-step-ahead horizons, to model ETNs returns and volatilities. The article finds long-memory processes in ETNs; however, dual long-memory process in returns and volatilities is not verified. The research also poses a challenge to the weak-form efficiency hypothesis of Fama (1970), because lagged changes determine future values, especially in volatility. The findings also show that differences in the characteristics of commodity, currency and equity ETNs are not concluded because of similarities in ETN traits and several insignificant results. However, the presence of intermediate memory was identified, and should serve as a warning sign for investors not to keep these investments in the long run. Lastly, the ARFIMA-FIGARCH model has a slight edge over the ARFIMA-GARCH and ARFIMA-HYGARCH specifications using 1-, 5- and 20-forecast horizons.

2.2. Fractional integrated GARCH (FIGARCH) model

Tayefi and Ramanathan (2012) described "Baillie and Morana (2009) have introduced a new long memory volatility process known as Adaptive FIGARCH, or A-FIGARCH. This model is designed to account for both long-memory and structural changes in the volatility processes of economic and financial time series. Hence the A-FIGARCH has a stochastic long-memory component and a deterministic break process component. The A-FIGARCH (*p, d, q, k*) process can be derived from the FIGARCH (*p, d, q*) process by allowing the intercept *w* in the conditional variance equation to be time varying. The conditional variance equation is given by

$$\left[1-\beta\left(L\right)\right]\left(ht-wt\right)= \\ =\left[1-\beta\left(L\right)-\phi\left(L\right)\left(1-L\right)d\right]\in 2t, \quad (1)$$

where

$$wt=\sum_{j=1}^{k}w0+\left[\gamma j\ sin\left(\frac{2\pi jt}{T}\right)+\delta j\ cos\left(\frac{2\pi jt}{T}\right)\right].$$

This model has components with long memory effect and a time-varying intercept. It allows for breaks, cycles and changes in drift. Even though *wt* is smooth, it is capable of approximating abrupt regime switching. Inference related to the parameters of the A-FIGARCH can be done by the method of QMLE.

2.3. The fractional integrated asymmetric power ARCH (FIAPARCH) model

Degiannakis (2004) observed that predicting the one-step-ahead volatility is of great importance in measuring and managing investment risk more accurately. As such, he estimated an asymmetric autoregressive conditional heteroscedasticity (ARCH) model. The model is extended to also capture i) the skewness and excess kurtosis that the asset returns exhibit and ii) the fractional integration of the conditional variance. The model, which takes into consideration both the fractional integration of the conditional variance, as well as the skewed and leptokurtic conditional distribution

of innovations, produces the most accurate one-day-ahead volatility forecasts. Degiannakis (2005) recommended that portfolio managers and traders that extended ARCH models generate more accurate volatility forecasts of stock returns.

Mabrouk (2016) focused on forecast evaluation and comparison where the forecast accuracy is measured by a statistical criterion. We tried to study the predictive ability of FIGARCH, HYGARCH and FIAPARCH models adjusted by the skewed Student-t distribution for three horizons (one, five and fifteen days). The results of the forecasting exercise show that the three models have the same predictive power. However, result based on the MZ regression (1969) confirms that the FIAPARCH model has relatively better predictive ability compared to FIGARCH and HYGARCH models.

2.4. Data analysis

In the study, we used the daily data ranging from 15 December 2003 to July 31, 2013 of Dhaka Stock Exchange markets index, i.e., DSE General Index (DGEN), a total of 2591 observations. Day-to-day stock returns were distinct as the logarithmic variance of the daily closing index values. Data were taken from Dhaka Stock Exchange and Bangladesh Bank. The study endeavors at doing research work with long-memory data set, as it provides a superior strategy, as well as gives real picture with short memory data set. We estimated descriptive statistics and stationarity analysis. The Quantile-Quantile Test is also plotted. Autoregressive fractional integrated moving average (ARFIMA) model, fractional integrated GARCH (FIGARCH) model and The fractional integrated asymmetric power ARCH (FIAPARCH) model will be estimated for Dhaka Stock Exchange market. Estimation of the ARFIMA and ARFIMA-FIGARCH and ARFIMA-FIAPARCH models results were given in the next section.

3. ESTIMATED RESULTS

Below we gave descriptive statistics and stationarity analysis and presented first results in Table 1.

Table 1 of Panel A provides a summary of statistics of the stock return series. The significance of all the normality tests applied (in Panel B) indicated that the residuals appear to be leptokurtic. Further, the significant Ljung-Box statistics for the returns, Q(20) and squared returns, Qs(20), indicating the rejection of the null of white noise, asserting that these return series are autocorrelated. It is evident that Dhaka Stock Exchange market displayed numerous volatilities with wide spread breadth (which is shown in Figure 1). This implied that the assumption of normal distribution may not be suitable for capturing asymmetry and tail-fatness in a return distribution.

Finally, unit root and stationary results reported in Panel C of Table 1 indicate that return series is stationary.

Table 1. Descriptive statistics and stationarity analysis

Source: compiled by authors.

Descriptive statistics (Panel A)		Normality tests (Panel B)		Unit root and stationarity analysis (Panel C)	
Mean	0.082851	Doornik-Hansen test	1517.02 (0.000)	ADF (constant)	-8.60692* (0.000)
Median	0.068251	Shapiro-Wilk	0.932903 (0.000)	ADF (constant and trend)	-8.77125* (0.000)
Minimum	-7.7644	Lilliefors test	0.0765059 (0.000)	ADF-GLS (constant)	-7.18309* (0.000)
Maximum	13.071	Jarque-Bera test	4573.48 (0.000)	ADF-GLS (constant and trend)	-6.01418* (0.000)
Standard deviation	1.425	Q(20)		KPSS (constant)	0.514663* (0.042)
Skewness	0.073755	Q2(20)		KPSS (constant and trend)	-15.41639* (0.11)
Ex. Kurtosis	6.507				

Note: in the parentheses, we report p-values. * denotes significance at 1% level.

Source: compiled by authors.

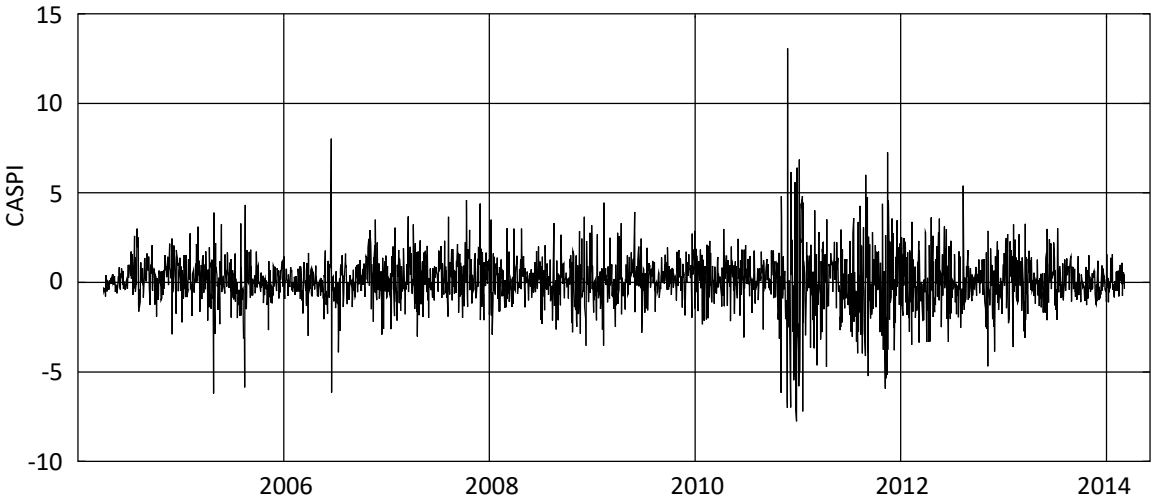

Figure 2. Frequent volatilities with extensive amplitude at DSE

The Quantile-Quantile test (Q-Q plot). The Q-Q plot helps us to compare shapes of probability distributions by plotting their quantiles against each other. When we compare two distributions, if the points in the Q-Q plot lies approximately on the line y = x, then, both distribution have similar pattern. If the Q-Q plot lies exactly on a line, then, the distributions are linearly related. The Quantile-Quantile plots results (Figure 3) suggest that both share common and similar distributions.

The results obtained from the ARFIMA model, ARFIMA-FIGARCH model and ARFIMA-FIAPARCH are reported in Table 2, while those are based on Student-t distribution. The ARFIMA model is selected using the Akaike Information Criteria (AIC) while fixing AR and MA at the maximum of 3. An ARFIMA (3, *d*, 3) model is found to best represent the long-memory process in stock return series. The estimates of *d* are statistically significant at less than 1% percent level of significance. Thus, the results support that the returns are forecastable and supportive of long memory processes. However, the residuals are mostly negatively skewed, implying that the distribution is non-symmetric. The J-B test statistics also reveal that the residuals appear to be leptokurtic. Moreover, the ARCH statistics are highly significant, indicating the existence of ARCH effects in the standardized residuals. The significant Q-statistics denote that the residuals are not independent. These statistics signify the limitations of building the ARFIMA model in the return series and signal the importance of testing the existence of long memory in volatility.

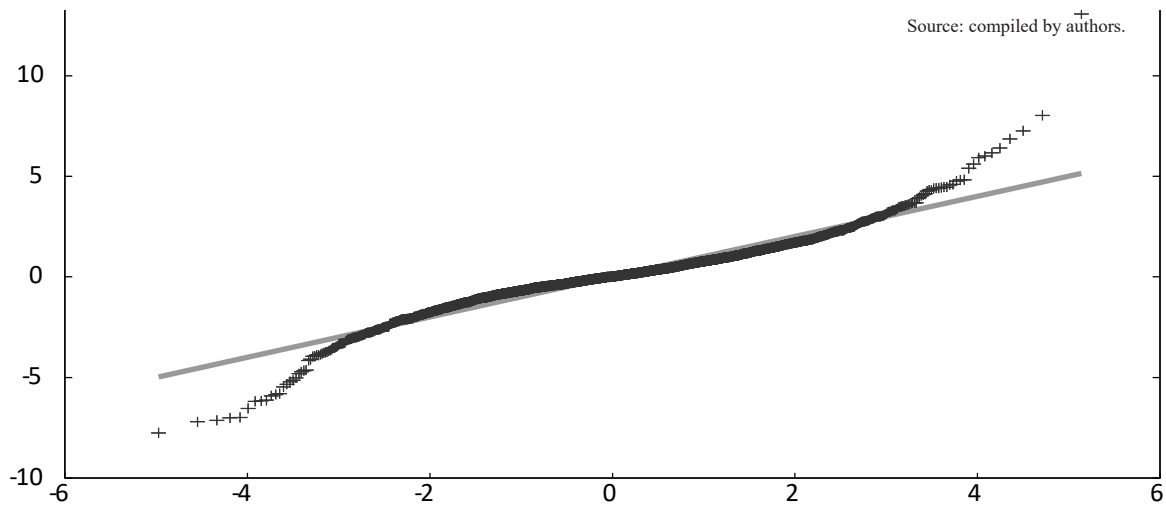

Figure 3. Quantile-Quantile plot for CASPI

Source: compiled by authors.

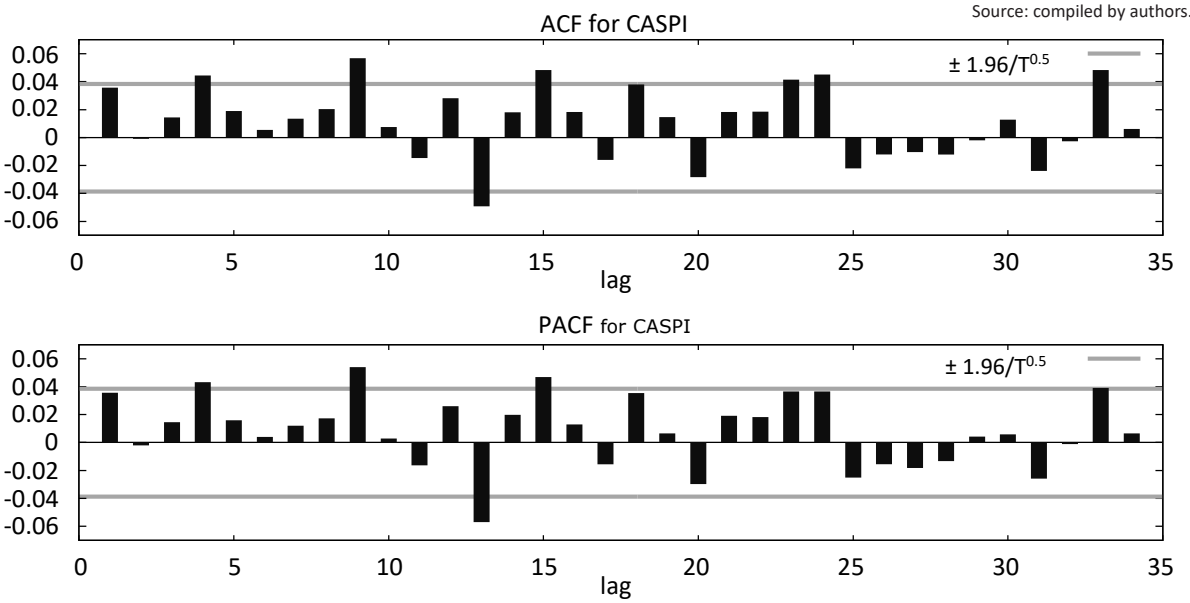

Figure 4. ACF for CASPI and PACF for CASPI

Table 2. Estimation results of the ARFIMA models

Source: authors' calculation.

ARFIMA (3, d, 3)			ARFIMA-FIGARCH: BBM's method (Student distribution)			ARFIMA-FIAPARCH: BBM's method (Student distribution)		
Coefficient	**Estimate**	**p-values**	**Coefficient**	**Estimate**	**p-values**	**Coefficient**	**Estimate**	**p-values**
Cst(M)	0.03224	0	Cst(M)	0.113271	0.0073	Cst(M)	0.038488	0.5143
d-Arfima	0.18744	0	d-Arfima	0.121492	0	d-Arfima	0.144021	0
AR(1)	-0.83014	0	AR(1)	-0.17943	0.5649	AR(1)	-0.13572	0.7273
AR(2)	-0.52943	0	AR(2)	-0.36154	0.1447	AR(2)	-0.2498	0.2664
AR(3)	0.38229	0	AR(3)	-0.38872	0.0864	AR(3)	-0.3857	0.0513
MA(1)	0.65943	0	MA(1)	0.17163	0.5934	MA(1)	0.103024	0.7916
MA(2)	0.3173	0	MA(2)	0.29029	0.2579	MA(2)	0.175115	0.445
MA(3)	-0.56561	0	MA(3)	0.374926	0.0801	MA(3)	0.379155	0.0481
Sigma	1.41345	0	Cst(V)	0.045543	0.0133	Cst(V)	0.077798	0.1796
			d-Figarch	0.667971	0.0002	d-Figarch	0.712989	0.0558
			ARCH (Phi1)	0.282858	0.0041	ARCH (Phi1)	0.23981	0.1329
			GARCH (Beta1)	0.692238	0	GARCH (Beta1)	0.723083	0.0029
			Student (DF)	6.455669	0	APARCH (Gamma1)	0.197599	0.0016
						APARCH (Delta)	1.231684	0.0016
						Student (DF)	7.092466	0
						ARCH-in-mean (var)	0.040163	0.2856
ln(L)	-4576.12		ln (L)	-4047.88		ln (L)	-4036.73	
ARCH (5)	464.3		ARCH (5)	0.22988	[0.9496]	ARCH (5)	9.24087	[0.3223862]
ARCH (10)	568.6		ARCH (10)	0.2971	[0.9820]	ARCH (10)	32.4028	[0.0196908]*
Q(5)			Q(5)	1.17139	[0.7598736]	Q(5)	53.4343	[0.2734275]
Q(10)			Q(10)	2.87565	[0.9419170]	Q(10)	2.9441	[0.0528]
Q(20)			Q(20)	24.6801	[0.1339838]	Q(20)	1.3584	[0.2370]
Q(50)			Q(50)	45.1316	[0.5910888]	Q(50)	0.93269	[0.5016]

Notes: Standard errors and p-values are in parentheses and brackets, respectively. ** and * indicate significant at 5 and 1 percent significance level, respectively. ln(L) value is the maximized value of the log likelihood function, and AIC is the Akaike (1974) Information criteria. J-B refers to Jarque-Bera normality test. The ARCH(5) and ARCH(10) denotes the ARCH test statistic with lag 5 and 10, while the Q(p) is the Ljung-Box test statistic for standardized residuals at lag p.

Table 3. Estimated results of ARFIMA-FIGARCH and ARFIMA-FIAPARCH

Source: compiled by authors.

BBM's method (Skewed Student distribution)				BBM's method (Skewed Student distribution)			
ARFIMA-FIGARCH				ARFIMA-FIAPARCH			
	Coefficient	Std.Error	t-prob		Coefficient	Std.Error	t-prob
Cst(M)	0.119854	0.049985	0.0166	Cst(M)	0.053285	0.05974	0.3725
d-Arfima	0.123613	0.028625	0	d-Arfima	0.142744	0.0397	0.0003
AR(1)	-0.14303	0.39231	0.7154	AR(1)	-0.11044	0.55128	0.8412
AR(2)	-0.33395	0.24374	0.1708	AR(2)	-0.24247	0.23606	0.3044
AR(3)	-0.36607	0.24246	0.1312	AR(3)	-0.37639	0.26926	0.1623
MA(1)	0.132662	0.39851	0.7392	MA(1)	0.078595	0.54068	0.8844
MA(2)	0.263166	0.25044	0.2934	MA(2)	0.170482	0.25374	0.5017
MA(3)	0.355631	0.22455	0.1134	MA(3)	0.372257	0.2522	0.1401
Cst(V)	0.047949	0.019935	0.0162	Cst(V)	0.07723	0.054833	0.1591
d-Figarch	0.648335	0.15495	0	d-Figarch	0.712191	0.35528	0.0451
ARCH(Phi1)	0.280886	0.092288	0.0024	ARCH(Phi1)	0.241145	0.15184	0.1124
GARCH(Beta1)	0.672066	0.12659	0	GARCH(Beta1)	0.722595	0.23246	0.0019
–	–	–	–	APARCH(Gamma1)	0.194797	0.063	0.002
–	–	–	–	APARCH(Delta)	1.242459	0.3795	0.0011
Asymmetry	0.031157	0.026954	0.2478	Asymmetry	0.022646	0.026161	0.3868
Tail	6.468502	0.81628	0	Tail	7.091862	0.96065	0
ARCH-in-mean(var)	0.019047	0.028173	0.499	ARCH-in-mean(var)	0.040027	0.03746	0.2854
ln(L)	-4047.38			ln(L)	-4036.38		
ARCH (2)	0.17955	[0.8357]		ARCH (2)	2.8013	[0.0609]	
ARCH (5)	0.26148	[0.9341]		ARCH (5)	1.3016	[0.2603]	
ARCH (10)	0.31473	[0.9777]		ARCH (10)	0.90446	[0.5280]	
Q(5)	1.3343	[0.7210051]		Q (5)	6.61702	[0.0851600]	
Q(10)	3.05141	[0.9310897]		Q (10)	8.95905	[0.3457621]	
Q(20)	24.661	[0.1345434]		Q (20)	32.0011	[0.0219807]*	
Q(50)	44.7101	[0.6084431]		Q (50)	52.9305	[0.2896189]	

Notes: d and ξ are the long memory parameters for return and volatility process, respectively. Standard errors and p-values are in parentheses and brackets respectively. ** and * indicate significant at 5 and 10 percent significance level respectively. ln(L) value is the maximized value of log likelihood function, and AIC is the Akaike (1974) Information criteria. The Qs(20) is the Ljung-Box test statistic for square standardized residuals while the ARCH(5) denotes the ARCH test statistic with lag 5. P(60) is the Pearson goodness-of-fit statistic for 60 cells and RBD(5) represents the RBD statistics with the embedding dimension m = 5.

Therefore, in the next step, we relied on ARFIMA-FIGARCH model. As shown in Table 3, the parameter d (i.e., d-Arfima) remains significant revealing the presence of long memory in return series. For the volatility component, the long memory parameters, (d-Figarch), is 0.67 and significant at 1 percent significance level, indicating the long-range memory phenomenon for volatilities. The existence of long memory in both return and volatility contradicts the efficient market hypothesis of Fama (1970) that the future return and volatility values are unpredictable. Besides, the estimates of fat-tailed parameter (Student(DF)) is 6.455669, and it is statistically significant at the 1 percent level suggesting the usefulness of Student-t distribution in modelling the leptokurtosis of estimated residuals.

Further, we estimated the ARFIMA-FIAPARCH model under Student-t distribution. The values of fractionally differencing parameters (i.e., d-Arfima and d-Figarch) are significantly different from zero, indicating the existence of dual long memory process. Besides, the estimates of fat-tailed parameter (Student (DF)) is 7.09, and it is statistically significant at the 1 percent level suggesting the usefulness of Student-t distribution in modelling the leptokurtosis of estimated residuals. The insignificant diagnostic statistics, for instance, the Q (p), and ARCH(p) also further confirm the selection of Student-t distribution to capture time-varying volatility.

DISCUSSIONS, CONCLUSION AND IMPLICATION OF THE STUDY

This paper mainly focused on testing the long-memory features in return and volatility of Bangladesh Stock Index. In order to determine the presence of long-memory in returns and volatility, we utilized the ARFIMA-FIGARCH and ARFIMA-FIAPARCH models. The empirical findings adding to the growing literature that demonstrates the long memory in volatility and stock returns. Our empirical findings suggest the residuals appeared to typically leptokurtic and exhibits heavy-tail behavior and squared returns evident that series are autocorrelated. The results of ARFIMA and ARFIMA-GIGARCH model supports the presence of long memory in Bangladesh stock returns, which employs that returns are forecastable and supportive of long-memory processes. However, long-memory parameters for volatility components are highly significant which supports the long-range memory phenomenon for volatility of Bangladesh stock returns. This implies that Bangladesh Bank did not play due role during the volatility of the stock market and they failed to regulate the stock market with proper policy prescriptions. Instability of the financial system may create harm, as both capital and monetary market works as complementary. Corruption free, fairness, accountable and transparent banking sector is much required to ensure and support healthy and sound stock exchange market. Formal sector of the country should be strenged then so that financial intermediaries can work without any sort of legal-political-corruption free atmosphere. Further authority of capital market of the country should take to develop debt market and derivatives markets in the country. Dependency on the money market for capital investment should be reduced by creating a conducive capital market.

Taslim (2015) rightly observed that Bangladesh Bank ought to intervene by reducing the interest rates during capital market scam of the county in 2010–2011 when artificial bubble was injected. As a Central Bank, they need to decrease interest rates in dispute that the market was down so that it can be able to also influence not to climb rates during the floating of the market. Due to inefficiency in the market, corruption, individual and institutional investors faces stock market scam in the country. As such, capital market cannot grow properly, which is being needed to expand at international standard benchmarking containing yardstick so that bank can work with capital markets, somewhat merely existence of contributors, are, in detail, embellishments with both markets.

Moreover, the supporting evidence for presence of long memory in both return and volatility of Dhaka Stock Exchange market contradicts the efficient market hypothesis of Fama (1970) that the future return and volatility values are unpredictable. Monetary policy should be more conducive to give opportunity to improve the stock market for fair pricing. Policy makers should be emphasized on improvement of the Dhaka Stock Exchange market so that both individuals and institutional investors can get proper and fair treatment. Share market should be regulated without interference and corruption free. Bangladesh bank should play reasonable role through pro friendly monetary policy so that Dhaka Stock Exchange become strong efficient market, which needs proper policy formulation and implementation. Fiscal policy should also consider for long-term investment through developing capital market by its three subareas: share market, debt market, financial derivatives. Still, debt market and financial derivatives market are not properly developed in the country. Distant from Bangladesh Bank there are a lot of issues such as lack of commodity shares and absence of short position hindering the depth of capital market of the country. Fiscal policy of the country should be pro investor friendly as well as monetary policy should work as complementary towards investment at stock exchange market.

FUTURE RESEARCH DIRECTIONS

From August 1, 2013, DSE General Index had not been given in the website. With the introduction of the new indexes whether volatility of predictability of return on Dhaka Stock Exchange reduces can be measured by taking data for at least ten years for which we have to wait to see long-run situation or a comparative study between present and earlier indexes through panel data can be done where rational-

ity, sensitivity of the investors in the stock market may be counted. Behavioral finance can be tested in Dhaka Stock Exchange market's return. Moreover, in future, a study needs to concentrate on long memory versus short memory in forecasting share price in a volatile market situation in Bangladesh. Further, impact of monetary policy on Dhaka Stock Exchange market need to be examined as share market is dominated by the banking sector of the county.

REFERENCES

1. Ahmed, Md. Kabir et al. (2006). *Effects of Monetary Policy on Price Formation of Financial Assets: A Test for Bangladesh* (Bangladesh Bank, Policy Analysis Unit (PAU), September Working Paper Series No: WP 0703, 19-20).
2. Assaf, Ata (2015). Long memory and level shifts in REITs returns and volatility. *International Review of Financial Analysis, 42,* December, 172-182.
3. Bangladesh Bank. (2015–2016). Monetary management and financial Market development. Chapter: 5, 49-62. Retrieved from http://www.mof.gov.bd/en/budget/15_16/ber/en/Ch-05.pdf
4. Conrad ,Christian, Haag, Berthold R. (2006). Inequality Constraints in the Fractionally Integrated GARCH Model. *Journal of Financial Econometrics, 4*(3), 413-449.
5. Contreras-Reyes, Javier E., & Palma, Wilfredo. (2012). Statistical Analysis of Autoregressive Fractionally Integrated Moving Average Models, 1-18 Retrieved 3 March, 2017 from https://arxiv.org/pdf/1208.1728.pdf
6. Chowdhury, S. S. H., & Shimon, Z. A. (2008). A closer look at the size effect in the Dhaka Stock exchange (DSE). *Independent Business Review, 1*(2), July, 42-52.
7. Christensen, Bent Jesper, & Varneskov, Rasmus T. (2015). *Medium Band Least Squares Estimation of Fractional Cointegration in the Presence of Low-Frequency Contamination* (CREATES Research Papers 2015-25, Department of Economics and Business Economics, Aarhus University, 1-30). Retrieved from http://pure.au.dk/portal/files/87064404/rp15_25.pdf
8. Degiannakis, Stavros Antonios. (2004). Volatility Forecasting: Evidence from a Fractional Integrated Asymmetric Power ARCH Skewed-t Model. *Applied Financial Economics, 14,* 1333-1342.
9. Dissanayake, G. S. (2016). Rapid Optimal Lag Order Detection and Parameter Estimation of Standard Long Memory Time Series. Huynh, V.-N. et al. (eds.), *Causal Inference in Econometrics, Studies in Computational Intelligence.* (pp. 17-26). Springer International Publishing Switzerland.
10. Evans, Kevin, & Speight, Alan E. H. (2007). *International Macroeconomic Announcements and Intraday Euro Exchange Rate Volatility* (CARDIFF BUSINESS SCHOOL, WORKING PAPER SERIES, A2007/4, September, 1-21).
11. Fabrizio, Lilloand Doyne, Farmer, J. (2004). The Long Memory of the Efficient Market. *Studies in Nonlinear Dynamics & Econometrics, 8*(1), 1-30.
12. Fama, Eugene F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance, 25,* 383-17.
13. Granger, Clive W. J. (1998). Real and spurious long-memory properties of stock-market data: Comment. *Journal of Business & Economic Studies, 16*(3), July, 268-269.
14. Wikipedia. (2017). Autoregressive fractionally integrated moving average. Retrieved 3 March, 2017 from https://en.wikipedia.org/wiki/Autoregressive_fractionally_integrated_moving_average
15. Hossain, Tanzina, & Hossain, M. T. (2017). Application of switching approach for determining vacation of markov-Stolatilit of stock return's: A study on some selected companies on Dhaka stock exchange. *MTC Global Journal of Management and Entrepreneurship, 5*(12), Jan-March, 1-18.
16. Islam, K. M. Zahidul et al. (2015). Corporate Governance and firm Performance: Evidence from selected firms listed in Dhaka Stock Exchange. *Daffodil International university-Journal of Business and technology, 9*(2), 11-25. Retrieved from https://daffodilvarsity.edu.bd/photos/pdf/Business-Journal-Dec15.pdf
17. Kononovicius, V., Gontis, A. (2017). Burst and inter-burst duration statistics as empirical test of long-range memory in the financial markets, 1-7. Retrieved March 1, 2017 from https://arxiv.org/pdf/1701.01255.pdf
18. Korolev, V. Yu. (2017). Statistical Decomposition of Volatility. *Journal of Mathematical Sciences, 221*(4), March, 530-552. Retrieved from https://link.springer.com/article/10.1007/s10958-017-3248-0
19. Litimi, Houda, Ben Saïda, Ahmed, & Bouraoui, Omar. (2016). Herding and excessive risk in the American stock market: A sectoral analysis. *Research in International Business and Finance, 38,* September, 6-21.
20. Mabrouk, Samir (2016). Forecasting Financial Assets Volatility Using Integrated GARCH-Type Models: International Evidence. *Journal of Finance and Economics, 4*(2), 54-62. Retrieved from http://pubs.sciepub.com/jfe/4/2/3/
21. Maheshchandra, Joshi Prashant. (2014). Long Memory Volatility of Stock Markets of India and China.

International Journal of Science and Research (IJSR), 3(7), July, 1198-1200.

22. Masa, Argel S., & Diaz, John Francis T. (2017). Long-memory Modelling and Forecasting of the Returns and Volatility of Exchange-traded Notes (ETNs). *Margin: The Journal of Applied Economic Research, 11*(1), 23-53.

23. Moazzem, Khondker Golam, & Rahman, Md. Tariqur. (2012). *Stabilising the Capital Market* of *Bangladesh*: *Addressing the Structural*, *Institutional and Operational Issues* (March 18, Working Paper, 95, CPD, 1-32).

24. Mukit, Dewan Muktadir Al, & Shafiullah, A. Z. M. (2012). Impact of Monetary Policy on Post Crashed Stock Market Performance: Evidence from Dhaka Stock Exchange. *Journal of Business & Economics, 4*(1), Jan-June, 106-123.

25. Muktadir-Al-Mukit, Dewan. (2013). An Econometric Analysis of the Impact of Monetary Policy on Stock Market Performance in Bangladesh. *World Review of Business Research, 3*(3), July, 16-29.

26. Norwood, B., & Killick, R. (2017). Long memory and change point models: a spectral classification procedure. *Statistics and Computing,* 1-12. Retrieved from https://link.springer.com/article/10.1007/s11222-017-9731-0

27. Rahman, Md. Tariqur, & Moazzem, Khondker Golam. (2011). Capital Market of Bangladesh: Volatility in the Dhaka Stock Exchange (DSE) and Role of Regulators. *International Journal of Business and Management, 6*(7), July, 86-93.

28. Rayhan, Mohammed Abu et al. (2011). The Volatility of Dhaka Stock Exchange (DSE) Returns: Evidence and Implications. *ASA University Review,* 5(2), July-December, 88-99.

29. Sarker, M. M. et al. (2012). Identifying the Critical Issues of Stock Market: A Study on Dhaka Stock Exchange (DSE). *IJAR-BAE, 1*(3), 48-55.

30. Siegel, B. N. (1965). *Aggregate economy and public policy* (2nd edition), 284-325. Irwin Homewood Publicher

31. Siddik, Md. Nur Alam. (2011). Test of market of Dhaka Stock exchange limited: Evidence from Banking sector of Bangladesh. *Stamford Journal of Business,* 65-80.

32. Stiglitz, Joseph E. (2013). The 15th C. D. Deshmukh Memorial Lecture on "A Revolution in Monetary Policy: Lessons in the Wake of the Global Financial Crisis" delivered at Taj Mahal Palace, Mumbai on January 3. Retrieved March 5, 2017 from https://www.rbi.org.in/scripts/BS_SpeechesView.aspx?Id=765

33. Sochi, M. H. (2015). A Test of Market Efficiency When Short Selling is Prohibited: A Case of the Dhaka Stock Exchange, A thesis submitted to the Graduate Faculty of Auburn University, Alabama (mimeo), 12, December, 29-30.

34. Tan, Siow-Hooi, & Khan, Mohammad Tariqul Islam. (2010). Long Memory Features in Return and Volatility of the Malaysian Stock Market. *Economics Bulletin, 30*(4), 3267-3281.

35. Tamilselvan, M., & Vali, Shaik Mastan. (2016). Forecasting stock market volatility – evidence from MUSCAT security market using GARCH models. *International Journal of Commerce and Finance, 2*(1), 37-53. Retrieved from http://oaji.net/articles/2017/2748-1485002113.pdf

36. Taslim, M. A. (2015). Should Bangladesh Bank prop up the share market? Retrieved March 1, 2017 from http://opinion.bdnews24.com/2015/05/21/should-bangladesh-bank-prop-up-the-share-market/

37. Tayefi, Maryam, & Ramanathan, T. V. (2012). An Overview of FIGARCH and Related Time Series Models. *Austrian journal of statistics, 41*(3), 175-196.

38. Turkyilmaz, Serpil, & Balibey, Mesut. (2014). Long Memory Behavior in the Returns of Pakistan Stock Market: ARFIMA-FIGARCH Models. *International Journal of Economics and Financial Issues, 4*(2), 400-410.