European Journal of Business and Management
ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online)
Vol.10, No.29, 2018

Time Series Analysis of Stock Returns for Two Pharmaceutical Companies Listed in Chittagong Stock Exchange

Md Rokonuzzaman
Department of Statistics
University of Chittagong
Chattogram, Bangladesh
Email: rokonuzzaman@cu.ac.bd
and
Mohammad Akram Hossen
Shanto-Mariam University of Creative Technology
Dhaka, Bangladesh
Email: akram.alahabad@gmail.com

Abstract
The primary aim of the study is to analyze and prediction of stock returns for 02 popular pharmaceutical companies namely BEXIMCO and SQUARE pharmaceuticals which are listed in Chittagong Stock Exchange. Generally the effective performance of stock market is one of the major indicators for economic development of a country. In this study, secondary data on stock index and daily average stock price with a sample period 1st January 2010 to 27th December 2016 for selected 02 popular pharmaceutical companies listed in Chittagong Stock Exchange. Descriptive statistics, important graphs, statistical tests, fitted dynamic time series regression models with ARCH effect are used to complete the analysis. It is found that for both companies , the return occurs high with a high risk and risk is low for the companies with small amount of return. Generally SQUARE pharmaceutical has more gross return than BEXIMCO pharmaceutical. The gross returns for both companies follow the non-stationary but the log returns shows stationarity and the transformed variable log returns is used in the analysis to predict the return for these two companies. The daily log returns of selected 2 companies confer the normality of the white noise of this variable. It is observed that the average VIF for both companies are less than 10, indicate the not severity of multicollinearity and can use these transform explanatory variables ΔY_t , $\Delta^2 Y_t$, ΔX_t and $\Delta^2 X_t$ in the model. Significant LM test statistic indicates the situation of having ARCH effect for the log return of both companies. Parkinson's monthly volatility of both companies also confers the conditional heteroscadisticity in the behavior of the residuals. The dynamic regression model with volatility regression of ARCH(1) and ARCH(2) are employed for the log return of BEXIMCO and SQUARE pharmaceutical respectively. A modified ARDL (2, 2) regression model is proposed for forecasting the log return for BEXIMCO and SQUARE pharmaceuticals. Predicted daily log return for BEXIMCO pharmaceuticals for 28 th December ,2016 is 0.78122,i.e. the gross return is 2.1236 with 1-step ahead volatility is 0.04701, whereas the actual return is 2.087. One can try to analyze the data considering dynamic models such as GARCH, PARCH, ARIMAX, EGARCH model and different dynamic panel data models to predict the data.

Key Words: Stock returns, Parkinson's Volatility, ARCH model, Modified ARDL model.

Introduction

Stock market is considered to be a barometer of the Economy. A stock market is the aggregation of buyers and seller of stocks or shares of companies. In Bangladesh there are two stock exchanges namely Dhaka Stock Exchange and Chittagong Stock Exchange with automation system of trading shares and securities. The purpose of a stock exchange is to facilitate the exchange of securities between buyers and sellers, thus providing a marketplace. The stock market can be very volatile, and in a bad day one could see the loss of a significant part of his investment. An effective performance of stock market is one of the major indicator for economic development of a country. Stock markets play an essential role in growing industries that ultimately affect the economy through transferring available funds from units that have excess funds to those who are suffering from funds deficit (Naik and Padhi, 2012). Bangladesh capital market is the third largest market within the south Asian region. Chittagong Stock Exchange (CSE) opening by Bangladesh Government is the second stock exchange of the country which began its journey in 10th October of 1995 from Chittagong City through the cry-out trading system. It is promise to create an effective, efficient and transparent market atmosphere of international standard to save and invest in Bangladesh in order to raise fund and accelerate industrial growth for overall benefit of the economy.
The main objective of this study is to investigate the dynamics of the time varying volatility for selected two pharmaceutical companies over the sample period. However, the specific objectives of this study are to evaluate

the performance of selected two pharmaceutical companies, to build an appropriate volatility model of daily log return and to forecast or predict stock market return for both companies which helps in investment.
In the next section, literature review of stock return will be discussed. Data methodology and the obtained results be presented in the section 3 and 4 respectively . Finally, the last section comprises the conclusion.

Literature Review

The efficiency of stock market is one of the most controversial and well studied propositions in the literature of capital market. The wide range of studies concerning the efficiency hypothesis of Bangladesh stock market provides mixed evidences. The studies such as, Chowdhury (2001), Hassan and Maroney(2008), Ainul and Khaled(2005), Uddin and Khoda (2009) do not support the weak form of efficiency of Bangladesh's Dhaka Stock Exchange market. There have been also a very few studies like ; Hassan, and Chowdhury(2008), Uddin and Shakila (2008) support the existence of weak form efficiency of Bangladesh stock market.According to the knowledge of the authors a very few number of researchers have done work see for example Basher, Hassan, and Islam (2008) in order to find the relationship between risk and return over the past decades of DSE using the GARCH model. Chowdhury (2001) has studied the relationship between the predicted volatility of DSE returns and that of selected macroeconomic variables of Bangladesh economy. They have calculated volatility from errors after using an autoregressive and seasonality adjusted forecasting model. The volatility series derived from such process has some limitations, which have been corrected in Generalized Conditional Auto Regressive Heteroscedasticity (GCARH) models developed. A large number of researcher's used ARCH and GARCH in capturing the dynamic characteristics of stock market return across the countries, such as Elsheikh (2011), Islam (2013), Bucevska (2012), Ajab (2012) and many more. Islam (2014) has studied Stock market volatility comparison between Dhaka stock exchange and Chittagong stock exchange considering Standard deviation, coefficient of Variation, F-test. Study results revealed that stock price at CSE is more volatile than DSE. Even the stock price of leading companies (top 20 and 30 companies of DSE and CSE) also varies from DSE to CSE and the volatility is much high than CSE30 of DSE20. Rokonuzzaman (2018) studied Volatility Analysis of Stock Returns for Fifteen Listed Banks in Chittagong Stock Exchange and proposed a modified ARDL model to predict the stock return. Islam (2014) has studied Stock market volatility comparison between Dhaka stock exchange and Chittagong stock exchange considering Standard deviation, coefficient of Variation, F-test. Study results revealed that stock price at CSE is more volatile than DSE. Even the stock price of leading companies also varies from DSE to CSE. In the next section data and methods will be discussed.

Data and Methodology

In this study, the daily log returns based on the daily total turnover values of 02 popular pharmaceutical companies namely BEXIMCO and SQUARE pharmaceuticals which are listed in Chittagong Stock Exchange have been analyzed. The required secondary data are collected for a purposive sample period 1st January 2010 to 27th December 2016 from the CSE, Bangladesh. The natural logarithm of the simple gross return of an asset is called the continuously compounded return or log return:

$$ln\, r_t = ln\,(1+R_t) = \ln\frac{P_t}{P_{t-1}} = \ln P_t - \ln P_{t-1};\;\; r_t = 1+R_t$$

A popular statistical approach is Augmented Dickey Fuller (1979)statistic to test whether the log return lnr_t of an asset follows a random walk or a random walk with drift. i.e. the data is stationary or not. Variance inflating factor is used for detecting of multicollinearity among the explanatory variables used in a regression model. There are several measures of volatility such as intra-day high-low volatility and inter-day close price or open price volatility. Among these measures Parkinson's(1980) extreme value estimator based on intra-day high and low price of an asset is more efficient. The Parkinson's volatility is denoted by σ and defined as

$$\sigma = k\sqrt{\Sigma \ln \frac{(H_t/L_t)^2}{n}}$$

Where, H_t= High price of an asset at time t, L_t= Low price of an asset at time t
n= No of days used in calculation, k= 0.601
Here ARCH model is employed for analyzing and prediction of data. In the next section result will be discussed.

Results and Discussion

In this study, 02 pharmaceutical companies BEXIMCO and SQUARE pharmaceuticals, listed in Chittagong Stock Exchange are considered for analysis. Year wise and moth wise daily average return with its standard error are shown in Table1 & 2 respectively. After 2012, SQUARE pharmaceutical has more gross return than BEXIMCO. For SQUARE pharmaceutical, the average daily return is highest with high variability in the year 2013 and that is for BEXIMCO pharmaceutical is in the year 2014. For both companies, the daily average

return is highest with high standard error in the month of December.

Table 1. Descriptive statistics of gross returns of BEXIMCO and SQUARE pharmaceuticals by year

Year	BEXIMCO		SQUARE	
	Mean	SE	Mean	SE
2010	1.42	2.15	1.40	2.40
2011	1.37	1.96	1.26	1.22
2012	1.46	2.30	1.19	0.80
2013	1.70	7.98	2.04	12.29
2014	1.66	5.09	2.73	13.68
2015	1.38	1.47	2.06	8.22
2016	1.40	1.90	2.06	8.22
Ave	1.49	2.44	1.78	5.11

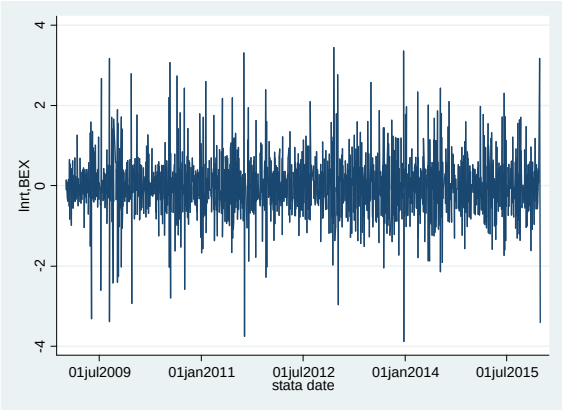
****se*** indicates standard error

Table 2. Descriptive statistics of gross returns of BEXIMCO and SQUARE pharmaceuticals by year

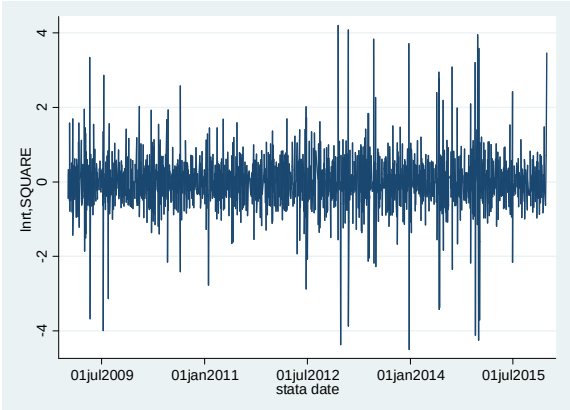
Month	BEXIMCO		SQUARE	
	Mean	SE	Mean	SE
JAN	1.38	1.86	1.81	6.40
FEB	1.13	0.81	2.34	14.00
MAR	1.27	1.14	1.24	1.04
APR	1.22	0.98	1.42	2.68
MAY	1.23	0.94	1.35	1.27
JUNE	1.41	1.45	2.29	8.37
JULY	1.60	2.66	1.24	1.55
AUG	1.73	3.47	1.43	2.31
SEP	1.42	1.49	1.20	0.91
OCT	1.30	1.10	1.09	0.54
NOV	1.22	0.85	1.19	0.93
DEC	2.97	12.55	4.72	21.35
Ave	1.49	2.44	1.78	5.11

For fitting any model of time series data, stationarity is an important issue. For these data set, the stationarity are tested for different companies by using Stata software with graphical and statistical method. In statistical method, ADF unit root test is used to check the stationarity of data set which are described in the Table 3. Significant unit root test statistic indicates the stationarity of data. For graphical method the line diagram of log return for these two companies are shown in Figure 1. Since the line graph of gross return follows the non-stationary of the dataset and the line graph of log returns for every companies shows the random variation around zero. So the log return variable is used in the analysis to predict the return for these two companies. From the Figure 1, it is obvious that there are some ups and down in the daily log returns but the Figures confer the stationary *i.e.*, the random shocks follow the white noise stationary process.

Fig 1. The line diagram of log return of BEXIMCO and SQUARE pharmaceuticals.



BEXIMCO pharmaceutical



SQUARE pharmaceutical

Table 3. Augmented Dickey-Fuller test Statistic for Stationarity of log return of BEXIMCO and SQUARE pharmaceuticals.

BEXIMCO pharmaceutical

Dickey-Fuller test for unit root Number of obs = 1264

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-50.343	-3.430	-2.860	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

SQUARE pharmaceutical

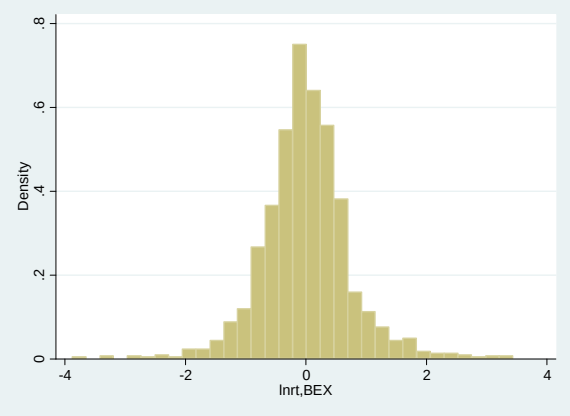
Dickey-Fuller test for unit root Number of obs = 1264

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		---------- Interpolated Dickey-Fuller ---------		
Z(t)	-52.404	-3.430	-2.860	-2.570

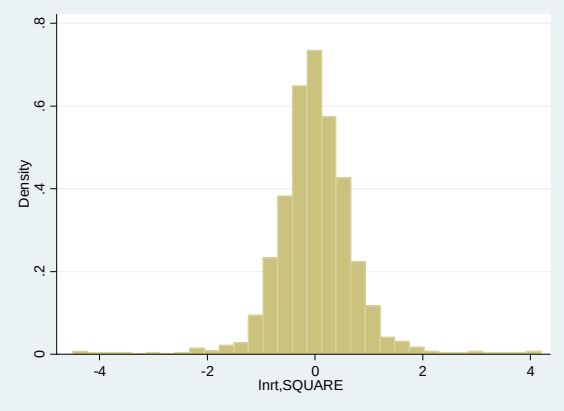
MacKinnon approximate p-value for Z(t) = 0.0000

Normality of any data set is a big challenge for fitting any model of a time series data. Figure 2 shows the histograms of daily log returns of selected 2 companies. From the diagrams it is obvious that the daily log returns for both companies are almost normally distributed. For fitting and estimating any statistical model it is essential to test the multicollinearity among the explanatory variables. Variance Inflating Factor is an important tool to check the multicollinearity. The average VIF for both companies are less than 10, indicate the not severity of multicollinearity and can use these explanatory variables ΔY_t , $\Delta^2 Y_t$, ΔX_t and $\Delta^2 X_t$ in the model. From the Table 4, it is observed that the mean VIF for BEXIMCO and SQUARE pharmaceuticals are 3.34 and 8.74 respectively.

Fig 2. The histogram of log return of BEXIMCO and SQUARE pharmaceuticals.



BEXIMCO pharmaceutical



SQUARE pharmaceutical

Table 4. Variance Inflating Factor(VIF) for regression

Variable	BEXIMCO	SQUARE
ΔY_t	4.9	6.56
$\Delta^2 Y_t$	4.8	6.57
ΔX_t	1.81	9.42
$\Delta^2 X_t$	1.86	10.42
Average	3.34	8.74

Table 5. Lagrange Multipliers test statistic of log returns of BEXIMCO and SQUARE pharmaceuticals.

BEXIMCO pharmaceutical

Number of gaps in sample: 330
LM test for autoregressive conditional heteroskedasticity (ARCH)

lags(p)	chi2	df	Prob > chi2
1	48.559	1	0.0000

H0: no ARCH effects vs. H1: ARCH(p) disturbance

SQUARE pharmaceutical

Number of gaps in sample: 330
LM test for autoregressive conditional heteroskedasticity (ARCH)

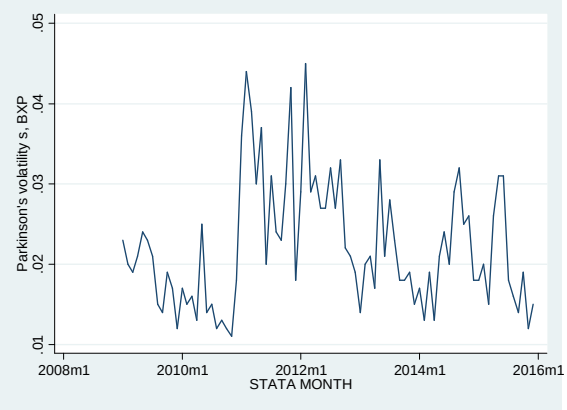
lags(p)	chi2	df	Prob > chi2
2	28.253	2	0.0000

H0: no ARCH effects vs. H1: ARCH(p) disturbance

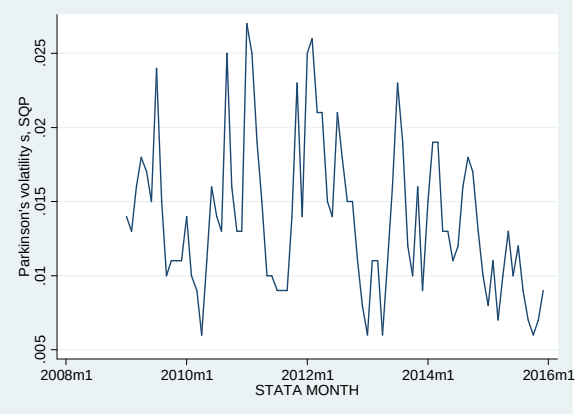
Generally in time series data, after fitting a mean regression model ARCH effect is tested for building a volatility model. The test is based on the residuals of this mean regression model. Lagrange multiplier(LM) test is the common method to test the ARCH effect. Significant LM test statistic indicate the situation of having ARCH effect. Table 5 shows the LM test for the log returns of both companies. From the table it is seen that all the test

statistics' are statistically significant. So, it can be concluded that the data getting from all the companies have the conditional heteroscadisticity in the behavior of the residuals. Another method to measure of heteroscedasticity in time series data is Parkinson's extreme value estimator based on intra-day high and low price of an asset is more efficient. Figure 3 shows the Parkinson's monthly volatility of both companies which confer that there have conditional heteroscadisticity in the behavior of the residuals.

Figure 3. Parkinson's volatility of log returns of BEXIMCO and SQUARE pharmaceuticals.



BEXIMCO pharmaceuticals



SQUARE pharmaceuticals

Table 6. Stata output of ARCH family regression for BEXIMCO pharmaceutical

ARCH family regression

Sample: 06jan2009 - 15dec2015, but with gaps Number of obs = 887
Distribution: Gaussian Wald chi2(4) = 19247.68
Log likelihood = -94.15745 Prob > chi2 = 0.0000

	OPG				
lnrtbex	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
lnrtbex					
D1.	.9804007	.0088351	110.97	0.000	.9630843 .9977171
D2.	-.2837955	.0057429	-49.42	0.000	-.2950514 -.2725396
lndav					
D1.	4.644667	.4088041	11.36	0.000	3.843425 5.445908
D2.	-2.193302	.3387688	-6.47	0.000	-2.857276 -1.529327
_cons	.0003059	.0084958	0.04	0.971	-.0163456 .0169574
ARCH					
arch					
L1.	.5032947	.0586205	8.59	0.000	.3884007 .6181887
_cons	.0429952	.0034213	12.57	0.000	.0362897 .0497008

The dynamic regression model with volatility regression of ARCH effect for BEXIMCO pharmaceuticals with one period significant lag is shown in Table 6. For this bank , first difference of log return (Δy_t) and first difference of log daily average Δx_t have positive significant contribution, whereas second difference of these variables ($\Delta^2 y_t, \Delta^2 x_t$) have opposite significant contribution to the log return y_t. ARCH effect with one period lags is also significant.

Table 7. Stata output of ARCH family regression for SQUARE pharmaceutical

ARCH family regression

Sample: 06jan2009 - 15dec2015, but with gaps Number of obs = 887
Distribution: Gaussian Wald chi2(4) = 16691.20
Log likelihood = -86.73595 Prob > chi2 = 0.0000

	OPG				
lnrtsquare	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
lnrtsquare					
D1.	.9978918	.0098788	101.01	0.000	.9785298 1.017254
D2.	-.2848584	.0052666	-54.09	0.000	-.2951808 -.2745361
lndav					
D1.	2.759694	.3145112	8.77	0.000	2.143264 3.376125
D2.	-2.332451	.2962074	-7.87	0.000	-2.913007 -1.751896
_cons	.0049671	.0082063	0.61	0.545	-.011117 .0210512
ARCH					
arch					
L1.	.4175617	.0576243	7.25	0.000	.3046201 .5305033
L2.	.2748443	.06107	4.50	0.000	.1551493 .3945393
_cons	.0295291	.0051564	5.73	0.000	.0194228 .0396353

Table 7 shows the dynamic regression model with volatility regression of ARCH effect for SQUARE pharmaceuticals . For this company , first difference of log return (Δy_t) and first difference of log daily average Δx_t have positive significant contribution, whereas second difference of these variables $(\Delta^2 y_t, \Delta^2 x_t)$ have opposite significant contribution to the log return y_t. ARCH effect with two period lags is also significant.

Table 8. Volatility model for log returns of BEXIMCO and SQUARE pharmaceuticals.

SL	Company name	Fitted Volatility model
1	BEXIMCO pharmaceuticals	$\hat{\sigma}_t^2 = \underset{(0.000)}{0.04210} + \underset{(0.000)}{0.50330}\, a_{t-1}^2$
2	SQUARE pharmaceuticals.	$\hat{\sigma}_t^2 = \underset{(0.000)}{0.02953} + \underset{(0.000)}{0.41756}\, a_{t-1}^2 + \underset{(0.000)}{0.27484}\, a_{t-2}^2$

**Figure in parenthesis indicate the significant P value for estimated coefficients*

Table 9. Parameters of proposed modified ARDL (2,2) regression model

SL	Company name	Intercept	Explanatory variables				
		$(\hat{\beta}_0')$	Y_{t-1} $(\hat{\beta}_1')$	Y_{t-2} $(\hat{\beta}_2')$	X_t $(\hat{\alpha}_0')$	X_{t-1} $(\hat{\alpha}_1')$	X_{t-2} $(\hat{\alpha}_2')$
1	BEXIMCO	0.00101	-1.36066	-0.93541	8.07991	-0.85060	-7.22932
2	SQUARE	0.01731	-1.49205	-0.99264	1.48881	6.63905	-8.12786

After transformation, the modified ARDL(2,2) model obtained from the original ARDL model is proposed in the following form;

$$Y_t = \beta_0' + \beta_1' Y_{t-1} + \beta_2' Y_{t-2} + \alpha_0' X_t + \alpha_1' X_{t-1} + \alpha_2' X_{t-2} + v_t$$

$$where\ ,\ \beta_0' = \frac{\beta_0}{1-\beta_1-\beta_2}, \qquad \beta_1' = -\frac{\beta_1+2\beta_2}{1-\beta_1-\beta_2}$$

$$\beta_2' = \frac{\beta_2}{1-\beta_1-\beta_2}, \qquad \alpha_0' = \frac{\alpha_1+\alpha_2}{1-\beta_1-\beta_2}$$

$$\alpha_1' = -\frac{\alpha_1+2\alpha_2}{1-\beta_1-\beta_2}, \qquad \alpha_2' = \frac{\alpha_2}{1-\beta_1-\beta_2}$$

$$v_t = \frac{u_t}{1-\beta_1-\beta_2}$$

$\beta_1, \beta_2, \alpha_1, \alpha_2$ are the coefficients of $\Delta Y_t, \Delta^2 Y_t, \Delta X_t$ *and* $\Delta^2 X_t$ respectively.

And the fitted proposed ARDL(2,2) regression model for BEXIMCO pharmaceuticals is as following:

$$\hat{Y}_t = \hat{\beta}_0' + \hat{\beta}_1' Y_{t-1} + \hat{\beta}_2' Y_{t-2} + \hat{\alpha}_0' X_t + \hat{\alpha}_1' X_{t-1} + \hat{\alpha}_2' X_{t-2}$$

$$= 0.00101 - 1.36066\, Y_{t-1} - 0.93541 Y_{t-2} + 8.07991 X_t - 0.85060 X_{t-1} - 7.22932 X_{t-2}$$

And the fitted proposed ARDL(2,2) regression model for SQUARE pharmaceuticals is as following:

$$\hat{Y}_t = \hat{\beta}_0' + \hat{\beta}_1' Y_{t-1} + \hat{\beta}_2' Y_{t-2} + \hat{\alpha}_0' X_t + \hat{\alpha}_1' X_{t-1} + \hat{\alpha}_2' X_{t-2}$$

$$= 0.01731 - 1.49205\, Y_{t-1} - 0.992641 Y_{t-2} + 1.48881 X_t - 6.63905 X_{t-1} - 8.12786 X_{t-2}$$

Where, Y_t *and* X_t represent the log return(lnr_t) and log daily average($lndav$) at trade date t. Now the 1- step ahead forecasted model for the log return of BEXIMCO pharmaceuticals will be;

$$\hat{Y}_{t+1} = \hat{\beta}_0' + \hat{\beta}_1' Y_t + \hat{\beta}_2' Y_{t-1} + \hat{\alpha}_0' X_{t+1} + \hat{\alpha}_1' X_t + \hat{\alpha}_2' X_{t-1}$$

$$or,\ \hat{Y}_t(1) = 0.00101 - 1.36066\, Y_t - 0.93541 Y_{t-1} + 8.07991 X_{t+1} - 0.85060 X_t - 7.22932\, X_{t-1}$$

Where, X_{t+1} is the log daily average of an asset at trade date (t+1), which is not available. So, this value can be replaced by the average of previous traded 30 days log daily averages.

And the 1- step ahead forecasted volatility model for the log returns of BEXIMCO pharmaceuticals will be;

$$\hat{\sigma}_t^2 = \underset{(0.000)}{0.04210} + \underset{(0.000)}{0.50330}\, a_{t-1}^2$$

Suppose, to predict the daily log return of BEXIMCO pharmaceuticals for 28th December, 2016 where the data are available up to 27th December, 2016 the forecasted model will be $\hat{Y}_{28th\ dec,16} = 0.78122$, And the predicted gross return of BEXIMCO pharmaceuticals for 28th December, 2016 is 2.1236 whereas the actual return was 2.087. And 1-step ahead volatility

$$\hat{\sigma}^2_{28th\ dec,16} = 0.04210 + 0.50330\, a^2_{27th\ dec,16} = 0.04701$$

Similarly, the forecasting for the log return of SQUARE pharmaceutical can be done.

Conclusion

In this study, 02 pharmaceutical companies BEXIMCO and SQUARE pharmaceuticals, listed in Chittagong Stock Exchange are considered for analysis. The conclusions of this study are following as;

1. Generally SQUARE pharmaceutical has more gross return than BEXIMCO pharmaceutical. For SQUARE pharmaceutical, the average daily return is highest with high variability in the year 2013 and that is for BEXIMCO pharmaceutical is in the year 2014. For both companies, the daily average return is highest with high standard error in the month of December.

2. The gross returns for both companies follow the non-stationary and the log returns for every company shows the random variation around zero implies the log return follows stationarity and this transformed variable is used in the analysis to predict the return for these two companies. The histograms of daily log returns of selected 2 companies confer the normality of the white noise of this variable.
3. The average VIF for both companies are less than 10, indicate the not severity of multicollinearity and can use these transform explanatory variables ΔY_t , $\Delta^2 Y_t$, ΔX_t and $\Delta^2 X_t$ in the model. It is observed that the mean VIF for BEXIMCO and SQUARE pharmaceuticals are 3.34 and 8.74 respectively.
4. Significant LM test statistic indicates the situation of having ARCH effect for the log return of both companies. So, it can be concluded that the data getting from these two companies have the conditional heteroscadisticity in the behavior of the residuals. Another method to measure of heteroscedasticity in time series data is Parkinson's extreme value estimator based on intra-day high and low price of an asset is more efficient. Parkinson's monthly volatility of both companies also confers the conditional heteroscadisticity in the behavior of the residuals.
5. The dynamic regression model with volatility regression of ARCH(1) and ARCH(2) are employed for the log return of BEXIMCO and SQUARE pharmaceutical respectively.
6. The fitted proposed ARDL(2,2) regression model of log return for BEXIMCO pharmaceuticals is;

$$\hat{Y}_t = \hat{\beta}_0' + \hat{\beta}_1' Y_{t-1} + \hat{\beta}_2' Y_{t-2} + \hat{\alpha}_0' X_t + \hat{\alpha}_1' X_{t-1} + \hat{\alpha}_2' X_{t-2}$$

$$= 0.00101 - 1.36066\, Y_{t-1} - 0.93541 Y_{t-2} + 8.07991 X_t - 0.85060 X_{t-1} - 7.22932 X_{t-2}$$

And the fitted proposed ARDL (2,2) regression model of log return for SQUARE pharmaceuticals is;

$$\hat{Y}_t = \hat{\beta}_0' + \hat{\beta}_1' Y_{t-1} + \hat{\beta}_2' Y_{t-2} + \hat{\alpha}_0' X_t + \hat{\alpha}_1' X_{t-1} + \hat{\alpha}_2' X_{t-2}$$

$$= 0.01731 - 1.49205\, Y_{t-1} - 0.992641 Y_{t-2} + 1.48881 X_t - 6.63905 X_{t-1} - 8.12786 X_{t-2}$$

Where, Y_t *and* X_t represent the log return and log daily average at trade date t.

Now the 1- step ahead forecasted mean model for the log return of BEXIMCO pharmaceuticals will be;

$$\hat{Y}_t(1) = 0.00101 - 1.36066\, Y_t - 0.93541 Y_{t-1} + 8.07991 X_{t+1} - 0.85060 X_t - 7.22932\, X_{t-1}$$

Where, X_{t+1} is the log daily average of an asset at trade date (t+1), which is not available. So, this value can be replaced by the average of previous traded 30 days log daily averages.

And the 1- step ahead forecasted volatility model for the log returns of BEXIMCO pharmaceuticals will be;

$$\hat{\sigma}_t^{\,2} = \underset{(0.000)}{0.04210} + \underset{(0.000)}{0.50330}\, a_{t-1}^2$$

7. Predicted the daily log return of BEXIMCO pharmaceuticals for 28th December, 2016 is $\hat{Y}_{28th\ dec,16} = 0.78122$, And the predicted gross return of BEXIMCO pharmaceuticals for 28th December, 2016 is 2.1236 whereas the actual return was 2.087. And 1-step ahead volatility 0.04701.

References

1. Ainul, I. & Khaled, M. (2005). Tests of weak-form efficiency of the Dhaka stock exchange. *Journal of Business Finance & Accounting*, 32 (7-8), 1613-1622.

2. Ajab Al Freedi (2012). A study on the behavior of volatility in Saudi Arabia stock market using symmetric and asymmetric GARCH Models. *Journal of Mathematics and Statistics*, 8(1), 98-106.

3. Baillie, R.T., and R.P. DeGennaro (1990). Stock Returns and Volatility, *Journal of Financial and Quantitative Analysis*, 25, 203-215.

4. Bucevska V. (2012). An empirical evaluation of GARCH Models in value-at-risk estimation: evidence from the Macedonian stock exchange. *Business Systems Research Journal*, 4(1), 49-64.

5. Chowdhury, S. S. H., Sadique, M. S. & Rahman, M. A. (2001). Capital market seasonality: The case of Dhaka stock exchange (DSE) returns. *South Asian Journal of Management*, 8, 1-8.

6. Dickey, D. A. and Fuller, W.A. (1979). Distribution of the estimates for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, 427–431.

7. Elsheikh A. A. (2011). Modeling stock market volatility using GARCH models evidence from Sudan. *International Journal of Business and Social Science*, 2(23),114-128.

8. 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.

9. Islam M. (2013). Modeling univariate volatility of modeling univariate volatility of evidence from 4-Asian markets. *International Research Journal of Finance and Economics*, 163, 110-117.

10. Islam, M. A., M. Rayhan Islam and Mahmudul Hasan Siddiqui (2014). Stock market volatility: Comparison between Dhaka stock exchange and Chittagong stock exchange. *International Journal of Economics, Finance and Management Sciences*, 2(1), 43-52.

11. .Naik, P. K. And P. Padhi (2012). The Impact of Macroeconomic Fundamentals on Stock Prices Revisited: Evidence from Indian Data . *Eurasian Journal of Business and Economics* , 5 (10), 25-44.

12. Parkinson, M. (1980). The extreme value method for estimating the variance of the rate of return. *Journal of Business*, 53, 61–65.

13. Rokonuzzamanan, M. & Mohammad Akram Hossain (2018). Volatility Analysis of Stock Market Returns for Fifteen Banks Listed in Chittagong Stock Exchange. *International Business Research.*11(8), 129-143

14. Uddin, Md. G. S. & Khoda, N. M. A. K. (2009) "An empirical examination of random walk hypothesis for Dhaka stock exchange: evidence from pharmaceutical sector of Bangladesh. *International Research Journal of Finance and Economics*, 33, 87-100.

15. Uddin Md. G. S. & Shakila Y. (2008). Random walk model in the Dhaka stock exchange: An empirical evidence of daily returns. *Journal of Business Administration*, **35(1 & 2), 75-86.**

.