North South Business Review, Volume 3, Number 1, July 2009, ISSN 1991-4938

FORECASTING DHAKA STOCK EXCHANGE (DSE) RETURN: AN AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) APPROACH

ASM Shakil Haider
School of Business, North South University, Bangladesh
Md. Rezaul Kabir
Institute of Business Administration, Dhaka University, Bangladesh

ABSTRACT

This paper investigates the predictability of Dhaka Stock Exchange (DSE) of Bangladesh by proving the market is not weak form efficient and then predicts the monthly index and the return series by using the Autoregressive Integrated Moving Average (ARIMA) process. Through different formal tests on the dataset, the best fitted model selected was ARIMA (3,1,2) for the index series and ARMA(3,1) for the return series. The forecasted values indicate that the market will remain stable with no extreme shocks in near future extending to 2015 The maximum growth possibility of the market indicated in the model is in the year of 2011 specially from September to November; where 2012 remains moderate; and 2013 to 2015 remains in low growth. For the validity of the forecast the Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error(MAPE) and Theil U statistics are checked.

Keywords: Forecasting, Stock index, Stock return, ARIMA, Dhaka Stock Exchange (DSE), Chittagong Stock Exchange (CSE)

INTRODUCTION

In a Weak Form Efficient market there will be no statistical dependence among the price changes or returns of the market which implies that prices are random. If any dependence is found, Weak Form Efficiency hypothesis is violated and one may conclude that it is possible to predict the future market return based on past prices. It has been found that the inefficiency of any emerging market occurs due to the size of the market, thinness of trading and quality of information disclosure (Keane, 1983). Dhaka Stock Exchange (DSE) is a recently organized stock market and the first Stock Exchange of Bangladesh> In this stock exchange low depth of capital and liquidity, high level of volatility and market concentration, thin trading, low turnover exist. Though, some of the earlier studies examining the weak form efficiency of DSE were inconclusive, more recent studies examining weak form inefficiency confirmed market inefficiency. If DSE is weak form inefficient which is also a conclusion of this paper, then prediction of the market is possible.

Among the two stock exchanges of Bangladesh, Dhaka Stock Exchange was the first and began trading in 1976 with a paid up capital of Tk 0.138 billion and market capitalization of Tk 0.147 billion which was 0.138% of the GDP (Bepari and Mollik, 2008). In order to control the operation of the stock market and protect the interest of the investors the Security and Exchange Commission (SEC) was formed in 1993. But still the market crashed in1996 and it had a

prolonged effect through 1999 with cumulative a decline of 83.44% and annual rate of decline of 27.82%. This crash damaged the confidence of the investors. Therefore, a model providing directions for the stock market prediction of stock market index and dependable prediction of the return for DSE may play a vital role in reducing uncertainty in the stock prices, reducing the risk of adverse volatility in the market and helping to form an expectation for the market. According to Pesaran and Timmermann(1995), stock market forecast is important for both the timing of stock investment and the relative investment desirability among the various sectors in the market. In 1997 the government of Bangladesh undertook Capital Market Development Program (CMDP) supported by ADB. But market suffered shocks again during the year of 2010 and 2011 (in November and December of 2010 the shock was extreme and the index moved up to near 9,000 but just on 2011 it fell back to near 6,500) which indicates the importance of forecasting the market to minimize the risk of investment.

LITERATURE REVIEW

The random walk is usually found in the developed country's stock markets (Kendall,1953; Granger & Morgenstern,1963; Solnik,1973). The research findings on the developing or emerging stock markets regarding the efficiency of the market are inconclusive. There were two types of conclusions; one group found weak form efficiency in the developing markets (Branes, 1986; Chan et al, 1992; Dickinson & Muragu, 1994; Ojah & Karemera, 1999). The other group found no randomness or random behavior in the stock price of developing stock markets (Poterba & Summers, 1988: Roux & Gilberson, 1978; Harvey,1994; Classens et al 1995; Khababa, 1998) which indicates that the market is not efficient in the weak form. The implication is that it is possible to predict future stock prices and design a profitable trading strategy based on historical stock prices.

There are a few published studies on the efficiency of DSE. Rahman et al. (2004) found some support for random walk behavior in the DSE returns, but the majority of published work provide evidence of inefficiency in the Dhaka Stock Exchange (Kader and Rahman, 2005; Islam and Khaled, 2005; Ahmed, 2002; Rahman and Hossain, 2006; Alam and Uddin, 2007). The findings from these articles generally lead one to conclude that previous prices of the stocks have impact on the future returns of the market. This information was used by researchers to forecast index values and returns in emerging markets which were not efficient in the weak form. Using the ARIMA method, Simons and Laryea (2004) predicted the Egypt, Ghana and Mauritius stock market return (as none of the markets were weak form efficient). They fitted ARIMA (1,0,1) for Egypt, ARIMA (1,0,2) for Ghana and ARIMA (2,0,1) for Mauritius and generated one period forecasts for the subsequent twelve periods. Al-Shihab (2006) analyzed the daily index (from April, 2004 to October, 2004) of Amman Stock Exchange (ASE) and tried to forecast the return of the market. On the basis of Akaike Information Criterion (AIC), Schwartz Information Criterion (SIC), R-square, Adjusted R-Square, the best fit model was found to be ARIMA(4,1,5) and the forecasts were generated.

Rahman and Hossain (2006) conducted a study based on ARIMA method on the Dhaka Stock Exchange and concluded that ARIMA (3,0,1) and ARIMA (1,0,1) models were the models of best fit. They used the best fit models to generatedata for validation period and concluded that the generated data set fits well with the actual data for the validation period. Hossain et al. (2011) made a comparative study of GARCH and ARIMA models on the DSE and concluded that

ARIMA (2, 0 , 1) and GARCH (1,1) offer the best fit for the DSE. Mollick and Bepari (2008) concluded that DSE returns may be predicted using ARIMA (1, 0,2). This study is unique in the sense that it not only identifies the best fit model but also generates forecasts beyond the sample period.

METHODOLOGY

The objective of this study is to generate forecasted return of Dhaka Stock Exchange and then to check the cointegration between the Dhaka Stock Exchange (DSE) and Chittagong stock Exchange (CSE). The methods used in this research for generating forecast based on trend, stationarity, and cyclicality of the Dhaka Stock Exchange Index dataset. Box-Jenkins (ARIMA) approach is used to select tentative model and used for forecasting DSE monthly return and index series. For the cointegration part, both the Engel Granger approach and Johansen & Juselius approach has been done. The Box Jenkins procedure has been applied on the dataset using "EViews 5".

Data Sources And Data Transformation

The sample dataset used in this research is the monthly general index of Dhaka Stock Exchange (DSE) starting from January 1993 to March 2011 which refers to 219 observations. The daily general index of DSE was actually collected from the official website of Dhaka Stock Exchange and then transformed to the monthly general index based on the available observations of the certain month. To capture the monthly effect on the stock index and the return series, dummy variables has been introduced against every single month (January = d1, February = d2, March = d3, April = d4, May = d5, June = d6, July = d7, August = d8, September = d9, October = d10, November = d11, December = D12). They are called the "monthly dummies". When there is a data point in a certain month, the dummy for that month will show "1"; otherwise it will show "0".

Methods Applied For Forecasting Stock Return

A stationary time series dataset is a must when the Box-Jenkins methodology is used for the analysis. To check the stationarity and to know the order of integration, ACF and PACF of the series have been checked and the Dickey Fuller (DF), Augmented Dickey Fuller (ADF) and Philips Perron (PP) test has been done. The tests consider null hypothesis as "the series contain unit root" against "no unit root in the series" as the alternative. In this research it is important to have stationarity for the "return" series to test the Weak Form Efficiency hypothesis of the Dhaka Stock Exchange. The return series can be shown as-

$$R_t = PI_t - PI_{t-1}$$

Here, R_t = Market Return at Period t; PI_t = Price Index at time t; PI_{t-1} = Price Index at time t-1
Thus, the return series is nothing but the 1st difference series of the general price index. In the research for simplicity of writing down equations and software purpose the index series and return series are defined as-

$PI_t = Y_t$ = Index; $R_t = \Delta Y_t$ = D(Index)

Where Y_t and ΔY_t are used in writing the equations for this study; Index and D(Index) are used for estimating the equations in the software.

The Autoregressive Integrated Moving Average (ARIMA) method has three model parameters. They are for the AR(p) process, I(d) process and MA(q) process. The AR(p) is for the Autoregressive process where the memory of past event is considered. The "p" lags are used for the forecast improvement. The model looks like-

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \ldots + \phi_p Y_{t-p} + \varepsilon_t$$

The next part is the integrated process. If the time series needs to be differenced for "d" times to make it stationary, then it is integrated of order "d" or I(d) (Gujrati, 2003). The last component for the process is moving average process. MA(q) takes into account the q number of lags of errors for the improvement of the forecast. The model looks like-

$$Y_t = \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q}$$

Therefore, the combined ARMA(p,q) can be written as-

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \ldots + \phi_p Y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q}$$

For the identification of a proper model through Box-Jenkins or ARIMA (p, d, q) procedure and forecasting the DSE return and the index, there are four steps - 1) Model Identification, 2) Model Estimation, 3) Model Diagnostics, 4) Forecasting

Model Identification

At model identification stage the specific model that is appropriate for the dataset is identified. The specific order of p, d, q are tried to be found in this stage. The auto correlation function (ACF) and partial autocorrelation function (PACF), Dickey Fuller (DF), Augmented Dickey Fuller (ADF) and Philips Perron (PP) tests are used to find out the order of integration or I(d). The trend of the main data series is also seen for the trend analysis based on AIC and SIC criterion and the monthly effect has also been tested through dummy variable approach. Later on, the ACF, PACF, lowest Akaike Information Criterion (AIC), lowest Schwartz Information Criterion (SIC), Durbin Watson statistic (close to 2), lowest Log likelihood, lowest Standard Error, highest Adjusted R-square are used to figure out the ARMA(p , q) for the DSE return series.

Model Estimation

In the second step the parameter of the autoregressive and moving average terms are estimated. Dummy variables for each month are included in the main model to control for "Monthly Effect". To avoid the "Dummy Trap", the model is estimated without the "intercept" term. The trend terms are also kept for the regression; though they become insignificant in the main model, keeping them provide better results for the forecasted values and capture better graphical structure. Therefore, the tentative estimated model is

$$\Delta Y_t = \Psi_1 t + \Psi_2 t^2 + \phi_1 \Delta Y_{t-1} + \ldots + \phi_p \Delta Y_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \ldots - \theta_q \varepsilon_{t-q} + \beta_1 d1 + \beta_2 d2 + \cdots \beta_{12} d12$$

Here, d1, d2, …, d12= January, February,…,December

($\beta_1, \beta_2, \ldots \beta_{12}$ = Coefficients for January, February …December)

ΔY_t is the 1st difference of the index dataset as it reflects the return series.

Model Diagnostic

To ensure that the model estimated for Dhaka Stock Exchange Return series is a good fit, the autocorrelation of the errors are examined. Here, the Breuish-Godfrey LM test is done for the white noise test of the errors. When the errors are white noise or follow random path, then the model is perceived to be a good fit. The ACF and PACF of errors are also observed in the model diagnostic process. Finally the Portmanteu test for white noise (Box Pierce or Q test for residuals) and the Unit root test of the residuals are also performed.

Forecasting

In case of Dhaka Stock Exchange Return series, both the in sample and out of sample forecasting was done. In sample forecasting was done to compare the predicted value with the actual value of the sample. Out of sample forecasting was done for the next 48 months and for the validity of the forecast the Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error(MAPE) and Theil U statistics are checked.

MODEL SELECTION, EMPIRICAL RESULTS AND ANALYSIS

Depending on the dataset Dhaka Stock Exchange monthly index, the model selection is based on the Identification, Estimation, Diagnostics and later on the Forecasting was done. Here, trend, cycle and model selection criteria are used and the empirical results through different tests are also analyzed. The processes are explained below-

Identification and Estimation

Trend Analysis

By looking at the data plot of DSE monthly index series (Figure 2), one can detect a trend visible in the series. Based on the specific plot with the trend component (Figure 3) and AIC and SIC criterion from the regression, the quadratic trend line is a better fit than linear trend. From Table 1, both linear and quadratic trends are statistically significant (p-value < 0.05), the AIC and SIC criteria are indicating better

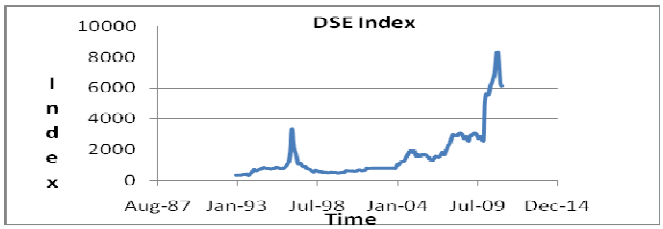


Figure 2: Line Plot of the DSE monthly Index

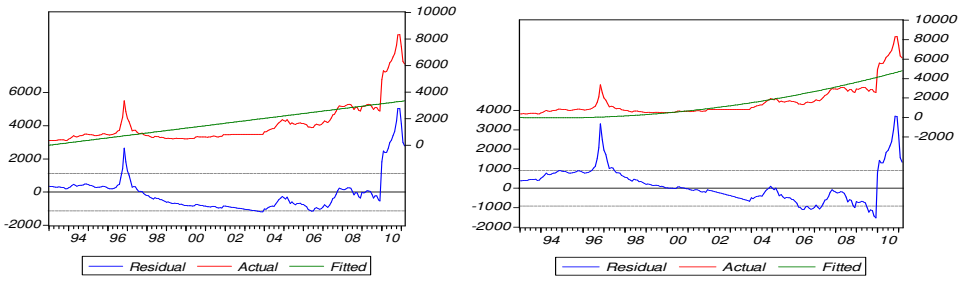


Figure 3: Linear and Quadratic trend model (respectively) for DSE monthly stock index

Table 1: Trend selection of DSE Index Series (Level) based on AIC and SIC criterion

Model Type	AIC	SIC	Prob. (p-value)
Linear Trend Model	**16.876**	**16.907**	**0.000**
Quadratic Trend Model	**16.119**	**16.115**	**0.000**

fit of the quadratic trend. The specific trend of the main series (DSE monthly index series) is important as the forecast of this series will also be reported.

Stationarity Test

The ACF (Appendix A: Table 1) of the DSE general Index at level goes down gradually. It is visible that up to 36 lags the ACF is statistically significant (to show a random walk process) different from zero as they are outside the 95% confidence interval. The PACF drops significantly after the first lag from 0.966 to -0.172 and all the following values are statistically insignificant. Therefore, the DSE monthly general index series (at level) indicates non stationarity. For applying Box-Jenkins procedure, we need a stationary series and this series is becoming stationary through first difference (Appendix A: Table 1). It shows that in first differenced series, ACF and PACF drastically converges to zero. Furthermore, as there is no observed trend in the differenced series, we can say that the first differenced series of DSE monthly index (which is nothing but the DSE Return series) is stationary.

Stationarity Test By Unit Root Test

To confirm the stationarity of the dataset, Dickey Fuller, Augmented Dickey Fuller, and Philips Perron tests are done. From Table 2 we can see that the calculated value is lower than the critical values in all the cases regarding the DSE Level Monthly Index series. Therefore, we can conclude that the DSE Level Monthly Index has a unit root (as the null

hypothesis here is DSE Level Monthly Index has unit root against it does not contain unit root, and we are accepting the null as calculated value < critical value). Calculated value is not less than critical value here unless critical value should be taken as an absolute number. Therefore, to make the series stationary, it becomes important to take difference

Table 2: DSE Level Monthly Index Stationarity Test

Critical value at 1%	Critical value at 5%	Critical value at 10%	Calculated value	Unit Root Test
-2.575712	-1.942303	-1.615721	0.920231	**Dickey Fuller**
-3.460596	-2.874741	-2.573883	0.30278	**Augmented Dickey Fuller** (p-value : 0.9780)
-3.460313	-2.874617	-2.573817	0.446441	**Phillips-Perron** (p-value : 0.9845)

If we take the 1st difference of the DSE Monthly Index, we get the DSE Monthly return series. Table 4 shows the DSE Return series does not contain a unit root. Regarding the DSE Return series, the null and alternatives are-

Ho: DSE Return Series has a Unit Root

Ha**:** DSE Return Series does not have a Unit Root

As presented in Table 3, all the tests lead to the conclusion that the null is rejected, since the calculated value is greater than the critical value. Therefore, the Integration of the level series (which is the DSE Monthly Index series) is I(1). When we are dealing with the 1st differenced series that becomes the monthly return series of DSE. The monthly effect through the dummy variables on the DSE Monthly Return series has been checked (Appendix A: Table 2). It has been found that, none of the month has

Table 3: DSE Return Series (DSE First Differenced Monthly Index) Stationarity Test

Critical value at 1%	Critical value at 5%	Critical value at 10%	Calculated value	Unit Root Test
-2.575712	-1.942303	-1.615721	-10.17502	**Dickey Fuller**
-3.460596	-2.874741	-2.573883	-10.28007	**Augmented Dickey Fuller** (p-value : 0.000)
-3.460453	-2.874679	-2.57385	-10.24755	**Phillips-Perron Test** (p-value : 0.000)

significant effect on the return series as well as there is no significant trend effect on the return series.

Order Of ARMA (p, q):

For the order of AR(p) and MA(q), a guess can be made by looking at the correlogram (Figure 1, Appendix B). The correlogram suggests that the AR(p) process should have

Table 4: ARMA(p,q) Model Selection and Estimation

ARMA(3,1)				
Variable	Co-efficient	Std. Error	t-statistic	Prob.
AR(1)	-0.569585	0.069596	-8.184149	0.000
AR(2)	0.155241	0.083673	1.855326	0.065
AR(3)	-0.220287	0.07419	-2.969228	0.003
MA(1)	0.997497	1.98E-05	50279.15	0.000
R-squared	20.99%		AIC	13.847
Adjusted R-squared	14.17%		SIC	14.130
D-W	2.037		Log Likelihood	-1470.598
ARMA(2,1)				
Variable	Co-efficient	Std. Error	t-statistic	Prob.
AR(1)	0.394492	0.297257	1.327111	0.186
AR(2)	-0.254858	0.12351	-2.063457	0.040
MA(1)	0.002022	0.306196	0.006605	0.995
R-squared	20.13%		AIC	13.870
Adjusted R-Squared	13.71%		SIC	14.193
D-W	1.999		Log Likelihood	-1478.110
ARMA(2,2)				
Variable	Co-efficient	Std. Error	t-statistic	Prob.
AR(1)	1.016069	0.145076	7.003721	0.000
AR(2)	-0.181213	0.127673	-1.419354	0.157
MA(1)	-0.683774	0.147174	-4.646012	0.000
MA(2)	-0.312926	0.135885	-2.302872	0.022
R-squared	25.20%		AIC	13.877
Adjusted R-squared	18.78%		SIC	14.160
D-W	2.0144		Log Likelihood	-1471.598

an order 2 as the PACF has 2 spikes outside of the band. The MA(q) process should have an order of 1 as the ACF is showing 1 spike outside of the bend. Therefore, to select and estimate a proper model starting from AR(1) and MA(1) individually towards AR(5) MA(5) combinedly for each and every combination of AR and MA process are tested. Some of the closest results which can actually show that this can be the process as a part of the final composite model are shown in Table 4. From the table it can be concluded that the best fit model for DSE monthly return series is ARMA(3,1) based on the AIC, SIC, DW-Statistic, Adjusted R-squared, Log likelihood compared to the other closest models. Estimated AR(1) coefficient (-0.569585), AR(3) coefficient (-0.220287) and MA(1) coefficient (0.997497) are significant at 1% level of significance. These estimated parameters minimized the sum squared error (which indicates the convergence) and satisfy the invertibility condition. Among the other closest models ARMA(2,2) could not be selected as the AR(2) coefficient (-0.220287) is insignificant even at 10% significance level and the statistical criteria are showing lower performance than the ARMA(3,1) model. Therefore, the identified and estimated model ARMA(3,1) for the DSE monthly Return series can be written as

$$\Delta Y_t = \Psi_1 t + \Psi_2 t^2 - 0.569585\,\Delta Y_{t-1} + 0.155241\,\Delta Y_{t-2} - 0.220287\Delta Y_{t-3} + \varepsilon_t - 0.997497\,\varepsilon_{t-1} \ldots + \beta_1\, d1 + \beta_2\, d2 + \cdots \beta_{1\,2}\, d12$$

Here, the dummy variables (as well as the trend components) are controlled and not significant. That is why their coefficients are not reported in the model. Only the significant variable coefficients are reported in the estimated model. The other variables are kept for better performance for forecasting. For the DSE monthly Index series, the estimated model then should be ARIMA(3,1,1) as that is the level series.

Diagnostic Check

Diagnostic checking ensures whether the model is fit for forecasting the future period or not. If the residuals show white noise, then the model performs better, if not, then, search for another model should continue. For a formal test of the autocorrelation among the residuals of the estimated model, the Breusch-Godfrey Serial Correlation LM test is done. The null and the alternative hypothesis are-

Ho: White Noise exists among the residuals

Ha: White Noise doesn't exist among the residuals

The decision rule is p-value > 0.05 (or 0.01 or 0.10), then the null is accepted and the residuals show white noise. From Table 5, we can conclude that as the p-value (0.485195) > 0.05, then we can accept the null hypothesis and conclude that the residual show white noise behavior. Even from the plot of the residuals from Figure 6 (graph-2) we can see that the residuals are white noise. Plotting of actual dataset and the fitted values also provide an indication that the selected model is a good fit for the dataset and forecasting. Looking at the ACF, PACF of the residuals from (Appendix A: Table 3)

indicates that the residuals are truly random as the calculated ACF and PACF for the residuals are statistically equal to zero and all of the autocorrelation or partial autocorrelation coefficients are insignificant.

Table 5: Breusch-Godfrey Serial Correlation LM test

Statistics	Value	Prob.
F-statistic	**0.667144**	**0.51434**
Obs* R-squared	**1.44641**	**0.485195**

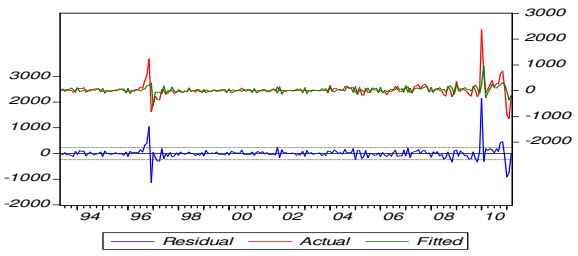


Figure 6: Residual Plot (graph -2), Actual Dataset (1st differenced) and Fitted Values Plot (graph-1)

The Portmanteau test (Box Pierce or Q-test for residuals) has been done to confirm the white noise existence. The null hypothesis is that all correlation coefficients are equal to zero and the alternative is not all the correlation coefficients are equal to zero-

Ho: $\rho_1 = \rho_2 = \ldots = \rho_k = 0$

Ha: $Not\ all\ \rho_k = 0$

From Table 6, it is visible that the Q-value is 4.6343 and the corresponding p-value for this is 0.9142

Table 6: Box Pierce or Q test for residuals

Portmanteau test for white noise	
Statistics	**Value**
Portmanteau (Q) statistic	4.6343
Prob > chi2(10)	0.9142

which is not significant. Therefore, we can accept the null hypothesis and conclude that the correlation coefficients are equal to zero. This result implies that the residuals show white noise behavior. Finally, as an additional test, unit root test has been performed on

the residuals through DF, ADF and Philips-Perron (PP) test. From Table 7, the test results show that the residuals show white noise behavior.

Table 7: Unit Root test for residuals

Critical value at 1%	Critical value at 5%	Critical value at 10%	Calculated value	Unit Root Test
-2.575813	-1.942317	-1.615712	-14.8699	**Dickey Fuller**
-3.460884	-2.874868	-2.573951	-14.83621	**Augmented Dickey Fuller (p-value : 0.000)**
-3.460884	-2.874868	-2.573951	-14.83621	**Phillips-Perron Test (p-value : 0.000)**

Forecasting

To forecast the DSE monthly return series for the 48 periods starting from April 2011 to March 2015, the estimated model for forecasting which can be written as-

$$\Delta Y_t = \Psi_1 t + \Psi_2 t^2 - 0.569585\,\Delta Y_{t-1} + 0.155241\,\Delta Y_{t-2} - 0.220287\,\Delta Y_{t-3} + \varepsilon_t - 0.997497\,\varepsilon_{t-1} \ldots + \beta_1\, d1 + \beta_2\, d2 + \cdots \beta_{1\,2}\, d12$$

The return series is nothing but the 1st differenced series of the DSE monthly index series. It can be written in terms of the original data and solved algebraically for Y_t. The final model to forecast DSE monthly Index series can be written as-

$$Y_t = \Psi_1 t + \Psi_2 t^2 + 0.430415\,Y_{t-1} + 0.724826\,Y_{t-2} - 0.375529\,Y_{t-3} + 0.220287\,Y_{t-4} + \varepsilon_t - 0.997497\,\varepsilon_{t-1} \ldots + \beta_1\, d1 + \beta_2\, d2 + \cdots \beta_{1\,2}\, d12$$

From Figure 7, we get the forecasted monthly index and the forecasted return series. Figure 7 show that the index series has a possibility to follow the quadratic up rise from 2011. It also indicates slight increase in monthly return series starting from 2011 but there is also a decreasing return starting from the middle of 2012 towards the year 2015. Figure 8 indicates the forecasting through the estimated models show good fit for the whole dataset except for the extreme shocks occurred in Dhaka Stock Exchange during the year of 1995-1996. But the forecasted graph of index series show an indication of extreme shock during 2010-2011 in DSE. From the index series, though the fluctuations are not very apparent, but from the return series, the fluctuations are quite obvious. From the forecasted values of the monthly index series (Appendix A: Table 4), during the year of 2011 the index series has a possibility to follow a growth path towards 2.279% in the

Figure 7(a): Forecasted Index Series

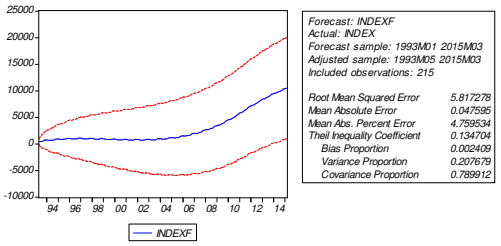
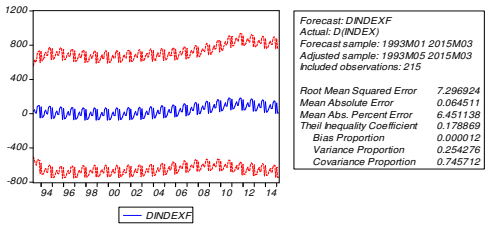
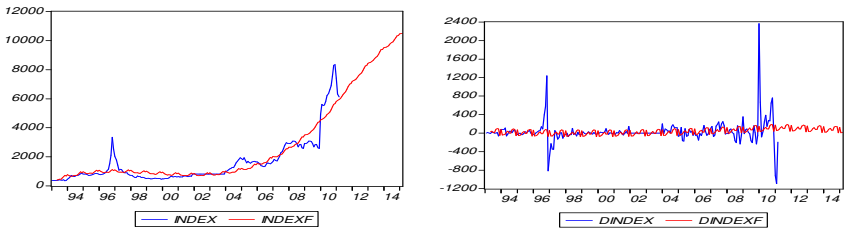


Figure 7(b): Forecasted Return series



It month of June, 2011 but falls back to 1.5% growth on average during July and August of 2011. It is important to mention that, as the month of April and May has already been observed and we have the predicted value for the month of April and May. In comparison with the observed value and the predicted values, the model predicted for an index point of 6,020.83 and 6,138.41 in April and may successively for 2011 and the actual index point observed 6272.81 and 5644.18. These certain results give another indication that the model can predict the future quite accurately. However, the results

Figure 8: Actual and Forecasted DSE monthly Index and Return series



from September to November shows the growth remains moderately stable with an average of 2.6% but falls back to a growth of 0.5% in December 2011. As there will be few ups and downs in the market during 2011, the monthly return series focus on the possibility of gain and loss in a magnified way. It suggests the return is better during the month of May(45%), June (19%), September (69.34%) and October (12.01%). During the year of 2012, the forecasted monthly index series shows a growth of 2.29% starting in January but has a possibility to fall back and face a decreasing growth (on average 0.7%) up to the month of April. From the month of May to August, the index remains moderately stable but starts increasing from September to November (on average 2.1% in October and November). In December the growth rate falls back. The index has a possibility to touch the point 8,285.53 by December. The forecasted return series indicates a better return during the month of January, April, May and September as the change of returns towards a higher gain is substantial with on average 60% (approximately) gain in return. Forecasted index values for the year of 2013 suggest an increase in growth in January (1.83%) but a decelerating or less growth from February to April (on average 0.45%). Though the growth has an indication of increase during the month of May and June, it falls back in July and August (on average 0.8%). Finally, the

growth increases from September and remains growing up to November (on average 1.6%). The forecasted return series suggest better than a moderate gain during the month of January, April and May (on average 60%) and a very high gain possibility in the month of September. In the year of 2014, the forecasted index suggest lowest growth. The maximum growth rate of index is 1.47% during the month of October. From February to May the market has a possibility to perform very moderately (0.4% growth). From September to November the market has a possibility to up rise the index but in December, 2014 the market can start with diminishing growth and the effect has a possibility to sustain up to the March 2015 (with on average 0.08% growth only). The return series suggest investing during the month of January, April, May, June and September for substantial gain during the year of 2014. Though, in 2015 the gain in February and March are very low, it is possible to gain in the month of January as the absolute gain in December 2014 can be very low than the absolute gain of January 2015.

Forecast Validity

The validity of the forecast has been measured through RMSE (Root mean squared error), MAPE(Mean absolute percentage error), MAE (Mean absolute error) and Theil U indicators. For the monthly Index series , the RMSE(5.817278), MAE(0.047595), MAPE (4.759534) are showing lower values which indicate a good fit of the forecast and the estimated model. For the monthly Return series, the RMSE (7.296924), MAE(0.064511), MAPE(6.451138) are also low. As the RMSE and the MAPE are showing close and lower values, there is no programming mistake in the model. The final indicator for forecast validation is the Theil U statistics (Theil inequality statistics). The U statistic has a range to ensure the forecast validity. The statistic lies in between 0 and 1. If the U statistic yields a value near 0, then the forecasting is implied to be a good forecast and the model has good predicting power.

Table 8: Forecast Validity by RMSE, MAE and MAPE

Series	RMSE	MAE	MAPE
DSE Monthly Index Series	5.817278	0.047595	4.759534
DSE Monthly Return Series	7.296924	0.064511	6.451138

Table 9: Forecast Validity by Theil U statistic

Theil Inequality Statistics			
Series	Bias Proportion	Variance Proportion	Covariance Proportion
DSE Monthly Index Series	0.002409	0.207679	0.789912
DSE Monthly Return Series	0.000012	0.254276	0.745712

From Table 9 the Theil U statistic is showing low value for bias portion and variance portion for both the monthly index and the return series and a high value for the covariance portion (0.7899 and 0.745712). These results indicate that in the forecasted and actual monthly index series the correlation is very high and similarly in the forecasted and actual monthly return series the correlation is also very high. Therefore, the model can predict future values reliably.

CONCLUDING REMARK

The research paper found the evidence of an effect of previous time period's stock index and return on future stock index and return, which indicates weak form inefficiency of Dhaka Stock Exchange. The modeling and predictions of the stock index and return series were done by Autoregressive Integrated Moving Average (ARIMA) process. Through different diagnostic testing, the best fit model for the index and return series of Dhaka Stock Exchange (from January 1993 to March 2011) were found to be ARIMA(3,1,1) and ARMA(3,1) respectively. Based on the models, forecasting has been done for 48 months (from April 2011 to March 2015). The results show that the market has a possibility to grow during the forecasted periods where extreme fluctuations are less probable. The forecasted return series provide a magnified view of the growth of the index series in the future. In the forecasting part of DSE monthly index, the index forecast for the year 2011 suggest a stable growth of 2.6% during September to November where the return series suggest best returns during the month of September and May for 2011. As the month of April and May of 2011 has already been observed and the predictions by the estimated model are very close to the observed values, there is an indication that the model can predict the future quite accurately. In 2012 the index grows moderately in September and it causes the higher growth in October and November (2.1%). But the return of the market is also better in January, April, May and September. In 2013 and 2014 the predicted growth of the index will remain low (maximum 1.6% and 1.47% respectively) where still there will be some possibility of gain from the market. The low growth in 2013 and 2014 has a possibility to effect the growth of the market in 2015 and may cause a very low growth at that time. As the analysis is a univariate analysis, the exact reason of the rise and fall can not be explained properly. Still the growth of the market and higher return starting from the month of May or June to September or October may be because of starting of a new fiscal year from that certain time period and its lagged effect towards September or October. As the diagnostic tests (lower RMSE, low MAE, low MAPE, higher co variance portion of Theil U) also suggest a good fit of the model, it can be concluded that the predictions are reliable and they can help to figure out the future market condition and minimize the risk of investment in Dhaka Stock Exchange.

References

Ahmed, F. (2002). "Market Efficiency in Emerging Stock Markets: The Case of Dhaka Stock Exchange", *Journal of Business Studies,* 23 (1) , pp. 157-172.

Alam, M. M. and Uddin, M. G. S. (2007), **"**The Impacts of Interest Rate on Stock Market:

Empirical Evidence from Dhaka Stock Exchange", *South Asian Journal of Management and Sciences*, Vol. 1(2), pp. 123-132.

Al-Shaib, M. (2006)," The predictability of the Amman Stock Exchange Using Univariate Autoregressive Integrated Moving Average (ARIMA) Model", *Journal of Economic & Administrative Sciences*, 22, (2), 17-35.

Bakaert, G. and Harvey, C.R (1997), ''Emerging equity market volatility'', *Journal of Financial Economics*, Vol. 43, pp. 403-44.

Bepari, M.K. and Mollik, A. (2008),"Bangladesh Stock Market Growing? a key indicators based assessment". *Journal of Business Administration Online (JBAO)*, Issue 8, 2008, Arkansas: School of Business, Arkansas Tech University.

Branes, P. (1986), " Thin trading and stock market efficiency: A case of the Kuala Lumpur Stock Exchange", *Journal of Business Finance & Accounting* , volume 13(4) winter , pp. 609- 617.

Chan, K.C., Gup B.E. and Pan, M. (1992) , "An Empirical Analysis of Stock Prices in Major Asian Markets and United States", *The financial Review*, vol-27, no-2, May1992, pp-289-307.

Claessens, S., Dasgupta S. and Glen, J. (1995); "Return behaviour in emerging Stock Market", *The world Bank economic Review*, vol.9, no.1, Pp. 131-151.

Cowels, A. (1933)," Can Stock Market Forecasters Forecast?", ***Econometrica***, 1, 309-324

Dickinson, J. P. and Muragu, K. (1994), "Market Efficiency in Developing Countries: A case study of the Nairobi Stock Exchange", *Journal of Business Finance & Accounting*, vol.21(1), pp.133-150, January.

Granger, M., and Morgenstern, O. (1963), "Spectral Analysis of New York Stock Market Prices", *Kyklos,* 16: 1–27

Harvey, C. R., (1994), "Conditional Asset allocation in Emerging Markets", *Working Paper,* No.4623, Cambridge, MA.

Hossain, M.M., Rajeb, M. and Shitan, M. (2011), "Time Series Analysis of the General Index of Dhaka Stock Exchange In Bangladesh: A Comparative Study of GARCH and ARIMA Models", *Proceeding of 2nd ICBER conference,* pp 2756-2769

Islam, Ainul and Mohammed Khaled 2005, "Tests Of Weak-Form Efficiency of the Dhaka Stock Exchange", *Journal Of Business Finance & Accounting*, vol.32 (7-8), pp.1613-1624, September/October.

Kader, A. A. and Rahman, A. F. M A. (2005), "Testing the Weak-Form Efficiency of an Emerging Market: Evidence from the Dhaka Stock Exchange of Bangladesh", *AIUB Journal*, vol.4 (2), August.

Kendall, M. (1953), "The Analysis of Economic Time Series. Part I. Prices," *Journal of the Royal Statistical Society,* 96: 11–25.

Khababa, N. (1998), "Behavior of stock prices in the Saudi Arabian Financial Market: Empirical research findings", *Journal of Financial Management & Analysis*, vol.11(1), pp.48-55, Jan-June.

Longin, F. and B. Solnki (1995), Is the correlation in international equity returns constant: 1960-1990?, *Journal of International Money and Finance*, 14, 3-26.

Manning, N. (2002), Common trends and convergence? South East Asian equity markets, 1988-1999, *Journal of International Money and Finance*, 21, 183-202.

Meric, I. and Meric, G. (1989), ''Potential gains from international portfolio diversification and inter-temporal stability and seasonality in international stock market relationships'',

Journal of Banking and Finance, Vol. 13, pp. 627-40.

Mobarek, A. and Keasey, K. (2000), Weak-form market efficiency of an emerging Market: Evidence from", *Proceedings ENBS Conference at Oslo,* pp 59-67

Narayan, P., Smyth, R. and Nandha, M. (2003), "Interdependence and dynamic linkages between the emerging stock markets of South Asia", *Accounting and Finance*, 44 (2004), 419-439

Ojah, K. and Karemera, D. 1999, "Random walks and market efficiency tests of Latin American emerging equity markets", *The Financial Review,* 34(1), 57-72.

Pesaran, M.H. and Timmermann, A. (1995)," Predictability of Stock Returns: Robustness and Economic Significance," *The Journal of Finance*, 50:1201-1228.

Poterba, J. M. and L. H. Summers (1988), "Mean Reversion in Stock Returns: Evidence and Implications", *Journal of Financial Economics*, Vol. 22, pp. 27-59.

Rahman, S. and Hossain, F. (2006), Weak-Form Efficiency: Testimony of Dhaka Stock Exchange, *Journal of Business Research*, 8, pp.1-12,

Rahman , S., Zahidur, M., Salat, A. and Bhuiyan, M. M. H. (2004), "Testing Weak-Form Efficiency of the Dhaka Stock Exchange", *Journal of Business Studies,* 25 (2) , pp. 175-188.

Roux, F. J. P. and Gilbertson, D. P. (1978), "The behavior of share prices on the Johannesburg

Stock Exchange", *Journal of Business Finance and Accounting*, vol.5 (2), pp.223-232

Simons, D. and Laryea, S.A. (2004), "Testing the Efficiency of selected African Stock Markets", A Working Paper. http://paper.ssrn.com/so13/paper.cfm?abstract_id=874808.

Sims, C. (1980)," Macroeconomics and Reality", ***Econometrica***, 48, 1-48.

Skolpadungket, P., Dahal, K. and Harnpornchai, N. (2005), "Forecasting Stock Returns using Evolutionary Artificial Neural Networks," *IEEE Transactions on Neural Networks*, vol. 16, No. 3, pp. 831-846. May 2005

Solnik, B. (1973), "Note on the Validity of the Random Walk for European Stock Prices", *Journal of Finance,* 28: 1151–1159.

Appendix A

Table 1: Level and First Difference ACF and PACF of DSE

	DSE Monthly General Index		**DSE First Differenced Monthly General Index**	
Lags	ACF	PACF	ACF	PACF
1	0.966	0.966	0.321	0.321
2	0.922	-0.172	-0.075	-0.199
3	0.871	-0.118	-0.069	0.028
4	0.813	-0.099	0.025	0.032
5	0.754	-0.013	-0.038	-0.083
6	0.703	0.094	-0.053	-0.002
7	0.658	0.052	-0.016	-0.005
8	0.615	-0.036	0.007	-0.004
9	0.574	-0.04	0.105	0.123
10	0.532	-0.079	0.109	0.033
11	0.489	-0.012	-0.047	-0.093
12	0.45	0.046	-0.166	-0.102
13	0.415	0.052	-0.199	-0.148
14	0.384	0.02	-0.073	0.01
15	0.361	0.049	-0.011	-0.017
16	0.359	0.254	0.002	0.002
17	0.355	-0.114	-0.038	-0.047
18	0.351	-0.076	-0.04	-0.05
19	0.347	-0.007	0.013	0.004
20	0.345	0.048	0.020	0.000
21	0.34	0.033	0.016	0.047
22	0.333	-0.007	-0.007	0.025
23	0.326	-0.025	-0.015	-0.009
24	0.32	-0.007	-0.043	-0.077
25	0.315	0.01	-0.039	-0.055
26	0.312	0.034	0.02	0.014
27	0.308	0.002	0.047	0.038
28	0.306	0.04	0.025	0.006
29	0.302	-0.024	0.004	-0.012
30	0.296	-0.002	0.06	0.037
31	0.289	0.061	0.098	0.045
32	0.28	-0.069	0.067	0.045
33	0.267	-0.08	0.005	0.018
34	0.253	0.001	-0.014	0.023
35	0.239	0.038	0.03	0.037
36	0.225	-0.011	0.046	0.003

Sample: January 1993- March 2011

Table 2: Seasonality test on DSE Monthly Return series based on Dummy variables

Dependent Variable: DSE Monthly Return Series				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**Prob.**
T	-0.930538	1.108088	-0.83977	0.402
T2	0.006053	0.004859	1.245799	0.2143
D1	85.4251	78.741	1.084887	0.2793
D2	-30.20039	75.93047	-0.39774	0.6912
D3	-15.87547	76.03919	-0.20878	0.8348
D4	-13.2967	77.79104	-0.17093	0.8644
D5	23.45859	77.91349	0.301085	0.7637
D6	53.22198	78.03169	0.682056	0.496
D7	16.59724	78.14564	0.212389	0.832
D8	15.70559	78.25535	0.200697	0.8411
D9	84.31491	78.36085	1.075983	0.2832
D10	104.0844	78.46214	1.326556	0.1861
D11	96.9747	78.55924	1.234415	0.2185
D12	-38.11851	78.65219	-0.48465	0.6284

(i.e. D1, D2, …, D12= January, February, …, December)

Table 3: ACF and PACF of the residuals

Lags	AC	PAC	Q-Stat	Prob.
1	-0.019	-0.019	0.0772	0.781
2	-0.01	-0.01	0.0993	0.952
3	-0.043	-0.043	0.5096	0.917
4	0.044	0.042	0.9315	0.92
5	-0.095	-0.095	2.9457	0.708
6	-0.017	-0.021	3.0112	0.807
7	-0.009	-0.008	3.0287	0.882
8	-0.04	-0.051	3.3831	0.908
9	0.037	0.042	3.6889	0.931
10	0.065	0.058	4.6518	0.913
11	-0.063	-0.069	5.5768	0.9
12	-0.142	-0.141	10.247	0.594
13	-0.163	-0.184	16.401	0.228
14	-0.051	-0.077	17.005	0.256
15	-0.002	-0.007	17.006	0.319

(i.e. lags have been taken up to 15 periods)

Table 4: Forecasted DSE monthly Index Series and growth of the Index

2011			2012			2013		
Month	Forecasted Index	Growth Rate	Month	Forecasted Index	Growth Rate	Month	Forecasted Index	Growth Rate
-	-	-	Jan-12	7202.704	2.298598	Jan-13	8435.165	1.805983
-	-	-	Feb-12	7247.91	0.627614	Feb-13	8468.166	0.391224
-	-	-	Mar-12	7294.305	0.640124	Mar-13	8502.356	0.403745
Apr-11	6020.836	-	Apr-12	7363.146	0.943758	Apr-13	8558.991	0.666119
May-11	6138.401	1.952637	May-12	7468.505	1.430897	May-13	8652.145	1.088367
Jun-11	6278.326	2.279501	Jun-12	7596.225	1.710119	Jun-13	8767.66	1.335108
Jul-11	6376.48	1.563367	Jul-12	7682.172	1.131447	Jul-13	8841.402	0.841062
Aug-11	6474.069	1.530452	Aug-12	7767.557	1.111461	Aug-13	8914.581	0.827691
Sep-11	6639.332	2.552703	Sep-12	7920.615	1.970475	Sep-13	9055.433	1.580019
Oct-11	6824.457	2.788297	Oct-12	8093.534	2.183159	Oct-13	9216.148	1.774788
Nov-11	7000.443	2.578759	Nov-12	8257.315	2.023595	Nov-13	9367.722	1.644664
Dec-11	7040.863	0.577396	Dec-12	8285.53	0.341703	Dec-13	9383.733	0.170912

Table 4: Forecasted DSE monthly Index Series and growth of the Index (continued)

2014			2015		
Month	Forecasted Index	Growth Rate	Month	Forecasted Index	Growth Rate
Jan-14	9521.163	1.464552	Jan-15	10460.7	1.211595
Feb-14	9541.958	0.218413	Feb-15	10469.29	0.082121
Mar-14	9563.942	0.230394	Mar-15	10479.07	0.093403
Apr-14	9608.373	0.464566	-	-	-
May-14	9689.321	0.842469	-	-	-
Jun-14	9792.631	1.066231	-	-	-
Jul-14	9854.167	0.62839	-	-	-
Aug-14	9915.141	0.618768	-	-	-
Sep-14	10043.79	1.297475	-	-	-
Oct-14	10192.3	1.478622	-	-	-
Nov-14	10331.67	1.367396	-	-	-
Dec-14	10335.47	0.036834	-	-	-

Table 5: Forecasted DSE monthly Return Series

2011		2012		2013		2014		2015	
Month	Forecasted Return	Month	Forecasted Return	Month	Forecasted Return	Month	Forecasted Return	Month	Forecasted Return
-	-	Jan-12	161.84117	Jan-13	149.635296	Jan-14	137.429614	Jan-15	125.22406
-	-	Feb-12	45.20517	Feb-13	33.0004041	Feb-14	20.7954542	Feb-15	8.5903827
-	-	Mar-12	46.395617	Mar-13	34.1897816	Mar-14	21.9841238	Mar-15	9.7785836
Apr-11	81.0451155	Apr-12	68.840572	Apr-13	56.6357702	Apr-14	44.4307963	-	-
May-11	117.565087	May-12	105.35904	May-13	93.1532354	May-14	80.9476007	-	-
Jun-11	139.924929	Jun-12	127.72034	Jun-13	115.515499	Jun-14	103.310503	-	-
Jul-11	98.1532645	Jul-12	85.947263	Jul-13	73.7414951	Jul-14	61.535882	-	-
Aug-11	97.5889578	Aug-12	85.384316	Aug-13	73.1794487	Aug-14	60.9744318	-	-
Sep-11	165.263757	Sep-12	153.0578	Sep-13	140.852064	Sep-14	128.646471	-	-
Oct-11	185.124318	Oct-12	172.91963	Oct-13	160.714735	Oct-14	148.509699	-	-
Nov-11	175.98628	Nov-12	163.78037	Nov-13	151.574658	Nov-14	139.369084	-	-
Dec-11	40.4202455	Dec-12	28.215518	Dec-13	16.0105938	Dec-14	3.80553916	-	-

Appendix B

Autocorrelation	Partial Correlation		AC	PAC
.|** |	.|** |	1	0.321	0.321
*|. |	**|. |	2	-0.075	-0.199
*|. |	.|. |	3	-0.069	0.028
.|. |	.|. |	4	0.025	0.032
.|. |	*|. |	5	-0.038	-0.083
.|. |	.|. |	6	-0.053	-0.002
.|. |	.|. |	7	-0.016	-0.005
.|. |	.|. |	8	0.007	-0.004
.|* |	.|* |	9	0.105	0.123
.|* |	.|. |	10	0.109	0.033
.|. |	*|. |	11	-0.047	-0.093
*|. |	*|. |	12	-0.166	-0.102
**|. |	*|. |	13	-0.199	-0.148
*|. |	.|. |	14	-0.073	0.010
.|. |	.|. |	15	-0.011	-0.017
.|. |	.|. |	16	0.002	0.002
.|. |	.|. |	17	-0.038	-0.047
.|. |	.|. |	18	-0.040	-0.050

(i.e. Selected maximum lag is 18)

Figure 1: Correlogram for the DSE Monthly Return (1st differenced Index) Series