

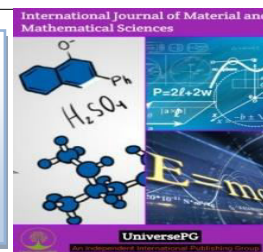


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## Prediction of Banking Sectors Financial Data of Dhaka Stock Exchange Using Autoregressive Integrated Moving Average (ARIMA) Approach

Md. Farhad Hossain<sup>1\*</sup>, Dulal Chandra Nandi<sup>1</sup>, and Kazi Mohammed Kamal Uddin<sup>2</sup>

<sup>1</sup>Department of Statistics, Comilla University, Cumilla, Bangladesh; and <sup>2</sup>Department of Economics, Comilla University, Cumilla, Bangladesh.

\*Correspondence: [farhad390ju@gmail.com](mailto:farhad390ju@gmail.com) (Md. Farhad Hossain, Assistant Professor, Department of Statistics, Comilla University, Cumilla, Bangladesh).

### ABSTRACT

This paper investigates the predictability with the banking sector data of the Dhaka Stock Exchange (DSE) by using the Autoregressive Integrated Moving Average (ARIMA) process. Through different formal tests on the data set, the best-fitted model selected was ARIMA (0, 2, 1) for the data series. This study was select five banks from DSE such as Al-Arafah bank limited, EXIM bank limited, Islami bank limited, National bank limited, and one bank limited and use these data to train the model and checks the predictive power of the model. Only analyzed results of Al-Arafah bank limited are presented in this paper because the same results have been produced for other remaining companies. The obtained results show that all the companies closing stock prices are non-stationary. It is also found that the original value curve and the predicted value curve are very much identical. So, the fitted model is performed better. For the validity of the model, the root means squared error (RMSE), mean absolute error (MAE) and mean absolute percentage error (MAPE) were checked.

**Keywords:** Forecasting, Dhaka Stock Exchange (DSE), ARIMA, Stationary, Chittagong Stock Exchange (CSE).

### INTRODUCTION:

Stock prices and their volatility have been a hot issue; the stock market in an economy plays a vital rule in accessing its economic condition. The random walk is usually established in the developed country's stock markets (Kendall, 1953; Granger & Morgenstern, 1963; Solnik, 1973). Stock market forecasters focus on developing a successful approach for close prices. The frugality and the stock market are interrelated as claimed by Moffatt (2010). Ultimate aiming to earn a high profit using well-defined trading strategies. The cardinal conception to successful stock market prediction is achieving the best results also lessen the inaccurate prognosis of the close price. Among the

two stock exchanges of Bangladesh, DSE 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).

According to Wayne A. Fuller (1995), the stock market forecast is important for both the timing of stock investment and the relative investment desirability among the various sectors in the market. Many people observe the stock market to assess the performance of the economy and it is a common presumption that if the share market is declining, the economy is also about to decline (Moffatt, 2010).

On the other hand, the condition of the economy also affects investments and this is based on the idea that changes in the economy have a significant effect on interest rates and inflation, which in turn have a direct influence on the stock and bond markets (Faerber, 2000). The financial sector is a vital part of our economy because it plays an important role in intermediating savings of the private and public sectors to productive activities including investment. During the economic downturn, the earnings of the average companies decline to result in the stock market index to fall (Duca, 2007). The banking sector has evolved to become the dominant financial intermediary in Bangladeshi financial system due to the underdeveloped money and capital markets, limited availability of financial instruments, and lack of confidence in the financial system as a whole (Chu *et al.*, 2011).

In analyzing closing price index data, the series should be identically and independently distributed with zero mean and constant variance (Akgiray, 1989). Bangladesh has a stock market, with its known difficulties. Most of the Asian stock markets except few have experienced a rapid growth in gross national product through contributing to a significant rise in savings and, hence, in the supply of lendable funds (Chiang and Doong, 2012). A couple of studies have been found to deal with prediction of stock prices in several countries including Bangladesh (Sohail *et al.*, 2012; Kumar, 2006; and Al-Zeaud, 2011). But no such study has been performed yet that prediction of closing stock prices in DSE. Hence, this research context was chosen. This study will start with a general overview of the current composition of the monetary system in Bangladesh in terms of the share market as well as the close price of five banking sectors of DSE.

## MATERIAL AND METHODS:

This study considers daily stock exchange data (general index) for building time series modeling and forecast (Dickey and Fuller, 1979). To fulfill this purpose we collect data from the databank of the Dhaka Stock Exchange website. The data series is

from January 01, 2013, to January 30, 2015, and the length is 499 realizations. The objective of this study is to fit a model for forecasting the closing stock price of the banking sector of DSE by the ARIMA process (Peter and Davis, 2020). The methods used in this research for producing prediction based on trend and stationary of the DSE closing price index dataset. Box-Jenkins (ARIMA) approach is used to pick the piloted model and used to predict the DSE index series. The Box Jenkins procedure has been applied to the dataset using “STATA 13”.

### ARIMA Process

A very popular process in econometric time series is the ARIMA process. Time series models are based on the assumption that it is stationary. But many of the econometric time series are non-stationary that are integrated. If a time sequence is integrated of order one i.e.  $I(1)$ , its first difference is  $I(0)$ , i.e. stationary. Similarly, if a time series is  $I(2)$ , its second difference is  $I(0)$ . In general, if a time orders are  $I(d)$ , then after differencing it  $d$  times we get an  $I(0)$  series. Therefore, if we take difference a time orders  $d$  times and then apply the  $ARIMA(p, q)$  model to it, then the time series model is  $ARIMA(p, d, q)$  where  $p$  is the number of autoregressive terms,  $d$  the number of time orders has to difference and  $q$  the number of moving average terms. The  $ARIMA(1, 1, 1)$  process can be written as,

$$\Delta u_t = \rho \Delta u_{t-1} + \varepsilon_t + \theta \varepsilon_{t-1}$$

Where,  $\Delta u_t = u_t - u_{t-1}$  and  $\Delta u_{t-1} = u_{t-1} - u_{t-2}$  are the first difference between  $u_i$ .

The  $ARIMA(2, 2, 2)$  process in the form,

$$\Delta^2 u_t = \rho \Delta^2 u_{t-1} + \rho \Delta^2 u_{t-2} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2}$$

Where,  $\Delta^2 u_t = u_t - u_{t-1} - u_{t-2}$ ,  $\Delta^2 u_{t-1} = u_{t-1} - u_{t-2} - u_{t-3}$  and  $\Delta^2 u_{t-2} = u_{t-2} - u_{t-3} - u_{t-4}$  are the second difference of  $u_t$ .

Similarly,  $ARIMA(p, d, q)$  is

$$\Delta^d u_t = \rho_1 \Delta^d u_{t-1} + \dots + \rho_p \Delta^d u_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \dots + \theta_q \varepsilon_{t-q}.$$

Where,  $\Delta^d$  indicates the  $d^{th}$  difference in  $u_i$  (Gujrati and Sangeetha, 2007).

## RESULTS AND DISCUSSION:

This study collects data on the closing price index from the Dhaka Stock Exchange, Bangladesh from January 01, 2013, to January 30, 2015, and the interval is 499 realizations. This study divided the sample into two parts such as the first 450 and last 49 samples for training and test sample, respectively to permit a more efficient model. The most popular programming software R and STATA used to whole analysis according to the objective of the present research.

This study use ARIMA model in time series forecasting and collects the daily closing price of some selected bank of DSE such as Al-Arafah Islami bank limited, EXIM bank limited, Islami bank limited, National bank limited and One bank limited. Only analyzed results of Al-Arafah Islami Bank Limited are presented in this paper because the same results have been produced for other remaining banks.

A visual plot of the observation is usually the first step in any time series analysis. **Fig 1** illustrates that the Closing Stock Price is decreased over time. The closing stock price of Al-Arafah Islami bank limited is downward with fluctuations. Therefore resulting data is non-stationary. After taking differences the data moves to stationary. From **Fig 2** it is clear that the second-order differenced of closing stock price time series is stationary. So, the average and variance for this stationary time series are constant and the covariance is time-invariant after taking the second difference.

Therefore the series is stationary after taking the second difference. It has displayed from **Table 1** the calculated measure of the test statistic in the absolute

term is larger than the critical value in an absolute term at a 1% level of the significance, at a 10% level of the significance and 5% level of significance. So, the study decides that the data is stationary for these three cases.

This study recognizes the sample autocorrelation functions of this non-stationary time series data is declined very slowly as shown in **Fig 3**, ACFs at all lags are individually statistically significantly different from zero i.e. for they all are outside of the 95% confidence bounds except the first four lags, the PACF drops dramatically all PACFs except this three lags are statistically insignificant. Since this time series is non-stationary, after integrating it move to stationary.

The ACF and PACF suggest that the model is between  $ARIMA(0, 2, 3)$ . After combining the different model between the  $ARIMA(0, 2, 3)$  model this study will get an appropriate model. **Table 2** suggests the appropriate model forecast for the closing price index of Al-Arafah Islami Bank Limited. According to minimum AIC (Akaike Information Criteria), the appropriate model is  $ARIMA(0, 2, 1)$ .

The actual, forecast and average values for the out-sample are presented as **Fig 4** and indicates the difference between actual and forecast values are very small. Also, the original value curve and the predicted value curve are very much identical. Therefore, the chosen model is acceptable. From **Table 3** it is evident that all the value for root means a square error, mean absolute error, mean absolute percent error and MSD are smaller for out-sample forecast than in-sample forecast.

Therefore, the chosen model is adequate. Also from **Fig 5**, it is evident that the residual plot follows IID (0,1) which indicates our fitted model is best. So the fitted model is acceptable. Policymakers or investors should use this model for better prediction of the share prices of the banking sector of DSE.

**CONCLUSION:**

The closing price index of the stock market is a very important index for the analysis and predicting investment. The index of Dhaka Stock Market over the time January 01, 2013, to 01 January 2015 with sample size is 499 were used in this study. The modeling and predictions of the closing stock price index were done by the ARIMA process (Islam *et al.*, 2020). Care of different diagnostic testing, the best-fitted model for the closing price of DSE (from January 01, 2013, to January 30, 2015) was found to be *ARIMA(0, 2, 1)*. Based on the models, Prediction can be done for the index. This study use ARIMA model in time series forecasting and collects the daily closing price of some selected

bank of DSE such as Al-Arafah Islami bank limited, EXIM bank limited, Islami bank limited, National bank limited and One bank limited. The study shows that the predicted value curve is identical to the actual value curve. Therefore the ARIMA model predicts the actual value very well. This result will provide an informative guideline for the researchers and policymakers. As the diagnostic tests (lower RMSE, low MAE, low MAPE and low MSD) 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 the banking sectors.

**Table 1:** ADF test of Closing Price of Al-Arafah Islami Bank Limited.

Test Statistic, Z(t)	1% Critical Value	5% Critical Value	10% Critical Value	p-value
-3.843	-3.430	-2.860	-2.570	0.0512

**Table 2:** Akaike Information Criteria (AIC) of different models for forecasting closing prices.

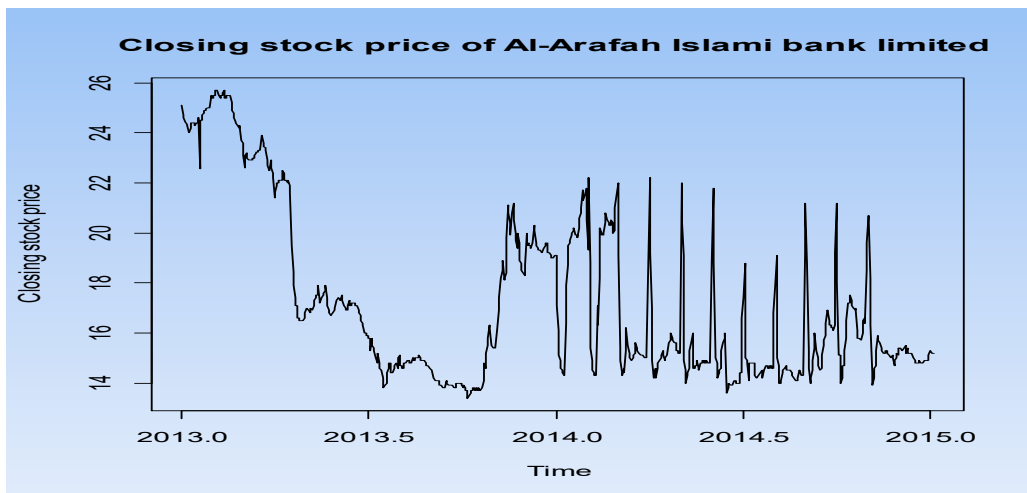
Models	AIC
<i>ARIMA(0, 2, 1)</i>	-57.08
<i>ARIMA(0, 2, 2)</i>	-44.31
<i>ARIMA(0, 2, 3)</i>	-35.87
<i>ARIMA(1, 2, 1)</i>	-49.65
<i>ARIMA(1, 2, 3)</i>	-44.09
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<i>ARIMA(2, 2, 3)</i>	-42.09

**Table 3:** Results of in-sample and the out-of-sample forecast properties of the fitted model.

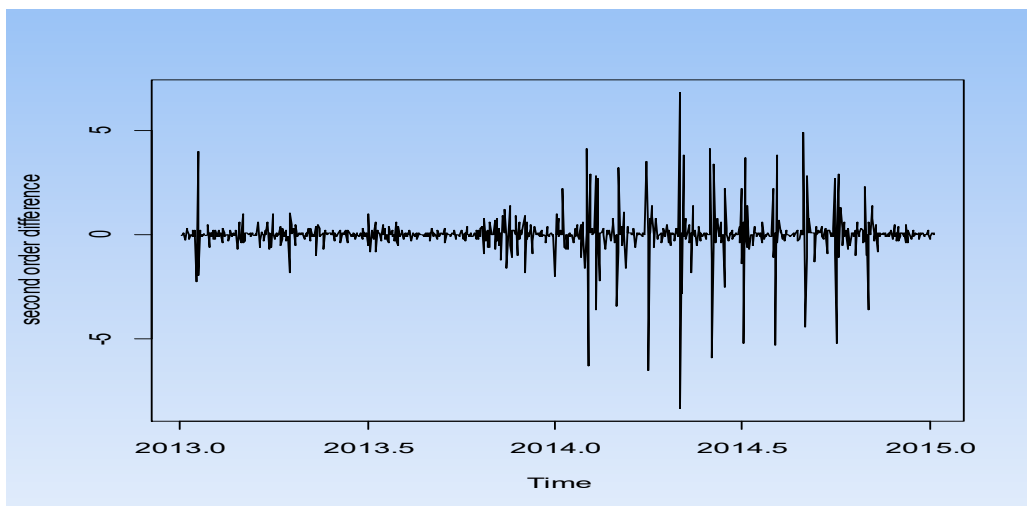
Model	In-sample	Out-of-sample
MAPE	1.72508	1.63261
MAD	0.29463	0.24825
RMSE	0.08594	0.04638
MSD	0.16754	0.12597

**Table 4:** Estimated ARIMA regressions Coefficient of Al-Arafah Islami Bank Limited.

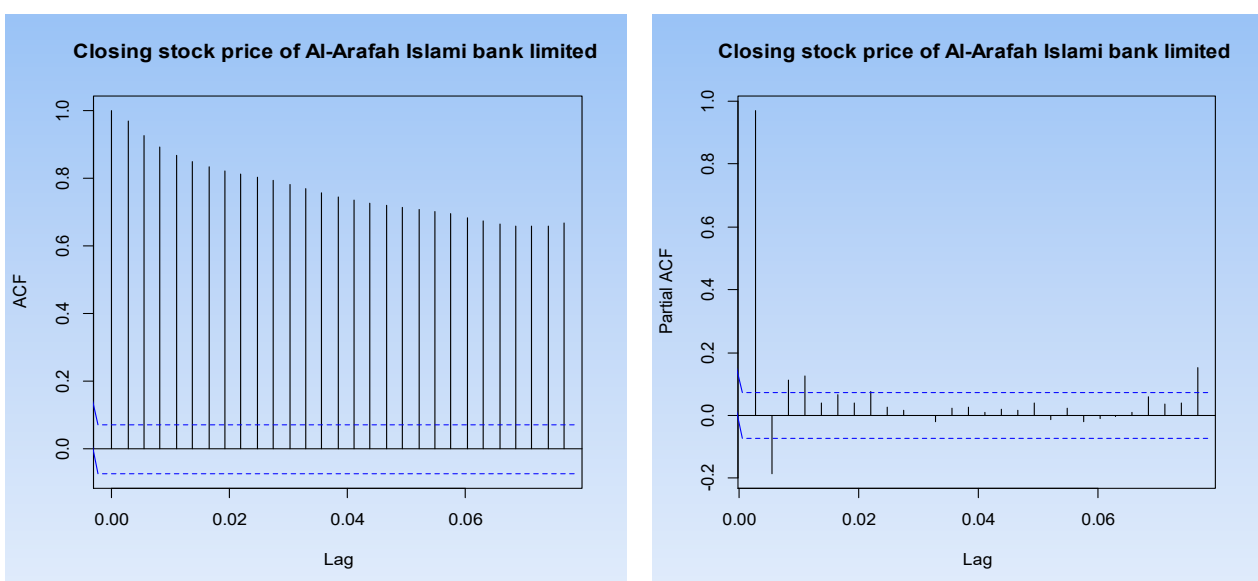
	CP Al-Arafah	AR				MA		
	_cons	L1.	L2.	L3.	L4.	L1.	L2.	L3.
<b>Coef.</b>	0.00302	-0.2456	-0.09774	-0.23565	0.00296	-2.26	1.22596	0.05383
<b>Std. Err.</b>	0.00292	2.2813	0.50546	0.23525	0.55200	2.13155	5.03893	2.94637



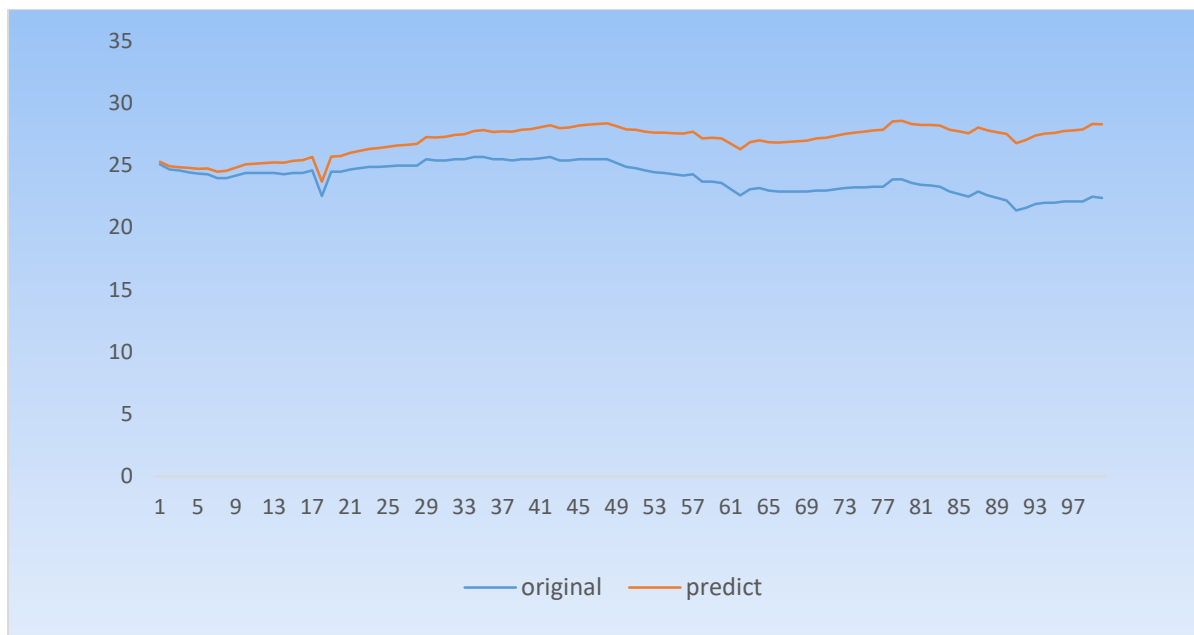
**Fig 1:** Time series plot of the closing stock price of Al-Arafah Islami Bank Limited.



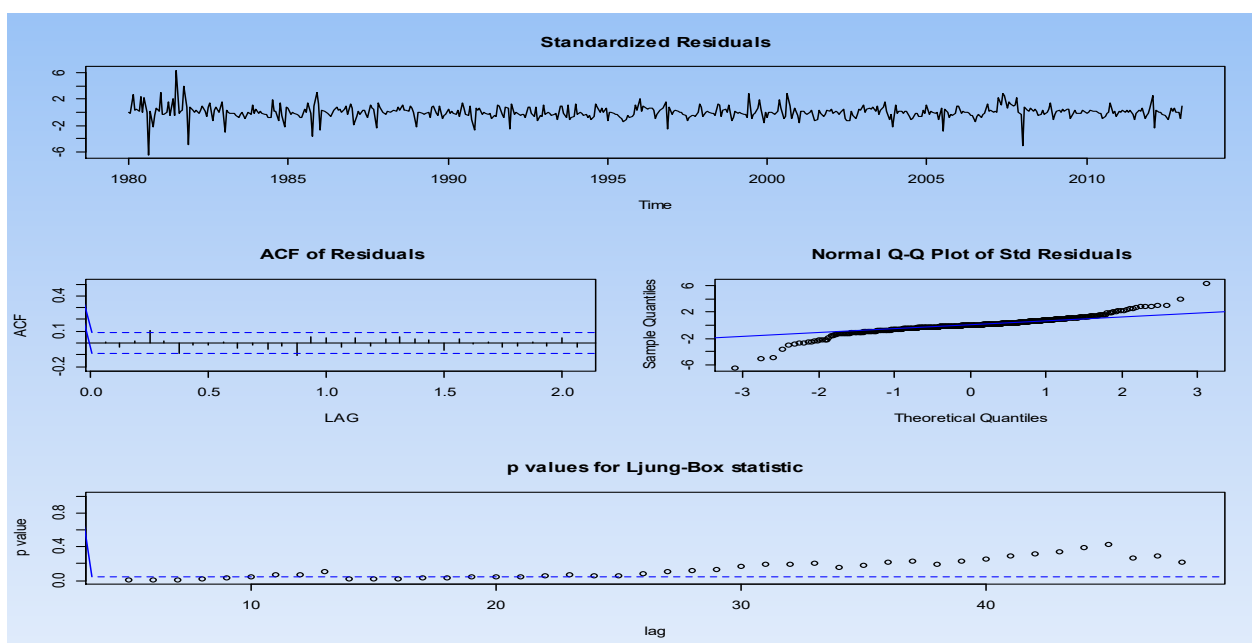
**Fig 2:** Time series plot of second-order difference of closing stock price of Al-Arafah Islami Bank Limited.



**Fig 3:** ACF and PACF for closing stock price of Al-Arafah Islami Bank Limited.



**Fig 4:** Original data and predicted data of Al-Arafah Bank Limited.



**Fig 5:** Standard Residuals plot of the data Al-Arafah Bank Limited.

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**CONFLICT OF INTERESTS:**

The authors declared no conflicts of interest concerning the present research work.

**REFERENCE:**

1. Akgiray, V. (1989). Conditional heteroskedasticity in time series of stock returns: evidence and forecasts, *Journal of Business*, **62**, 55-80. <http://dx.doi.org/10.1086/296451>
2. Al-Zeaud, H. A. (2011). Modelling and Forecasting Volatility Using ARIMA Model. *European Journal of Economics, Finance and Administrative Sciences*. **35**, 109-125.

3. Bepari, M.K., and Mollik, A. (2008), "Bangladesh Stock Market Growing? a key indicators based assessment". *Journal of Business Administration Online*, **8**, 2008. <http://jbao.atu.edu/>
4. Chiang, T.C. and Doong, S.C. (2012). Empirical Analysis of Stock Returns and Volatility: Evidence from Seven Asian Stock Markets Based on TAR-GARCH Model. *Review of Quantitative Finance and Accounting*. **17**(3), 301-318. <https://ideas.repec.org/a/kap/rqfnac/v17y2001i3p301-18.html>
5. Chu V. Nguyen, Anisul M. Islam, Muhammad Mahboob Ali, (2011). The Current State of the Financial Sector of Bangladesh: An Analysis. *AIUB Bus Econ Working Paper Series*, No 2011-03, <http://orp.aiub.edu/WorkingPaper/WorkingPaper.aspx?year=2011>
6. Dickey, D, A., Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root, *J. of the American statistical association*, **74**, pp. 427-431.
7. Duca, G. (2007). The Relationship between the Stock Market and the Economy: Experience From International Financial Markets. *Bank of Valletta Review*, **36**, 1-12. <http://www.bov.com/filebank/documents/1-12Gevit%20Duca.pdf>
8. Faerber, E. (2000). All about bonds, bond mutual funds, and bond ETFs (3<sup>rd</sup> Ed.). New York, McGraw-Hill. <https://mhebooklibrary.com/doi/book/10.1036/9780071544283>
9. Granger, M., and Morgenstern, O. (1963). "Spectral Analysis of New York Stock Market Prices", *Kyklos*, **16**: 1-27. <https://doi.org/10.1111/j.1467-6435.1963.tb00270.x>
10. Gujarati D., and Sangeetha N., (2007). *Basic Econometrics*, 4<sup>th</sup> Edition; McGraw-Hill.
11. Islam MA, Uddin MA, and Hossain MS. (2020). Fitting ARIMA model and forecasting for the tea production, and internal consumption of tea (per year) and export of tea, *Int. J. Mat. Math. Sci.*, **2**(1), 8-15. <https://doi.org/10.34104/ijmms.020.08015>
12. Kendall, M. (1953). "The Analysis of Economic Time Series. Part I. Prices," *Journal of the Royal Statistical Society*, **96**: 11-25. <https://www.jstor.org/stable/2980947?seq=1>
13. Kumar, S. S. (2006). Forecasting Volatility Evidence from Indian Stock and Forex Markets. *IIM Working Paper series*, 6.
14. Moffatt, M. (2010). Do Changes in Stock Prices Cause Recessions? About.com. Retrieved July 15, 2010. [http://economics.about.com/cs/stockmarket/a/stock\\_recession.htm](http://economics.about.com/cs/stockmarket/a/stock_recession.htm)
15. Peter J. Brockwell, Richard A. Davis, (2002), *Introduction to Time Series and Forecasting*, Second edition.
16. Sohail, C., Kamal, S., and Ali, I. (2012). Modelling and volatility analysis of share prices using ARCH and GARCH models. *World Applied Sciences Journal*. **19**(1), 77-82. <https://doi.org/10.5829/idosi.wasj.2012.19.01.793>
17. Solnik, B. (1973). "Note on the Validity of the Random Walk for European Stock Prices", *Journal of Finance*, **28**: 1151-1159.
18. Wayne A. Fuller, (1995). "Introduction to Statistical Time Series", 2<sup>nd</sup> ed., first published: Print ISBN: 9780471552390. <https://doi.org/10.1002/9780470316917>

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