ISSN 1022-8594
JUJS

Vol. 40, No. 1, pp.11-18

Comparison of ARIMA and Neural Network Model to Forecast the Jute Production in Bangladesh

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Abstract
Bangladesh is a famous for jute production since 1971 and earned a significant amount of foreign currency by exporting jute and jute products to different countries. This paper compares the accuracy of forecasting jute productions in Bangladesh of the two models namely Auto-Regressive Integrated Moving Average (ARIMA) and Neural Network (NN). However, this paper considers a secondary data set of yearly jute production in Bangladesh over the period 1972 to 2013. Results of this paper shown that the Neural Network (NN) model performs better than ARIMA model to forecast the jute production in Bangladesh. Therefore, this paper suggests using NN model to forecast the jute productions in Bangladesh.

Keywords: Jute Production, Forecasting, Neural Network, ARIMA

Introduction

Once upon a time, Jute is called the Golden Fiber of Bangladesh. After the country's independence, more than 80% of total foreign currency in Bangladesh was earned from jute and jute related goods. But after 80's, the earning rate of foreign currency from jute industry has gradually declined. The sector provides about 10% of the total employment in the economy and 12% of GDP. About 90% of jute products produced in Bangladesh is exported (Rahman, 2001). Bangladesh is famous for jute production and earned a significant amount of foreign currency by exporting jute and jute products to different countries. At one stage, Jute was only the vital sector

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in Bangladesh from which major portion of foreign currency is to come and help Bangladesh's economy and a large number of manpower were employed there. Bangladesh was recognized as one of the best jute producing and exporting countries of the world (Islam *et al.*, 2013). Over the last 20-25 years it did slide down to the seventh position. Now it regained to come to the forth position (Abdullah, 2013*)*. Islam and Alauddin (2012) have pointed out the fluctuations and declining growth trend of jute production in the world and have created a good opportunity for countries like Bangladesh. Recently jute fibers are used in a wide range of diversified products: decorative fabrics, chic-saris, salwar kamizes, soft luggage's, footwear, greeting cards, molded door panels and other innumerable useful consumer products (Ghosh and Jethi, 2013). Gupta, *et al.*, (2009) attempts to forecast and compare the methods of forecasting using parametric models like polynomial, logarithmic, inverse, and exponential, with those of Box-Jenkins techniques, such as autoregressive (AR), autoregressive moving average (ARMA), and autoregressive integrated moving average techniques (ARIMA) of forecasting using data for the period of 1961–2002 of India and Bangladesh. Hossain and Abdulla (2015) used Box-Jenkin's ARIMA model for forecasting the jute productions in Bangladesh. Padhan (2012) has been used ARIMA model to forecast annual productivity of selected agricultural product in India.

Due to its importance, several Time Series Forecasting methods have been proposed, such as the the ARIMA methodology (Box and Jenkins, 1976) and Neural Networks (NN) (Lapedes and Farber, 1987; Ding, et al., 1995; Cortez, 2005). The ARIMA is a more complex approach, requiring steps such as model identification, estimation and validation. Each ARIMA model is based on a linear combination of past values and/or errors. Recent studies have shown the classification and prediction power of the Artificial Neural Networks. It has been demonstrated that a neural network can approximate any continuous function. Neural networks have been successfully used for forecasting of financial data series. Neural Networks have the advantage that can approximate any nonlinear functions without any apriori information about the properties of the data series. Also, in contrast to technical analysis, which is based on common recommendations, neural networks are capable to find optimal, for given financial instrument, indicators and build optimal, for given time series,

forecasting strategy. Thus, this paper attempts to compare the accuracy of ARIMA and NN for forecasting the jute production in Bangladesh and suggest the better model for forecasting the jute production in Bangladesh.

Methods and Materials

Data Source

This paper considers an online data set of yearly jute production in Bangladesh which was collected over the period 1972 to 2013 from the website of Food and Agricultural Organization (FAO).

ARIMA Model

The Box-Jenkins methodology is another important forecasting approach, going over model identification, parameter estimation, and model validation. The global model is based on a linear combination of past values (AR components) and errors (MA components), being named Auto Regressive Integrated Moving-Average (ARIMA). The non seasonal model is denoted by the form ARIMA(p,d,q) and is denoted by the equation:

$$\phi_p(L)(1-L)^d y_t = \theta_q(L)e_t$$

where, y_t is the series; e_t is the error; L is the lag or backshift operator (e.g. $L^3 y_t = y_{t-3}$); $\phi_p = 1-\phi_1 L-\phi_2 L^2-...-\phi_p L^p$ is the AR polynomial of order p ; d is the differencing order; and $\theta_q = 1-\theta_1 L-\theta_2 L^2-...-\theta_q L^q$ is the MA polynomial of order q .

Artificial Neural Networks

Neural models are innate candidates for forecasting due to their nonlinear and noise tolerance capabilities. The basic idea is to train a NN with past data and then use this network to predict future values. The use of NNs for Time Series Forecasting began in the late eighties with encouraging results and the field has been consistently growing since (Lapedes and Farber, 1987; Ding, et al., 1995; Hallas and Dorffner, 1998; Cortez, 2005).

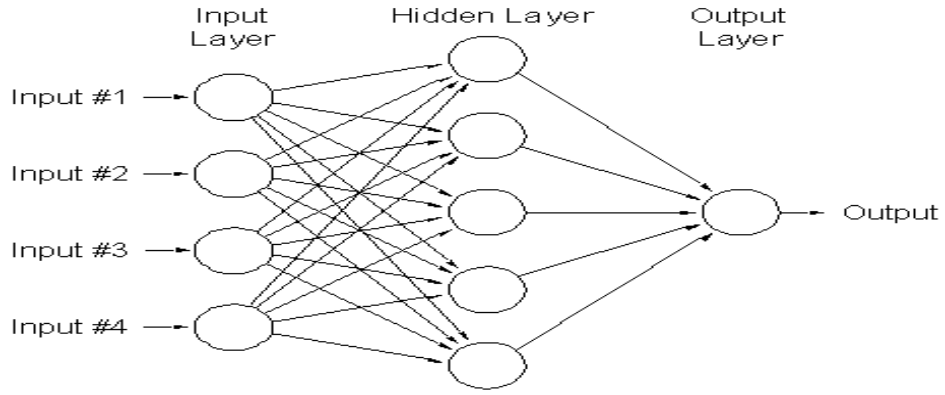

Figure 1: The Multilayer Perception Model

Model Selection Criteria

There are many summary statistics available in literature for evaluating the forecast errors of any Time Series or Econometric model. Here, an attempt is made to identify the best model for jute production in Bangladesh using the following contemporary model selection criteria:

Root Mean Square Percentage Error (RMSPE): Root Mean Square Percentage Error (RMSPE) is defined as,

$RMSPE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y_t^f - Y_t^a}{Y_t^a}\right)^2}$, where Y_t^f is the forecast value at time t and Y_t^a is the actual value at time t.

Mean Percent Forecast Error (MPFE): Hossain *et al.* (2006) used the Mean Percent Forecast Error (MPFE) which is defined as, $MPFE = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y_t^a - Y_t^f}{Y_t^a}\right)$, where Y_t^a is the actual value at time t and Y_t^f is the forecast value at time t.

Theil Inequality Coefficient (TIC): Theil (Theil, 1966) Inequality Coefficient (TIC) is defined as

$TIC = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^f - Y_t^a\right)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^a\right)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(Y_t^f\right)^2}}$, where Y_t^f is the forecast value at time t and Y_t^a is the actual value at time t.

Results and Discussion

In order to compare the ARIMA and NN model firstly this paper computes the values of the well known model selection criteria considered in this paper. The values of the most useful forecasting criteria used in this paper of the fitted ARIMA and NN model are shown in **Table 1**.

Table 1: Forecasting criteria of the fitted ARIMA and NN model

Model	Forecasting criteria		
	RMSPE	**MPFE**	**TIC**
ARIMA	0.1750648	0.02029182	0.09545639
NN	0.14155	0.02194237	0.08082781

The results given in Table 1 reveals that the NN model is better to forecast the jute production in Bangladesh comparing to ARIMA model. The forecasted jute productions in Bangladesh by the two models considered in this paper are given in **Table 2.**

Table 2: Forecasted Jute production by the ARIMA and NN models

Year	Forecasted production (tonnes)	
	ARIMA	**NN**
2014	1464553	1449269.2
2015	1470808	823460.0
2016	1477063	1520001.6
2017	1483317	745212.2

Year	Forecasted production (tonnes)	
	ARIMA	NN
2018	1489572	1681382.3
2019	1495827	709987.1
2020	1502082	1953890.3
2021	1508336	684828.7
2022	1514591	2387457.4
2023	1520846	667474.7
2024	1527100	2949597.0
2025	1533355	662569.3

The following Figure 2, depicts the comparison of the original time series and fitted time series by the two methods used in this paper namely ARIMA and Neural Network.

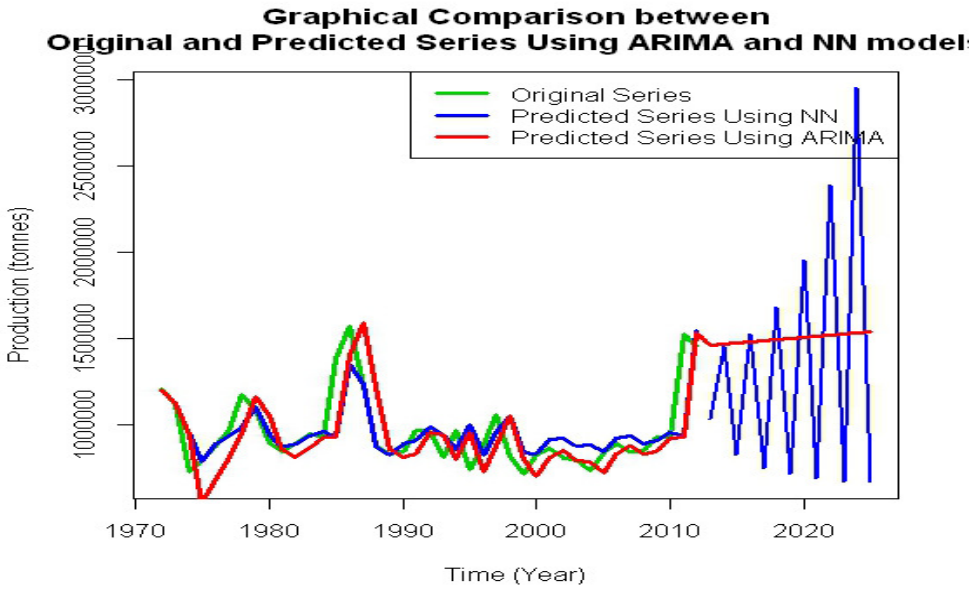

Figure 2: Comparison between Original series and predicted series.

From Figure 2, it is observed that the forecasted series by NN (blue-color) and ARIMA (red-color) fluctuated from the original series (dark-green-color). However, the fluctuations of the forecasted series by NN are less compared to ARIMA which showed that the neural network performs better than classical ARIMA in this case. Therefore, this paper suggests to use NN model to forecast the jute productions in Bangladesh.

Conclusion

On the basis of forecasting criteria used in this study as well as from Figure 2, this paper may conclude that Neural Network model performs better than ARIMA model to forecast the jute productions in Bangladesh. Thus, this model can be used for policy purposes as far as forecasts the jute production in Bangladesh.

Reference

Abdullah, A.B.M., (2013), *Challenges of 21st Century: Global Climate Changes and Jute Based-Development Strategy of Bangladesh*, Asiatic Society of Bangladesh, Dhaka.

Box, G. and Jenkins, G., (1976), *Time Series Analysis: Forecasting and Control*, Holden Day, San Francisco, USA.

Cortez, P., Rocha, M., and Neves, J., (2005), Time Series Forecasting by Evolutionary Neural Networks, chapter III: *Arti_cial Neural Networks in Real-Life Applications*, Idea Group Publishing, USA, pages 47-70.

Ding, X., Canu, S. and Denoeux, T., (1995), Neural network based models for forecasting, in *Proceedings of Applied Decision Technologies Conf. (ADT'95)*, Uxbridge, UK, 1995, pp. 243-252.

Ghosh, B.K. and Jethi, A., (2013), Growth and Instability in World Jute Production: A Disaggregated Analysis, *International Journal of Electronics & Communication Technology*, 4(1): 191-195.

Gupta, D., Sahu, P.K. and Banerjee, R., (2009), Forecasting Jute Production in Major Contributing Countries in the World, *Journal of Natural Fibers*, 6(2): 127-137. doi: 10.1080/15440470902931436.

Hallas, M. and Dorffner, G., (1998), A comparative study on feed forward and recurrent neural networks in time series prediction using gradient descent learning, in *Proceedings of the European Meetings on Cybernetics and Systems Research (EMCSR'98)*, Vienna, Austria.

Hossain, M.Z., Samad, Q.A and Ali, M.Z., (2006), ARIMA model and forecasting with three types of pulse prices in Bangladesh: a case study, *International Journal of Social Economics*, 33(4): 344-353. DOI 10.1108/03068290610651652

Hossain, M. M. and Abdulla F., (2015), Jute Production in Bangladesh: A Time Series Analysis, *Journal of Mathematics and Statistics*, 11 (3): 93-98. DOI: 10.3844/jmss.2015.93.98

Islam, M.S. and M. Alauddin, (2012), World Production of Jute: A Comparative Analysis of Bangladesh, *International Journal of Management and Business Studies*, 2(1): 14-22.

Islam, M.R., Rana, M., Hoque, M., Azad, M.M.H. and Ahmed, M.K., (2013), Causes and Consequences of Labour Unrest in Jute Mills of Khulna Division in Bangladesh: An Empirical Study, *International Journal of Business and Management Review*, 1(2): 57-68.

Lapedes, A. and Farber, R., (1987), *Non-Linear Signal Processing Using Neural Networks: Prediction and System Modelling*, Los Alamos National Laboratory, USA, Technical Report LA-UR-87-2662.

Padhan, P.C., (2012), Application of ARIMA Model for Forecasting Agricultural Productivity in India, *Journal of Agriculture & Social Sciences*, 8(2): 50–56.

Rahman, M.M., (2001), *Policy and Prospect of Jute and Allied fibers with special Reference to Bangladesh*, Bangladesh Institute of Labor Studies.

Theil, H., (1966), *Applied Economic Forecasting*, North-Holland Publishing Company, Amsterdam.