Comparing the Forecasting Performance of ARIMA and Neural Network Model by using the Remittances of Bangladesh

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Abstract

At present, remittances play a crucial role in the economy of Bangladesh. However, the trends in the share of remittance to macroeconomic variable point to the growing importance of remittance in the Bangladesh economy and testify to the popular view that remittances are gradually providing more and more important contribution to our GDP over time. This paper considers a secondary data set collected from Bangladesh Bank over the period 1987-88 to 2014-15. This paper attempts here to forecast the total remittance received by Bangladesh with the help of ARIMA and Neural Network (NN) model and compare the performance of those models by using well-known model selection criteria. The time series plot is given in Figure 1(a) illustrates that remittance flows to Bangladesh have grown rapidly over the last two decades. Moreover, the fluctuations between forecasted series and original series are less by NN compared to ARIMA. In addition, based on the model selection criteria it may be concluded that the neural network performs better than ARIMA to forecast the remittance of Bangladesh.

Keywords: Remittance, Model Selection, Forecasting, Bangladesh

1. Introduction

Remittances are the unrequited transfer of funds by the migrants to their families at home – are a source of foreign exchange which is much scarce in developing economies. It is a more stable and less volatile source of external finance when compared to the other forms of flows which include official development assistance and foreign direct investment (Ratha, 2007). Remittances have been promoted as a development tool because they can raise incomes and reduce poverty rates in developing countries. Remittances may also promote development by providing funds that recipients can spend on education or health care or invest in entrepreneurial activities. From a macroeconomic perspective, remittances can boost aggregate demand and thereby GDP as well as spur economic growth. However, remittances may also have adverse macroeconomic impacts by increasing income inequality and reducing labor supply among recipients (Orrenius, *et al.*, 2010).Remittance constitutes an important source of foreign exchange for the developing countries like Bangladesh,

which has substantial development impact as can be understood from the micro and macro point of view. Remittances in Bangladesh have been growing steadily over the last decade. It is just not a part of the income of nations but it is a power on which developments run smoothly. Nowadays, remittance has kept the economy of Bangladesh more dynamic. Bangladesh receives remittance from different countries that play an important role in smoothening household consumption as well as the socio-economic development of our country.

For many developing countries, however, remittances represent a major part of international capital flows, surpassing foreign direct investment (FDI), export revenues, and foreign aid (Giuliano and Ruiz-Arranz, 2005). A recent World Bank (2006) study suggests that recorded remittances have grown faster than foreign direct investment, or official development assistance. Government and Bangladesh Bank extend their efforts to encourage expatriate Bangladeshi nationals to send their hard earned foreign currency through official channels. Nowadays, nationalized and commercial bank has established strong network abroad for easy transfer of remittance to Bangladesh. Remittances in Bangladesh arise as a poverty alleviating policy tool. It contributes directly in broadening the opportunities to increase incomes. It allows households to increase their consumption of local goods and services. At the community level, remittances generate multiplier effects in the local economy, creating jobs and spurring new economic and social infrastructure and services. At the national level, remittances provide foreign currency and contribute significantly to GDP. Since remittances have become a major source of income for many developing countries, there is a large and fast-growing economics literature on the effects of remittances on receiving countries.

Due to the importance, several Time Series Forecasting methods have been proposed, such as the ARIMA methodology (Box, *et al.*, 2015) 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 a priori information about the properties of the data series. Also, in contrast to technical analysis, which is based on common recommendations, neural networks are capable of finding optimal, for given financial instrument, indicators and build optimal, for given time series, forecasting strategy. Salma (2016) used the ARIMA model to forecast the Remittance Inflows in Bangladesh. Also, most of the researcher used ARIMA model for forecasting the financial data. However, currently, researchers used NN model for forecasting different financial data (Vaisla and Bhatt, 2010; Aghababaeyan, *et al.*, 2011; Thakur, *et al.*, 2016). So, the most of the researchers used these models separately. However, Hossain, *et al.*, (2017) compare the forecasting performance of ARIMA and NN model to forecast the Jute production in Bangladesh and they show that NN model performs better. Thus, this paper focus here on forecasting the total remittance received by Bangladesh by ARIMA and Neural Network (NN) model and compare the performance of those models. Finally, it is recommended the more suitable model for forecasting the remittances in Bangladesh.

2. Literature Review
In the short-term remittances help loosen the budget constraints of their recipients, allowing them to increase expenditures on both durables and non-durables products, and provides them with protection against negative income shocks (Bruyn and Kuddus, 2005). Orrenius, *et al.*, (2010) says that from a macroeconomic perspective, remittances can boost aggregate demand and thereby GDP as well as spur economic growth. O'neill (2001) says that developing countries, ready to explore every option available to increase their citizens' welfare, should focus on developing policies that maximize and channel this increasing flow of remittances. Formally, the export of manpower from Bangladesh has been started in 1976. After that, the amount of remittance and the numbers of migrant workers have been increasing gradually (Rahim and Alam, 2013). They explore the actual remittance income and its impact on the overall economy of Bangladesh. They articulate the opportunities and challenges of remittance income in Bangladesh and suggested some possible courses of action to face these challenges with smart at hand.

Many valuable studies have been taken on remittance inflows in Bangladesh. But most of the studies have been found on the impact of remittance on poverty and income level

in Bangladesh. Mahmud and Osmani (1980) found that migrants remit more than eighty percent of their income from abroad and that there is a significant difference in the saving rate between remittance receiving and non-receiving household in Bangladesh. Qubria (1986) make a comparison of remittances in Bangladesh to other Asian countries and showed that the steady flows of remittances have eased the foreign exchange constraints, improved the balance of payments and has augmented national savings. Stahl and Habib (1989) showed that even if only small proportions of remittances income go to direct investment while the majorities go to serve the purpose of consumption needs, remittances could still be developmental in Bangladesh. Murshid, *et al.*, (2002) provided a Keynesian type analysis of macroeconomic effects of remittances on the Bangladesh economy. Siddiqui and Abrar (2003) provided detailed characteristics of remittance receiving households in Bangladesh, their socio economic profiles and the different ways remittances are used by them. Azad (2004) discussed various prospects of channeling the huge volume of remittances received by Bangladesh in an official way towards the development of micro-enterprises by financing their capital needs. Siddidui (2004) identifies the different types of agents and institutions of Bangladesh involved in remittances transfer process. Barua, *et al.*, (2007) identified the major determinants of the inflow of workers' remittances in Bangladesh. Khan (2008) used Household Income and Expenditure Survey 2005 data conducted by Bangladesh Bureau of Statistics to carry out a micro-level study on the impact of remittances on household incomes to infer about the status of poverty in Bangladesh. Hasan (2008) examines the macroeconomic determinants of remittances in Bangladesh. Buchenau (2008) outlines the various aspects of migrational and remittances in Bangladesh. He also provides a framework for analyzing the link between migration, remittances and poverty at the household level as well as macro level. Mahmud, *et al.*, (2015) evaluate the inward as well as outward remittance performance of United Commercial Bank (UCB), Bangladesh. They said that UCB should introduce new inward remittance product as well as it should arrange seminar and symposium to introduce the cost and benefits of their remittance products in home and abroad which may increase the remittance flow from different countries and this will ultimately benefit the county's economy.

3. Methods and Materials
Data Source
This paper considers a data set of remittances received by Bangladesh over the period 1987-88 to 2014-15 which was collected from the Bangladesh Bank.

ARIMA Methodology
The Box-Jenkins methodology is the 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 an 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).
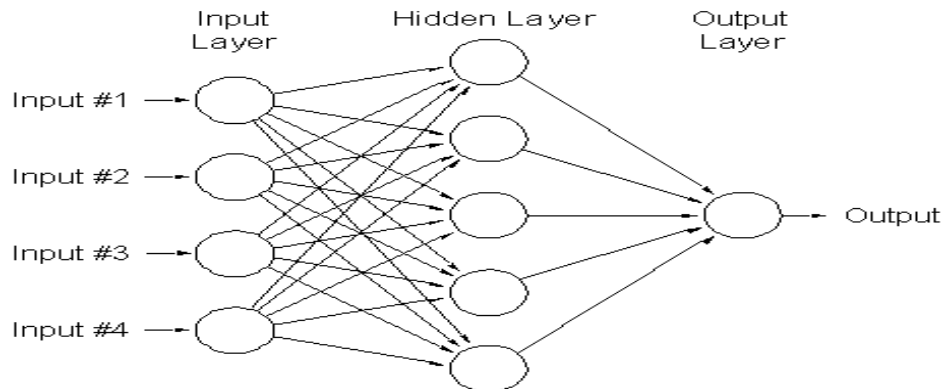
Figure 1: The Multilayer Perception architecture

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Model Selection Criteria

There are several statistics available in the literature for evaluating the forecast errors of any Time Series or Econometric model. Here, an attempt is made to identify the best models for remittances in Bangladesh using the following contemporary model selection criteria, such as RMSE, MASE, MAPE and TIC.

Root Mean Square Error (RMSE): $RMSE = \sqrt{\dfrac{1}{T}\sum_{t=1}^{T}\left(Y_t^a - Y_t^f\right)^2}$

Mean Absolute Scaled Error (MASE): $MASE = \dfrac{\dfrac{1}{T}\sum_{t=1}^{T}\left|Y_t^a - Y_t^f\right|}{\dfrac{1}{T-1}\sum_{t=2}^{T}\left|Y_t^a - Y_{t-1}^a\right|}$

Mean Absolute Percentage Error (MAPE): $MAPE = \dfrac{100}{T}\sum_{t=1}^{T}\left|\dfrac{Y_t^a - Y_t^f}{Y_t^a}\right|$

Theil Inequality Coefficient (TIC): $TIC = \dfrac{\sqrt{\dfrac{1}{T}\sum_{t=1}^{T}\left(Y_t^f - Y_t^a\right)^2}}{\sqrt{\dfrac{1}{T}\sum_{t=1}^{T}\left(Y_t^a\right)^2} + \sqrt{\dfrac{1}{T}\sum_{t=1}^{T}\left(Y_t^f\right)^2}}$

where, Y_t^f is the forecast value at time t and Y_t^a is the actual value at time t.

4. Results and Discussion

Bangladesh received 33883.40 crore taka (Taka is the currency of Bangladesh) remittances on an average over the study period with standard deviation 39789.52. The maximum remittance was 118982.32 crore taka in the year 2014-15 and the minimum was 2303.89c rore taka in the year 1987-88. Figure 1 depicts the time series plot of total remittances of Bangladesh over the study period. From Figure-1 it is clear that the total remittance data series shows an increasing trend. Beyond the year 2000, the remittances increased slowly. However, there is a dramatic increasing trend observed after the year 2005 (Figure 1 (a)). Here, Augmented-Dickey-Fuller (ADF) unit root test, Phillips-Perron (PP) unit root test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root test are used to check whether the data series is stationary or not. After third differencing the Augmented-Dickey-Fuller (ADF) test with $\Pr\left(|\tau| \geq -6.9896\right) < 0.01$ and Phillips-Perron (PP) test with $\Pr\left(|\tau| \geq -21.0182\right) < 0.02$ and

Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test with $\Pr\left(|\tau| \geq 0.0667\right) > 0.1$ adequately declared that the data series is stationaryat 5% level of significance and suggest that there is no unit root in third differenced series. Also, the graph of third difference of the total remittance data series (Figure 1 (b)) shows the stable variance i.e., the differenced data series becomes stationary. To stabilize the variance and to make the data stationary, the third difference is enough that is the difference order is 3 and it is said that the data series is integrated of order 3. The graphical representations are as follows:

(a)   (b)
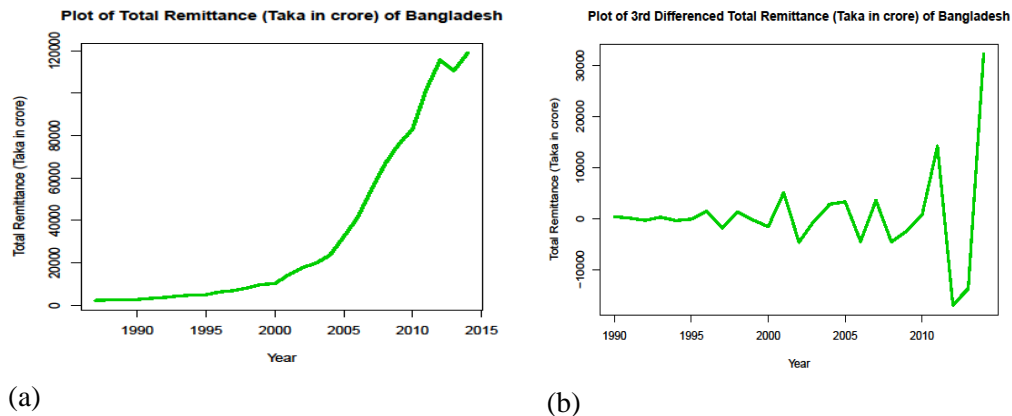
Figure-1: Time series plot of total remittance (a) and 3rd differenced of total remittance (b) of Bangladesh.

The alternative positive and negative ACF(Figure 2(a)) and PACF(Figure 2(b)) indicates an autoregressive moving average process. The ACF and PACF with a significant spike at lag 2 suggest that the second order autoregressive and second order moving average are effective on total remittance of Bangladesh.

(a)   (b)
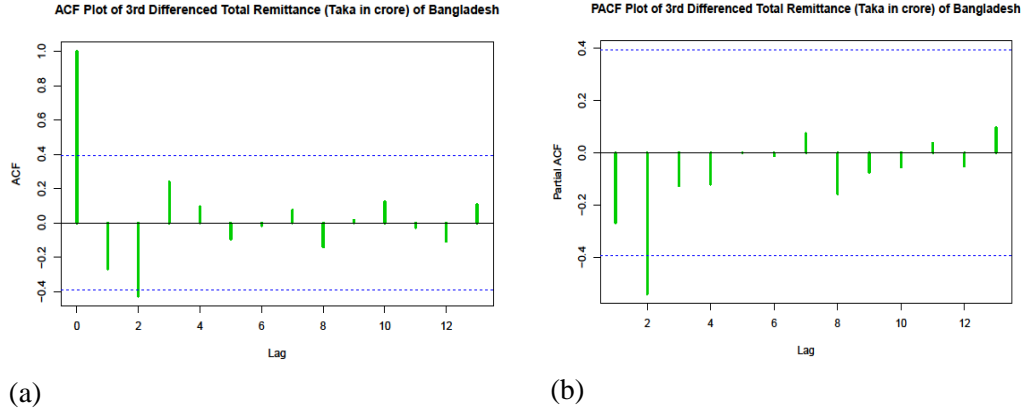
Figure-2:(a) ACF and (b) PACF of 3rd differenced of total remittance of Bangladesh. The ARIMA model is identified with the help of well-known model selection criteria like AIC and BIC. The lowest value of $\text{AIC} = 509.57$, $\text{AIC}_C = 510.12$ and $\text{BIC} = 512.01$ select the ARIMA(0,3,1) model for forecasting the total remittance of Bangladesh.The "Box-Pierce" test with $\text{Pr}\left(\left|\chi_1^2\right| \geq 2.5611\right) = 0.1095$ and the "Box-Ljung" test with $\text{Pr}\left(\left|\chi_1^2\right| \geq 2.8457\right) = 0.09162$ at 5% level of significance suggest that there is no autocorrelation among the residuals of the fitted ARIMA(0,3,1) model.

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 and theirvalues of these models are presented in Table 1.

Table 1: Forecasting Criteria of the Fitted ARIMA and NN Model

| Model	Forecasting criteria			
	RMSE	MASE	MAPE	TIC
ARIMA	5371.32	0.59301	7.6159	0.05078
NN	2925.22	0.38165	5.77738	0.02779

The results given in Table 1 reveal that the NN model performs better to forecast the total remittances of Bangladesh comparing to ARIMA model. The forecasted remittances of Bangladesh by the two models considered in this paper are given in Table 2.

Table 2: Forecasted Remittances by the ARIMA and NN Models

Year	Forecasted remittances (Taka in crore)	
	ARIMA	**NN**
2015-2016	127698.7	119936.6
2016-2017	136731.4	120429.2
2017-2018	146080.5	120680.7
2018-2019	155746.1	120808.4
2019-2020	165728.0	120873.0
2020-2021	176026.3	120905.6
2021-2022	186641.1	120922.1
2022-2023	197572.2	120930.4
2023-2024	208819.7	120934.6
2024-2025	220383.7	120936.7

Figure 3, 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 (NN). From Figure 3, it is observed that the forecasted series by NN (blue-color) and ARIMA (red-color) fluctuated from the original series (dark-green-color). The fluctuations of the forecasted series to original series by NN are less compared to ARIMA which shows the neural network performs better than ARIMA in this case. Therefore, this paper suggests to use NN model to forecast the remittances of Bangladesh.
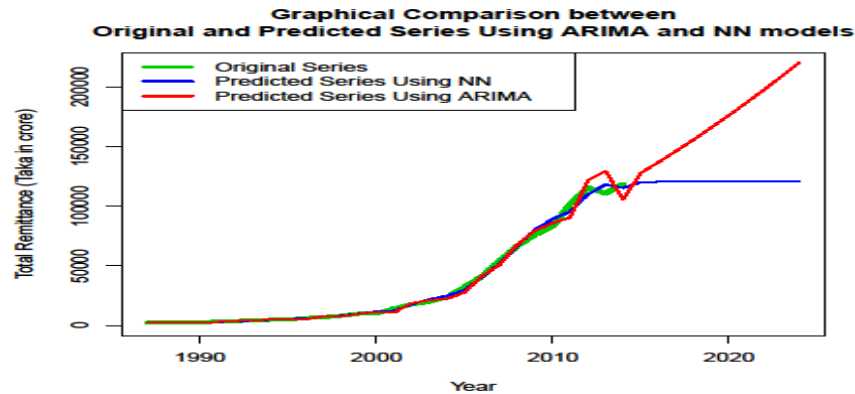
Figure 3: Comparison between Original series and predicted series.

8. Conclusion

The Government of Bangladesh with 160 million people is faced with a challenge to use the human resource effectively. Also, poverty reduction has become an immediate agenda of the government of Bangladesh. The Government of Bangladesh has

recognized labor migration as a potential tool for the socio-economic development of the country. One of the most important ways for reduction of poverty is migrant workers' remittances. On the basis of forecasting criteria used in this study and with the help of Figure 3, this paper may conclude that Neural Network model performs better than ARIMA model to forecast the remittances in Bangladesh. Thus, this model can be used for policy purposes as far as forecasts the remittances in Bangladesh.

Acknowledgement

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