Volume: 4, Issue: 1
Page: 13-23
2020

ISSN 2520-4750 (Online) & ISSN 2521-3040 (Print)

International Journal of Science and Business

Forecasting the Remittance inflow Based on Time Series Models in Bangladesh

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Abstract

Remittance plays a very important role in the national economy. Remittance inflow in Bangladesh is one of the prime sources of foreign currency reserve. A certain amount of foreign currency reserve is indeed a vital need for the country because of its high degree of dependency on import. Inflow of remittance depends on the amount of manpower migration. Remittance earnings have increased more than five times during the past decade and it is currently the single largest foreign exchange earner for Bangladesh. Inward remittances to Bangladesh during the first six months of FY2011-12 stood at about USD 6.1 billion which is 9.3 per cent higher than the comparable period of the previous fiscal and Reaching an all-time high of 1491.36 USD Million in july of 2014 and a record low of 856.87 USD Million in September of 2017. The main purpose of this study is to forecast the next ten years Remittance in Bangladesh. Here, we applied different methods of time series and analyze the yearly Remittance data in Bangladesh over the period 1996-1997 to 2016-2017. We applied Box-Jenkin's methodology to identify the actual model based on different model selection criterion. On the study at first we have checked the stationarity. For checking stationarity we have used both graphical method and Dickey Fuller test. Then to find the appropriate model for Remittance we have used the ACF, PACF curves. In this research, we found that ARIMA (1, 1, 0) model is suitable for the forecasting the Remittance in Bangladesh. Comparing between the original series and forecasted series, we found that the Remittance flow is in Bangladesh is projected to increasing.

IJSB
Accepted 21 December 2019
Published 01 January 2020
DOI: 10.5281/zenodo.3592656

Keywords: Remittance inflow, Box-Jenkin's methodology, Dickey Fuller Test, ACF, PCAF, ARIMA Model, Forecasting.

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Introduction

Remittance is one of capital flows that play very important role in economic development, especially for developing countries. From a microeconomic perspective, previous studies found empirical evidence that remittance inflows promote economic development by providing funds that recipients can spend on education, health care, business investment. Regarding macroeconomic aspect, it can boost aggregate demand and thereby GDP as well as spur economic growth. According to (Ummah Salma, 2016) studied Forecasting Remittance Inflows in Bangladesh. By using different univariate models and a multivariate model for forecasting the remittance flow of Bangladesh, it is found that multivariate models forecasts better hat univariate models, as fluctuations in remittance flow in Bangladesh not only affected by its own previous values but also with global indicators like global economic activity and global oil price. According to (Islam, 2011) Bangladesh Expatriate Workers and their Contribution to National Development (Profile of migration, remittance and impact on economy).The conclusion of the study is the Government of Bangladesh(GOB) with 160 million people is faced with a challenge to use the human resource effectively. The GOB has recognized labour migration as a potential tool for the socio-economic development of the country. Efforts to manage migration have been strengthened and introduced digitized migration management system in order to maximize benefits from migration and minimize the harmful effects. Poverty reduction has become an immediate agenda of the government of Bangladesh that it has taken up the National Strategy for Accelerating of Poverty Reduction (NSAPR-II) in order to combat it urgently. One of the most important vehicles for reduction of poverty is migrant workers' remittances in discussed (Gupta, et al., 2009). (Hasan, 2008) examines the macroeconomic determinants of remittances in Bangladesh. He found that if the domestic interest rate goes up by 1 percent, on average, remittance will increase by 1.94 percent and if GDP of the five host countries increases by 1 percent, remittance will increase by 3.06 percent. (Ratha, 2003) finds the determinants of remittance of saudi Arabia. He found that there is a significant positive relationship between the level of per capita GDP and remittance per worker from the kingdom. That is remittances are seen to pro-cyclical with the activity in the kingdom. He also finds that the per capita remittances are more elastic with respect to wages as compared to per capita income and inelastic with interest rate. (Begum et al., 2012) studied Behavior of Remittance Inflows and its Determinants in Bangladesh .They found that domestic inflation goes up by 1 percent, on average, remittance will increase by 0.29 percent and if GDP of the six host countries increases by 1 percent, remittance will increase by 1.95 percent. (Rahim, 2012) studied that Problems and Prospects of Remittance Service in the Public Banking Sectors of Bangladesh (A study on Janata Bank Limited). He found that the remittance has the great impact on national economy and the Janata bank as a part of serving remittance service is also helps the country to economically stable. And this way the bank has also achieve greater prospects in remittance service. The bank also has some problem in remittance service. In order to increase remittance some strategy may be taken by the bank. Giuliano et al. (2006) studied that Remittances, Financial Development, and Growth. In this study analyzed that the relationship between remittances and growth and its interaction with the financial development in the recipient country.

Objectives of the study

The main objective of this study is to forecast the future Remittance in Bangladesh. Here the study time series analysis on Remittance. On the basis of this analysis firstly to fit the accurate model for Remittance in Bangladesh. Secondly check the model adequacy for different fitted

model. Thirdly, to forecast future GDP obtain form Remittance in Bangladesh and finally to see the forecasting performances of the selected ARIMA models.

Methodology

One of the important types of data used in empirical analysis is time series data. The empirical work based on time series data assumes that the underlying time series is stationary. The time series analysis based on the stationary time series data. In this section we briefly discuss on stationary and non-stationary time series. A stochastic process is said to be stationary if its mean and variance are constant over time. Otherwise it will be non-stationary. Why are stationary time series so important? Because if a time series is non-stationary, we can study its behavior only for the time period under consideration. Each set of time series data will therefore be for a particular episode. As a consequence, it is not possible to generalize it to other time periods. Therefore, for the purpose of forecasting, such (non-stationary) time series may be of little practical value. How do we know that a particular time series is stationary? There are several tests of stationary. Here we used graphical and analytical recognized test. Graphical test: if we depend on common sense, it would seem that the time series depicted in figure is non-stationary, at least in the mean value. Here we applied most widely used popular formal test over the past several years are Autocorrelation function (ACF), Partial Auto-correlation function (PACF) and Augmented dickey-fuller test.

1. Auto correlation function (ACF)

Seasonal patterns of time series can be examined via correlograms. The correlogram (auto correlogram) displays graphically and numerically the autocorrelation function (ACF), that is, serial correlation coefficients (and their standard errors) for consecutive lags in a specified range of lags (e.g., 1 through 30). Ranges of two standard errors for each lag are usually marked in correlograms but typically the size of auto correlation is of more interest than its reliability because we are usually interested only in very strong autocorrelations (Box et al., 1994). While examining correlograms one should keep in mind that autocorrelations for consecutive lags are formally dependent. Mathematically the auto-correlation function is,

$$\rho_k = \frac{\frac{\sum (Y_t - \bar{Y})(Y_{t+k} - \bar{Y})}{n}}{\frac{\sum (Y_t - \bar{Y})}{n}}$$

2. Partial Auto-correlation function (PACF)

Another useful method to examine serial dependencies is to examine the partial autocorrelation function (PACF) - an extension of autocorrelation, where the dependence on the intermediate elements (those within the lag) is removed (Brockwell et al., 2002). Mathematically the partial auto-correlation function is,

$$\phi_{p+1,p+1} = \frac{r_{p+1} - \sum_{j=1}^{p} \phi_{pj} r_{p+1-j}}{1 - \sum \phi_{pj} r_j}$$

Where, $\phi_{p+1,j} = \phi_{pj} - \phi_{p+1,p+1}\phi_{p,p-j+1}$

3. Augmented Dickey-fuller test

For theoretical and practical reasons the Dickey Fuller test (Box et al., 1994) is applied to regression model of the following form:

$$\Delta y_t = \delta y_{t-1} + u_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (a)$$

$$\Delta y_t = \beta_1 + \delta y_{t-1} + u_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (b)$$

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + u_t \dots\dots\dots\dots\dots\dots\dots (c)$$

Where t is the time or trend variable. In each case the null hypothesis is that $\delta = 0$, that is there is a unit root. The difference between (a) and the other two regression lines are in the inclusion of the constant (intercept) and the trend term.

If the error term u_t is auto correlated, one modified (c) as follows:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta y_{t-1} + \varepsilon_t \dots\dots\dots\dots\dots (d)$$

Where $for\ example, \Delta y_{t-1} = (y_{t-1} - y_{t-2}), \Delta y_{t-2} = (y_{t-2} - y_{t-3})\ etc.$ i.e. one uses lag difference terms.

The null hypothesis is still that $\delta = 0$ or $\delta = 1$, i.e., a unit root exists in y (i.e. is non-stationary) when the Dickey Fuller test is applied to models like (d), it is called augmented Dickey-Fuller (ADF) test. The ADF the test statistic has same asymptotic distribution as the DF statistic, so the same critical values can be used.

4. Model selection

Here, we applied Box-Jenkin's Methodology to identify the appropriate model for analyzing and forecasting the production of Aman rice in Bangladesh. The Box-Jenkin's Methodology (Box et al., 1994) is shown below:

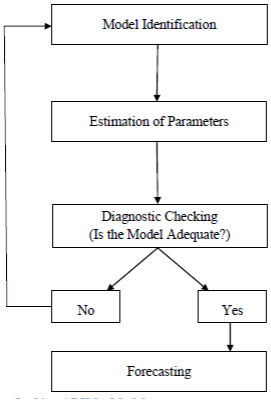

Figure 1: Box-Jenkin's Methodology

5. Forecasting

A planning tools that helps management in its attempts to cope with the uncertainty of the future, relying mainly on data from the past and present and analysis of trends. Predictions of future events and conditions are called forecasts, and the act of making such predictions is called forecasting (Brockwell et al., 2002).

Results and Discussion

I have used the secondary data regarding Remittance in Bangladesh which are collected through the year 1996 to 2017 from Department, Bangladesh Bank.

1. Checking non-stationarity of original Remittances by time series plot

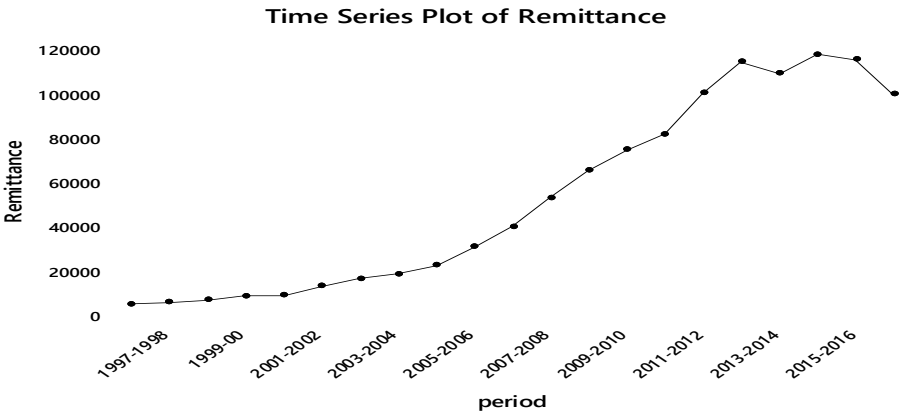

Figure 2: Time series Plot of original Remittances

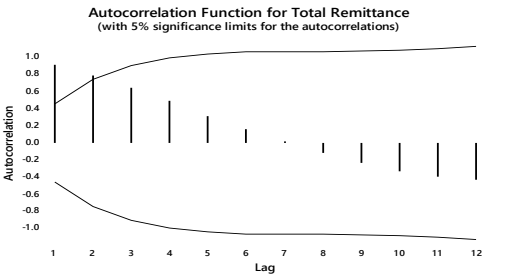

Figure 3: ACF Plot of Original Remittances

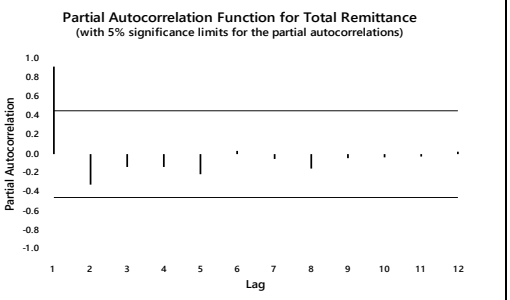

Figure 4: PACF Plot of Original Remittances

It is clear that the yearly total remittances in Bangladesh fluctuated over the study period 1996-2017. The total remittances about 6300.04 taka(in crore) in 1996-1997 and reached a peak in 2014-2015 of around 118982.32 taka (in crore) . After the period 2014-2015 there was an upward trend in the yearly total remittances in Bangladesh, i.e., the variance is unstable which indicates the total remittances data series is not stationary (in Figure 2, 3 & 4).Though from the graph we can see that the series is not stationary but we have to check ACF,PACF and ADF to ensure that.

Table 1. Q-test and LB Test for Remittance inflow

	Q-stat	Critical value
ACF	47.08088	11.07
PACF	21.56697	11.07

From Table 1 we observed that the series of Remittance inflow is correlated. Therefore the series is non-stationary.

2. Checking Non-Stationarity of original Remittances by Augmented Dickey Fuller Test

Table 2. Unit root test of original Remittances

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.035076	0.9365
Test critical values:	1% level	-4.121990	
	5% level	-3.144920	
	10% level	-2.713751	

From the above Table 2 we can see that -0.035076(ADF value) >-3.144920 (Negative Critical Value) and accept the null hypothesis. So the remittance is non-stationary.

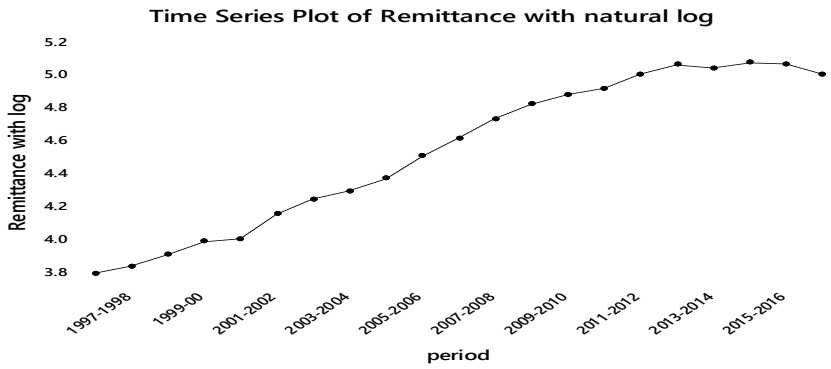

Figure 5: Time series Plot of log transform of Remittances

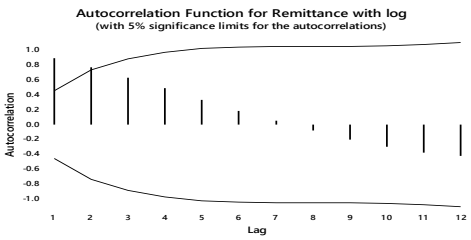

Figure 6: ACF Plot of natural log of Remittances

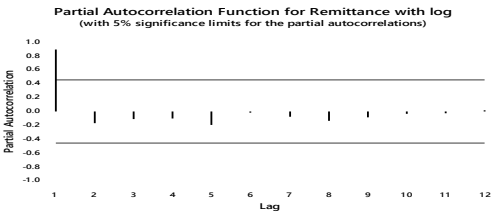

Figure 7: PACF Plot of natural log of Remittances

From the time series plot we can see that the Remittance is non-stationary in mean. After log transform again the Remittance contains non-stationary. It is clear that the yearly Remittances with log in Bangladesh fluctuated over the study period 1996-1997 to 2016-17. There is no significant change after log transformation. That indicates it follows the same manner of original Remittances in Bangladesh. So, from the above figure of time series plot (Figure 5), ACF (Figure 6) and PACF (Figure 7).we obtain that the data are also non-stationary. Now we perform ADF test to ensure the non-stationary about the series.

Table 3. Q-test and LB Test for Remittance inflow

	Q-stat	Critical value
ACF	44.93629	11.07
PACF	18.64297	11.07

From Table 3 we observed that the series of sugarcane production with first difference is correlated. Therefore the series is stationary.

3. Checking Stationarity of Remittances with Natural log by Augmented Dickey Fuller Test

Table 4: Unit root test of Remittances with natural log

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.090884	0.2498
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

From the above Table 4 we can see that -2.090884 (ADF value) >-3.020686(Negative Critical Value) accept the null hypothesis. So, the Remittances of natural logis non-stationary.
Checking stationarity by time series plot of Remittances for 1st differentiate of Square Root transformation

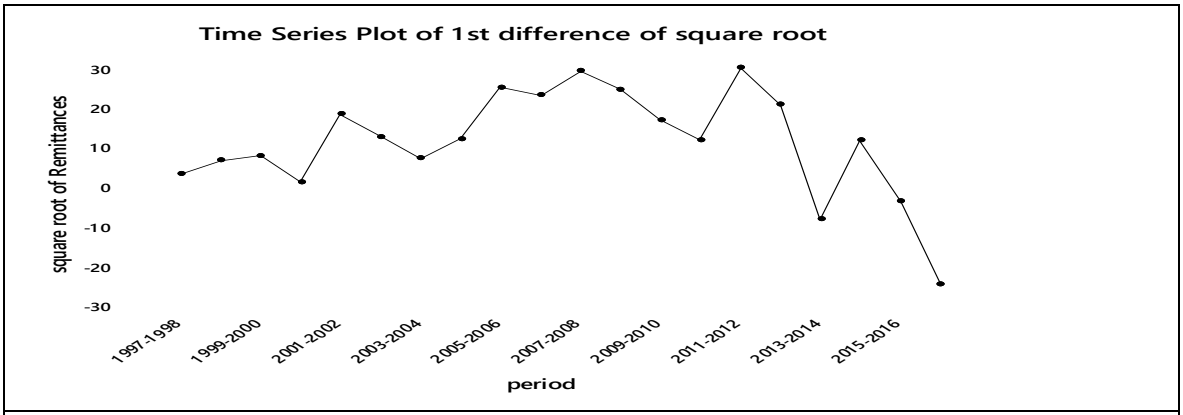

Figure 8: Time series Plot of 1st difference of Square Root Remittances

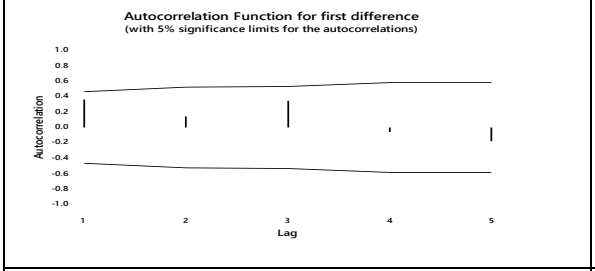

Figure 9: ACF Plot for 1st differentiate of Square Root of Remittances

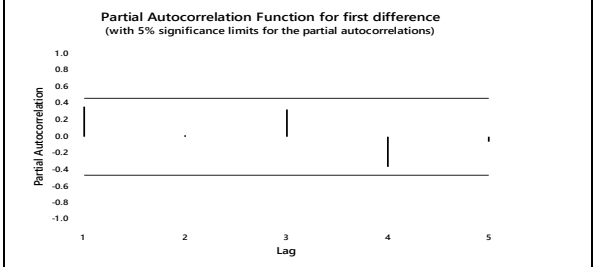

Figure 10: PACF Plot for 1st differentiate of Square Root of Remittances

It is clear that the yearly Remittances of 1st difference with square root in Bangladesh shows stable variance over the study period 1996-1997 to 2016-17. A significant change is being noticed after 1st difference. So, from the above figure of time series plot (Figure 8-10) we obtain that the data series are stationary. Now we have to perform 2nd difference for identifying comparatively better stationary data series.

Table 5. Q-test and LB Test for Remittance inflow

	Q-stat	Critical value
ACF	6.360328	11.07
PACF	7.805036	11.07

From Table 5 we observed that the calculated values are less than the tabulated values. So, the series is stationary.

Table 6. Unit root test(ADF for square root transform for 1st difference)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.594506	0.0055
Test critical values:	1% level	-4.200056	
	5% level	-3.175352	
	10% level	-2.728985	

From the above Table 6 we can see that the test statistic value 4.594506(calculated ADF value) <-3.175352 (Critical Value at 5% level of significance).So we reject the null hypothesis. Hence, the production is stationary.

4. ARIMA Modeling of the Remittances in Bangladesh

It's clear that 1st difference of Remittances with square root transform is stationary and other differences are non -stationary. But for predicting purpose we have 1st difference of Remittances with square root of transform. If we see the ADF value for Remittances with square root transform is5.302516 is-4.594506. By the ADF method it's the better difference for stationarizing the Remittance.

Finally, we have to say, to stabilize the variance and to make the data stationary first difference with square root transform is enough that is difference order is 1and it is said to be integrated of order 1. The alternative positive and negative ACF & PACF and exponentially indicates an autoregressive moving average process.

5. Model Selection of Remittances

The plot of ACF and PACF can give a primary guess about the parameter p and q for ARIMA model. Now we will identify the tentative models for the transformed series by the inspection of ACF and PACF.

Let us consider the different types of tentative models as much as possible from which we select the best model using the model selection criterion. Since the characteristics of a good ARIMA model is parsimonious ignoring the higher order of p and q, the tentative models on the basis of model selection criterion are as follows:

Table7. Different significant ARIMA Model

Model	MaxAPE	NBIC	RMSE
ARIMA(1,1,0)	**20.649**	**18.101**	**7337.159**
ARIMA(1,1,1)	20.897	18.285	7462.720
ARIMA(1,1,2)	21.585	18.442	7489.468
ARIMA(2,1,1)	22.357	18.427	7436.323

Using the tentative procedure, from Table 7, it is clear that ARIMA (1, 1,0) model with NBIC = 18.101 is better selected model for forecasting the yearly remittances in Bangladesh. The estimates of the parameters of the fitted ARIMA (1, 1, 0) model are shown in the given table. Also, the value of the most useful "forecasting criteria" of the fitted model is shown in given Table.

6. Diagnostic checking

To check the diagnosis, we should follow the residual ACF & PACF for the selected models.We have already that ARIMA (1,1,0) the better selected model for forecasting the Remittances in Bangladesh. Now we will perform ACF & PACF plots of residual of ARIMA (1, 1 , 0) for checking autocorrelation. Also, we are displayed ACF & PACF plots in Figure 11 of residual of other selected models just for comparison purposes. So all of the plots are displayed sequentially-

For ARIMA (1,1,0)

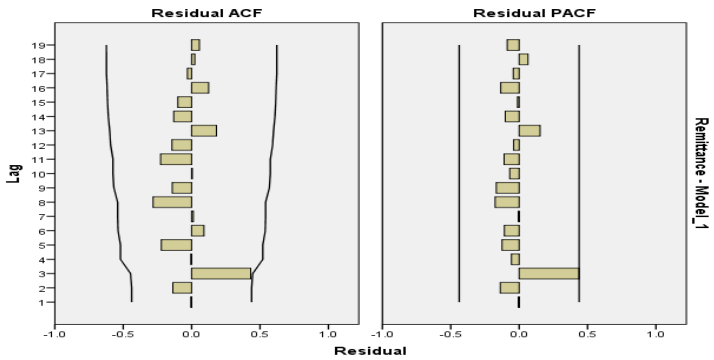

Figure: 11 Residual ACF, PACF of ARIMA(1,1,0)

7. Parameter estimation

Now we have to estimate the parameters of best fitted model ARIMA(1,1,0). The estimated values of the parameters are displayed in the following tale 5.2:

Table 8. Significance Test of the parameters of ARIMA (1, 1, 0) model

Coefficients	Estimates	Std. Error	t-value	p-value
AR(1)	0.557030	.260	2.142	.046

From the above Table 8, we see that the p-values corresponding to coefficients are approximately less than 0.05, which leads to the conclusion that the parameters are significant. Therefore, it is clear that our fitted ARIMA(1,1,0) model is the best fitted model and is adequate to forecast the Remittances in Bangladesh.

8. Forecasting

By using the best fitted model ARIMA(1,1,0), the forecasted Remittances along with 95% confidence level for ten years are shown in Table 9 The graphical comparison of the original series and the forecasted series is shown in Figure 12. It is observed that the forecasted series (blue-color) fluctuated from the original series (red) with a very small amount which shows the fitted series has the same manner of the original series (Figure 12). Therefore, the forecasted series is really a better representation of the original remittances series in Bangladesh.

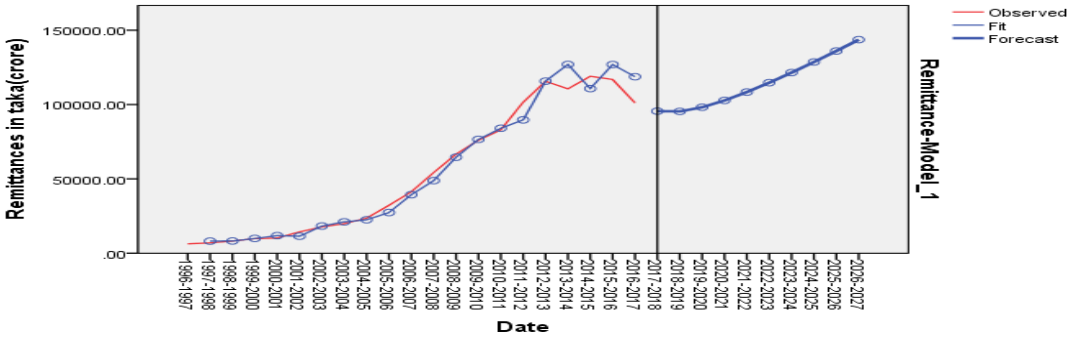

Figure 12: Plot for Forecasts for Remittances for Bangladesh

We have already fitted an ARIMA (1, 1, 0) model for the forecasting of yearly data of Remittances. Now to see the performance of this model in the out of sample forecasting, the forecasted value of Remittances data for the year 2017-18 to 2026-2027 will be derived using

this model. Then we compare the forecasted value with the actual value, which is available from 2017-18 to 2026-2027. The Table 9 gives the forecasted value obtained by ARIMA (1, 1, 0) model along with the forecasting errors in the test set. The following table contains the forecasted values under the period 2017-18 to 2026-27

Table 9. Forecasted Remittance value in Bangladesh for the period 2017-18 to 2026-27

Period	Forecasted	LCL	UCL
2017-18	95542.34	80167.50	111940.32
2018-19	95367.91	67804.90	126434.50
2019-20	98191.80	59579.01	143875.72
2020-21	102762.32	54003.03	162851.27
2021-22	108396.36	50156.64	182635.65
2022-23	114712.48	47473.94	202857.93
2023-24	121495.00	45602.68	223336.33
2024-25	128621.12	44318.89	243990.34
2025-26	136020.71	43476.50	264792.41
2026-27	143653.65	42977.64	285741.39

From the above Table 9, it is clear that the forecasts of Remittances showed a increasing trend. For 2017-18, a forecast of Remittances was about 95542.34 taka (in crore) with lower limit & upper limits of 80167.50 taka (in crore) and 111940.32taka (in crore) respectively. If the present increase rates continue, Remittances in Bangladesh, in 2026-27 would be about 143653.65 taka in crore with lower and upper limits of 42977.64 and 285741.39 taka in crore respectively.

Conclusion

It is clear that the yearly Remittance in Bangladesh fluctuated over the study period 1996-2017. The Remittance started in this study at about 6300.04 taka (in crore) in 1996-1997 and reached a peak in 2011-2012 of around 118982.3taka in crore then it dropped dramatically up to the period 2012-2013 and the remittance reached to around 116856.7 taka in crore. After the period 2012-2013 there was an upward trend in the Remittance in Bangladesh. The best selected Box-Jenkins ARIMA model for forecasting the Remittance in Bangladesh is ARIMA (1,1,0). From the comparison between the original series and forecasted series shows the same manner indicating fitted model are statistically well behaved to forecast Remittances in Bangladesh i.e., the models forecast well during and beyond the estimation period which reached at a satisfactory level. Thus, this model can be used for policy purposes as far as forecasts the Remittances in Bangladesh.

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Cite this article:
Md. Ziaul Hassan, Md. Siraj-Ud-Doulah & Shamima Nasrin Sathi (2020). Forecasting the Remittance inflow Based on Time Series Models in Bangladesh. *International Journal of Science and Business,* 4(1), 13-23. doi: 10.5281/zenodo.3592656

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