RedFame

International Journal of Social Science Studies
Vol. 12, No. 5; September 2024
ISSN 2324-8033 E-ISSN 2324-8041
Published by Redfame Publishing
URL: http://ijsss.redfame.com

Box Jenkins ARMA Model for Forecasting Bangladesh's Remittance Inflow

Sabiha Binta Hasan[1], Roksana Akhter[1], Dipti Bhowmik[1], Shakil Mahmood Shaon[1], Md. Ariful Islam[1]

[1] Mawlana Bhashani Science and Technology University, Tangail, Bangladesh

Correspondence: Sabiha Binta Hasan, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh.

Received: July 7, 2024 Accepted: August 16, 2024 Available online: September 4, 2024

doi:10.11114/ijsss.v12i5.7174 URL: https://doi.org/10.11114/ijsss.v12i5.7174

Abstract:

This study uses Eviews software in order to determine the best Box-Jenkins ARMA model for forecasting the growth rate of remittances in Bangladesh by utilizing time series data from the year 1980 to 2022. In our study, we used the Augmented Dickey-Fuller Test (ADF Test) to check the stationarity of the time series data. This test shows that data is stationary at level 0, i.e., Remittance (0). By performing several selection criteria for the lowest SIGMASQ and the lowest value of AIC and BIC, we obtain ARMA (1, 1), which is the best model for forecasting remittances in Bangladesh. Diagnostic tests additionally demonstrate the stability and acceptability of the parsimonious model that has been given for remittance prediction in Bangladesh. The study's findings reportedly demonstrate that Bangladesh's remittance inflows are declining. The article makes the case that, in order to increase remittance inflows into Bangladesh, the country's emigration policy needs to be strengthened.

Keywords: Remittance, Forecasting, Box Jenkins, ARMA, Time Series

1. Introduction

Bangladesh is one of the world's economies that is growing at a rapid rate. The growth of an economy is mostly dictated by the development of its many economic sectors. Bangladesh is a small developing nation. Therefore, the country's development is happening very slowly and is influenced by a number of sectors, including the financial market, manufacturing and industry, agriculture, investment, and external commerce. It is not necessary to emphasize how important overseas remittances are to Bangladesh's economy. Remittances have been identified as one of the three major factors that have reduced the overall incidence of poverty in Bangladesh and maintained a healthy balance of payments, along with the ready-made garment (RMG) sector and non-farm activities in the agriculture sector. In the fiscal year 2010, Bangladesh became a part of the 10 billion USD remittance influxes. Remittance inflow to GDP is likewise increasing, and its contribution to the balance of payments creates surplus balance to lower deficits.(Hasan et al., 2019)

In the context of the national economy, remittances are quite significant. One form of money mobility that is essential to economic progress, especially for developing countries, is remittances. Remittance inflows, according to earlier research, boost economic development from a microeconomic perspective by providing beneficiaries with access to the capital for investments in companies, healthcare, and education. From a macroeconomic point of view, by raising aggregate demand, it can boost GDP and quicken economic growth.

Remittance inflow is one of Bangladesh's primary sources of foreign exchange reserves. A certain amount of foreign exchange reserves must be maintained by the country because of its substantial reliance on imports. The amount of labour migration is connected with the inflow of remittances. Over the past ten years, remittance income has increased nearly five times, making it currently Bangladesh's main source of foreign exchange profits.

Bangladesh received almost $22.1 billion in remittances in 2021, placing it as the seventh-highest recipient worldwide and the third-highest recipient in South Asia, according to the World Bank.(World Bank, 2022)

According to a 2013 survey on remittance utilization by the Bangladesh Bureau of Statistics, 32.81% and 32.82% of remittances, respectively, are spent for expenses related to food and non-food items. 17.39% of the remittances were used for land purchases, accounting for 18.84% of the expenses for durable goods and other purposes. 33.45% of remittances are allocated to investments, and 13.74% are allocated to savings, according to data from the Bangladesh Bureau of Statistic.("Remittances to Bangladesh," 2024)

At the moment, the World Bank is Bangladesh's primary external lender. Bangladesh's impressive achievements and the necessary steps to maintain its progress towards the goal of being an upper-middle-income country by 2031 are the foundation for the commitment to continue supporting.(“Remittances to Bangladesh,” 2024)

2. Objectives of the Study

This study's primary goal is to project Bangladesh's future remittance flows. This is a time series analysis of the study on remittances. The main objectives are subdivided into three objectives.

- First, to develop an accurate model for remittances in Bangladesh based on this data.
- Second, to determine whether an alternative fitted model is adequate and
- Lastly, to assess the accuracy of the chosen ARMA models' forecasts.

3. Literature Review

Countries differ in how important remittances are. Thus, research focused on a particular nation is a better method to produce pertinent policy across a range of industries. Numerous scholars have previously addressed the remittance in their publications. They have employed a variety of techniques, including the VAR model, GARCH, ARIMA, and ARCH. In order to forecast the remittance using the ARMA mode, we have attempted to highlight the remittance in the contemporary context of Bangladesh in this work.

(Md. Ziaul Hassan et al., 2019) identifies an increasing trend in remittances by forecasting the time series data from 1996 to 2017. They used the Box Jenkin technique to determine the true model using various model selection criteria. To confirm stationarity, they have used the Dickey Fuller test in addition to the graphical method. Next, the ACF and PACF curves are used to determine which model was best for remittance. According to their research, the ARIMA (1, 1, 0) model can be used to forecast remittances to Bangladesh.

(Devkota & Pokhrel, 2023) suggest the best ARIMA model to anticipate the inflows of remittances from Napal between 1990–1991 and 2021–2022. The annual remittance influx is modeled and forecasted using the Box-Jenkins approach and extensive data analysis is performed using EViews 12. In order to capture the subtleties in annual remittance trends, many ARIMA models were assessed. The study confirmed that the ARIMA (1, 1, 1) was best one to use in order to predict the remittance influx to Nepal. This discovery offers crucial perspectives for decision-makers, economists, and interested parties, enabling well-informed choices for future economic strategizing inside the nation.

(Golder et al., 2023) studied the relationship among financial advancement and inward remittances and economic growth, assuming a symmetric relationship between the variables and neglecting the possibility of an asymmetric relationship. This article applies the Nonlinear Autoregressive Distributed Lag (NARDL) model with time series data from 1988 to 2020. The study's novel findings include that remittances and both positive and negative swings in financial advancement contribute to Bangladesh's economic growth.

Zhang et al., (2022) examine how household spending in Ukraine, a developing nation, has been impacted by the COVID-19 pandemic. The data series were built for this purpose, spanning from the second quarter of 2021 to 2010. The primary variables were household expenditure by category and remittances from migrants. The Dickey–Fuller Unit Root test and the ARIMA model were used to accomplish the objectives of the article. This study concluded that COVID-19 has altered the makeup of household spending in Ukraine. The projected results through 2026 showed that, as a result of shifting migrant remittances, household spending on transport increased at the highest rate.

Majumder et al., (2020) examine how Covid-19 has affected the inflow of remittances into the chosen emerging south Asian nations. The ARMA approach is used in the current study to forecast up to 2021M12. The study shows that restrictive conditions in the wage workers' markets now resulted in negative or zero growth rates for the remittance inflow into the chosen nations.

(Islam et al., 2017) used the RB prospective data to create a special and useful forecasting model. From January 1998 to December 2003, information was gathered from Bangladesh Bank (BB). To determine which was best, two models were used: the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) and the (ARIMA). The results showed that the GARCH (2, 1) model seemed to be the most appropriate among them, and the ARIMA (0, 1, 1) (0, 2, 1) were suitable for their study.

(Nyoni, 2019) forecasts remittances using the Box-Jenkins ARIMA technique on remittances into Bangladesh from 1976 to 2017. Diagnostic examinations show that data is stationary at level 2, i. e., REM (2). The ARIMA (2, 2, 0) model for forecasting remittances is presented in the paper. According to the study's findings, remittance inflows into Bangladesh appear to be declining. In order to increase remittance inflows into Bangladesh, the article makes the case that Bangladesh's emigration policy needs to be strengthened.

4. Methodology

4.1 Data Sources

The data of remittances are collected from the World Development Indicator (WDI). We have collected data from 1980-2022. Our data set contains 43 observations. We have collected the data of remittance as the percentage of GDP. Based on this 43 observations we have tried to forecast next 1 decade inflow of remittance from 2022-2032.

4.2 Model Selection

Generally, for forecasting any variable, two models are used: ARIMA and ARMA. ARIMA model is used where the time series data are not integrated at level. In our study we have used ARMA model, where the data are integrated at the level. Autoregressive (AR) and moving average (MA) are the two components of this model. If data are stationary, you can use the ARMA (p, q) model.

4.3 The Autoregressive (AR) Models

When a variable's value in present year is correlated with its values in previous year, the model is said to be autoregressive (AR). For example, by AR (1) and AR (2) indicate that the dependent variable is correlated with its previous two period's data which indicates lag two.

We can write the AR (p) Model as,

$$y_t = \beta + \gamma_1 y_{t-1} + \gamma_2 y_{t-2} + \cdots + \gamma_p y_{t-p} + u_t$$

$$In\ short, \qquad y_t = \beta + \textstyle\sum_{i=1}^{p} \gamma_i\, y_{t-1} + u_t$$

Here β is constant, γ_i is the lagged variable's coefficient in time t – p

4.4 The Moving Average (MA) Models

There may exist a relationship between a variable and error term from a prior period, which is known as moving average (MA) model. Therefore, the residuals have an impact on the dependent variable, or past period error terms. Model error term's first and second period lags are used, respectively, according to MA (1) and MA (2).

We can write the MA(q) Model as,

$$y_t = \beta + u_t + \varepsilon_1 u_{t-1} + \varepsilon_2 u_{t-2} + \cdots + \varepsilon_q u_{t-q}$$

$$In\ short, \qquad y_t = \beta + u_t + \sum_{i=1}^{q} \varepsilon_i\, u_{t-1}$$

Where ε_i is the lagged variable's coefficient in time $t - q$

4.5 The Autoregressive Moving Average (ARMA) Model

Autoregressive Moving Average (ARMA) models co-ordinate both (p) autoregressive terms and (q) moving average terms, which is also named as ARMA (p,q).

Now, the combination of ARMA (p,q) model can be written as the following formula:

$$y_t = \beta + \textstyle\sum_{i=1}^{p} \gamma_i\, y_{t-1} + \sum_{i=1}^{q} \varepsilon_i u_{t-1} + u_t$$

Here, $y_t$is the actual value of the variable, u_t is a white noise disturbance term. p and q integer's are referred to as lag order of Auto Regressive(AR) and Moving Average(MA) term.

4.6 The Autocorrelation Function (ACF)

Correlograms can be used to examine the time series data's seasonal tendencies. The autocorrelation function (ACF), or serial correlation coefficients for successive lags in a given spectrum of lags (e.g., 1 through 30), is graphically and quantitatively displayed by the correlogram, also known as the auto-correlogram (Box et al., 1994). ACF is the ratio of the covariance of y_t and y_{t-k} to the variance of y_t.

$$ACF\ (k) = \rho_k = \frac{Cov\ (y_t, y_{t-k})}{Var(y_t\ )}$$

The autocorrelation function ACF (k) provides the gross correlation between y_t and y_{t-k} i, e, it indicates the optimum lag of Moving Average (MA) term.

4.7 The Partial Auto-correlation Function (PACF)

The Partial auto-correlation function (PACF) analysis is another helpful technique for investigating serial dependencies. PACC is a version of autocorrelation in which the reliance on intermediate elements (those in the lag) is eliminated (Brockwell & Davis, 2002).

PACF shows the correlation between y_t and y_{t-k}minus the part clarified by the intervening lags. It determines the optimum lag of Auto Regressive (AR) term.

The partial auto-correlation function can be expressed mathematically as-

$$\rho_k^* = Corr\left[y_t - E^*\left(\frac{y_t}{y_{t-1,,,,,}y_{t-k+1}}\right), y_{t-k}\right]$$

Where, $E^*\left(\frac{y_t}{y_{t-1,,,,,}y_{t-k+1}}\right)$ is the minimum mean-squared error predictor of y_t by $y_{t-k,,,,,,}y_{t-k+1}$

4.8 Box-Jenkins approach of ARMA

An adequate model was fitted for the remittance data using the Box Jenkins (BJ) technique of ARMA (Box & Jenkins, 1976). This approach is divided into three stages: (1) identification; (2) estimation and diagnostic checking; and (3) application. In identification stage we have to check the stationary of the data by using graph plot, correlogram test and unit root test. If the data is stationary then we go for ARMA procedure. In estimation stage we have to select best ARMA model for estimation by several section criteria.

5. Results and Discussions

We have utilized secondary data from the World Development Indicator that covers remittances as the percentage of GDP in Bangladesh from 1980 to 2022. In our study we have used the Eviews software to facilitate the ARMA model.

5.1 Recognizing Stationery

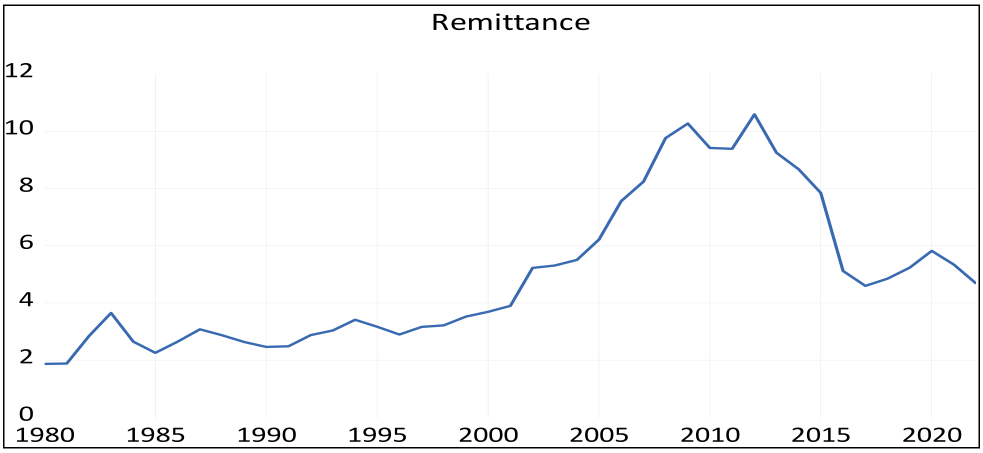

Figure 1. The trend line of the inflow of remittances in Bangladesh

Figure-1 displays the trend line of the remittances which is measured as the percentage of GDP of Bangladesh. The trend shows that from 1980-2000 remittance did not increase at large volume and after that it started to increase so sharply up to 2013. But, after 2013 it started to fall remarkably. The overarching argument seems that the decrease in remittance flow can be attributed to the slow growth of Bangladeshi migrants overseas. There are two explanations for this. Firstly, Bangladesh is not sending enough workers overseas to explore new markets and existing markets. In 2013, just 450,000 migrants managed work abroad, a decrease of approximately 33% from 680,000 in 2012(Hussain, 2014). Second, the government's inability to use diplomatic channels to resolve issues pertaining to the legal status of Bangladeshi migrant laborers in Saudi Arabia, the United Arab Emirates, and Kuwait has resulted in an increase in the number of migrant workers returning to their home country. Regretfully, there is no trustworthy time series available for the yearly total of foreign migrants who return (Hussain, 2014). Another breakdown in remittance from 2020 was occurred for COVID-19. As a result of the COVID-19 global crisis and the decrease in overseas Bangladeshi migrant workers, the inflow of remittances to the country was predicted to decline significantly from 2020.

Table 1. The result of ADF Unit root test on Remittance

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.638234	0.0404
Test critical values:	1% level	-4.234972	
	5% level	-3.540328	
	10% level	-3.202445	

* MacKinnon (1996) one-sided p-values.

Table-1, represents the results of Augmented Dickey Fuller (ADF) unit root test, verified the presence of significance to accept the null hypothesis of unit root. And the data set is stationary at 95% confidence level interval.

5.2 Optimum Lag Selection for ARMA Model

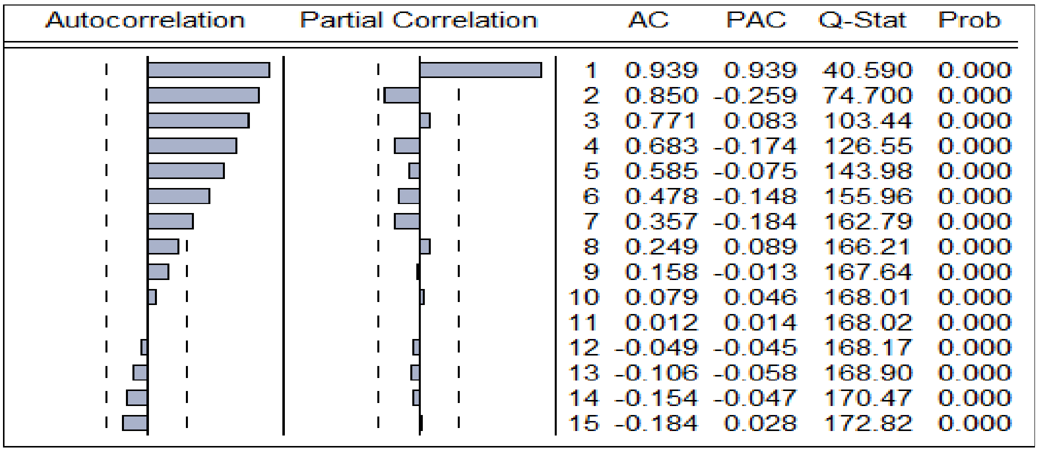

Figure 2. Correlogram of inflows of remittances in Bangladesh

Figure 2 depicts the correlogram of the annual remittance influx to Bangladesh. As our study shows that the raw data of remittances is stationary, from the level correlogram the autocorrelation and partial correlation depicts the number of lags of MA and AR terms respectively. In our study up to 15 lags, the ACF and PACF were the main subjects of the investigation.

By examining the ACFs and PAFs of the remittance at level, computed for 15 lags, it was possible to determine the possible AR and MA orders. Figure 2 shows that the ACF of Remittance has a spiral-shaped decay pattern beyond lag 7, with an exponential trend indicating significant autocorrelation at lag 7. That means, up to MA (7) are outside of the normal expectance level. As a result, this points to a possible order of 7 (q = 7) for the moving average process.

In Figure 2, the PACF pertaining to the primal deviation of remittance series are displayed. Additionally, lag 1 exhibits a significant positive spike, but the 95 percent confidence interval is maintained by all other partial autocorrelations. P = 1 suggests that the autoregressive process may have an order of 1.

From the figure 2, the moving average and autoregressive processes with orders ranging from 0 to 7, which match this pattern, are compatible.

Thus probable order of our model will be: ARMA (0,1); ARMA (1,0); ARMA (1,1); ARMA (1,2); ARMA (1,3); ARMA (1,4); ARMA (1,5); ARMA (1,6); and ARMA (1,7).

5.3 Model Estimation

To identify the best ARMA model, this study takes into account a number of measures, including volatility, the Akaike Information Criterion (AIC), and the Schwarz Information Criterion (SIC), adjusted R-square, significant AR and MA factors (Depken et al., 2021). The volatility of the model is used to quantify its performance. A lower Sigma square (SIGMASQ) indicates a more effective predictive capacity. The more the significant AR and MA factors the more will be model fitness. Furthermore, the improved model has lower values for the AIC, and SIC, as well as a greater adjusted R-square (Adj. R^2) (Cheung and Lai, 1993); (Reddy, 2019)

To get the best fit, the researchers evaluated a number of models using moving average and autoregressive orders. Table-2 shows the results of the estimated ARMA models, which aids in the selection of the top models according to AIC, SIC, SIGMASQ, and Adj. R2.

Table 2. Test Findings for the ARMA (p,q) Model Fitting

Models	**SIGMASQ**	**Adj. R^2**	**AIC**	**SIC**
ARMA (0,1)	2.040826	0.672524	3.733275	3.856150
ARMA (1,0)	0.574992	0.907735	2.477961	2.600835
ARMA (1,1)	0.486000	0.920015	**2.367411**	**2.531244**
ARMA (1,2)	0.480659	0.918813	2.403594	2.608384
ARMA (1,3)	0.465366	0.919271	2.419803	2.665551
ARMA (1,4)	0.463966	0.917279	2.463852	2.750559
ARMA (1,5)	**0.376932**	**0.930876**	2.419317	2.746982
ARMA (1,6)	**0.329433**	**0.937810**	2.404853	2.773476
ARMA (1,7)	**0.340965**	**0.933682**	2.417554	2.827136

Table-2 confirms that, when compared to other models and perform the diagnostic test, the ARMA (1, 1) model is the best option according to metrics like AR and MA factors, SIGMASQ, Adj. R2, AIC, and SIC. In our study, the best models in sequence are ARMA (1, 7); ARMA (1, 6); ARMA (1, 5) and ARMA (1, 1). If we consider the percentage significance of AR and MA factor then ARMA (1, 1) is best. Moreover, other three models failed to pass the diagnostic test. That is why we select the ARMA (1, 1) as the best model.

Table 3. Results of ARMA (1, 1) Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.394743	1.766220	2.488220	0.0172
AR(1)	0.909016	0.054979	16.53397	0.0000
MA(1)	0.503464	0.128068	3.931210	0.0003
SIGMASQ	0.486000	0.093681	5.187829	0.0000
R-squared	0.925729	Mean dependent var		4.953706
Adjusted R-squared	0.920015	S.D. dependent var		2.588315
S.E. of regression	0.732015	Akaike info criterion		2.367411
Sum squared resid	20.89801	Schwarz criterion		2.531244
Log likelihood	-46.89935	Hannan-Quinn criter.		2.427828
F-statistic	162.0338	Durbin-Watson stat		2.066035
Prob(F-statistic)	0.000000			

The results presented in Table-3 validate that both the coefficients of AR and MA are statistically significant at the 1% significance level. The chosen model, ARIMA (1, 1) is indicated in Table-2 and can be written as follows:

$$Remittance = 4.394743 + 0.909016(Remittance_{t-1}) + 0.503464\epsilon_{t-1} + \epsilon_t$$

5.4 Diagnostic Checking

Before using the final model for forecasting, it is important to perform several diagnostic tests to confirm its goodness to fit. When selecting the optimal model, one of the most crucial assumptions is that the residuals be uncorrelated and resemble white noise. Thus, examining these residuals is a necessary step in evaluating the Box-Jenkins model.

Autocorrelation test for ARMA model:

In order to evaluate autocorrelation, the study looks into partial autocorrelation and autocorrelation of residuals at specified lag intervals. Its main objective is to analyze the residual autocorrelations for serial autocorrelation over 16 lags applying Ljung-Box Q statistic tests.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.058	-0.058	0.1546	
		2	-0.028	-0.032	0.1918	
		3	0.239	0.237	2.9548	0.086
		4	-0.051	-0.027	3.0822	0.214
		5	0.002	0.009	3.0824	0.379
		6	0.247	0.202	6.2846	0.179
		7	-0.107	-0.075	6.8981	0.228
		8	-0.111	-0.129	7.5826	0.270
		9	-0.065	-0.193	7.8240	0.348
		10	-0.073	-0.045	8.1392	0.420
		11	-0.104	-0.087	8.7927	0.457
		12	0.034	0.024	8.8638	0.545
		13	-0.071	-0.006	9.1879	0.605
		14	-0.165	-0.091	11.004	0.529
		15	0.040	0.063	11.114	0.601
		16	-0.092	-0.092	11.722	0.629

Figure 3. Ljung-Q statistic for Autocorrelation Test

Figure 3 depicts the findings of the Ljung Box test based on quadratic error terms, which is commonly used to assess autocorrelation. When the Ljung Box Q statistic is employed, the autocorrelations and partial autocorrelations of the error terms at various delays display no discernible variations from zero. This suggests that the residuals will exhibit an irregular pattern since all fluctuations are contained within the 95 percent confidence range (Safi, 2014). Therefore, it can be concluded that the model effectively matches the data

Heteroscadasticity test for ARMA:

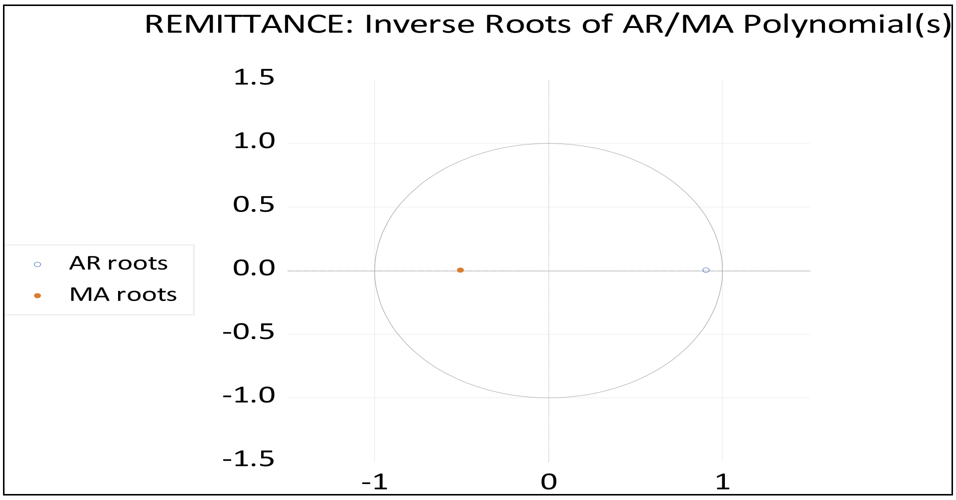

Figure 4. AR/MA Polynomials' Inverse Roots

Figure 4 shows the inverse roots of the Auto Regressive and Moving Average polynomials to assess the consistency of the chosen ARMA (1,1) model. It provides the evidence for the ARMA model's stability by showing inverse roots inside the circle, which represent values smaller than unity. The stability of the model is further shown when the AR and MA roots synchronize in the same direction within the circle, suggesting reliable and consistent trends in the remittances data (Pesaran, 2007).

5.5 Forecasting

Predicting future values within a time series is the main goal of forecasting (Shumway & Stoffer, 2016). Specifically, this study used a technique known as Univariate Time Series Forecasting which uses the time series historical values to predict its future values. ARMA is a forecasting technique considering the idea that Values in the future can be predicted using only the information available in past time series values (Prabhakaran, D., Jeemon, P., Sharma, et al., 2018). The study came to the conclusion that the ARMA (1, 1) model is the best option for remittance forecasting after taking into account the findings from the prior sections.

Year	Forecasted value of Remittance
2023	4.351079
2024	4.355052
2025	4.358663
2026	4.361946
2027	4.364930
2028	4.367642
2029	4.370108
2030	4.372350
2031	4.374387
2032	4.376239

The forecasted graph is given below-

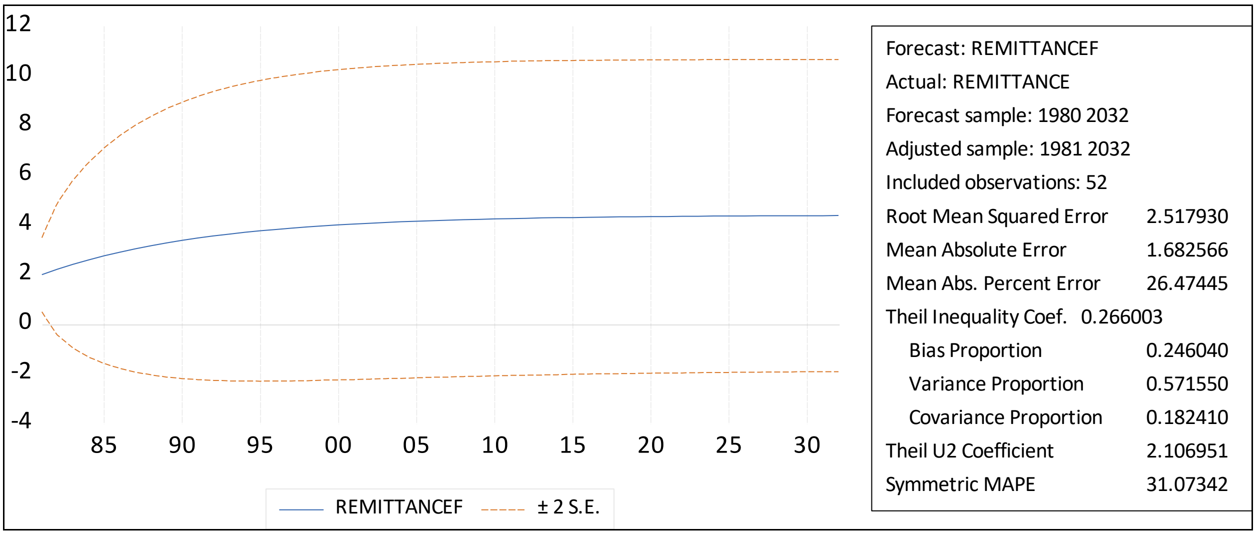

Figure 5. Forecasting of Remittance Inflow in-Sample

Figure 5 presents a sample forecasting of remittance inflows from the years 1980 to 2032 .Values for the remittance are projected to fall between plus and minus two estimated standard errors. This displays a reasonably reliable prediction interval, demonstrating the model's degree of confidence in predicting the values (Henderson et al., 2012).

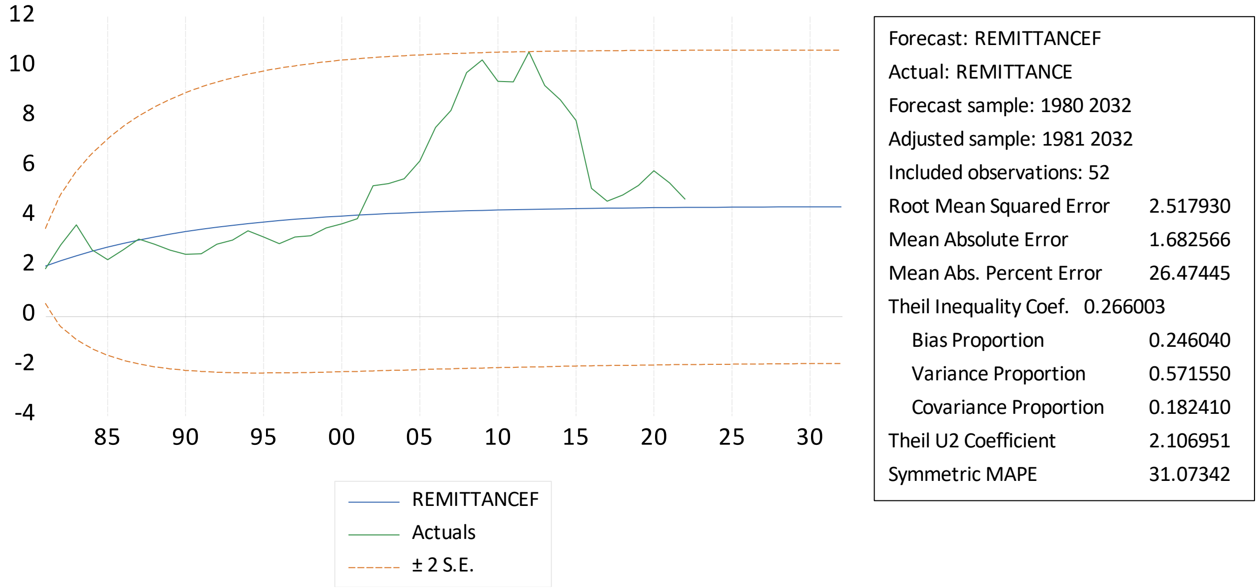

Figure 6. Forecasting Remittance inflow as compared to actual inflow

We can predict the remittance growth as compared to actual data bay following formula-

$$\frac{Forecasted\ data - Actual\ data}{Actual\ data} * 100 = \frac{4.4 - 4.7}{4.7} * 100 = -6.38\%$$

Thus, the outcome demonstrates that, with an average yearly percentage change of 6.38, the remittances prediction has been decreasing consistently over the years under observation. Because, from 2005 to 2022 there was an irregular pattern of remittance inflow. At first remittance growth increased so sharply and suddenly from 2013 it started to fall.

6. Conclusions

This study looked closely at the remittance inflow statistics for Bangladesh from 1980 to 2022 using the Box-Jenkins ARMA approach. The inquiry comprised transformation processes, series stationarity checks, and the identification of model parameters using unit root tests and correlograms. In our study the best model was ARMA (1, 1). Diagnostic tests confirmed the model's suitability for forecasting by validating its goodness of fit. Remittance inflow trends were shown to be consistent by the research, and the ARMA model's predictions closely matched the observed values, indicating precise projections. Our forecasting confirmed the diminishing trend in remittance inflow in Bangladesh. This is may be because of poor emigration policy. The standard refrain appears to be that the flow of remittance has declined because the stock of Bangladeshi migrants abroad is not growing like it used to. This is because of two reasons. First, Bangladesh is failing to send more workers abroad to traditional markets and exploring new markets. Second, the number of migrant workers returning to Bangladesh has also increased because the government could not resolve problems related to the legal status of Bangladeshi migrant labors. There may have been a decline in their capacity to remit because of decline in earnings per migrant worker or decline in the propensity to save or decline in the propensity to remit out of their saving or a combination of all these factors. However, there are far too many macroeconomic factors contribute to diminishing remittance inflow beyond emigration issues. For instance, the investment prospective, the profitable projects available, the government investment policies, etc. The study suggests that Bangladesh, as the front-runner among Asian nations receiving remittances, may effectively utilize its potential to greatly raise the standard of living for Bangladeshi citizens. As a result, the emigration policy needs to be strengthened in order to enable citizens of Bangladesh, the country from which the emigrants are departing, to obtain sufficient security and legal status to support the quality of the work they will undertake in the destination nation. This is because the amount of money an individual earns directly correlates with the amount of money that they will need to send home in the form of remittances, which in this case is Bangladesh.

6.1 Limitations and the Direction of Future Research

ARMA model is a very basic linear time series model. Due to some limitations we could not investigate on large volume of observations. Researcher may try different types of time series models like ARCH or GARCH and make comparisons in order to judge which model works the best. Similar research might be done in different nations or economic groupings, even taking panel estimate methods into consideration.

Acknowledgments

I am expressing our deepest gratitude and appreciation for the assistance and support received throughout the completion of this research paper. I would like to extend my gratitude to the research team for their collaborative efforts in collection and analysis of data. Their expertise has greatly benefited the study. I would like to thank all those people who have supported me intellectually and emotionally as I worked on my reaserch.

Authors' contributions

Sabiha Binta Hasan, Roksana Akhter and Dipti Bhowmik were responsible for study design and revising. Shakil Mahmood Shaon and Ariful Islam were responsible for data collection. Sabiha Binta Hasan drafted the manuscript and Roksana Akhter revised it. All authors read and approved the final manuscript.

Funding

Not applicable.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Redfame Publishing.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

References

Box, G. E. P., & Jenkins, G. M. (1976). *Time Series Analysis: Forecasting and Control*. Holden-Day.

Box, G. E. P., Jenkins, G. M., & Reinsel, G. C. (1994). *Time series analysis: Forecasting and control* (Third edition). Prentice Hall. http://www.gbv.de/dms/bowker/toc/9780130607744.pdf

Brockwell, P. J., & Davis, R. A. (2002). *Introduction to time series and forecasting* (2nd ed). Springer. https://doi.org/10.1007/b97391

Cheung, Y. W., & Lai, K. S. (1993). Finite-Sample Sizes of Johansen's Likelihood Ratio Tests for Cointegration. *Oxford Bulletin of Economics and Statistics*, *55*(3), 313–328. https://doi.org/10.1111/j.1468-0084.1993.mp55003003.x

Depken, C. A., Niksic Radic, M., & Paleka, H. (2021). Causality between Foreign Remittance and Economic Growth: Empirical Evidence from Croatia. *Sustainability*, *13*(21), Article 21. https://doi.org/10.3390/su132112201

Devkota, B. P., & Pokhrel, S. (2023). Forecasting Remittance Inflow in Nepal Using the Box-Jenkins ARIMA Model. *Kathford Journal of Engineering and Management*, *3*(1), 72-86. https://doi.org/10.3126/kjem.v3i1.62878

Golder, U., Rumaly, N., Hossain, M. K., & Nigar, M. (2023). Financial progress, inward remittances, and economic growth in Bangladesh: Is the nexus asymmetric? *Heliyon*, *9*(3), e14454. https://doi.org/10.1016/j.heliyon.2023.e14454

Hasan, S. B., Akhter, R., Al Abbasi, A. A., & Saha, S. (2019). Impact of Remittance on Economic Growth in Bangladesh. *American Journal of Trade and Policy*, *6*(1), 41-48. https://doi.org/10.18034/ajtp.v6i1.346

Henderson, J. V., Storeygard, A., & Weil, D. N. (2012). Measuring Economic Growth from Outer Space. *American Economic Review*, *102*(2), 994-1028. https://doi.org/10.1257/aer.102.2.994

Hussain, Z. (2014, 12). *Explaining-recent-decline-remittances-bangladesh.htm*. World Bank Blogs. Retrieved from https://blogs.worldbank.org/en/endpovertyinsouthasia/explaining-recent-decline-remittances-bangladesh

Islam, T., Mohib, A. A., & Haque, S. Z. (2017). Econometric Models for Forecasting Remittances of Bangladesh. *Business and Management Studies*, *4*(1), 1. https://doi.org/10.11114/bms.v4i1.2860

Majumder, S., Rahman, Md. H., Layla, F., & Abedin, M. Z. (2020). Forecasting the Impact of COVID-19 on Remittance Inflows in Selected South Asian Countries. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3648937

Md. Ziaul Hassan, Md. Siraj-Ud-Doulah, & Shamima Nasrin Sathi. (2019). *Forecasting the Remittance inflow Based on Time Series Models in Bangladesh*. https://doi.org/10.5281/ZENODO.3592656

Nyoni, T. (2019, February 26). *Modeling and Forecasting Remittances in Bangladesh Using The Box-Jenkins ARIMA Methodology*. Munich Personal RePEc Archive. Retrieved from https://mpra.ub.uni-muenchen.de/92463/

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, *22*(2), 265-312. https://doi.org/10.1002/jae.951

Prabhakaran, D., Jeemon, P., Sharma, M., Roth, G. A., Johnson, C., Harikrishnan, S., . . . Roy, India State-Level Disease Burden Initiative CVD Collaborators. (2018). The changing patterns of cardiovascular diseases and their risk factors in the states of India: The Global Burden of Disease Study 1990-2016. *The Lancet. Global Health*, *6*(12), e1339-e1351. https://doi.org/10.1016/S2214-109X(18)30407-8

Reddy, C. (2019). Predicting the Stock Market Index using Stochastic Time Series ARIMA Modelling: The Sample of BSE and NSE. *Indian Journal of Finance*, *13*, 7-25. https://doi.org/10.17010/ijf/2019/v13i8/146301

Remittances to Bangladesh. (2024). In *Wikipedia*. Retrieved from https://en.wikipedia.org/w/index.php?title=Remittances_to_Bangladesh&oldid=1194314301

Safi, S. (2014). Comparative Study of Portmanteau Tests for the Residuals Autocorrelation in ARMA Models. *Science Journal of Applied Mathematics and Statistics*, *2*, 1. https://doi.org/10.11648/j.sjams.20140201.11

Shumway, R. H., & Stoffer, D. S. (2016). *Time Series Analysis and Its Applications* (fourth). Springer. https://doi.org/10.1007/978-3-319-52452-8

World Bank. (2022, May 13). *Bangladesh 7th highest remittance recipient*. The Daily Star. Retrieved from https://www.thedailystar.net/business/economy/news/bangladesh-7th-highest-remittance-recipient-wb-3022611

Zhang, L., Chen, Y., Lyulyov, O., & Pimonenko, T. (2022). Forecasting the Effect of Migrants' Remittances on Household Expenditure: COVID-19 Impact. *Sustainability*, *14*(7), 4361. https://doi.org/10.3390/su14074361