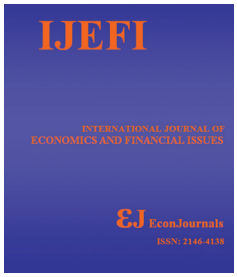

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Forecasting Lending Interest Rate and Deposit Interest Rate of Bangladesh Using the Autoregressive Integrated Moving Average Model

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ABSTRACT

The purpose of this paper is to predict the lending interest rate and deposit interest rate of Bangladesh using the Autoregressive Integrated Moving Average (ARIMA) model. The dataset collected from World Bank Open Data consists of 46 years of secondary data from 1976 to 2021. Box-Jenkins (BJ) model has been adopted to prepare the appropriate ARIMA model based on three parameters (p,d and q). Six ARIMA (p,d,q) models have been estimated and to check the goodness of fit among the estimated ARIMA models such as ARIMA (1,0,1), ARIMA (1,1,1), ARIMA (1,1,2), ARIMA (1,2,1), ARIMA (2,1,2) and ARIMA (2,2,1), AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) index values have been calculated. ARIMA (1,0,1) model has been found appropriate in predicting the lending and deposit interest rates from 2022 to 2026. Diagnostic tests such as Dickey-Fuller unit root test and Correlogram have been conducted in order to make the dataset and residual of the selected model constant across time or stationary. Finally, based on the ARIMA (1,0,1) model, lending interest rate and deposit interest rate are predicted for the next couple of years revealing the increasing trend of the predicted values which are subject to the adjustment due to macroeconomic conditions and policy implications. This paper shall provide important insight of the lending and deposit interest rates in Bangladesh to the managements, regulators and other concerned parties.

Keywords: Lending Interest Rate, Deposit Interest Rate, Stationary, Box–Jenkins Approach, ARIMA (p,d,q) Model, Forecasting
JEL Classifications: B22, B23, C53

1. INTRODUCTION

Lending interest rate refers to the rate charged to the borrowers on the amount granted as loans and advances for a specific period. On the contrary, deposit interest rate is the rate offered to the account holders for the amount deposited in banks or other financial institutions. Both lending and deposit interest rates are two important determinants among other factors for the macroeconomic stability of any country.

It is important to maintain the lending and deposit interest rates of a country as they are directly or indirectly associated with the inflation level, exchange rate volatility, liquidity scenario etc. After the liberation war of 1971, Bangladesh bank introduced a controlled interest rate policy for commercial banks continued till the end of 1990s. In November 1989, Bangladesh Bank allowed an administered range of interest rates for commercial banks. Due to a reform program including interest rate liberalization, Banks were allowed to set their own interest rates based on market forces effective from February 19, 1997 and continued till the end of 2010s. In years 2020 and 2021, Bangladesh Bank introduced the single digit lending interest rate cap of 9% for all loan products except credit card and deposit interest rate floor of 6%. However, recent behavior of inflationary situation, exchange rate volatility and liquidity crisis, Bangladesh Bank, during the last quarter of 2022, unofficially declared the lending interest rate cap to be 12% instead of 9% for consumer loans. Besides, if experts' suggestions are to be believed, floor on deposit interest should

also be withdrawn. Therefore, it is critical to follow the trend of both lending and deposit interest rates and their impact on the macroeconomic condition of the country. Regarding this matter, this paper presents the predicted lending and deposit interest rates of Bangladesh for next couple of years. Besides, this paper might be the first one to present a full study on the prediction of lending and deposit interest rates of Bangladesh and this could be helpful for the policymakers in checking and taking necessary steps for controlling the lending and deposit interest rates behavior of Bangladesh.

The rest of the paper is presented as follows: Section 2 reviews the previous literatures on this topic; section 3 presents the details of the data and methods revealing the sample collection technique, selected variables, econometric techniques for the appropriate model; section 4 shows the details analysis along with the results of findings; finally, section 5 concludes the results of the paper.

2. LITERATURE REVIEW

I have provided the literatures on the historical behavior of lending and deposit interest rates of Bangladesh and previous studies based on the ARIMA model. This section is organized in two parts. Part 2.1 is about the historical behavior of lending interest rate and deposit interest rate of Bangladesh. Part 2.2 presents the previous findings of forecasted macroeconomic variables based on the ARIMA model.

2.1. Historical Behavior of Lending Interest Rate and Deposit Interest Rate of Bangladesh

New Age Business (2023) reported the lifting of minimum deposit rates as well as the hiking of lending rate up to 12pc by Bangladesh Bank. The article reported that removal of the minimum deposit rate and relaxation of lending rate cap would help increase the deposit of the banks. The article also reported that removal of deposit rate ceiling and increasing policy rate are good measures to tame inflation but lifting the lending rate limit is also necessary to fight the inflation. Keeping the lending rate cap unchanged would not result in effective monetary policy statement for Bangladesh as well as create more pressure on exchange rate.

In April 2020 Bangladesh Bank announced the 9 percent lending rate limit to support the faster economic growth, industrialization and lower cost of fund. Uddin (2022) wrote an article regarding the easing of that landing rate cap on consumer loans by Bangladesh Bank after 31 months. The report presented that an increase in the lending interest rate will reduce the money supply flow into the economy and bring positive impact in containing inflation.

Mavis (2022) presented that decreasing confidence in NBFI sector, volatility in stock market, lack of confidence of investors in business sector among others accelerated savings deposits despite the lower deposit rates. The column also highlighted that low interest rate on deposits is working as a blessing for borrowers but it is a curse for those middle income depositors who depend on earnings from deposits. To ease the pressure on foreign reserves, the article suggested higher lending interest rate such as 12% or more for letter of credit (LC) while keeping the 9% lending cap on other types of loans.

Prince (2022) stated that Non-Bank Financial Institutions were taking deposits and granting loans at higher rates compared to the newly set rates of 7% and 11% by Bangladesh Bank for deposits and loans respectively. The report shows that financial expenditures of some NBFIs are in upward trend due to the charge of higher deposit rates and this compels the NBFIs to impose higher lending rates resulting in loan defaults by customers and hampering of production. The article also presented that six NBFIs were accepting deposits at rates between 12% and 13% whereas lending rates range between 17% and 18% were imposed by eight financial institutions.

Introduction of the single digit interest rate of 6-9% by Bangladesh was intended to help out and expand the industries and production along with aversion of probable recession during the pandemic. Ahmed (2022) evaluated the fixed interest rate band and found that advance and deposit rates have consistently decreased. As a result, the interest rate spread has fallen to 3% from 4%. The report also showed that introduction of the interest rate band has no significant impact on the growth trend of the private sector credit. The report also shared that small and medium businesses might be affected significantly as raising interest rate will help increase the cost of financing for them.

According to the analysis of Sarker (2020) the average deposit interest rate and advance interest rate were 6.56% and 12.30% respectively from the year 1994-1995 to 2018-2019. It was found that main determinant of deposit level is deposit interest rate. When the range of deposit rate was around 6-7%, deposit growth level increased but the growth level started experiencing decline when the weighted average deposit rate was registered to be 5.62% during the years 2014-2015 to 2018-2019. On the contrary, lending interest rate is found to be just one of the catalysts of changes in the level of loans. The report shows that quantity of lending grew but the growth rate fell to 99% from 146% despite the reduction of weighted average lending rate during the years 2014-2015 to 2018-2019. It was concluded that actual behavior of interest rate and growth rate of loan changes do not consistent with the lowering of lending interest rate.

2.2. Previous Literatures on the ARIMA Model

Abonazel and Abd-Elftah (2019) used the Box-Jenkins approach to construct the appropriate ARIMA model in order to predict the GDP of Egypt. Data of annual GDP of Egypt has been collected from World Bank for the time period of 1965 to 2016. It has been found that ARIMA (1, 2, 1) is appropriate in predicting the GDP of Egypt for next the 10 years.

Wabomba et al. (2016) built a class of ARIMA models by following the Box-Jenkins approach to forecast the GDP of Kenya. ARIMA (2, 2, 2) model has been chosen as the best model in predicting the GDP of Kenya for the next 5 years. The result showed that the range of predicted values was within 5% and the forecasting effect was efficient and relative adequate in modeling the annual returns of Kenya's GDP.

Eissa (2020) forecasted the GDP per capita for Egypt and Saudi Arabia by employing the Box-Jenkins ARIMA model based on

the data period of 1960-2018 for Egypt and 1968-2018 for Saudi Arabia. The results conveyed that ARIMA (1, 1, 2) and ARIMA (1, 1, 1) models are accurate in predicting the GDP per capita of Egypt and Saudi Arabia respectively. The diagnostic tests show that models are stable as well as reliable.

Ghazo (2021) applied the Box-Jenkins approach to predict the GDP and CPI of Jordan for the period of 1976 to 2019. ARIMA (3, 1, 1) model and ARIMA (1, 1, 0) model are best in forecasting GDP and CPI respectively. The results revealed that Jordanian economy tends to stagflation in 2019 and after 2020, it is inclining towards cost-push inflation based on the forecasted GDP and CPI.

Miah et al. (2019) aimed to forecast the GDP of Bangladesh for the period of 1960 to 2017. The result showed that autoregressive integrated moving average ARIMA (1, 2, 1) model is appropriate in predicting the GDP of Bangladesh for the next 13 years. It is revealed that the forecasted values of GDP are gradually improving over the estimated periods.

Abdulrahman et al. (2018) forecasted the inflation rates in Sudan for the period of 1970-2016 by employing the Box-Jenkins method and ARIMA model. The ideal model to forecast inflation in Sudan is ARIMA model (1, 2, 1). The finding shows that inflation in Sudan will increase in the coming years (2017-2026).

Adenomon (2017) used the ARIMA model to forecast the unemployment rates in Nigeria for the period of 1972 to 2014. The study revealed that the most adequate model to forecast unemployment rates is ARIMA (2, 1, 2). The result also revealed that from 2015 to 2018, unemployment rates are very high in Nigeria.

3. DATA AND METHODS

A sample size of 46 years of secondary data on lending interest rate (LIR) and deposit interest rate (DIR) from 1976 to 2021 are applied to prepare this paper. Box-Jenkins (BJ) model has been adopted to prepare the appropriate ARIMA model based on three parameters (p,d and q). Parameters p, d and q are used to generate Autoregressive (AR) order, Integrated (I) order and Moving Average (MA) order respectively. The whole process of the ARIMA model is described below:

3.1. Autoregressive (AR) Model

It is a model where dependent variable (Y_t = lending/deposit interest rate) is regressed with the lagged values of dependent variable as explanatory variables. The term autoregression means the variable is regressed against itself. The AR process for our time series data will be constructed based on the following equations-

$$LIR_t = \propto_1 LIR_{t-1} + \propto_2 LIR_{t-2} + ... + \propto_p LIR_{t-p} + u_t \quad (1)$$

$$DIR_t = \propto_1 DIR_{t-1} + \propto_2 DIR_{t-2} + \cdots + \propto_p DIR_{t-p} + u_t \quad (2)$$

The first part of the equations (1) and (2) shows that explanatory variables LIR_{t-1} and DIR_{t-1} have been taken as 1 year lagged values of lending and deposit interest rates indicating first-order autoregressive or AR(1) process. It means that lending and deposit interest rates at current period expressed as time t depends on their 1 year lagged values and random error term. Now based on LIR_{t-2} and DIR_{t-2}, we can say that both lending and deposit interest rates follow second-order autoregressive or AR(2) process. AR(2) process expresses that current year lending and deposit interest rates depend on 2 years lagged values along with a stochastic error term. Finally LIR_{t-p} and DIR_{t-p} indicate both LIR_t and DIR_t follow p^{th} – order autoregressive or AR(P) scheme.

3.2. Moving Average (MA) Model

Under MA model, dependent variable is regressed using the past forecast errors. More precisely, the dependent variable is regressed with a constant, current year error term as well as lagged values of error term. The constructed equations would be as follows:

$$LIR_t = \mu + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \cdots + \beta_q u_{t-q} \quad (3)$$

$$DIR_t = \mu + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} + \cdots + \beta_q u_{t-q} \quad (4)$$

Where μ is constant and u_t is a random error term. Based on equations (3) and (4) The lending interest rate and deposit interest of current period follow the first - order moving average or MA(1), second - order moving average or MA(2) and q^{th} - order moving average or MA (q) process respectively.

3.3. Autoregressive Moving Average (ARMA) Model

Now ARMA (1, 1) can be constructed if it is assumed that both lending and deposit interest rates have the properties of AR (p) and MA (q). Based on AR (1) and MA (1), the following equations have been developed.

$$LIR_t = \propto_1 LIR_{t-1} + u_t + \mu + \beta_0 u_t + \beta_1 u_{t-1} \quad (5)$$

$$DIR_t = \propto_1 DIR_{t-1} + u_t + \mu + \beta_0 u_t + \beta_1 u_{t-1} \quad (6)$$

3.4. Autoregressive Integrated Moving Average (ARIMA) Model

So far in the above equations we have assumed that mean, variance and covariance of the data set of the lending and deposit interest rates are constant across time or stationary. But many time series data are not constant across time indicating they might be integrated of particular order. For instance, if a time series is integrated of order 1 or I (1), we will take first difference to make it I (0) or stationary. Similarly, if time series data are of I (d), we will obtain I (0) after taking d times differences. Now if we have to conduct d times difference to make it stationary and incorporate ARMA (p,q) with it, we will get the ARIMA(p,d,q) meaning Autoregressive Integrated Moving Average process. The ARIMA process is presented below in the equation format:

$$\widehat{LIR_t} = \propto_1 LIR_{t-1} + \mu + \beta_0 u_t + \beta_1 u_{t-1} + LIR_{t-1} \quad (7)$$

$$\widehat{DIR_t} = \propto_1 DIR_{t-1} + \mu + \beta_0 u_t + \beta_1 u_{t-1} + DIR_{t-1} \quad (8)$$

Now to apply ARIMA (p,d,q) and predict the lending and deposit interest rates of Bangladesh for upcoming few years, the BJ approach consisting of following steps has been adopted:

3.4.1. Identification

To select the appropriate ARIMA model, we have to make sure the dataset is stationary by applying the Dickey-Fuller unit root test or correlogram test. If we fail at first try to make the data table stationary, we will take the approach of 1st difference and check the stationary by applying the unit root test or correlogram test. This will help us identify how many lag values of dependent variables and error terms will be used in autoregressive (p) and moving average (q) process in selecting appropriate ARIMA model.

3.4.2. Estimation

After identifying the ARIMA model based on three parameters p, d and q, coefficients such as $\propto_1$, β_0, β_1 etc. will be estimated.

3.4.3. Diagnostic

To check the goodness of fit among the estimated ARIMA models such as ARIMA (1,0,1), ARIMA (1,1,1), ARIMA (1,1,2), ARIMA (1,2,1), ARIMA (2,1,2) and ARIMA (2,2,1), AIC and BIC index values are estimated. After choosing the best ARIMA model, the estimated residual of selected ARIMA model will be tested by conducting diagnostic tests like Dickey-Fuller test of unit root and Correlogram test.

3.4.4. Forecasting

Once the chosen ARIMA (p,d,q) passes the diagnostic tests like unit root and correlogram tests to confirm the nature of stationary, we can go ahead to predict the lending interest rate and deposit interest rate of Bangladesh for the next couple of years.

4. DATA ANALYSIS AND DISCUSSION

4.1. Unit Root Test of Lending Interest Rate and Deposit Interest Rate Dataset

Unit root test is employed in order to make the time series data stationary so that mean, variance and co-variance are constant across time. To make the data series constant across time, null (H_0) and alternative (H_1) hypotheses are constructed as dataset is not stationary and dataset is stationary respectively. According to the results of Tables 1 and 2, the P-values in both cases are less than stated significance level indicating the rejection of null hypothesis. Therefore, time series data of both lending and deposit interest rates are constant across time.

4.2. Correlogram of Lending Interest Rate and Deposit Interest Rate Dataset

Another way to test the stationary behavior of data set is to conduct the correlogram test where both autocorrelation (AC) function and partial autocorrelation (PAC) function are used. To confirm the data series as stationary, null hypothesis (H_0) is set as dataset is stationary whereas alternative hypothesis is set as dataset is not stationary. According to the results of Tables 1 and 2 presented in the Appendix section, P values of Q-test show that all the P > 0.05 except few P values. These results suggest that both lending and deposit interest rates of Bangladesh follow stationary behavior since 1976.

4.3. Appropriate ARIMA Model Formation

Once it has been found that the time series data of lending and deposit interest rates are stationary, we can proceed to develop the appropriate ARIMA model based on the parameters p, d and q. According to the calculation in STATA 12.0, it is expected that proper values of p, d and q are p =1, d = 0 and q = 1 indicating ARIMA (1, 0, 1) model to predict the lending interest rate and deposit interest rate of Bangladesh up to 2026. Estimated results of ARIMA (1, 0, 1) have been found using the maximum likelihood estimation (MLE) approach. Based on Tables 3 and 4, coefficients of autoregressive or AR (1) and moving average or MA (1) for both lending and deposit interest rates have been found statistically

Table 1: Output of Dickey–Fuller test for unit root of lending interest rate

Dickey–Fuller test for unit root number of observation=44 Interpolated Dickey–Fuller				
	Test statistic	1% critical value	5% critical value	10% critical value
Z (*t*)	−4.030	−3.621	−2.947	−2.607

MacKinnon approximate *P*-value for *Z* (*t*)=0.0013. Source: Output estimated by STATA 12.0

Table 2: Output of Dickey–Fuller test for unit root of deposit interest rate

Dickey–Fuller test for unit root number of observation=44 Interpolated Dickey-Fuller				
	Test statistic	1% critical value	5% critical value	10% critical value
Z (*t*)	−4.013	−3.621	−2.947	−2.607

MacKinnon approximate *P*-value for *Z* (*t*)=0.0013. Source: Output estimated by STATA 12.0

Table 3: Output of Autoregressive Integrated Moving Average (1, 0, 1) model to predict lending interest rate of Bangladesh

ARIMA regression Sample: 1976–2021 Number of observation=46 Wald χ^2=163.97 Log likelihood=−46.5512 Probability >χ^2=0.0000					
OPG					
lr	Coefficient	SE	*Z*	*P*>|*Z*|	95% CI
lr					
_cons	10.98893	1.941024	5.66	0.000	7.184595–14.79327
ARMA					
arL1.	0.9113408	0.1019832	8.94	0.000	0.7114574–1.111224
maL1.	0.445494	0.1226712	3.63	0.000	0.2050629–0.6859251
/sigma	0.6465711	0.0559936	11.55	0.000	0.5368257–0.7563164

Source: Output estimated by STATA 12.0. ARIMA: Autoregressive Integrated Moving Average, SE: Standard error, CI: Confidence interval

significant at 5% significance level. According to the value of chi-square, the model is also jointly significant. The results are presented in Tables 3 and 4.

Besides, to check the goodness of fit of the ARIMA (1, 0, 1) model, other ARIMA (p, d, q) models are also estimated. Order of the parameters of these estimated models are revealed in Table 5.

Table 4: Output of Autoregressive Integrated Moving Average (1, 0, 1) model to predict deposit interest rate of Bangladesh

ARIMA regression–deposit					
Sample: 1976–2021					
Number of observation=46					
Wald χ^2=99.38					
Log likelihood=−68.3702					
Probability >χ^2=0.0000					
OPG					
dr	**Coefficient**	**SE**	***Z***	***P>|Z|***	**95% CI**
dr					
_cons	8.556838	2.003689	4.27	0.000	4.629679–12.484
ARMA					
arL1.	0.8679218	0.1034716	8.39	0.000	0.6651212–1.070722
maL1.	0.4093972	0.1573133	2.60	0.009	0.1010688–0.7177255
/sigma	1.044517	0.0848207	12.31	0.000	0.8782711–1.210762

Source: Output estimated by STATA 12.0. ARIMA: Autoregressive Integrated Moving Average, SE: Standard error, CI: Confidence interval

Table 5: Autoregressive Integrated Moving Average (p, d, q) orders of six selected models

Model	ARIMA (p, d, q) order
ARIMA_Model1	ARIMA (1, 0, 1)
ARIMA_Model2	ARIMA (1, 1, 1)
ARIMA_Model3	ARIMA (1, 1, 2)
ARIMA_Model4	ARIMA (1, 2, 1)
ARIMA_Model5	ARIMA (2, 1, 2)
ARIMA_Model6	ARIMA (2, 2, 1)

Source: Author's self – contribution. ARIMA: Autoregressive Integrated Moving Average

Now Tables 6 and 7 present the estimated coefficients and constants for different ARIMA models at 0.1%, 1% and 5% significance level to derive the appropriate ARIMA model in order to predict the both lending and deposit interest rates of Bangladesh. According to Table 6, estimated coefficients and constant of AR (1) and MA (1) of lending interest rate are only statistically significant at 0.1% level under ARIMA_Model1. On the other hand, Table 7 also shows that coefficients and constant of AR (1) and MA (1) process for deposit interest rate are statistically significant under ARIMA_Model1.

4.4. Selection of Appropriate ARIMA Model Based on AIC and BIC Index

In addition, model specification test has also been performed among estimated ARIMA models and based on the derived AIC and BIC value, appropriate ARIMA model has been selected. The criteria to choose the appropriate ARIMA model is that the best model should have the lowest AIC and BIC value. According to the Table 8, ARIMA (1, 2, 1) has the lowest AIC and BIC value for lending interest rate. But ARIMA (1, 2, 1) model is not statistically significant in predicting the lending interest rate of Bangladesh. On the other hand, ARIMA (2, 1, 2) and ARIMA (2, 2, 1) have the lowest AIC and BIC value respectively for deposit interest rate. Again these models are not statistically significant to predict the deposit interest rate of Bangladesh for the next couple of years. Therefore, ARIMA (1, 0, 1) model has been selected as the best model to predict both lending and deposit interest rates because constant and coefficients of AR (1) and MA (1) under ARIMA (1, 0, 1) model are statistically significant.

Now the equation format of ARIMA (1, 0, 1) with respect to the order of p = 1, d = 0 and q = 1 is presented below:

$$LIR_t = 10.99 + 0.9113\ (LIR_{t-1}) + 0.4455\ (u_{t-1}) + u_t \quad (9)$$

$$DIR_t = 8.56 + 0.8679\ (DIR_{t-1}) + 0.4094\ (u_{t-1}) + u_t \quad (10)$$

Where LIR_t *and* DIR_t are lending and deposit interest rates for the respective year, LIR_{t-1} and DIR_{t-1} are 1 year lagged value of both lending and deposit interest rates, u_t is the error term of the respective year and lastly u_{t-1} is the 1 year lagged value of error term.

Table 6: Comparison among several ARIMA (p, d, q) models for lending interest rate

Variable	ARIMA_Model1	ARIMA_Model2	ARIMA_Model3	ARIMA_Model4	ARIMA_Model5	ARIMA_Model6
lr						
_cons	10.988933***	−0.07066611	−0.07069078	−0.02011373	−0.07570331	−0.01972877*
ARMA						
ar						
L1.	0.9113408***	0.18316396	−0.94956939***	0.36407587**	−0.88705872*	0.41934815**
L2.					0.15926412	−0.18895948
ma						
L1.	0.44549403***	0.28699274	1.4567856***	−1.0000002	1.3392095	−1.0000011
L2.			0.51735968***		0.33920079	
sigma						
_cons	0.64657107***	0.65442816***	0.63988281***	0.64688887***	0.66003072	0.63238602***
Statistics						
n	46	45	45	44	45	44
sigma	0.64657107	0.65442816	0.63988281	0.64688887	0.66003072	0.63238602
χ^2	163.96502	15.409214	78.735948	8.4854922	5614.3639	10.124373

Significance level: *P<0.05, **P<0.01, ***P<0.001. Source: Output estimated by STATA 12.0. ARIMA: Autoregressive Integrated Moving Average

Table 7: Comparison among several ARIMA (p, d, q) models for deposit interest rate

Variable	ARIMA_Model1	ARIMA_Model2	ARIMA_Model3	ARIMA_Model4	ARIMA_Model5	ARIMA_Model6
dr						
_cons	8.5568375***	−0.0653844	−0.06106479	−0.01894148	−0.01300518	−0.01855729
ARMA						
ar						
L1.	0.86792177***	0.29182727	−0.24056148	0.44113873**	0.62381341***	0.51231642***
L2.					−0.84386667***	−0.18090877
ma						
L1.	0.40939715**	0.18348005	0.76833019	−1.0000021	−0.25779292	−1.0000003
L2.			0.42674264		0.99978647	
sigma						
_cons	1.0445166***	1.0639739***	1.0290915***	1.074729	0.91811303	1.0519278***
Statistics						
n	46	45	45	44	45	44
sigma	1.0445166	1.0639739	1.0290915	1.074729	0.91811303	1.0519278
χ^2	99.375293	15.30559	19.713587	14.995716	59.829122	20.381771

Significance level: *P<0.05, **P<0.01, ***P<0.001. Source: Output estimated by STATA 12.0. ARIMA: Autoregressive Integrated Moving Average

Table 8: Akaike Information Criterion and Bayesian Information Criterion value of all selected Autoregressive Integrated Moving Average models

ARIMA models with order (p, d, q)	Lending interest rate		Deposit interest rate	
	AIC value	BIC value	AIC value	BIC value
ARIMA (1, 0, 1)	101.1024	108.417	144.7404	152.055
ARIMA (1, 1, 1)	97.76576	104.9924	141.5132	148.7398
ARIMA (1, 1, 2)	98.03939	107.0727	140.7404	149.7737
ARIMA (1, 2, 1)	95.60164	100.9542	142.1022	149. 239
ARIMA (2, 1, 2)	100.5376	111.3776	137.4985	148.3385
ARIMA (2, 2, 1)	96.03199	103.1687	140.6078	147.7445

Source: Author's self – contribution based on the output from STATA 12.0. AIC: Akaike Information Criterion, BIC: Bayesian Information Criterion, ARIMA: Autoregressive Integrated Moving Average

Table 9: Output of Dickey–Fuller test for unit root of lending interest rate residual

Dickey-Fuller test for unit root number of observation=45 Interpolated Dickey–Fuller				
	Test statistic	1% critical value	5% critical value	10% critical value
Z (*t*)	−6.013	−3.614	−2.944	−2.606

MacKinnon approximate *P* value for *Z* (*t*)=0.0000. Source: Output estimated by STATA 12.0

Table 10: Output of Dickey–Fuller test for unit root of deposit interest rate residual

Dickey–Fuller test for unit root number of observation=45 Interpolated Dickey–Fuller				
	Test statistic	1% critical value	5% critical value	10% critical value
Z (*t*)	−5.750	−3.614	−2.944	−2.606

MacKinnon approximate *P* value for *Z* (*t*)=0.0000. Source: Output estimated by STATA 12.0

4.5. Diagnostic Check of the Residual of ARIMA (1, 0, 1) Model

According to the BJ approach, a diagnostic test to confirm the stationary behavior of the residual is needed to be conducted so that the validity of the selected ARIMA (1, 0, 1) model can be ensured. Dickey-Fuller unit root test has been performed for the residual to check the constant mean, variance and covariance across time where null hypothesis indicates the presence of non-stationary behavior in the data of residual. According to the results of Tables 9 and 10, the P values in both cases are less than stated significance level confirming the stationary behavior of the residuals of both lending and deposit interest rates.

Moreover, correlogram test has also been conducted to check the stationary behavior of the residual. Null hypothesis states the presence of stationary behavior of the residual. According to the results of Appendices Tables 3 and 4 presented in the Appendix section, P values for the residuals of both lending and deposit interest rates are higher than 0.05. This also concludes that mean, variance and covariance of residuals of both lending and deposit interest rates are constant across time.

4.6. Forecasted Annual Lending Interest Rate and Deposit Interest Rate of Bangladesh

Based on the equations 9 and 10, we can now predict the annual lending and deposit interest rates of Bangladesh from 2022 to 2026 by employing the ARIMA (1, 0, 1) model. The predicted result is shown below:

Table 11 reveals the increasing trend of the predicted values of lending interest rate and deposit interest rate based on the ARIMA (1, 0, 1) model. These are just the forecasted values of lending and deposit interest rates. They are subject to the adjustment due to macroeconomic conditions and policy implications in order to maintain the stability of economy especially in the cases of high inflation rate, exchange rate volatility and liquidity crisis in Bangladesh as well as the global impact of Russian - Ukrain war. Moreover, in 2022, Bangladesh Bank has unofficially declared the lending interest rate cap on consumer loans to be 12% from 9% and it has been suggested by experts to withdraw the previously held 6% floor on the deposit considering maintaining the economic stability of Bangladesh.

5. CONCLUSION

Both lending interest rate and deposit interest rate are two important factors among others in maintaining the economic stability of a

Table 11: Predicted values of lending and deposit interest rates of Bangladesh

Year	Predicted lending interest rate (%)	Predicted deposit interest rate (%)
2022	7.35781	5.084292
2023	7.679742	5.54294
2024	7.973133	5.94101
2025	8.240511	6.286504
2026	8.484184	6.586366

Source: Author's self - contribution based on the output from STATA 12.0

country, especially during the period of inflationary pressure. I have tried to forecast the lending interest rate and deposit interest rate of Bangladesh from 2022 to 2026 using an Autoregressive Integrated Moving Average (ARIMA) model. To predict the lending and deposit interest rates, secondary data from 1976 to 2021 have been used for the aforesaid variables. Box-Jenkins (BJ) approach has been adopted to form the appropriate ARIMA Model. It is noticed that ARIMA (1, 0, 1) model is appropriate in predicting the lending and deposit interest rates and the estimated coefficients of AR (1) and MA (1) along with the constant have been found statistically significant. In Table 11, predicted lending and deposit interest rates are shown but they are subject to adjustments to macroeconomic and policy conditions of Bangladesh.

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APPENDICES

Table 1: Correlogram of lending interest rate dataset of Bangladesh since 1976

					-1 0 1	-1 0 1
LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocorrelation]
1	0.4096	0.4246	8.0629	0.0045		
2	0.0325	-0.1582	8.115	0.0173		
3	-0.0373	0.0073	8.1849	0.0423		
4	0.0193	0.0528	8.204	0.0844		
5	0.0636	0.0614	8.4176	0.1347		
6	0.1735	0.2073	10.051	0.1225		
7	-0.0567	-0.2691	10.23	0.1759		
8	-0.238	-0.1897	13.468	0.0967		
9	-0.1985	-0.0551	15.784	0.0715		
10	0.0106	0.1303	15.791	0.1058		
11	0.0159	-0.0422	15.806	0.1485		
12	0.0997	0.2447	16.443	0.1718		
13	-0.0177	-0.1945	16.464	0.2250		
14	-0.1693	-0.2158	18.419	0.1884		
15	-0.0853	0.1558	18.933	0.2168		
16	0.0045	-0.2318	18.934	0.2721		
17	-0.1316	-0.3091	20.243	0.2620		
18	-0.0523	0.6179	20.457	0.3077		
19	0.0806	0.5976	20.985	0.3376		
20	0.1763	0.6882	23.615	0.2596		

Source: Output estimated by STATA 12.0

Table 2: Correlogram of deposit interest rate dataset of Bangladesh since 1976

					-1 0 1	-1 0 1
LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocorrelation]
1	0.4326	0.4392	8.9948	0.0027		
2	0.0327	-0.1918	9.0475	0.0108		
3	-0.2610	-0.2579	12.478	0.0059		
4	-0.1440	0.1228	13.548	0.0089		
5	-0.0130	0.0514	13.557	0.0187		
6	0.0461	-0.0689	13.672	0.0335		
7	-0.0568	-0.1249	13.852	0.0539		
8	-0.1376	-0.0239	14.933	0.0605		
9	-0.0905	0.0154	15.415	0.0802		
10	0.1186	0.1969	16.264	0.0923		
11	0.0311	-0.3178	16.324	0.1295		
12	-0.0788	-0.1113	16.722	0.1604		
13	-0.2290	-0.0209	20.189	0.0906		
14	-0.1208	0.0251	21.184	0.0970		
15	0.0629	0.0488	21.463	0.1227		
16	0.1211	-0.1154	22.532	0.1268		
17	0.0125	-0.2049	22.544	0.1647		
18	-0.1479	-0.1345	24.257	0.1468		
19	-0.2271	-0.2916	28.452	0.0751		
20	-0.0622	-0.4764	28.779	0.0922		

Source: Output estimated by STATA 12.0

Table 3: Correlogram of lending interest rate residual

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocorrelation]
1	0.0900	0.0915	0.3974	0.5284		
2	0.0998	0.1052	0.89709	0.6386		
3	-0.0412	-0.0605	0.98443	0.8050		
4	0.0831	0.0866	1.3475	0.8533		
5	-0.0226	-0.0283	1.3844	0.9260		
6	0.2282	0.2712	4.2595	0.6416		
7	-0.0853	-0.1083	4.6716	0.7000		
8	-0.1354	-0.2315	5.737	0.6767		
9	-0.1925	-0.2030	7.9485	0.5393		
10	0.0128	0.0100	7.9586	0.6329		
11	-0.1132	-0.1322	8.7671	0.6434		
12	0.1432	0.2714	10.099	0.6073		
13	-0.0396	0.0240	10.204	0.6772		
14	-0.1250	-0.3041	11.282	0.6638		
15	-0.0661	0.1141	11.593	0.7096		
16	0.1217	0.1487	12.684	0.6957		
17	-0.1493	-0.4282	14.381	0.6400		
18	0.0372	0.3800	14.49	0.6966		
19	0.0241	0.5885	14.537	0.7515		
20	0.1234	0.6956	15.831	0.7270		
21	0.0488	0.6013	16.042	0.7673		

Source: Output estimated by STATA 12.0

Table 4: Correlogram of deposit interest rate residual

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocorrelation]
1	0.1256	0.1280	0.77383	0.3790		
2	0.1690	0.1616	2.2071	0.3317		
3	-0.2249	-0.2806	4.8035	0.1868		
4	-0.0128	0.0227	4.8121	0.3071		
5	-0.0418	0.0534	4.9062	0.4274		
6	0.1253	0.0950	5.7733	0.4491		
7	-0.0520	-0.1288	5.9265	0.5484		
8	-0.0603	-0.0570	6.1377	0.6318		
9	-0.1314	-0.0304	7.1678	0.6197		
10	0.1689	0.2968	8.9172	0.5400		
11	-0.0259	-0.1842	8.9596	0.6256		
12	0.0181	-0.1634	8.9809	0.7046		
13	-0.1955	0.0120	11.538	0.5659		
14	-0.0574	0.0577	11.765	0.6252		
15	0.0524	0.1604	11.961	0.6820		
16	0.1350	0.0775	13.302	0.6506		
17	0.0402	-0.1423	13.425	0.7073		
18	-0.0496	-0.0775	13.619	0.7536		
19	-0.2034	-0.1870	17.002	0.5897		
20	-0.0142	-0.4029	17.019	0.6517		
21	-0.0378	-0.6695	17.145	0.7023		

Source: Output estimated by STATA 12.0