



ISSN: 2617 – 8338 (Online)
: 2617 – 832X (Print)

EBAUB Journal

An Academic Journal of
EXIM Bank Agricultural University Bangladesh

Forecasting Economic Growth through Econometric Models: A Study on Bangladesh

Manzur Ahmad*, Md. Mashrur Rahman

Faculty of Business Administration, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh

ARTICLE	INFO	ABSTRACT
Received date: October 04, 2022 Accepted date: Dec. 30, 2022		A better economy ensures higher living standards and higher real incomes. It improves the quality of life and leads to broad social benefits for individuals and societies. The purpose of this paper is to model and forecast the economic growth in Bangladesh. To conduct this study, secondary gross domestic product (GDP) data of Bangladesh has been collected from World Bank from 1972 to 2021. GDP was used as a variable of economic growth, has been calculated using the international dollar as a currency. Autoregressive Integrated Moving Average (ARIMA) model was used to accomplish this work. The autocorrelation function (ACF), Augmented Dickey-Fuller test (ADF), and Phillips-Perron (PP) test were applied to determine the stationarity of the time series. The result shows that the best fit model for Bangladeshi GDP is ARIMA (1,2,1) and there is a steady downward trend for economic growth in Bangladesh for the next 10 years (2022–2031). This study will help macroeconomic policymakers formulate strategies and take decisions that can tackle any type of situation in the economy that may appear in front of Bangladesh.

Keywords: ARIMA, Bangladesh, Box-Jenkins approach, Forecasting, GDP

*CORRESPONDENCE

manzur1009@gmail.com

Faculty of Business Administration, EXIM Bank Agricultural University Bangladesh, Chapainawabganj-6300, Bangladesh

1. INTRODUCTION

Since its independence, Bangladesh has performed economic miracles. The country that was born with a basket-less economy is now considered as the World's Next Eleven emerging market (Helal & Hossain, 2013). In the last couple of months, several international organizations (World Bank, 2022; IMF, 2022) and economists (Doom, 2022) predicted that the global economy might face an economic recession in 2023. This is putting immense pressure on an emerging economy like Bangladesh. Bangladesh's prime minister requested that everyone should save resources whatever they can to tackle hard times in the economy (UNB, 2022).

The best recipe to measure the economic health of a nation is gross domestic product (GDP), which represents the total value of all finished products and services produced within a specific geographic area during a specific period.

Many researchers have forecasted the economic growth of Bangladesh for different periods using ARIMA model. Miah et al. (2019) gathered 57 years of data to predict that our country's GDP will improve steadily until the year 2030. They used ARIMA model, and other variables in this study were inflation and unemployment. Bhuiyan et al. (2008) predicted a sustainable upward trend for the GDP of manufacturing industries in this country, applying the same method based on data amassed from 1980 to 2002. Voumik & Smrity (2020) predicted that the country's living standards will continue to grow up to 2030 as the economy expands. They even used an approach identical to the earlier one, based on half a century year-long figure. In another study, Voumik et al. (2019) projected that Bangladesh's GDP is on an increasing trend that will continue rising. They used almost four decades of statistics. Ahmed & Salan, (2019) also explained an increasing tendency for our future GDP

based on data amassed from 1968–2017, using the ARIMA model. Almost three decades of data and the Box-Jenkins approach assisted Khan et al. (2012) in determining that the growth of our exports and imports will continue to improve in the future.

Studies have been conducted to foretell the economic growth of some other countries. Jain et al. (2015) examined that India will overtake the U.S economy to become the second biggest in 2051, with the assistance of multiple regression analysis and 11 years of facts. Statistics from four decades and the Keynes model helped Kira (2013) to foresee that Tanzania needs a sudden solution to prevent its GDP from sinking due to an increase in oil prices, power shortage, and political instability. Ilter (2017) found that the population, GDP, transparency score, and compulsory education had the most impacts on the GDP per capita of almost 40 other countries except Bangladesh. He used regression analysis and data collected from 2014 for this finding.

Thus, it has become essential for us to have a look at the future trend of our economic growth. Keeping these facts in mind, the purpose of this study is to model and forecast the economic growth of Bangladesh for the next ten years.

2. MATERIALS AND METHODS

2.1. Data Source

All the data for this study are GDP figures in US dollars, which were collected from the World Bank (1972-2021). Initially, the data was processed in a World Bank sheet, but later, it was extracted and manually entered an Excel sheet. After putting all the data in spreadsheet, their natural logarithm value has been calculated through Excel. Q-statistic Residual diagnostic test, ARMA Diagnostic views, GDP forecast test; all of these have been conducted using EViews 12 software.

2.2. Data Analyzing

After testing the stationarity of the data, we forecasted GDP up to 2031 by applying the four functions of ARIMA model, like as identification, estimation, diagnosis, and forecasting, approached by Box-Jenkins-1976 (Box et al. 2015).

2.3. Econometric Model

The time series analysis can provide more realistic short-run projections when there is a large amount of data on the relevant variables. The Augmented Dickey-Fuller test (ADF), the Phillips-Perron (PP) test, and the autocorrelation function (ACF) were used to examine the stationarity of data series. The ARIMA models are well-known and widely employed for short-run forecasting in time series analysis. The Box-Jenkins ARIMA method incorporates three models: the moving-average (MA), differencing, and autoregressive (AR) models.

2.3.1. Autoregressive (AR) model

The equation for an autoregressive model order p , AR (p), is

$$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \dots + \beta_p Y_{t-p} + m_t$$

Where, Y_t = the dependent variable at time t entity, β_1 to β_p = the change in Y_t for each one addition change in independent

variables at time t with p^{th} entity, and m_t = the stochastic error term.

2.3.2. Moving-average (MA) model

The equation for a moving-average model order q , MA (q), is

$$Y_t = m_t + \theta_1 m_{t-1} + \theta_2 m_{t-2} + \dots + \theta_q m_{t-q}$$

Where, θ_1 to θ_q = the change in Y_t for each one addition change in independent variables at time t with q^{th} entity.

2.3.3. ARIMA Model

ARIMA model is a combination of both AR and MA models. This model is used as an extension model of ARMA models for non-stationary data series. The ARMA (p, q) model is:

$$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \dots + \beta_p Y_{t-p} + m_t + \theta_1 m_{t-1} + \theta_2 m_{t-2} + \dots + \theta_q m_{t-q}$$

The predicted model of the value one year ahead given at time $t + i$, as:

$$Y_{t+i} = \mu + \beta_1 Y_{t+i-1} + \beta_2 Y_{t+i-2} + \dots + \beta_p Y_{t+i-p} + m_{t+i} + \theta_1 m_{t+i-1} + \theta_2 m_{t+i-2} + \dots + \theta_q m_{t+i-q}$$

3. RESULTS

3.1. Testing for Stationarity

The variable used in the analysis is the GDP (current USD) between 1972 and 2021, which is plotted in Fig. 1, where a visual evaluation of the time plots shows that Bangladesh's GDP has had an upward trend. According to this, the time series data is not constant that considered as non-stationary time series.

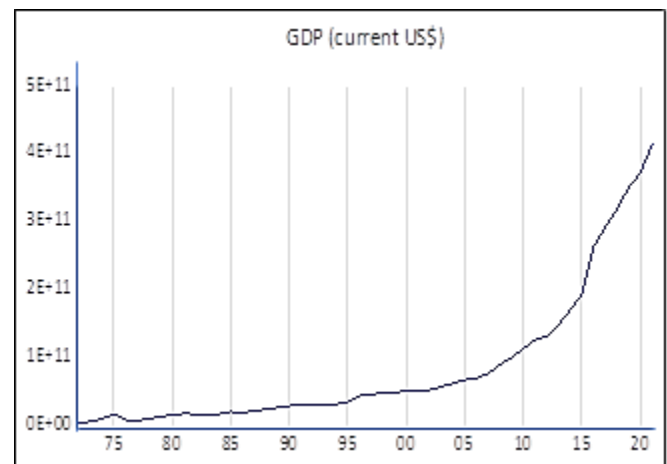


Fig. 1 Time series plot for Bangladeshi GDP during 1972 to 2021.

The Augmented Dickey-Fuller (ADF)- 1979 (Dickey & Fuller, 1979) and Phillips-Perron test have been applied for all the variables in level, first difference, and second difference assuming with intercept and trend models. The result of these tests in 2nd difference is presented in Table 1. Findings of the variables in second difference indicate that all the variables have a unit root that is stationary since the probability values of the ADF test, and the Philips-Perron test are less than 5%.

Table 1 ADF and Phillip-Perron's test in 2nd difference

Items		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.530183	0.0002
Test critical values	1% level	-4.186481	
	5% level	-3.518090	
	10% level	-3.189732	
Phillips-Perron test statistic		-19.19819	0.0000
Test critical values	1% level	-4.165756	
	5% level	-3.508508	
	10% level	-3.184230	

The autocorrelation function (ACF) and partial autocorrelation function (PACF) graphs of the data series in 2nd difference are presented in Fig. 2. From the figure it can be concluded that the probability value at lag 1 and lag 4 are smaller than the acceptance value of 0.05, so it cannot be rejected the null hypothesis as the data series is stationary. Also, the coefficient of autocorrelation and partial autocorrelation are significantly non-zero when lag value are 1 and 4. Therefore $q=1$ or 4, $p=1$ or 4 and $d=2$ can be considered to set more appropriate model for GDP prediction.

Sample (adjusted): 1974 2021						
Included observations: 48 after adjustments						
Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob	
		1	-0.451	-0.451	10.378	0.001
		2	-0.000	-0.255	10.378	0.008
		3	0.148	0.044	11.543	0.009
		4	-0.404	-0.407	20.457	0.000
		5	0.238	-0.188	23.561	0.000
		6	0.032	-0.028	23.621	0.001
		7	-0.019	0.087	23.842	0.001
		8	0.095	0.012	24.184	0.002
		9	-0.035	0.120	24.258	0.004
		10	-0.050	0.097	24.419	0.007
		11	0.020	0.098	24.443	0.011
		12	-0.008	0.088	24.447	0.018
		13	0.048	0.143	24.592	0.028
		14	-0.029	0.025	24.851	0.038
		15	0.011	0.006	24.880	0.055
		16	-0.011	-0.028	24.889	0.078
		17	-0.034	-0.048	24.781	0.100
		18	0.049	-0.083	24.954	0.128
		19	-0.088	-0.148	25.332	0.150
		20	0.082	-0.080	25.858	0.177

Fig. 2 Correlogram and partial correlogram of real GDP in 2nd difference.

3.2. Identification of the Model

By considering the q and p values from the Fig. 2, ARMA models can be created in Table 2. After considering and evaluating the criteria of selecting model, from Table 2, it can be said that ARMA(1,4) matches significant coefficients and highest adjusted R^2 criteria. Whereas, the lowest AIC and BIC values match with ARMA(1,1). The other two

models ARMA(4,1) & ARMA(4,4) don't match with any of the above mentioned requirements. Keeping this in mind, it can be concluded that ARMA (1,1) is the appropriate model as it fulfills the criteria of Akaike (AIC) and Schwartz (SIC) required characteristics. So, the best ARIMA model will be ARIMA (1,2,1) as the time series is stationary in 2nd difference.

3.3. Estimation of the Model

The following Table 3 shows the estimation model of ARMA (1,2,1).

The P value of the coefficient estimate of AR (1) and MA (1) are statistically significant at 5% level of significance. The chosen model is summarized in Table 3. The estimated regression equation of ARIMA (1,2,1) model is:

$$y_t = 2.05E+11 + 0.995090y_{t-1} + 0.632750\varepsilon_{t-1} + \varepsilon_t$$

The inverse roots of AR (1) and MA (1) polynomials are shown in the Fig. 3. The AR and MA roots of the characteristic polynomials are in the unit circle, demonstrating the stability of the ARIMA model.

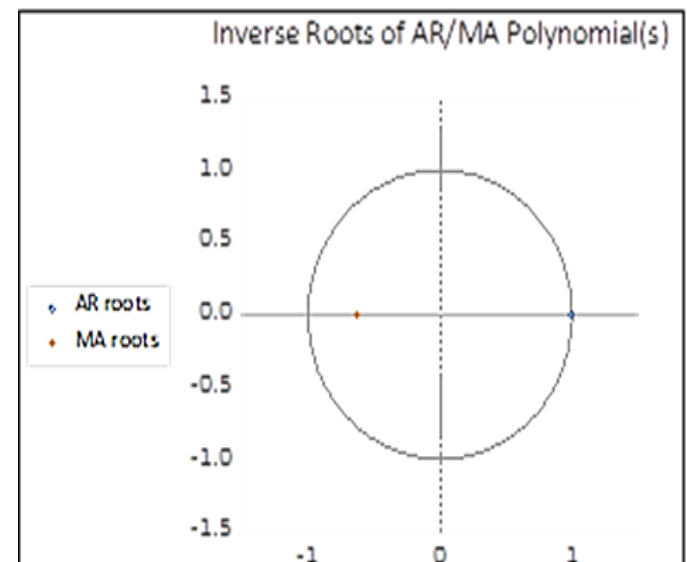


Fig. 3 Inverse roots of AR and MA.

3.4. Diagnostic Checking of the Model

The diagnostic tests of the model verify the normality and stationarity of the residuals of the ARIMA model. The Fig. 4 represents the histogram of the residuals of ARIMA (1,2,1). The results of Fig. 4 show that the residuals of ARIMA (1,2,1) model follow normal distribution because the P value of Jarque-Beta test is 38.58720 that is more than 0.05. From Fig. 5, all P values of Q-Stat are more than 0.05 that represents the residuals are stationary. Therefore, this model can be applied for forecasting real GDP in the economy.

3.5. Forecasting

In Fig. 6 represents the criteria for the evaluation of the forecasts of the model ARIMA(1,2,1). Using the appropriate model, we forecast the real GDP values over the period 2022 to 2031. Fig. 7 shows the trend of the Bangladeshi forecasted GDP values that has a consistent declining trend.

Table 2 Test result of various ARMA Models

Differenced GDP	ARMA (1,1)	ARMA (1,4)	ARMA (4,1)	ARMA (4,4)
Significant Coefficients	2.05E+11	2.11 E+11	1.72 E+11	1.76 E+11
S.E. of regression	1.30E+10	1.41 E+10	2.95 E+10	3.63 E+10
Adj. Rsq.	0.985360	0.981875	0.920175	0.879417
AIC	49.61926	49.78305	51.30893	51.99634
BIC	49.77222	49.93601	51.46189	52.14931

Table 3 Correlogram residuals of model ARIMA (1,2,1)

Sample: 1972 2021				
Included observations: 50				
Convergence achieved after 38 iterations				
Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.05E+11	2.15E+11	0.956435	0.3439
AR(1)	0.995090	0.032357	30.75387	0.0000
MA(1)	0.632750	0.071632	8.83352	0.0000
SIGMASQ	1.56E+20	1.37E+19	11.38759	0.0000
R-squared	0.985360	Mean dependent var		8.65E+10
Adjusted R-squared	0.984406	S.D. dependent var		1.04E+11
S.E. of regression	1.30E+10	Akaike info criterion		49.61926
Sum squared resid	7.82E+21	Schwarz criterion		49.77222
Log likelihood	-1236.481	Hannan-Quinn criter.		49.67751
F-statistic	1032.049	Durbin-Watson stat		1.502377
Prob(F-statistic)	0.000000			
Inverted AR Roots	1.00			
Inverted MA Roots	-0.63			

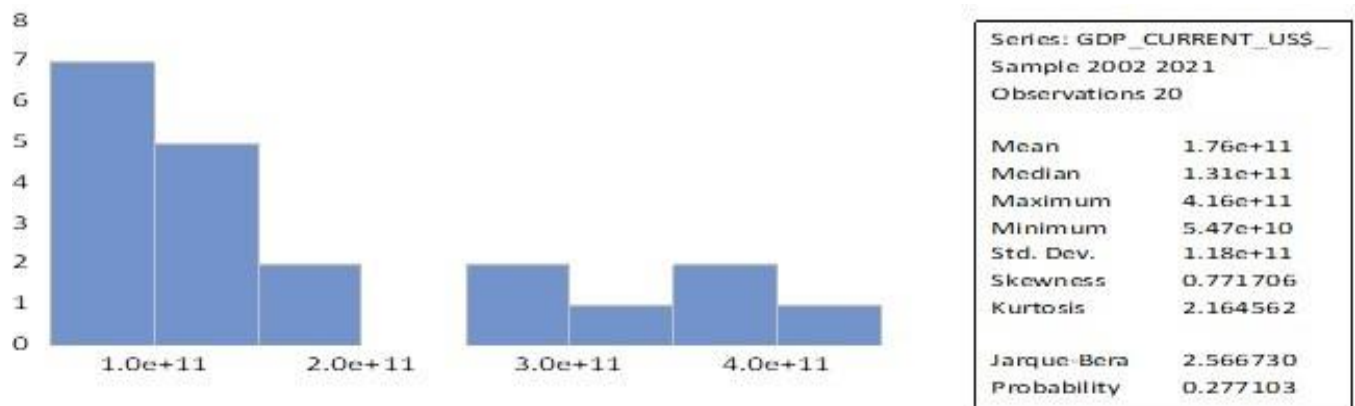


Fig. 4 Histogram of the residuals of ARIMA (1,2,1).

4. DISCUSSION

In this study, we applied Box-Jenkins-1976 ARIMA approach to model and project Bangladesh's GDP. Miah et al. (2019) used ARIMA model to predict the country's GDP with other variables, such as inflation and unemployment. Voumik & Smrity (2020) projected the living standards in the country using the same model based on 50 year-long figures. Dritsaki (2015) predicted real GDP rate of Greece

through ARIMA models. However, Multiple regression analysis was used by Jain et al. (2015) to investigate whether India's GDP will take over that of the United States and become the second largest in 2051. GDP of Egypt was predicted through ARIMA models by Abonazel & Abd-Elftah (2019). In our study, the best ARIMA model will be ARIMA (1,2,1) as the time series is stationary in 2nd difference. This fitted model is consistent with the findings of other studies (Uddin & Tanzim, 2021; Miah et al., 2019), where the selected model is ARIMA (1,2,1). Ahmed & Salan (2019) shows ARIMA (2, 1, 1) and Ferdous (2022) considers ARIMA (5, 1, 2) is the best suitable model to

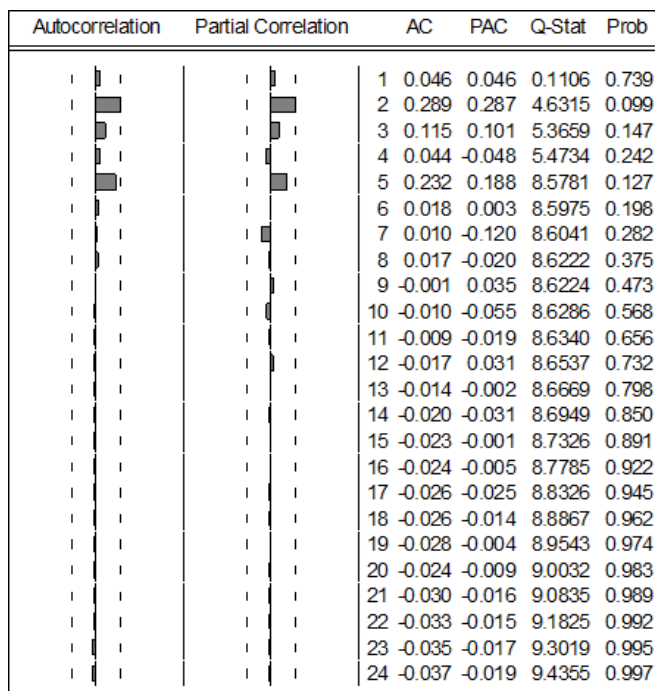


Fig. 5 Correlogram Residuals of ARIMA (1,2,1) Model.

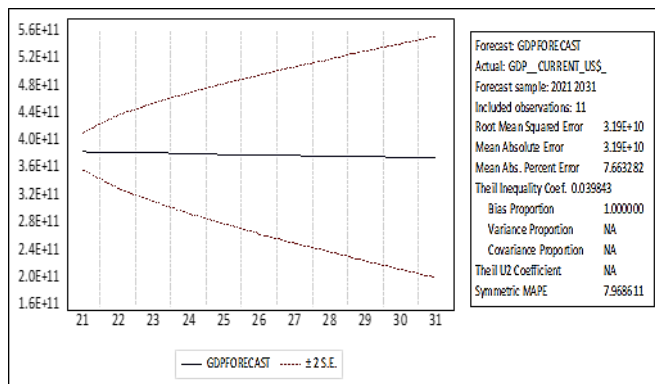


Fig. 6 Forecast accuracy test on the model ARIMA (1,2,1).

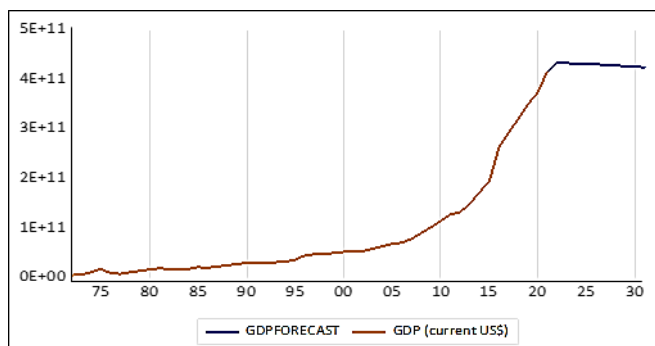


Fig. 7 GDP forecast (2022-2031)

forecast Bangladesh's GDP. The contradictions are created due to different variables and study period. The most significant result of our study is that the GDP values that were predicted in the study have a consistent downward trend. However, the results of this study are different from

the outcomes predicted by Raj & Singh (2022) and Uddin & Tanzim (2021), who predicted that Bangladesh's GDP is on the rise and would continue to increase in near future. It is observed that all the forecasts for real GDP trends up to the year 2030 are upward (Miah et al. 2019). The major causes of these findings are the different forecasted periods, using different analysis tools, such as Root Median Square Percentage Error (RMDSP), Mean Absolute Percentage Error (MAPE), Normalized Root Mean Square Error (NRMSE) and The Root Mean Squared Percentage Error (RMSPE).

5. CONCLUSION

The present study forecasted the economic growth of Bangladesh for the next 10 years (2022-2031) using Box-Jenkins technique. In this study, the ARIMA (1,2,1) model is the best model since it meets all the criteria for selecting models. It is concluded that the trend of the Bangladeshi forecasted GDP values has a steady decline for the next decade. It should be noted that the results of the present study are considered acceptable, but more studies are needed. A time series data may have a degree of deviation from the real picture. However, we expect that this research will help academics as well as policy makers to take sound decisions on macroeconomic arena.

REFERENCES

- Abonazel, M. R., & Abd-Elftah, A. I. (2019). Forecasting Egyptian GDP using ARIMA models. *Reports on Economics and Finance*, 5(1), 35-47.
- Ahmed, A., & Salan, M.S.A. (2020). Forecasting GDP of Bangladesh using time series analysis. *International Journal of Mathematics and Statistics Invention*, 8(1), 7-15.
- Bhuiyan, M. N. A., Ahmed, K.S., & Jahan, R. (2008). Study on modeling and forecasting of the GDP of manufacturing industries in Bangladesh. *Journal of Social Science and Humanities*, 2(2), 143-157.
- Box, G. E., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2015). *Time series analysis: Forecasting and control*. John Wiley & Sons, NJ, USA.
- Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association*, 74(366a), 427-431.
- Dritsaki, C. (2015). Forecasting real GDP rate through econometric models: an empirical study from Greece. *Journal of International Business and Economics*, 3(1), 13-19.
- Droom. (2022). "Prepare for a 'long and ugly' recession, says Dr. Doom, the economist who predicted the 2008 crash", available at: <https://fortune.com/2022/09/21/long-ugly-recession-dr-doom-nouriel-roubini/> (accessed 15 November 2022).

- Ferdous, R. (2022). Economic scratch on the future growth path of Bangladesh: An ARIMA approach. *International Journal of Publication and Social Studies*, 7(2), 38-54.
- Helal, M., & Hossain, M. A. (2013). Four decades of economic development of Bangladesh: An assessment. *Journal of the Asiatic Society of Bangladesh (Hum.)*, 58(2), 335-362.
- Ilter, C. (2017). What economic and social factors affect GDP per capita? A study on 40 countries. *Journal of Global Strategic Management*, 11(2), 51-62.
- IMF (2022). "Latest global growth forecasts show challenges facing economies", available at: <https://www.imf.org/en/Blogs/Articles/2022/10/19/latest-global-growth-forecasts-show-challenges-facing-economies/> (accessed 15 November 2022).
- Jain, D., Nair, K., & Jain, V. (2015). Factors affecting GDP (manufacturing, services, industry): An Indian perspective. *Annual Research Journal of SCMS Pune*, 3, 38-56.
- Khan, M., Ferdous, T., & Kundu, N. (2012). Future contribution of export and import to GDP in Bangladesh: A box-jenkins approach. *The Journal of Comilla University*, 1(1), 1-8.
- Kira, A.R. (2013). The factors affecting gross domestic product (GDP) in developing countries: The case of Tanzania. *European Journal of Business and Management*, 5(4), 148-158.
- Miah, M. M., Tabassum, M., & Rana, M.S. (2019). Modelling and forecasting of GDP in Bangladesh: An ARIMA approach. *J. Mech. Cont. & Math. Sci.*, 14(3), 150-166.
- Raj, A., & Singh, S. K. (2022). Forecasting GDP of India and its neighbouring countries using timeseries analysis. *IEEE Global Conference on Computing, Power and Communication Technologies* (4 June, Pune, India). pp. 1-6.
- Uddin, K. S., & Tanzim, N. (2021). Forecasting GDP of Bangladesh using ARIMA model. *International Journal of Business and Management*, 16(6), 56-65.
- UNB. (2022). "PM Hasina: Save money, produce food to face tough days ahead", available at: <https://www.dhakatribune.com/bangladesh/2022/10/11/pm-hasina-save-money-produce-food-to-face-tough-days-ahead/> (accessed 15 November 2022).
- Voumik, L. C., Rahman, M. M., Hossain, M. S., & Rahman, M. (2019). Forecasting GDP growth rates of Bangladesh: An empirical study. *Indian Journal of Economics and Development*, 7(7), 1-11.
- Voumik, L. C., & Smrity, D.Y. (2020). Forecasting GDP per capita in Bangladesh: Using ARIMA model. *European Journal of Business and Management Research*, 5(5), 1-5.
- World Bank (2022). "Risk of global recession in 2023 rises amid simultaneous rate hikes", available at: <https://www.worldbank.org/en/news/press-release/2022/09/15/risk-of-global-recession-in-2023-rises-amid-simultaneous-rate-hikes/> (accessed 15 November 2022).