



The Key Macroeconomic Factors Driving Foreign Exchange Reserves in Bangladesh: An Econometric Analysis

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Abstract: The research seeks to explore the key macroeconomic contributors influencing foreign exchange reserves in Bangladesh from FY2014 to FY2024. Data were obtained from the Statistics Department of the Bangladesh Bank. The research utilises an Autoregressive Distributed Lag (ARDL) technique to measure the effect of the regressors on reserve assets in Bangladesh. Findings from the ARDL bounds test state that the variables are co-integrated and that the regressors make a substantial contribution to changes in reserve assets in both the short and long term. Moreover, remittances and exports play a pivotal role in sustaining Bangladesh's foreign exchange reserves. In the long run, a 1% enhancement in remittances leads to an 88% rise in foreign exchange reserves. Similarly, foreign exchange reserves boost by 56% due to a 1% rise in exports. Therefore, remittances and exports are the key macroeconomic factors driving foreign exchange reserves in Bangladesh over the sample period. Finally, the study's policy implications recommend that the government, in coordination with Bangladesh Bank, focus on initiatives that enhance workers' remittances, exports, and foreign direct investment (FDI) to strengthen foreign exchange reserves in Bangladesh.

Keywords: ARDL, Export, Foreign exchange reserves and Remittance.

JEL classification: F29, F24, F31.

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INTRODUCTION

Ensuring foreign exchange reserves at an optimal level is essential to retaining the value of local currency, improving a country's creditworthiness, ensuring global payments, and safeguarding protection against external shocks (Nabi et al., 2014). So, official foreign exchange reserves are external assets that monetary authorities can easily access and manage for a variety of uses, such as directly financing payment imbalances, indirectly controlling foreign exchange markets, or other purposes. According to the IMF BPM6, foreign exchange reserves include monetary gold, Special Drawing Rights (SDR) holdings, the reserve position in the IMF, and other reserve assets such as currency and deposits, securities, financial derivatives, and various other claims. The ideal number of reserves enables a country to be independent and self-sufficient in meeting its payment obligations (Bhakri & Verma, 2021). The "precautionary motive" of preserving reserve assets and assisting governments to manage unpredictable oscillations in import and consumption payments is one of the key reasons (International Monetary Fund (IMF), 2003). A substantial foreign exchange reserve strengthens a nation's ability to implement different projects and promote its economic development. Additionally, it helps in assessing and evaluating present and future macroeconomic policies to accomplish the trade balance (Arize & Malindretos, 2012). Empirical research suggests that an increase in foreign exchange reserves can also promote investment and drive economic growth (Krušković & Maričić, 2015). The global financial crisis (2007–2008) shows that developing nations like Bangladesh must have a satisfactory amount of foreign exchange reserves in order to secure against unpredictable crises. Foreign loans and grants, exports, remittances, and foreign direct investment are the pivotal sources that boost foreign exchange reserves in Bangladesh. As a consequence of a huge inflow of remittances from the Middle East and other countries, as well as the settlement of low imports owing to COVID-19, the official reserves of Bangladesh recorded \$48.06 billion in August 2021. The Russia-Ukraine war and continuous unrest in the Middle East hampered the supply chain as well as elevated the price level, which depletes foreign exchange reserves in Bangladesh due to higher import payments and official reserves recorded at \$31.20 billion in June 2023. Due to the Balance of Payment (BoP) deficit and to mitigate disparity between supply and demand in the foreign exchange market, Bangladesh Bank (BB) compelled to sell a net total of USD

9.42 billion in FY24, resulting in a decline in foreign exchange reserves to \$26.71 billion in June 2024 (Monetary Policy statement, July-December, 2024) which covers approximately 4.4 months of import payments of goods and services, exceeding the thumb rule of covering 3 months of imports by IMF (Bangladesh Bank). Bangladesh Bank introduced the Crawling Peg system to ensure stability in the foreign exchange market, which contributed to building a foreign exchange reserve. According to the Monetary Policy Statement during July-December 2024 published by Bangladesh Bank, recent foreign exchange policy liberalisation, like the RFCD, NFCD, and Offshore Banking Act 2024, are expected to boost foreign exchange inflows, relieve exchange rate pressure, and assist in building foreign exchange reserves in Bangladesh. Effective exchange rate management under the Foreign Exchange Spot Reference Exchange Rate (RR) is expected to enhance remittance inflows, boost export activities, and increase foreign exchange reserves (Monetary Policy statement, January-June, 2025). As per the latest report of Bangladesh Bank, the official reserve stood at \$26.60 billion in March 2025. So, it is necessary for Bangladesh to hold a handsome amount of foreign exchange reserves to settle import payments, maintain stability in the foreign exchange market, increase creditworthiness, enhance foreign direct investment, secure trade balance and promote economic development in the country.

Figure 1 below illustrates the trend of foreign exchange reserves in Bangladesh over this period.

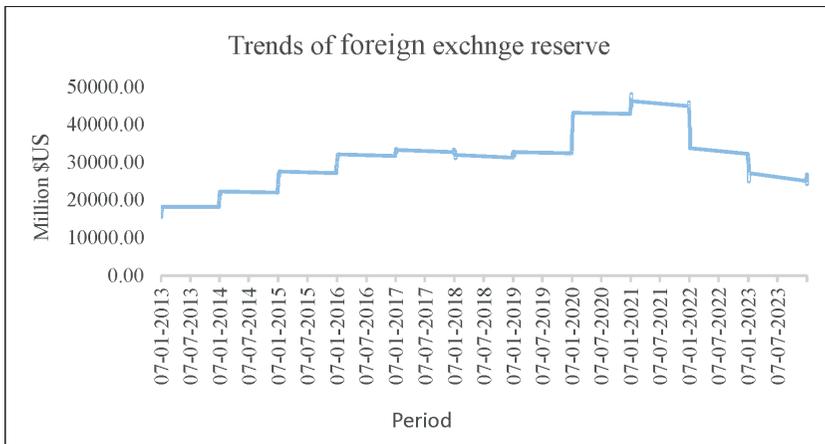


Figure 1: Trends of foreign exchange reserves in Bangladesh from FY2014 to FY2024
 Source: Statistics Department, Bangladesh Bank.

OBJECTIVES OF THE STUDY

The purpose of this analysis is to assess the key drivers of foreign exchange reserves in Bangladesh during FY2014 to FY2024.

The precise goals are as follows:

- (i) To investigate the key macroeconomic factors that boost foreign exchange reserves in Bangladesh.
- (ii) To assess whether these factors truly affect the foreign exchange reserves in Bangladesh or not.
- (iii) To recommend some policy measures to boost foreign exchange reserves in Bangladesh.

LITERATURE REVIEW

A review of local and international studies shows that remittances, export performance, FDI, and exchange-rate movements are the key drivers of Bangladesh's foreign exchange reserves.

Chowdhury, M. (2023) investigated the long-run response of the investment growth of Bangladesh to variations in foreign exchange reserve and remittance from 1982-2017 using the Johansen-Juselius co-integration and VAR model and concluded that foreign exchange reserve significantly stimulates both short- and long-run investment growth in Bangladesh, recommending channelising it for industrial and infrastructure development. Kasem (2022), by examining 1984-2021 data and applying ARDL and Granger co-integration, revealed that the current account balance (CAB), external debt (ED), exchange rate (ER), exports (X), and remittances (RM) significantly determine Bangladesh's foreign exchange reserves. In the long run, a 1% increase in CAB, ED, ER, exports, and remittances increases reserves by 0.47%, 1.05%, 0.02%, 5.35%, and 33%, respectively. Gajurel (2022) reports that a positive long-run impact of net FDI, GDP per capita, inflation, and official exchange rate on reserve assets and gross fixed capital formation has a reverse impact using 1980-2020 data for Nepal and the ARDL-ECM. Impulse response analysis indicates that the current account balance, private-sector credit, gross capital formation, and reserves respond positively to shocks, thus supporting the suggestion that policymakers should focus on gross capital formation and the current account balance to secure reserve stability. Using Generalised Method of Moments (GMM), Fixed Effect (FE), Pooled Ordinary Least Squares

(POLS), and Random Effect (RE) models on data from Bangladesh, India and Nepal from 2000 to 2020, Hayat & Jabbar (2022) found that exchange rates are significantly influenced by real GDP, foreign exchange reserves, and trade openness. They also indicate that higher exports and domestic resources have built up the reserves of these countries. Khan et al. (2021) applied ARDL bound testing over 1986 to 2021 data and observed a significant role of remittances and trade openness on Bangladesh's foreign reserves. They also found that there is bidirectional causality between reserves and trade openness, while unidirectional causality runs from remittances to both reserves and the exchange rate. Bhakri & Verma, 2021 (2021) obtained the results that the value of FOREX reserves of India depended on the FDI inflows, exchange rate, exports and short-term debt using the double log regression model. The analysis ended by stating that its findings could guide policymakers in taking measures to improve the nation's foreign exchange reserves. Dash et al. (2017) used an ARDL model on Indian quarterly data from 2000 to 2014 and found that in the long run, a 1% growth in the external debt-to-GDP ratio increases FER by 0.46% and 1% increase in inflation decreases the FER by 0.12%. In the near term, the movement of exchange rates has a positive impact on India's reserves. Chowdhury et al. (2014) revealed that the foreign exchange reserves in Bangladesh are also influenced by the determinants such as exchange rate, remittances, interest rate within the country, broad money (M2), unit price index (UPI) of export and import and per capita GDP and suggested that remittance policies, export growth, GDP expansion can be of pivotal importance in order to increase the foreign exchange reserves in Bangladesh. Afrin et al. (2014) examined that local money market disequilibrium plays a substantial role in short-run reserve demand, while long-term reserve is more subject to the influence of imports-to-GDP and exchange rate volatility on the basis of the co-integration and ECM technique. Alam & Rahim (2013) showed that the exchange rate, current account balance, capital and financial account balance had a positive and significant effect on FER in Bangladesh. Moreover, the exchange rate was directly influenced by 285.6894 units over the period in question, given a unit change in FER at a significance level.

It can be found in literature that remittances, exports, exchange rate, GDP, CA balance, Gross capital formation, and FDI are significant factors to determine the foreign exchange reserves, and there is a certain part of

the literature which investigates these issues; however, most of the literature providing quantitative analysis seems to be an imprecise methodology and variable analysis. However, in spite of these shortcomings, evidence always points to remittances, exports and exchange-rate fluctuations as the main determinants of reserve accumulation in Bangladesh.

DATA AND METHODOLOGY

Data

A sample of monthly data from FY14 to FY24 was assessed to investigate the longer-term co-integration between the foreign exchange reserves and regressors of the model, as well as to capture the impacts of those macroeconomic contributors on reserve assets in Bangladesh. The data were gathered from the *Monthly Economic Trends*¹ report prepared by the Statistics Department of the Bangladesh Bank. I conducted the econometric analysis for this study using E-Views 13 software. The natural logarithm was employed for all variables in the model. Moreover, the crisis dummy has been initiated to capture the impacts of the COVID-19 period.

METHODOLOGY

Model Specification

The econometric model was established to assess whether these explanatory variables influence the foreign exchange reserves in Bangladesh, as shown below:

$$(\text{Res})_t = \alpha_0 + \beta_1(\text{Remit})_t + \beta_2(\text{Export})_t + \beta_3(\text{ER})_t + \mu_t \quad (i)$$

Definition of Dependent Variable

(Res)_t : Foreign Exchange Reserves

This represents the total stock of foreign currency and assets held by the central bank of Bangladesh at time t. It serves as a crucial indicator of a country's financial soundness and capacity to meet external obligations.

Definition of Explanatory Variables

(Remit)_t : Workers' Inflow of Remittances

The total amount of money transferred by Bangladeshi expatriates back to the country at time t. Remittances are a key way of foreign currency inflow, contributing to foreign exchange reserves.

(Export)_t: Exports

The gross value of products and amenities sold abroad by Bangladesh at time t . Higher exports lead to increased foreign exchange earnings, positively impacting reserves.

(ER)_t: Exchange Rate

The amount of the Bangladeshi Taka (BDT) compared to foreign currencies at time t . Exchange rate fluctuations affect exports and remittances, which in turn affect foreign exchange reserves.

α_0 and μ_t represent the constant term and the white noise error term, respectively.

The model aims to examine how these macroeconomic variables influence the foreign exchange reserves in Bangladesh. The coefficients (β_1 , β_2 and β_3) represent the responsiveness of foreign exchange reserves (Res) with respect to each variable, helping policymakers understand the key factors driving foreign exchange reserves in Bangladesh.

Testing Stationary

The unit root test serves as a proxy for the correlogram for assessing stationarity. Stationarity tests primarily include the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.

(a) Augmented Dickey-Fuller (ADF) test

The most popular experiment for verifying time series stationarity is the ADF test. It builds upon the excellence Dickey-Fuller test by incorporating additional lagged terms to take more advanced levels of autocorrelation into consideration. However, this comes at the cost of reduced degrees of freedom and potential structural shifts in the data. According to Dickey and Fuller (1981) $\Delta Reserve_{t-i}$ can be added as the lagged difference form for incorporating serial correlation. The equations of the ADF test, including both trend and intercept for our model as follows:

$$\Delta Res_t = \alpha_0 + \alpha_1 Res_{t-1} + \alpha_2 t + \sum_{i=1}^n \beta_i \Delta Res_{t-i} + \epsilon_t \quad (\text{ii})$$

$$\Delta Remit_t = \alpha_0 + \alpha_1 Remit_{t-1} + \alpha_2 t + \sum_{i=1}^n \beta_i \Delta Remi_{t-i} + \epsilon_t \quad (\text{iii})$$

$$\Delta Export_t = \alpha_0 + \alpha_1 Export_{t-1} + \alpha_2 t + \sum_{i=1}^n \beta_i \Delta Export_{t-i} + \epsilon_t \quad (\text{iv})$$

$$\Delta ER_t = \alpha_0 + \alpha_1 ER_{t-1} + \alpha_2 t + \sum_{i=1}^n \beta_i \Delta ER_{t-i} + \epsilon_t \quad (\text{v})$$

Where, ΔRes_t , $Remit_t$, $\Delta Export_t$ and ΔER_t are the first differences for Reserve, Remittance, Export and Exchange rate, respectively. ϵ_t represents the white noise error term.

(b) Phillips-Perron (PP) test

Phillips Perron (1998) adopted a nonparametric unit root test technique to assess whether the data series is I(1) or not. The PP test generates good results even in the presence of an unknown higher-order autocorrelation, which can result in a reduction of degrees of freedom and heteroscedasticity. It employed the Newey-West estimator, which modifies for any serial correlation and heteroskedasticity without incorporating additional lagged terms to the model. The equations of the PP test for our model are as follows:

$$\Delta Res_t = \alpha_0 + \alpha_1 Res_{t-1} + \epsilon_t \quad (vi)$$

$$\Delta Remit_t = \alpha_0 + \alpha_1 Remit_{t-1} + \epsilon_t \quad (vii)$$

$$\Delta Export_t = \alpha_0 + \alpha_1 Export_{t-1} + \epsilon_t \quad (viii)$$

$$\Delta ER_t = \alpha_0 + \alpha_1 ER_{t-1} + \epsilon_t \quad (ix)$$

Where, ΔRes_t , $\Delta Remit_t$, $\Delta Export_t$ and ΔER_t are the first differences for Reserve, Remittance, Export and Exchange rate, respectively. ϵ_t represents the white noise error term.

Autoregressive Distributed Lag (ARDL) Model

Since the variables in our model exhibit a combination of different integration orders, incorporating both I(0) and I(1), it is recommended to use the ARDL Bounds testing approach, as suggested by Pesaran et al. (1998) and further developed in their 2001 work.

The ARDL has been employed to assess the long and short-term co-integration between foreign exchange reserves and the explanatory variables in the model. When dealing with endogenous regressors, the ARDL method typically provides reliable t-statistics and accurate long-run estimates. Moreover, dummy variables can be incorporated in the bounds test, and the critical values remain valid even with these variables included. Finally, the bounds testing method effectively addresses issues of autocorrelation and omitted

variables by evaluating both the long- and near-term constituents of the model simultaneously.

Assumptions of the ARDL model

The Autoregressive Distributed Lag (ARDL) model relies on several key assumptions to ensure its validity and reliability. First, there should be no autocorrelation, meaning the error terms must not be correlated with one another. Second, the model assumes no heteroscedasticity, requiring that the variance and mean of the error terms remain constant throughout. Third, the residuals must follow a normal distribution to facilitate accurate statistical inference. Fourth, the stationarity of variables is crucial, meaning that the time series must be either amalgamated at I(0) or I(1), but not at I(2). Finally, the stability of the model is essential to ensure its reliability, which is tested through CUSUM and CUSUMSQ tests, confirming that the model remains valid over time for meaningful economic analysis.

The OLS estimation technique is employed in the ARDL-bound testing approach to assess a conditional, unconstrained error correction model (ECM).

The equation can be symbolised in the following way using this method:

$$\Delta Res_t = \beta_0 + \sum_{i=0}^{\rho} \phi_i \Delta Res_{t-i} + \sum_{i=0}^{\rho} \theta_i \Delta Remit_{t-i} + \sum_{i=1}^{\rho} \varphi_i \Delta Export_{t-i} + \sum_{i=1}^{\rho} \alpha_i \Delta ER_{t-i} + \delta_1 Res_{t-1} + \delta_2 Remit_{t-1} + \delta_3 Export_{t-1} + \delta_4 ER_{t-1} + \varepsilon_t \quad (x)$$

Where, Res, Remit, Export and ER are natural logarithms of the foreign exchange reserves in Bangladesh, Remittance, Export and Exchange rate, respectively. The highest number of lags is denoted by ρ , whereas Δ represents the first difference operator.

The primary phase of the ARDL bound testing method presumes estimating an equation based on the OLS method, followed by conducting a Wald test or an F-test to examine the collective magnitude of the model's lagged level variable coefficients. The null hypothesis states that $H_0: \delta_1 = \delta_2 = \delta_3 = 0$, while the alternative hypothesis $H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq 0$. Two different sets of critical values for the F-test have been displayed by Pesaran and others (2001); one set presumes that all regressors are I(0), while the others are I(1).

If the estimated F-statistic exceeds the upper critical value, then long-term co-integration is present alongside the variables' integration order, and vice versa.

If co-integration is present in the first stage, the succeeding ARDL (a, b, c and d) of a long-term model is estimated in the second step:

$$Res_t = \beta_1 + \sum_{i=0}^a \phi_{1i} Res_{t-i} + \sum_{i=0}^b \theta_{1i} Remit_{t-i} + \sum_{i=1}^c \varphi_{1i} Export_{t-i} + \sum_{i=1}^d \alpha_{1i} ER_{t-i} + \varepsilon_{1t} \dots \tag{xi}$$

Where the variables' optimal number of lags is represented by a, b, c and d.

In the final phase, ECM can be constructed in the following way to build up the short-term dynamics of the ARDL specification:

$$\Delta Res_t = \beta_2 + \sum_{i=0}^p \phi_{2i} \Delta Res_{t-i} + \sum_{i=0}^p \theta_{2i} \Delta Remit_{t-i} + \sum_{i=1}^p \varphi_{2i} \Delta Export_{t-i} + \sum_{i=1}^p \alpha_{2i} \Delta ER_{t-i} + \mu ECM_{t-1} + \varepsilon_{2t} \tag{xii}$$

Where, μECM_{t-1} is the error correction term, and specify it as:

$$ECM_t = Res_t - \beta_1 - \sum_{i=0}^a \phi_{1i} Res_{t-i} + \sum_{i=0}^b \theta_{1i} Remit_{t-i} + \sum_{i=1}^c \varphi_{1i} Export_{t-i} + \sum_{i=0}^d \alpha_{1i} ER_{t-i} \tag{xiii}$$

The coefficients in equation (xii) represent the near-term dynamics of the model's adjustment towards equilibrium, where μ is the pace of adjustment.

Empirical Results and Findings

Stationarity of the Unit Root Test

To apply the ARDL approach and avoid any spurious results, it is mandatory to justify the stationarity and integration order of the time series. The time series must be integrated at I(0) or I(1), but not I(2), for the ARDL method. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were employed to assess the integration order of a time series. The outcomes of the unit root test are shown in Table 1 below:

Table 1: Findings of the Unit Root Test

| Variables | Augmented Dickey-Fuller (ADF) | | | Phillips-Perron (PP) | | |
|------------|-------------------------------|----------------------------|----------|----------------------|----------------------------|----------|
| | Level | 1 st Difference | Decision | Level | 1 st Difference | Decision |
| RESERVE | -0.3848 | -2.5878*** | I (1) | -1.3578 | -14.4289*** | I (1) |
| REMITTANCE | -1.8603 | -16.0521*** | I (1) | -3.0314** | -26.6997*** | I (1) |

| Variables | Augmented Dickey-Fuller (ADF) | | | Phillips-Perron (PP) | | |
|---------------|-------------------------------|----------------------------|----------|----------------------|----------------------------|----------|
| | Level | 1 st Difference | Decision | Level | 1 st Difference | Decision |
| EXPORT | -4.8250*** | -8.7413*** | I (0) | -4.7101*** | -27.6132*** | I (0) |
| EXCHANGE RATE | 2.1112 | -6.1785*** | I (1) | 2.9001 | -6.1770*** | I (1) |

*, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively. *All variables are in natural logarithm form. Source: Authors' own Calculation in E-Views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

Table 1 demonstrates the results of the ADF and PP tests, indicating all variables are stationary at I(1), whereas export is stationary at I(0). Given the variables' mixed order, it is advisable to apply the ARDL bounds testing approach to analyse the impact of the regressors on the dependent variable (Pesaran et al., 2001).

VAR lag order selection Criterion

The VAR model's lag length criteria are utilised to identify the optimal lag for the ARDL model. The findings of the VAR lag order selection are displayed in Table 2.

Table 2: VAR lag order selection

| Lag | Log L | LR | FPE | AIC | SC | HQ |
|-----|----------|-----------|-----------|------------|------------|------------|
| 0 | 179.5692 | NA | 3.89e-07 | -3.409111 | -3.306791 | -3.367668 |
| 1 | 671.8768 | 936.8184 | 3.74e-11 | -12.65780 | -12.14620 | -12.45059 |
| 2 | 725.3323 | 97.56913 | 1.81e-11 | -13.38509 | -12.46422* | -13.01211 |
| 3 | 756.0459 | 53.67439* | 1.37e-11* | -13.67080* | -12.34064 | -13.13204* |
| 4 | 767.5273 | 19.17273 | 1.50e-11 | -13.58305 | -11.84362 | -12.87852 |

* dictates lag order designated by the criterion. LR: sequential modified LR test statistic (each test at 5% level). Source: Researchers' own Calculation in E-views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

The VAR lag-order selection, shown in Table 2, compares 6 (six) criteria, and they are Log-Likelihood, sequential LR test, Final Prediction Error (FPE), Akaike (AIC), Schwarz (SC), and Hannan-Quinn (HQ) with lags from 0 (zero) to 4 (four). The LR test, FPE, AIC, and HQ attain their best values at 3 (three) lags (with the LR test leading to a significant Lag 3), but SC selects 2 (two) lags. Since 4 (four) out of 6 (six) measures indicate a 3 (three)-lag specification, I chose a maximum lag order of 3 for the regressors of our ARDL

model. This is a compromise between fitting with top performance and not over-fitting.

ARDL Results

A maximum of 3 lags for all regressors had been applied for the ARDL model after considering all the criteria suggested by the VAR model. The findings exhibit significant relationships of foreign exchange reserves with the explanatory variables at different lags. Notably, remittance and export demonstrated a positive and significant relationship with reserves, while a depreciating relationship has been observed with the exchange rate.

Results of ARDL Bound Tests for Co-integration

The ARDL bounds test was employed to evaluate the long-term co-integration between foreign exchange reserves and the regressors. The outcomes of the co-integration bounds test are provided in Table 3.

Table 3: Bounds Test Results for Co-integration

| <i>F-Statistic = 23.25</i> | | |
|------------------------------|--------------------------------|--------------------------------|
| <i>Level of Significance</i> | <i>Lower Bound Value I (0)</i> | <i>Upper Bound Value I (1)</i> |
| 10% | 2.72 | 3.77 |
| 5% | 3.23 | 4.35 |
| 1% | 4.29 | 5.61 |

Source: Authors' own Calculation in E-views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

The findings of the bounds testing approach, as exhibited in Table 3, indicate that the computed F-statistic (23.25) surpasses the upper bounds at the 10%, 5%, and 1% significance levels. As a result, rejecting the null hypothesis of no co-integration, showing that the dependent variable and the model's regressors are co-integrated. This confirms the presence of a long-run equilibrium relationship between Bangladesh's foreign exchange reserves, remittances, exports, and exchange rate for the analysis period.

The Outcomes of Long-Run and Short-Run Dynamics

Since co-integration has been identified, the next step is to evaluate the short and long-term dynamics of the model. The calculated long-term and short-term coefficients are presented in Tables 4 and 5, respectively.

Table 4: Estimated ARDL Long-Run Coefficients

| <i>Variables</i> | <i>Coefficient</i> | <i>Std. Error</i> | <i>T-Statistic</i> |
|----------------------|--------------------|-------------------|--------------------------|
| LNREMITTANCE (-1) | 0.884737 | 0.242428 | 3.649491*** (0.0000) |
| LNEXPORT(-1) | 0.562243 | 0.260688 | -2.156767** (0.0334) |
| LNEXCHANGE(-1) | -2.314961 | 0.464304 | -4.985875*** (0.0000) |

** and *** indicate significance at 5%, and 1% levels, respectively. *All variables are in natural logarithm form. Figures in parentheses indicate the probability value. Source: Authors' own Calculation in E-views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

Therefore, the ECT can be presented as follows:

$$ECT_{t-1} = 1.00 \ln Res_{t-1} - 0.884 \ln Remit_{t-1} - 0.562 \ln export_{t-1} - 2.314 \ln ER_{t-1} \quad (xiv)$$

The ECT Equation (xiv), constructed from Table 4, states that, as anticipated, remittance and export have a positive and considerable influence on foreign exchange reserves, while the exchange rate has a depreciating effect. This suggests that these regressors indeed influence foreign exchange reserves in the long term and are key determinants of reserves in Bangladesh. On average, a 1% increase in remittance and export will raise foreign exchange reserves by 88% and 56%, respectively, during the study period. Conversely, a 1% depreciation of the exchange rate will induce a 2.31% increase in foreign exchange reserves. As noted earlier, the short-run dynamics of the model illustrate the adjustment path, showing how any shocks may cause temporary imbalances. The short-term dynamics of the ARDL model are displayed in Table 5.

Table 5: Short Run Dynamics and ECM for the estimated ARDL Model

| <i>Variables</i> | <i>Coefficient</i> | <i>Std. Error</i> | <i>T-Statistic</i> |
|------------------|--------------------|-------------------|--------------------|
| LNRESERVE(-1)* | -0.0879 | 0.0235 | -3.7401 |
| LNREMITTANCE(-1) | 0.0778 | 0.0156 | 4.9857 |
| LNEXCHANGE(-1) | -0.2037 | 0.0456 | -4.4316 |
| D(LNEXPORT(-1)) | 0.0426 | 0.0109 | 3.8990 |
| C_D | 0.0134 | 0.0072 | 1.9264 |
| C | 1.6591 | 0.3059 | 5.4235 |

, and * indicate significance at 5%, and 1% levels, respectively. *All variables are in natural logarithm form. Figures in parentheses indicate the probability value. Source: Authors' own Calculation in E-views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

The co-integrating and long-run equation can be written as follows:

$$\Delta \ln Res = 1.659 - 0.0879 ECT_{t-1} - 0.884 \ln Remit_{t-1} - 0.562 \ln export_{t-1} - 2.314 \ln ER_{t-1} \quad (xv)$$

The most important component of the short-run dynamics is ECT_{t-1} is presented in Table 6.

Table 6: Error correction term

| Error Correction Term | Coefficient | Std. Dev. | T-Statistic |
|-----------------------|-------------|-----------|-------------|
| ECT_{t-1} | -0.0879 | 0.0235 | -3.7401*** |

*** indicates significance at 1% level. Source: Authors' own Calculation in E-Views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

The coefficient of the ECT_{t-1} is -0.0879, as demonstrated in Table 6, which is an adverse sign and less than 1, as well as displays strong significance even at the 1% level. The adverse sign states that the short-run dynamics work to restore equilibrium, confirming that long-term co-integration exists between Bangladesh's foreign exchange reserves and the model's regressors. Additionally, the ECT coefficient represents the pace of adjustment to equilibrium, meaning that any previous discrepancy from long-run equilibrium is rectified in the existing period at a rate of approximately 9.0 %. Therefore, the system takes about 12 months to return to long-term equilibrium.

ARDL Model Fitness Checking

Table 7 highlights the diagnostic tests for the proposed model. To assess the robustness and accuracy of our estimation, we conducted tests for normality, serial correlation, heteroscedasticity, and the Ramsey RESET test.

Table 7: ARDL Diagnostic Checking

| Diagnosis | Test Statistic (F) | P-value |
|--|--------------------|---------|
| Breusch-Godfrey Serial Correlation LM Experiment | 1.1613 | 0.2855 |
| Breusch-Pagan-Godfrey Heteroscedasticity Test | 1.4073 | 0.1712 |
| Normality (Jarque-Bera) Test | 3.5766 | 0.1672 |
| Ramsey RESET Test | 1.1745 | 0.2814 |

Source: Authors' own Calculation in E-views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

Table 7 illustrates the F-statistics and their equivalent probability values, indicating that the estimated model successfully passes diagnostic tests for residual serial correlation, heteroscedasticity, and non-normality. Furthermore, the p-value of the F-statistic in the Ramsey RESET test supports the null hypothesis's acceptance, indicating that there are no specification errors in the model and that the regression equation is appropriately fitted. Therefore, we can conclude that our model is well-suited as it meets all the diagnostic criteria.

Stability of the test

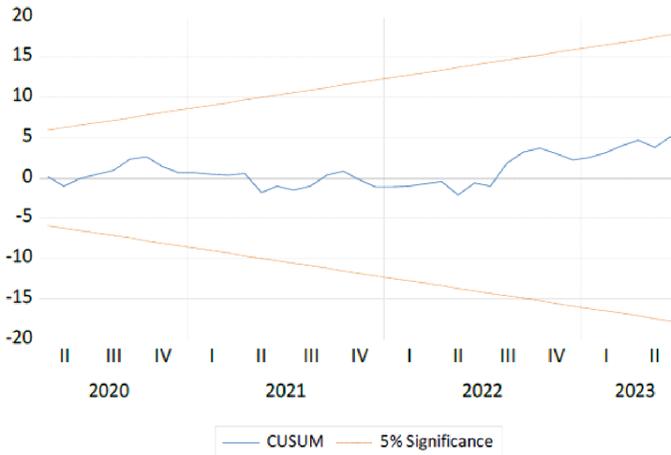


Figure 2: CUSUM test

Source: Authors' Calculation in E-views 13.

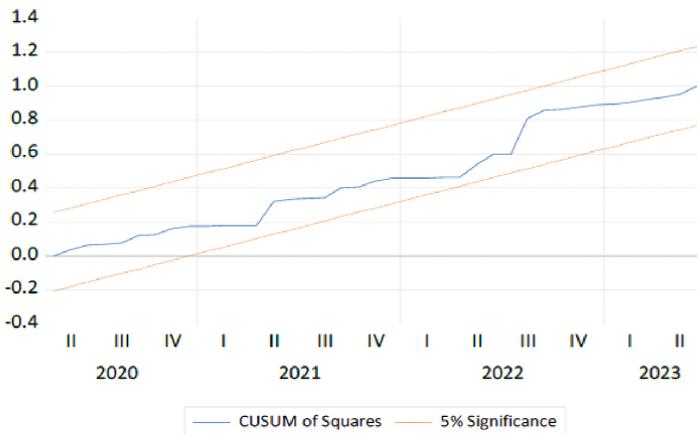


Figure 3: CUSUM Square test

Source: Authors' Calculation in E-views 13.

Moreover, to check the strength of our investigation's long-run and short-run inferences, we performed structural stability tests on the parameters with the CUSUM and CUSUMSQ experiments. These trials indicate the regression coefficients are typically constant across the period of the sample, as the blue band is within the two red bands at the 5% level for both tests, which are displayed in Figure 3 and Figure 4.

Finally, the diagnostic tests of the model successfully meet every basic assumption of the ARDL model, i.e., absence of autocorrelation, homoscedasticity, and normal distribution, as well as ensuring the magnitude of the regression coefficients with the CUSUM and CUSUMSQ tests, which ensure the robustness of our model.

Johansen test of co-integration

To verify the outcomes of the ARDL model and examine the presence of a longer-term link among the variables of interest, the Johansen test of co-integration was applied with 3 lags, and the findings are shown in Tables 7 and 8 (Annexure).

Table 7: Johansen Normalisation Interpretation Test

| | | | |
|--|------------------------|---------------------|--------------------|
| Co-integrating Equation Log-Likelihood: 724.9507 | | | |
| Normalised co-integrating coefficients (standard error in parentheses) | | | |
| LNRESERVE | LNREMITTANCE | LNEXPORT | LNEXCHANGE |
| 1.000000 | -1.009 (0.1504) | -0.5049 (0.1231) | 2.9778 (0.4303) |
| Adjustment coefficients (standard error in parentheses) | | | |
| D(LNRESERVE) | -0.005542 (0.00966) | | |
| D(LNREMITTANCE) | 0.425940 (0.06299) | | |
| D(LNEXPORT) | 0.561423 (0.11731) | | |
| D(LNE_RATE) | 0.000263 (0.00418) | | |

Source: Authors' own Calculation in E-Views 13. Data Source: Statistics Department of Bangladesh Bank (BB).

The results of the trace test and max-eigenvalue test, as presented in Table 8 in the Annexure part, indicate that at least two co-integrating equations

are found at the 0.05 significance level, meaning that co-integration exists between Bangladesh's foreign exchange reserves and the model's regressors. Furthermore, Table 7 demonstrates the outcomes of the Johansen normalisation interpretation, clearly stating that remittance and export have an optimistic and considerable influence on foreign exchange reserves (since the signs are reversed in the long run), and both are statistically significant at the 1% level. So, it can be inferred that there is a longer-term relationship between foreign exchange reserves and the model's regressors, and these factors indeed determine foreign exchange reserves in Bangladesh.

Analysis of the Results

The ARDL model incorporates the long and short-term dynamics of the dependent and independent variables. The Johansen normalisation interpretation shows that all regressors show considerable effects on foreign exchange reserves, with statistical significance at the 1% level. As a consequence, it is concluded that a longer-term relationship prevails between Bangladesh's foreign exchange reserves and the model's regressors.

The ECT equation indicates that, as anticipated, all the regressors, such as export, remittance, and exchange rate, have an optimistic and considerable influence on foreign exchange reserves, meaning that these factors genuinely affect Bangladesh's foreign reserve assets in the long run.

From the ECT equation, on average, a 1% rise in remittance will boost foreign exchange reserves of Bangladesh by 88% in the long-term, which is similar to the analysis of Abdul Mahidud Khan et al. (2021), who found that with a 1 % rise in remittance inflows will go up the foreign exchange reserve in Bangladesh by 43% and Dey and Salma (2023), who also showed that a 1% increase in remittance boosts foreign exchange reserve in Bangladesh by 33%. So, remittance is one of the pivotal factors driving foreign exchange reserves in Bangladesh.

Export is another crucial factor driving foreign exchange reserves in Bangladesh. Specifically, a 1% rise in exports will promote a 56% boost in foreign exchange reserves. This is consistent with the findings of Bhakri and Verma (2021), who observed that in the longer term, a 1% rise in exports results in a 47% improvement in foreign exchange reserves in Bangladesh.

The exchange rate (ER) is the third regressor that impacts foreign exchange reserves in Bangladesh. Specifically, a 1% depreciation in the exchange rate causes a 2.31% rise in foreign exchange reserves. This finding aligns with the work of Ram Prasad Gajurel (2022), who found that a 1% depreciation in the exchange rate increases foreign exchange reserves by 0.05% in India, and Muhammad Abul Kasem (2022), who discovered that a 1% change in the exchange rate positively affects Bangladesh's foreign exchange reserves by 0.02%. Notably, a depreciation in the exchange rate boosts remittance and exports, which in turn boosts foreign exchange reserves.

Considering the findings, we may infer that remittance, export, and exchange rate are the primary factors that significantly influence foreign exchange reserves in Bangladesh.

CONCLUSION, POLICY IMPLICATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The purpose of this analysis is to explore the key factors driving foreign exchange reserves in Bangladesh from FY2014 to FY2024. The data was collected from the Statistics Department of the Bangladesh Bank. To check the stationarity and integration order of the data, unit root tests (ADF and PP tests) are applied. Additionally, the ARDL approach is employed to examine whether the chosen variables are co-integrated, i.e., whether these regressors have a genuine influence on foreign exchange reserves in Bangladesh. Lastly, diagnostic and stability tests are conducted to ensure the model's validity and soundness.

The findings of the ARDL bounds test indicate that all variables are co-integrated, suggesting a longer-term relationship between foreign exchange reserves in Bangladesh and the model's regressors. In Bangladesh, foreign exchange reserves are significantly influenced by remittances, exports, and the exchange rate (ER) in both the short and long term. Specifically, a 1% increase in remittance results in an 88% rise in foreign exchange reserves, while a 1% growth in exports leads to a 56% increase in foreign exchange reserves. Therefore, these two factors are key drivers of the foreign exchange reserves in Bangladesh. So, the concerned authorities, like the government in coordination with the Bangladesh Bank, need to undertake robust initiatives to enhance exports and remittances, reduce unnecessary imports as well and need

to negotiate with our development partners to receive loans and grants with easier conditions, which help to boost foreign exchange reserves in Bangladesh.

The future study can consider the following issues: Firstly, additional variables may be incorporated into the model to capture more robust impacts on foreign exchange reserves. Secondly, a broader time span may be considered for future research on the determinants of foreign exchange reserves in Bangladesh.

Note

1. The data are available at <https://www.bb.org.bd/en/index.php/publication/publicctn/3/10>.

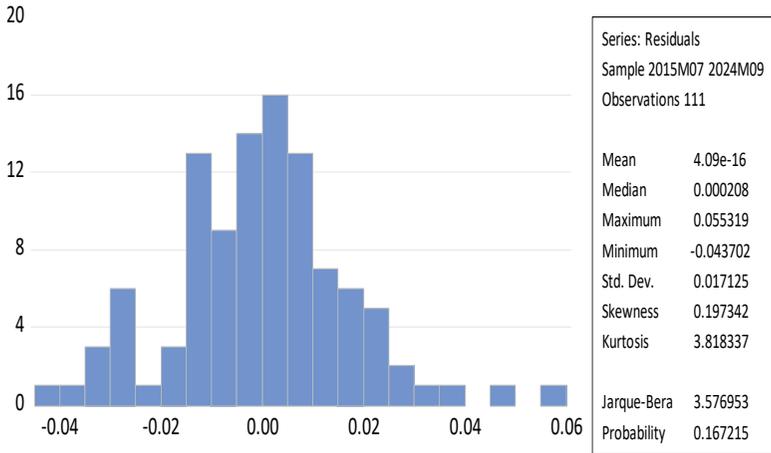
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APPENDIX

Normality Test



Source: Authors' own Calculation in E-Views 13.

Data Source: Statistics Department of Bangladesh Bank (BB).

Table 8: Johansen Co-integration Test

| <i>Unrestricted Cointegration Rank Test (Trace)</i> | | | | |
|---|--------------------|-------------------------|----------------------------|--------------------------------|
| <i>Hypothesised No. of CE(s)</i> | <i>Eigen value</i> | <i>Trace Statistics</i> | <i>0.05 Critical Value</i> | <i>Prob. ** Critical Value</i> |
| None * | 0.3764 | 80.7065 | 47.8561 | 0.0000 |
| At most 1 * | 0.2273 | 32.0582 | 29.7971 | 0.0270 |
| At most 2 * | 0.0515 | 5.4977 | 15.4947 | 0.7539 |
| At most 3 | 0.0005 | 0.0536 | 3.8415 | 0.8169 |

Trace test indicates 2 cointegrating equation(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

| <i>Unrestricted Cointegration Rank Test (Max-eigenvalue)</i> | | | | |
|--|--------------------|-------------------------|----------------------------|--------------------------------|
| <i>Hypothesised No. of CE(s)</i> | <i>Eigen value</i> | <i>Trace Statistics</i> | <i>0.05 Critical Value</i> | <i>Prob. ** Critical Value</i> |
| None * | 0.3764 | 48.6483 | 27.5843 | 0.0000 |
| At most 1 * | 0.2273 | 26.5605 | 21.1316 | 0.0078 |
| At most 2 * | 0.0515 | 5.4440 | 14.2646 | 0.6851 |
| At most 3 | 0.0005 | 0.0536 | 3.8415 | 0.8169 |

Max-eigenvalue test indicates 2 cointegrating equation(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values