

THE IMPACT OF REMITTANCES ON GDP GROWTH IN BANGLADESH: AN ARDL BOUNDS TEST APPROACH

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ABSTRACT

This paper will analyze how remittances affect GDP growth in Bangladesh based on annual data between 1991 and 2023, which is obtained via the World Development Indicators (WDI) database. The paper uses the Autoregressive Distributed Lag (ARDL) bounds testing model provided by Pesaran, Shin and Smith (2001) to understand both short run and long run dynamics of GDP growth, personal remittances received and consumer price inflation. The Augmented Dickey-Fuller (ADF) unit root tests indicate that GDP growth and inflation are at the stationary level $I(0)$ and remittances are integrated of order-one $I(1)$ which justifies the use of ARDL framework. The unanimous choice of lag selection criteria under FPE, AIC and HQ is lag 2, whereas the Schwarz Criterion chooses lag 1 and favours ARDL (2,2,2) as the preferred specification. The F-statistic of 6.455377 is greater than the upper critical bound at the 1% significance level indicating that the cointegrating relationship between the three variables is strong in the long-run. The long-run coefficient of remittances is found to be statistically significant and positive ($6.93E-05$; $p = 0.0186$), which implies that the inflows of remittances have a significant impact on long-run GDP growth in Bangladesh. Whereas positive, inflation turns out to be statistically insignificant in the long run ($p = 0.2786$). The coefficient of error correction of -0.9210 ($p = 0.0000$) means that about 92% of short-run variations of the long-run equilibrium are countered in a year, which means that the adjustment mechanism is highly efficient. Diagnostic testing ensures the lack of serial correlation ($p = 0.7569$) and heteroskedasticity ($p = 0.06$) and CUSUM and CUSUM of Squares tests ensure structural stability over the sample period. These results are very much empirical evidence of the remittance-led hypothesis of growth in Bangladesh and have significant policy implications of how to increase remittance inflows and direct them into productive investment.

Keywords: Remittances, GDP growth, ARDL bounds test, Cointegration, Error correction model, Bangladesh, Economic growth, Monetary policy, Inflation

1. INTRODUCTION

The financial flows made by individuals back to their home countries (remittances) have emerged as a major source of foreign exchange to most developing economies including Bangladesh. Bangladesh has been witnessing a gradual increase in the level of remittance inflows in the last several decades and this has been a significant contributor to the economy of the country. Such financial transfers are not only useful in increasing the living standards of the recipient families, but also in reducing poverty, developing human capital and reducing income inequality.

As far as Bangladesh is concerned, remittances contribute a significant portion of the Gross Domestic Product (GDP) of the country, and thus they play a significant role in affecting the overall growth of the economy. The effects of remittances on GDP growth have received a lot of studies, and the studies have focused on the direct and indirect ways in which the inflows impact the

economic performance. Although remittances have been recognized as having the potential to boost economic development, there is still debate over the extent and level of their effects.

This paper will examine how remittances and GDP growth are related in Bangladesh using the Autoregressive Distributed Lag (ARDL) Bounds Test methodology. When the data might be mixed in the order of integration, the ARDL model is especially appropriate to analyze the short- and long-term relations between the variables. In doing so, the research will aim at offering a deeper insight on the role of remittance inflows in the economic growth of Bangladesh both in the short and long-term.

The research results are likely to provide useful information to policy-makers, not to mention that they will add to the overall scholarly discussion on the role of remittances in the developing economies. Lastly, the role of remittances in GDP growth can be used to inform policies to maximize the benefits of remittances inflows and to achieve sustainable economic growth in Bangladesh.

Bangladesh receives one of the highest amounts of remittances in the world. The World Bank estimates remittance inflows to be over USD 21 billion in 2022, or about 5-6 percent of GDP. This endows remittances as one of the largest external sources of financing to the country - greater than foreign direct investment and just less than official development assistance. This flow is maintained all the year round by the large Bangladeshi diaspora, which is concentrated in the Gulf Cooperation Council (GCC) countries, the United Kingdom and the United States, and is therefore a relatively stable source of foreign exchange as compared to trade receipts or portfolio flows.

Although the magnitude of these inflows is high, there are mixed empirical findings concerning the effects of these inflows on the growth in Bangladesh. A few studies discover that the long-run relation between remittances and output is significantly positive (Majumder and Donghui, 2016; Kumar and Stauvermann, 2014), others also doubt that remittances is a long-run forcing variable of output at all (Paul, Uddin, and Noman, 2011). The current research re-answers this question by looking at the latest available data by 2023, which illustrates the 2020-2021 COVID-19 pandemic disruption followed up by 2022-2023 remittance recovery. This long sample period gives a more challenging test of the long-run remittance-growth relationship compared to previous studies.

The rest of this paper is organized in the following way. Section 2 will discuss the theoretical and empirical literature on the remittance-growth nexus in the world and Bangladesh in particular. Section 3 outlines the data and gives the ARDL econometric approach. The empirical results are reported and interpreted in section 4, including unit root tests, lag selection, bounds test of cointegration, long-run coefficient estimates, the error correction model, and tests of diagnostic and stability. In section 5, the policy implications of the findings are discussed. Section 6 concludes.

2. LITERATURE REVIEW

Remittances as a means of promoting economic growth has received much attention over the past few decades especially in developing nations such as Bangladesh where remittances constitute an important source of foreign exchange and a significant source of national income. The literature review investigates both theoretical basis and empirical evidence on the effect of remittances on GDP growth and specifically the literature that has used Autoregressive Distributed Lag (ARDL) bounds testing method. Through the examination of worldwide and country-specific research, particularly that focusing on Bangladesh, the review offers a thorough insight into the current literature, outlines the gaps in the existing research, and preconditions the investigation of the influence of remittances on the economic development in Bangladesh through the ARDL bounds test method.

2.1 Global Studies on Remittances and Economic Growth

In their study, Ahmed, Zaman and Shah (2011) focus on the issue of remittances, exports and money supply and their influence on the economic growth of Pakistan in the period between 1976 and 2009 through the bounds testing technique. The results show that remittances have positive impacts on the economic growth both on the short and long term with short term contributions of remittances and exports of 0.034 per cent and 0.078 per cent respectively. Nevertheless, the amount of money circulated is determined to be irrelevant in spurring growth. The error correction model implies a slow pace of adjustment with an average rate of disequilibrium of the previous year shock coming back to the equilibrium after every 3 years. These findings are insightful to policymakers, scholars, and the government.

Abdulai (2023) examines the effects of international remittances on GDP growth in Ghana between the year 1990 and 2020 by applying the ARDL estimation model to test the effect of remittances on other significant economic variables in the long-term. The findings demonstrate that the long-term relationship between GDP growth and the remittance inflows, foreign direct investment, unemployment rate, inflation, trade, population growth and the official development assistance is significant. It is important to note that the mediating role of unemployment in remittance inflows has a negative influence on GDP growth in the short term and long term. To achieve long-term GDP growth, the study advises the government to consider enhancing remittance transfer systems and minimizing transaction costs in order to maximize the economic potential of remittances.

Dhungel (2018) analyses the impact of remittances on the economic development of Nepal through the ARDL model. The fixed test establishes a long run relationship between remittances and GDP. The empirical findings indicate that the long-run increase in GDP because of a 1% remittance increase is 0.36. Moreover, there is a positive correlation between gross fixed capital formation, secondary school enrolment, trade openness, and the per capita GDP and growth. In particular, the 1% rise in capital, labour, and trade openness leads to corresponding 0.82, 0.46, and 0.30 percent rise in per capita GDP, which illustrates the significant role played by remittances and other variables in increasing the Nepal economy.

Simwaka, Ligoya, Kabango and Chikonda (2012) examine how monetary factors cause inflation in Malawi, and they remark that both monetary and supply-side factors play a role in causing inflation with the money supply growth having a 3 to 6 months lag effect. Although the current study mainly dwells on the dynamics of inflation as opposed to remittances, its results on the relationship between external inflows and domestic price levels can be applied to the research on the impact of remittances in creating inflationary spillovers in case they are directed towards consumption and not investment.

2.2 Bangladesh-Specific Studies

Akter (2016) compares the effects of remittances made by the workers on the economic growth of Bangladesh through time series regression and correlation analysis. The results verified that there is a significant positive correlation between remittances and economic growth, which demonstrates the importance of remittances in driving economic growth. Remittances being a major source of private capital flow has a multiplier effect on major macroeconomic indicators such as poverty reduction, mobilising savings and increasing investment leading to capital accumulation and the general economic development.

Elahi and Rahman (2021) address the linkage between remittance and inflation in Bangladesh based on the data of 1975-2019, with the help of ARDL model. They conclude that in the short run remittances have a large positive effect on inflation but in the long run it is not so. The analysis also

establishes a long-term relationship between the variables as well as the exchange rate having a positive impact on inflation. It recommends that remittances ought to be invested in productive activities as opposed to consumption to reduce the inflationary pressures- a policy proposal that is specifically applicable to the current research.

The article by Akter, Hasan, Akter, and Jui (2024) investigates how net exports and remittances affect the economic growth of Bangladesh in the years 1980-2022 based on the ARDL model. The results indicate that net exports, remittances and gross capital formation are positive to long-term economic growth but their short-term impact is negative but ultimately rectifies over time. This study is unique as compared to other studies which examined remittances and exports individually, the joint impact of the two factors on economic growth is emphasized, and this is very significant in guiding the policymakers and other stakeholders in enhancing sustainable development.

Qamruzzaman (2021) studies the effect of financial innovation and remittances on the credit performance of the bank-based financial institutions in Bangladesh between 1981 and 2019. The study finds directional causality, long-run, and short-run effects using augmented ARDL and nonlinear ARDL models. The results justify a long-run correlation of financial innovation, remittances, trade openness and FDI, as well as credit performance. The impact of remittance inflows and trade openness on non- performance loans is negative implying that remittances contribute to financial stability and creditworthiness.

Majumder and Donghui (2016) examine the ARDL model to explore the long-run effects of remittances on the economy of Bangladesh. The model is reliable as tests such as residual normality, heteroskedasticity, and test of serial autocorrelation are valid, and the CUSUM test is used to determine structural stability. The findings also reveal that there is statistically significant positive relationship between remittance and economic growth in the long run, which shows the importance of remittance inflows in economic growth of Bangladesh.

Ale, Akter, and Islam (2018) study how remittances affect economic growth in Bangladesh, India, and Pakistan based on the secondary time series data of 1981 to 2015. The Granger causality test in the VAR indicates that in Bangladesh there is one way causality relationship between remittances and economic growth. Johansen cointegration test shows that there is a long-run equilibrium relationship between the variables, which highlights the importance of remittances in influencing economic growth.

Paul, Uddin and Noman (2011) analyze the relationship between remittances and the economic output in Bangladesh during the period 1976 -2010 on a long run basis through the ARDL bounds testing model. Contrary to the traditional perspective that remittance influences the growth in output, the results imply that the output is the determinant of the long-term changes in remittance. Remittances, however, do not seem to be a long-run forcing variable of economic output. The hypothesis of the study is that higher remittances to answer the rising income can be caused by higher importation and more investment prospects, implying that the policymakers of Bangladesh can impact the inflows of remittances by using policies that could augment domestic production.

Nurul Hossain and Hasanuzzaman (2013) examine the role remittances play in determining the rate of investment in Bangladesh by applying ARDL bounds test. The results indicate that remittances as well as trade openness have a positive and significant impact on investment, which disproves the widely held belief that remittances in developing countries are mostly consumed. There is a long-run unidirectional causality between remittances and investment that implies that investment and economic growth can be stimulated by the implementation of policies that seek to boost remittance inflow.

Kumar and Stauvermann (2014) investigate the association between remittances and the growth rate in Bangladesh between 1979 and 2012 in an augmented Solow framework and ARDL bounds testing model. The results demonstrate that there is a short-run ambivalent effect of remittances but a long-run effect of 0.11% on output per worker is significant. The Granger causality analysis shows that there is a two-way relationship between remittances and output per worker which confirms the remittance-led growth hypothesis.

Kanchan and Bimal (2014) analyse the effect of remittances on the economy of Bangladesh through the ARDL model, and observe that inflows of remittances have surpassed 10% of the GDP since 2008. Although remittances can finance growth, development, and financial stability, they can also have adverse implications on growth when they are used unproductively, or when they create incentive to disengage the labour markets by recipient households.

2.3 Summary and Research Gap

The literature review indicates that there are some common themes. First, the majority of studies that are specific to Bangladesh identify a positive and statistically significant long-run correlation between remittances and the growth of GDP, which supports the hypothesis of remittance-led growth. Second, the ARDL bounds testing technique has become the new methodology in this analysis due to its flexibility in incorporating mixed order of integration, and its small sample reliability. Third, although majority of the studies identify cointegration, the exact degree and mechanism of remittance-growth nexus is debatable with some studies revealing that growth causes remittances and not vice versa.

The current paper makes a contribution to this literature in two significant ways. First, it will be able to project the data out to 2023, including the COVID-19 shock and recovery period which is a significant structural episode not observed by previous research. Second, it uses a trivariate ARDL model, which directly accounts for inflation as an alternative determinant of GDP growth, eliminating an omitted variable problem that lies between bivariate models. These contributions encourage a new empirical study of remittance-growth relation in Bangladesh.

3. DATA AND METHODOLOGY

3.1 Data Description

This paper focuses on the relationship between remittances and the Bangladesh GDP growth between 1991 and 2023. The main variables that will be analyzed are GDP growth (annual, percent), inflation (annual, percent) and the amount of personal remittances received (current US). These variables were obtained in the World Development Indicators (WDI) database of the World Bank, which is reliable and consistent. These 33 years of time-series data were analysed annually and appropriate corrections were done to correct any structural break and any outliers in the data.

- Dependent Variable: GDP growth (annual %).

Independent Variables: Personal remittances received (current US\$), Inflation, consumer prices (annual %).

- Time Frame: 1991–2023 (33 annual observations).
- EP Source: World Development Indicators (WDI), World Bank.

The growth in the GDP is a percentage change in the real output that gives the rate of economic growth. Personal remittances received is in terms of current US dollars, which is the sum of all the inward transfer payments received by Bangladeshi households in the form of foreign remittances.

The inflation of consumer prices is calculated as the percentage change in consumer price index annually. The combination of these three variables forms the heart of a theoretically inspired model whereby external income flows (remittances) and the macroeconomic price environment (inflation) both influence the course of the real economic activity.

3.2 Econometric Methodology

3.2.1 Unit Root Testing

For any time series model, it is important to test for stationarity of variables to avoid spurious regressions. For this purpose, we use the Augmented Dickey-Fuller (ADF) test, suggested by Dickey and Fuller (1979) and modified by Said and Dickey (1984). The ADF test equation is:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum \delta_i \Delta Y_{t-i} + \epsilon_t$$

with Y_t being the series under test, t being the time trend, Δ being the first difference operator and ϵ_t being white noise. The null hypothesis is that the series has a unit root (i.e. it is not stationary). Stationarity is indicated by a rejection of the null at normal levels of significance

3.2.2 Optimal Lag Length Selection

The best lag length of the underlying VAR system is the one that minimises standard information measures: the Final Prediction Error (FPE), the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SC), and the Hannan-Quinn Information Criterion (HQ). These criteria strike a balance between fit and parsimony of models. Where there is a conflict of criteria the majority rule is employed, although with the SC acting as a conservative guide to parsimonious modelling.

3.2.3 ARDL Bounds Testing Approach

To determine the relationship between the variables in the long-run and short-run, the Autoregressive Distributed Lag (ARDL) Bounds Test Approach, which was invented by Pesaran, Shin and Smith (2001) is utilized. This method has a number of benefits compared to the conventional cointegration techniques (Engle and Granger, 1987; Johansen, 1988). In particular, the ARDL method:

- Allows variables of varying integration order to be accommodated (i.e. $I(0)$, $I(1)$, or a mixture) without necessarily making all the variables $I(1)$.
- Gives strong and efficient estimates of small and finite sample sizes, especially considering the 33 years of data.
- At the same time approximates both the short-run dynamics and long-run equilibrium in one unified model.
- Gives unbiased long run estimates along with valid t-statistics regardless of the presence of endogenous regressors.

The ARDL model for this study is expressed as:

$$\Delta GDP_t = \alpha + \sum \beta_i \Delta GDP_{t-i} + \sum \gamma_j \Delta REMIT_{t-j} + \sum \delta_k \Delta INF_{t-k} + \lambda_1 GDP_{t-1} + \lambda_2 REMIT_{t-1} + \lambda_3 INF_{t-1} + \epsilon_t$$

Where: Δ is the first difference operator; GDP_t is the rate of growth of the GDP at a particular time; $REMIT_t$ is the amount of personal remittances received; INF_t is inflation; λ_1 , λ_2 , and λ_3 are the

long-run relationships; the lagged differences represent the short run dynamics; and ϵ_t is the stochastic error term.

The bounds test entails the estimation of the ARDL model using OLS and calculating the F-test of the joint null hypothesis $H_0: \lambda_1 = \lambda_2 = \lambda_3 = 0$ (no long-run relationship). Pesaran et al. (2001) give the lower $I(0)$ and upper $I(1)$ critical values as asymptotics. When the calculated F-statistic is greater than the upper bound, the null is rejected and the cointegration is proven, the order of integration of the variables being not important.

3.2.4 Long-Run and Short-Run Estimation

After the cointegration is confirmed, the coefficients of the long-run estimate are obtained using the ARDL model. The Error Correction Model (ECM) is a short-run dynamics and speed of adjustment:

$$\Delta GDP_t = \alpha + \sum \beta_i \Delta GDP_{t-i} + \sum \gamma_j \Delta REMIT_{t-j} + \sum \delta_k \Delta INF_{t-k} + \lambda ECT_{t-1} + \mu_t$$

Once the cointegration is established, the ARDL model is used to obtain the coefficients of the long-run estimate. Error Correction Model (ECM) is a short run dynamics and speed of adjustment:

3.2.5 Diagnostic and Stability Tests

In order to test the robustness of the model, the Breusch-Godfrey Serial Correlation LM test and the Breusch-Pagan-Godfrey Heteroskedasticity test are run. To measure structural stability, the CUSUM and CUSUM of Squares tests suggested by Brown, Durbin, and Evans (1975) are used, which plots recursive residual statistics versus time within 5% critical levels. The consistency of parameters over the sample period can be used to confirm the validity of the estimated long-run relationships.

4. EMPIRICAL RESULTS

4.1 Unit Root Test Results

The initial stage of the empirical analysis is to test the stationary properties of all three variables. Table 1 shows the results of the ADF test.

Table 1: Unit Root Test (Augmented Dickey-Fuller Test)

Variables	Level T-Statistic	Level P-Value	First Diff. T-Statistic	First Diff. P-Value	Order of Integration
GDP Growth	-4.008918	0.0041	-7.352172	0.0000	I(0)
Remittances	0.981557	0.9953	-3.960304	0.0049	I(1)
Inflation	-3.794493	0.0071	-7.302150	0.0000	I(0)

Source: Authors' Calculation in E-views. Data Source: World Development Indicators (WDI).

The results of the ADF test indicate distinct integration orders at the three variables. The levels of GDP growth are stationary, with a T-statistic of -4.008918 and p-value value of 0.0041, indicating that $I(0)$ is stationary at a 1% level of significance. The inflation is also at stationary levels, having a T-statistic of -3.794493 and p-value of 0.0071 which is also a check to $I(0)$ at 1% level. These findings imply that neither the GDP growth nor the inflation exhibit unit root behaviour and their statistical characteristics, mean and variance, stay the same with time.

Remittances, on the other hand, do not trend at levels, with a T-statistic of 0.981557 and a p-value of 0.9953, and clearly failing to reject the null hypothesis of a unit root. But, remittances, however, become stationary after first-differencing, where $I(1)$ is 0.0049 at a significance level of 1 percent, and T- statistic is -3.960304, and the p-value is 0.0049. It is in line with the empirical literature on remittances, which often identifies trending behaviour in nominal remittance flows as the stock of migrants and the average remittance per migrant increase over time.

The combination of $I(0)$ and $I(1)$ variables none of which are of order $I(2)$ or above is exactly the environment in which the ARDL bounds testing approach was intended to be used. Conventional tests of cointegration like the Engle-Granger 2-step process and the Johansen trace test demand all the variables to be $I(1)$ and are thus unable to test this mixed integration environment. The results of the ADF thus lend a solid methodological support to the ARDL framework used in the current study.

4.2 Lag Selection Criteria

The lag length of the VAR system is selected from various information criteria. The results are in Table 2.

Table 2: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-429.1549	NA	2.58e+08	27.88096	28.01974	27.92620
1	-362.0285	116.9300	6086458.	24.13087	24.68596*	24.31181
2*	-350.1245	18.43187*	514 5565.*	23.94352*	24.91493	24.26017*

Source: Authors' Calculation in E-views. * indicates lag order selected by the criterion. LR: Sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

The lag selection in Table 2 suggests that Lag 2 is the best choice for most criteria. The LR statistic (18.43187), FPE (514,5565), AIC (23.94352), and HQ (24.26017) all select lag 2, as marked by asterisks. The log-likelihood rises from -429.15 at lag 0 to -362.03 at lag 1 and -350.12 at lag 2 with quickly diminishing returns, indicating that two lags account for most of the dynamics of the system.

The only outlier is the Schwarz Criterion (SC), which chooses lag 1 (24.68596) since it penalises more heavily for model complexity. This is not uncommon in small samples: the SC is generally more conservative than the AIC (and especially so in small samples, $n = 33$). Since most criteria select lag 2, and following the choice of Majumder and Donghui (2016) for a similar data set from Bangladesh, lag 2 is used to specify the ARDL model. This strikes a balance between providing sufficient dynamic detail and having an identifiable model within the available degrees of freedom.

4.3 ARDL Bounds Test for Cointegration

We have verified the orders of integration and chosen the lag length in the ARDL model, so now we can perform the ARDL bounds test for cointegration. The results are shown in Table 3.

Table 3: Bounds Test Results for Cointegration

F-Statistic = 6.455377

Level of Significance	Lower Bound Value I(0)	Upper Bound Value I(1)
10%	2.63	3.35
5%	3.10	3.87
1%	4.13	5.00

Source: Authors' Calculation in E-views. Data Source: World Development Indicators (WDI).

The bounds test on cointegration decisively affirms the presence of a long-run nexus between the GDP growth, remittances and inflation in Bangladesh. The F-statistic of 6.455377 is much larger than the upper bound critical values of 10% (3.35), 5% (3.87), and 1% (5.00) respectively. As the F-statistic is greater than the upper critical bound even at the 1% significance level, the null hypothesis is decisively rejected.

This finding is in line with most of the previous Bangladesh-specific ARDL studies (Majumder and Donghui, 2016; Nurul Hossain and Hasanuzzaman, 2013; Kumar and Stauvermann, 2014), which report a cointegrating long-run relationship between remittances and GDP. The strong rejection of the null hypothesis (at all three levels) in the current study reinforces the previous findings and confirms the suitability of the ARDL approach to the analysis of the remittance-growth relationship in Bangladesh. It allows us to proceed with the estimation of long-run coefficients and the error correction model.

4.4 Long-Run Coefficient Estimates

The long-run estimates from the ARDL model are given in Table 4.

Table 4: Estimated ARDL Long-Run Coefficients

Variables	Coefficient	Std. Error	T-Statistic	P-Value
INFLATION	0.097204	0.087969	1.104984	0.2786
REMITTANCE	6.93E-05	2.78E-05	2.498644	0.0186
C (Constant)	4.485298	0.552768	8.114256	0.0000

Source: Authors' Calculation in E-views. Data Source: World Development Indicators (WDI).

The ARDL long-run coefficients provide an insightful and policy lessons for long-run Bangladesh GDP growth. The remittance coefficient is positive and significant (6.93E-05, $p = 0.0186$), suggesting that more remittances lead to higher long-run economic growth. The positive coefficient is in line with the remittance-led growth hypothesis, confirming the findings of Majumder and Donghui (2016), Kumar and Stauvermann (2014), and Akter et al. (2024) for Bangladesh, Dhungel (2018) for Nepal, and Abdulai (2023) for Ghana.

The size of the remittance coefficient - 6.93E-05 - implies that a USD 1 billion increase in annual remittance inflows is associated with an increase in the annual GDP growth rate of about 0.069 percentage points, all else held constant (including inflation). Though this marginal impact on the GDP growth rate seems small in percentage terms, the total effect on economic growth is significant in absolute terms given the size of remittance inflows to Bangladesh, which was greater than USD 21 billion in recent years. This result is consistent with the proposition that remittances play not only the role of consumption smoothing for remittance-recipient households, but also a role of long-run growth driver through their impact on aggregate demand, domestic investment and financial deepening (Nurul Hossain and Hasanuzzaman, 2013; Qamruzzaman, 2021).

Inflation also has a positive yet insignificant long run coefficient of 0.097204 ($p = 0.2786$). This finding suggests that after accounting for remittance inflows, inflation does not have a statistically significant long-run impact on GDP growth in Bangladesh over the period of analysis. This result could be explained by the relatively low and stable level of inflation in Bangladesh over the sample period, which may not have been high enough to cause significant long-term distortions to growth. It is also in line with Elahi and Rahman (2021), who show that remittances affect inflation in the short run but not in the long run, implying that the inflation-growth channel may be a short-run affair in Bangladesh.

The constant, 4.485298 ($p = 0.0000$), captures the baseline level of GDP growth when remittances and inflation are zero. Its statistical significance is a reflection of the underlying vibrancy of the Bangladesh economy which has grown at a rate of 5-8% p.a. during much of our sample period based on the textile sector, domestic consumption and productivity enhancements independent of remittance inflows.

4.5 Error Correction Model (Short-Run Dynamics)

In Table 5, we present the results of the Error Correction Model (ECM). The ECM describes the dynamics and mechanism of adjustment of short-run fluctuations to long-run equilibrium of GDP growth, remittances and inflation.

Table 5: ECM for the Estimated ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-0.920972	0.172248	-5.346784	0.0000

Source: Authors' Calculation in E-views. Data Source: World Development Indicators (WDI).

The ECM findings show a highly significant and fast adjustment to equilibrium. The coefficient of the error correction term CointEq(-1) is -0.920972, implying that 92.1% of a long-run disequilibrium between GDP growth, remittances and inflation is adjusted over a year. The t-statistic and p-value of -5.346784 and 0.0000 respectively confirm the extremely high statistical significance of this adjustment.

The speed of adjustment of 92% per year is relatively fast and suggests that the Bangladeshi economy very rapidly and effectively adjusts to short-run variations in remittance inflows. Such a high speed of convergence may be due to the direct channels of transmission of remittances to aggregate demand and growth in Bangladesh: remittances are mostly received by low-income households with high consumption propensities, and so a remittance inflow is rapidly converted into domestic consumption, output and growth. This may also reflect the stabilising influence of the exchange rate mechanism (ERM) whereby substantial remittance inflows appreciate the taka and reduce the import price, helping stabilise the economy.

The negative coefficient of the ECM is a necessary condition to establish the stability of the long-run cointegrating relationship. It ensures convergence, rather than divergence, toward equilibrium following a shock. Together with the bounds test confirmation of cointegration, this result represents compelling and mutually supportive evidence of the stability and economic significance of the relationship between GDP growth, remittances and inflation, over the 1991-2023 period.

4.6 Diagnostic Tests

To test the robustness and specification of the estimated ARDL model, we perform the following tests. The test results are presented in Table 6.

Table 6: Short-Run Diagnostic Tests

Diagnostic Test	F-Statistic	P-Value	Interpretation
Serial Correlation LM Test	0.281589	0.7569	No evidence of serial correlation
Heteroskedasticity Test	2.834324	0.0600	No strong evidence of heteroskedasticity

Source: Authors' Calculation in E-views. Data Source: World Development Indicators (WDI).

Serial Correlation LM Test: The Breusch-Godfrey Serial Correlation LM test gives an F-statistic of 0.281589 and a p-value of 0.7569, which is much higher than the 5% significance level. We fail to reject the null hypothesis of no autocorrelation in the residuals, implying that the model's residuals are uncorrelated over time. This finding confirms the dynamic structure of the ARDL model, and that the estimates of the coefficients are unbiased and efficient.

Heteroskedasticity Test: The Breusch-Pagan-Godfrey test for heteroskedasticity produces an F-statistic of 2.834324 and a p-value of 0.06, just above the 5% significance level. This test does not reject the null hypothesis of homoskedasticity at standard levels (although it is close to the threshold, so some caution is advised). This indicates that the residuals have reasonably homogeneous variance over time, and that the reported standard errors for the long run coefficients are about right. This means that the model's statistical inferences are not strongly affected by heteroskedasticity.

Overall, the diagnostic test results indicate that the estimated ARDL model is valid, and that the residuals meet the classical assumptions of linear regression that the errors are independent and homoskedastic, and that the statistical inferences from the long-run and short-run estimates are reliable and robust for policy purposes.

4.7 Stability Tests

The constancy of the ARDL model parameters is tested using the Cumulative Sum (CUSUM) and CUSUM of Squares tests (Brown, Durbin, and Evans, 1975). The tests use the recursive residuals from the model.

The CUSUM test is based on the cumulative sum of the recursive residuals against time within two bounds set at 5% level. The CUSUM of Squares test uses the cumulative sum of squared recursive residuals. In each test, the test statistic is contained within the 5% significance bounds across the entire sample period from 1991 to 2023, establishing the constancy of the parameters and the absence of any major structural changes in the relationship between GDP growth, remittances and inflation.

The constancy of the ARDL model over the entire 33-year timeframe is especially striking given the numerous macroeconomic shocks Bangladesh faced over this period. This includes the Asian financial crisis of 1997-98, global food and energy price shocks in 2007-08, the global financial crisis of 2008-09, and the COVID-19 pandemic in 2020-21 - the latter which initially led to a significant decline in formal remittance inflows, followed by a strong rebound in 2021-23. The consistency of the remittance-growth relationship during these periods also supports the view that remittances represent a robust long-term driver of GDP growth in Bangladesh.

5. POLICY IMPLICATIONS

The findings of this study have a number of policy implications for Bangladesh. The finding of a stable and substantial long-run association between remittance flows and GDP growth combined with a fast ECM speed of adjustment (92%) implies that policies to enhance and direct remittances are among the best ways to support long-run growth.

5.1 Lowering the Cost of Remittances

The transaction cost of remittances is a major obstacle to realising the growth potential of remittance inflows. Bangladesh remittances from the GCC and the United Kingdom are relatively expensive to transfer. Lowering these costs - through regulatory changes of money transfer operators, the promotion of mobile and digital remittance transfers, and bilateral agreements with

the key host economies - would result in higher net remittance inflows to Bangladeshi households, thus magnifying the growth effect estimated in this study. Targeting the Sustainable Development Goal set by the World Bank of reducing the average remittance transfer costs to less than 3% of the amount transferred is a good guideline.

5.2 Remittances as Investment

The long-term growth impact of remittances is expected to be greater when remittances are used for productive investment - physical investment, small businesses and human capital development - rather than for consumption. Policy measures to help such channelling include remittance-backed savings accounts, remittance bonds that are linked to investment opportunities, and financial education for remittance families. The findings of Nurul Hossain and Hasanuzzaman (2013) and Qamruzzaman (2021) that remittances have a positive impact on domestic investment in Bangladesh imply that such tools may be very effective. Bangladesh Bank and the Ministry of Finance should consider such financial instruments that would facilitate investment by overseas Bangladeshis in infrastructure, housing and small-scale business.

5.3 Improving the Overseas Employment Programme

Since the long-run effect of remittances on GDP growth is positive and significant, policies that increase the number of Bangladeshis working abroad and boost their productivity will have a direct impact on the economy. The government should focus on providing pre-departure training, language instruction and certification schemes to help Bangladeshi workers to compete in higher-wage labour markets overseas. Spread of the remittance job market beyond the conventional GCC markets, to Europe, East Asia and North America, would also make the remittance flow less susceptible to shocks specific to the GCC such as oil price shocks and changes in immigration policies.

5.4 Controlling Remittance-induced Inflation

Although the inflation coefficient in the long run is statistically insignificant in this analysis, evidence from Elahi and Rahman (2021) suggests that remittances can cause inflationary pressures in the short run when there is a sudden inflow of remittances and remitters spend their inflows on non-tradeable goods and services. The Bangladesh Bank needs to keep a close eye on the injection of money through remittances and be ready to use counter-cyclical monetary policy tools - such as reserve requirements, open market operations and interest rate setting - to stave off inflationary spikes from remittances, especially in the high global inflation environment of 2022-24.

5.5 Exchange Rate and Remittance Incentives

The exchange rate is a key factor in determining the taka value of remittances and, therefore, the incentive to send remittances through the formal channels. An overvalued taka diminishes the domestic value of remittances and incentivises remittances received through informal channels (hundi) that do not pass through the formal financial sector and reduce the multiplier effect of remittance inflows on the economy. Bangladesh Bank should ensure a competitive and stable exchange rate to attract a higher share of remittances through the formal channel, and should consider targeted remittance incentives (such as the 2% cash incentive currently being offered) to encourage remittances to flow through the formal channel. Such incentive schemes should be regularly reviewed and extended given their effectiveness in encouraging remittance formalisation.

6. CONCLUSION

This paper has investigated the effect of remittances on GDP growth for Bangladesh during the period 1991-2023 using the ARDL bounds testing approach in a trivariate model that also takes into account consumer price inflation. The empirical investigation follows a systematic approach: ADF unit root tests, lag order selection, ARDL bounds test for cointegration, long-run coefficient estimates, error correction model, diagnostic and stability tests.

The ADF unit root tests reveal that the GDP growth and inflation are stationary at levels $I(0)$; remittances are integrated of order one $I(1)$. This supports the use of the ARDL bounds testing approach. Most lag selection criteria point to lag 2, suggesting an ARDL(2,2,2) model.

The ARDL bounds test results in an F-statistic of 6.455377, which is greater than the upper critical bound at all three levels of significance (10%, 5% and 1%), which establishes the existence of a long-run cointegrating relationship between GDP growth, remittances and inflation. This finding is robust and in line with most previous studies on Bangladesh.

The estimated long-run coefficient of remittances is positive and significant ($6.93E-05$; $p = 0.0186$), suggesting that remittance inflow is a long-run driver of GDP growth in Bangladesh. Inflation is positive but statistically insignificant in the long run ($p = 0.2786$), implying that its impact on GDP growth is short run. The coefficient of error correction (ECM) of -0.9210 ($p = 0.0000$) suggest that 92% of the short-run disequilibrium is corrected in one year, implying quick and effective adjustment to equilibrium.

Tests for serial correlation, homoskedasticity and parameter stability (CUSUM and CUSUM of Squares) provide further evidence of the absence of serial correlation, homoskedasticity and the constancy of the parameters across the sample period, including during the 2020-23 COVID-19 disruption and recovery.

These results offer robust evidence in support of the remittance-led growth hypothesis for Bangladesh. They have direct implications for policy: lowering the cost of remittance transfers, facilitating remittance inflows for productive purposes, increasing the overseas employment program, dealing with inflationary effects of peak remittance inflows, and keeping the exchange rate competitive to stimulate remittance inflows through formal channels.

This analysis could be further developed by including other determinants of GDP growth - including trade openness, foreign direct investment, government spending and financial sector development - in a multivariate ARDL or VAR model. Use of nonlinear ARDL (NARDL) models, such as those used by Qamruzzaman (2021), would also facilitate study of any asymmetries in the effects of remittance increases and decreases on growth, another potentially important consideration in light of the COVID-19 shock. Province- or district-level micro data on remittance utilisation patterns would also help to clarify the pathways through which remittances flow to influence macroeconomic growth in Bangladesh.

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