

# Exploring Long-Run and Short-Run Dynamic Interaction among Real Exchange Rate, Economic Growth, Balance of Trade and Inflation: Insights from Bangladesh

Farjana Quayum Keya<sup>1</sup> Md. Elias Hossain<sup>1</sup> Md. Shamsuddin Sarker<sup>2</sup> S.M. Ashraf Hossain<sup>2</sup>

<sup>1</sup>Department of Economics, Rajshahi University, Rajshahi-6205.

<sup>2</sup>Department of Economics, Rabindra University, Bangladesh, Shahzadpur, Sirajganj-6770.

## Abstract

**Introduction:** This study investigates the dynamic interaction among the real exchange rate, economic growth, inflation, and the balance of trade in Bangladesh over the period 1986–2022. Understanding these interdependencies is crucial for formulating effective macroeconomic policies, as fluctuations in these variables can significantly influence the country's economic stability and growth trajectory.

**Objectives:** The primary objective of this study is to analyze the short-run and long-run relationships among the real exchange rate, economic growth, inflation, and balance of trade. Additionally, it aims to examine the causal relationships among these macroeconomic variables to understand their interdependencies. Furthermore, the study seeks to explore policy implications for effectively managing inflation, exchange rates, and trade performance to ensure sustainable economic growth.

**Methods** This study employs the Auto Regressive Distributed Lag (ARDL) model to analyze both short-run and long-run dynamics among the variables. Additionally, the Granger causality test is conducted to identify the direction of causality among economic growth, inflation, real exchange rate, and balance of trade.

**Results:** The findings highlight significant interdependencies among the selected macroeconomic variables. Inflation positively influences economic growth within certain thresholds, while the exchange rate plays a critical role in shaping both economic performance and trade balance. The study also identifies a bidirectional Granger causal relationship between economic growth, inflation, and balance of trade. Moreover, a unidirectional causality is observed from inflation to the real exchange rate. Despite these interactions, challenges such as inflationary pressures and trade deficits persist, affecting economic stability.

**Conclusions:** This study underscores the necessity of a comprehensive macroeconomic policy approach to manage the interplay among inflation, exchange rates, and trade performance. Policymakers should focus on coordinated strategies to sustain economic growth while mitigating inflationary risks and improving trade balance. Further research on external shocks and their macroeconomic effects is essential to strengthen economic resilience and enhance Bangladesh's position in the global market.

**Keywords:** Real Exchange Rate, Economic Growth, Inflation, Balance of Trade and Macroeconomic Policy.

## 1. Introduction

The interplay among the major macroeconomic variables e.g. real exchange rate, economic growth, balance of trade, and inflation plays a pivotal role ensuring macroeconomic stability of developing countries such as Bangladesh. Notably, a body of empirical studies has examined different aspects of this relationship within the context of Bangladesh, yielding significant insights into the interconnection of the

macroeconomic variables (Chowdhury et al., 2022; Hasan et al., 2021; Salma, 2021). Comprehending these interactions is essential for policymakers seeking to guarantee sustainable economic growth and macroeconomic stability. Inflation has consistently been a significant concern for Bangladesh's economy, with its correlation to economic growth being the subject of numerous studies. It is worth to mention that, *COVID-19 impacts country's long-standing*

macroeconomic stability and disrupts people's livelihood by rising poverty up to 40.9% (Gautam et al., 2021). In the analysis of impact of COVID-19 on macroeconomic stability the variables inflation, economic growth, balance of trade and exchange rate received significant attention of policy makers and academics (Gautam et al., 2021; Siddique et al., 2020; Bahttacharya et al., 2021; Ahamed, 2020). The relationship between economic growth and inflation remains one of the most debated topics in economic literature, particularly for developing economies (Adaramola and Dada, 2020; Ahmed, 2010; Hossain, 2015; Karke and Dumre, 2020; Azam and Khan, 2020). The dynamics between these two macroeconomic variables are complex and have significant implications for economic policy and stability. Previous studies argued that, a negative and statistically significant short-term correlation between inflation and growth (Adaramola and Dada, 2020; Ahmed, 2010; Ezako, 2023). Conversely, a moderate level of inflation facilitates economic growth by encouraging savings, augmenting investment, and expediting the growth process (Hossain, 2015; Karke and Dumre, 2020). It is to be noted that, volatile nature of inflation also affects the economic growth negatively. The findings of the study showed that exchange rate instability and inflation have a negative relationship with economic growth of the region (Olamide et al., 2021). Besides inflation, the real exchange rate significantly influences economic growth. Exchange rate most importantly real exchange rate plays pivotal role to determine the economic growth and ensuring equilibrium in national income (Razzaque et al., 2017). This emphasizes the potential of exchange rate policy as a developmental strategy while also highlighting the risk of inflationary pressures resulting from currency depreciation.

Additional studies have examined the wider macroeconomic ramifications of exchange rate policy

in Bangladesh. Hossain (2015) investigated the function of rule-based monetary policy in maintaining price stability and determined that the fixed exchange rate system implemented in Bangladesh, especially since 2003, has exacerbated inflation volatility and persistence. He contended that a more adaptable exchange rate system, coupled with inflation targeting, could bolster the credibility of monetary policy and mitigate inflationary pressures. Islam and Biswas (2009) analyzed the economic performance of fixed and floating exchange rate regimes in Bangladesh, concluding that the floating regime, implemented in 2003, has proven more effective in sustaining economic stability and fostering growth. The influence of exchange rate fluctuations on economic growth has been a topic of interest. Bristy (2014) examined this relationship and determined that exchange rate volatility adversely affects Bangladesh's economic growth, primarily due to its underdeveloped financial markets. Fluctuations in exchange rates were determined to deter innovation and long-term investment, consequently obstructing growth. This finding indicates that enhancing the financial market infrastructure in Bangladesh may alleviate certain adverse impacts of exchange rate volatility. Recent studies have emphasized the significance of external shocks, including foreign direct investment (FDI) and unforeseen events such as the COVID-19 pandemic. Khan (2021) examined the effects of inflation, exchange rate, foreign direct investment, and unforeseen shocks on Bangladesh's economic growth from 1990 to 2020. His findings indicated that inflation, foreign direct investment, and the exchange rate positively influence economic growth, whereas unforeseen events like pandemics and natural disasters adversely affect growth. This highlights the necessity for resilience in macroeconomic policies to withstand external shocks and guarantee long-term economic stability. The extensive literature indicates that the relationship

among the real exchange rate, economic growth, balance of trade, and inflation in Bangladesh is complex and context-specific. Although inflation can facilitate growth to a certain extent, excessive inflation generally yields detrimental effects. Exchange rate depreciation may foster growth and enhance the trade balance over the long term; however, it also presents risks of short-term contraction and inflationary pressures. This study seeks to expand upon these insights by delivering a thorough analysis of the interactions among these variables within the context of Bangladesh.

## **2. Objectives**

The primary objectives of this study are:

1. To analyze the short-run and long-run relationships among the real exchange rate, economic growth, inflation, and balance of trade.
2. To examine causal relationships among these macroeconomic variables.
3. To explore policy implications for managing inflation, exchange rates, and trade performance.

## **3. Literature Review**

### **Nexus between inflation and economic growth**

The intricate relationships among the real exchange rate, economic growth, inflation, and the balance of trade have been the subject of considerable research across different economies. Research in Bangladesh has revealed complex interdependencies between inflation, economic growth, and exchange rates. Ahmed (2010) highlighted a significant short-term negative relationship between inflation and economic growth, while Hossin (2015) found that moderate inflation could stimulate growth, suggesting a threshold beyond which inflation becomes detrimental. Sumon and Miyan (2017) further substantiated this notion, identifying an 8% inflation rate as a critical threshold. In contrast, Hossain et al. (2012) indicated a unidirectional causality running from inflation to growth, suggesting that inflation influences growth depending on

prevailing economic conditions. Another empirical study argued that, inflation impede growth when inflation exceeds the turning point 12.23% and 5.36% in developing and developed countries, respectively (Azam and Khan, 2020). A study conducted on developing countries found that inflation has positive effect on economic output (Uddin and Rahman, 2023). In contrast, it was revealed that inflation affects economic growth negatively in the developing economies (Olamide et al., 2022). In the same manner a study conducted in Ghana found that inflation has negative and significant effect on GDP (Kankpeyeng, et al., 2021). It is to be noted that, the economic performance of an economy affects the price level. A study found that, GDP and foreign exchange projects had also caused positive impacts, which have raised the prices of the stocks of almost every commodity (Deng et al., 2020). Bhunia (2016) demonstrated that economic growth influences inflation and interest rates in India, suggesting that growth shapes macroeconomic variables rather than being directly driven by them. Behera and Mishra (2017) identified a critical inflation threshold of 4%, beyond which growth is negatively impacted, echoing the findings of Tanwar (2014) regarding the trade-off between moderate inflation and growth. In light of the literature reviewed, the hypothesized linkage is given as follows:

H1: Inflation is likely to reduce economic growth while economic growth may promote inflation.

### **Linkage between real exchange rate, economic growth and balance of trade**

The role of exchange rates has also been a focal point in Bangladesh's economic research. Uddin et al. (2014) identified a significant positive correlation between exchange rates and economic growth, emphasizing a bi-directional causality. Razzaque et al. (2017) reinforced this finding, indicating that a 10% depreciation of the real exchange rate could enhance

aggregate output by 3.2%. However, they cautioned about potential inflationary pressures arising from such depreciation. Islam and Biswas (2009) argued for a more flexible exchange rate regime, while Khan (2021) underscored the impact of foreign direct investment (FDI) and external shocks on economic performance, highlighting the need for macroeconomic stability in shaping growth trajectories. The relationship between exchange rates and the balance of trade has also garnered attention. Aziz (2008) found that exchange rate depreciation positively influenced Bangladesh's trade balance, aligning with the J-curve theory. Zayed et al. (2019) added that exchange rate stability is crucial for sustaining economic growth, particularly in the context of Bangladesh's developing financial markets. The Indian context presents a rich tapestry of research concerning the dynamics of exchange rates, inflation, and economic growth. Jayachandran (2013) found that exchange rate volatility adversely affected trade, inhibiting both exports and imports. This aligns with the findings of Vasani et al. (2019), who emphasized the long-term relationship between real exchange rates and economic growth while noting the limited influence of the balance of payments and inflation. In China, the relationship between exchange rates, inflation, and economic growth has been extensively studied. Shu-ping and Xiao-meng (2017) explored the effects of exchange rates on FDI and growth, noting that exchange rate shocks had diminished adverse effects due to improved financial regulations. Tang (2014) found no long-term relationship between real exchange rates and growth but noted the significance of exports and FDI in driving economic performance. Hwang and Wu (2011) highlighted a nonlinear relationship, indicating that inflation above a 2.5% threshold impedes growth, while moderate inflation fosters economic expansion. The interactions among exchange rates, inflation, and growth dynamics in China have illustrated the nuanced effects of these

macroeconomic variables. Ahmed et al. (2020) emphasized the primacy of domestic demand over exchange rates in driving GDP growth, highlighting the importance of competitive exchange rate strategies.

In light of the literature reviewed, the hypothesized linkage is given as follows:

H2: Real exchange rate might have positive impact on inflation and balance of trade while balance of trade is likely to increase inflation.

### **Literature Gap**

Despite the extensive research conducted in Bangladesh, and other countries, significant gaps remain, particularly concerning the interaction of real exchange rates, economic growth, balance of trade, and inflation in the context of Bangladesh. While several studies have examined these relationships in isolation, a comprehensive analysis that integrates these variables in a unified framework is lacking. Moreover, the nuanced effects of external shocks, on these dynamics remain underexplored. Given the unique economic landscape of Bangladesh, characterized by its developing financial markets and distinct inflationary pressures, there is a pressing need for further research to understand how these variables interact and influence each other. Such studies could inform policymakers in designing effective strategies to foster sustainable economic growth while managing inflation and enhancing trade performance.

## **4. Methods**

### **Data**

To explore the dynamic interaction of the variables, GDP, RER, BoT and INF in Bangladesh, this study used time series data (annual basis) for Bangladesh from 1986 to 2022. The variable list, definition and sources of data are outlined in Table 1:

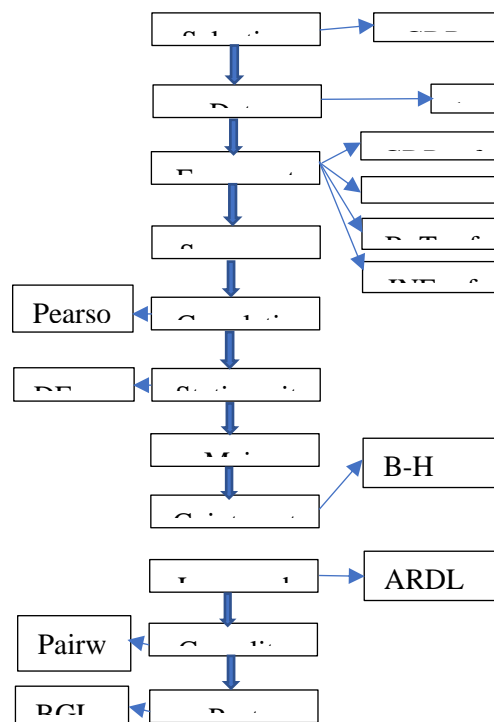
Variables	Symbol	Definition	Source of Data
GDP Growth	GDP	Gross Domestic Product at constant price 2015 US \$	World Development Indicators (WDI)
Nominal Exchange Rate	NER	Official exchange rate [Local Currency (LCU) per US\$, period average]	World Development Indicators (WDI)
Real Exchange Rate	RER	The exchange rate data are adjusted for the CPI of Bangladesh and the USA to yield the real exchange rate.	Calculated by the formula: $RER = NER * cpi(BD) / cpi(USA)$
Balance of Trade	BoT	Balance of Trade (BoT) at US\$	World Development Indicators (WDI)
Inflation	INF	Consumer Price Index (CPI) (2010 = 100)	World Development Indicators (WDI)

Note: 1. Consumer Price Index (cpi) 2. '\*' '/' denote multiplication and division respectively. 3. Bangladesh (BD), United States of America (USA).

After collecting data we have converted all the variables into natural logarithmic form for estimation purpose.

### Road Map of Research Methods

The road map of the analytical approaches used in the study is depicted by a flow chart figure (Fig.1).



### Methods

#### Unit root tests

Test for stationarity of the time series data for the variables, RER, GDP, BoT and INF, we employed augmented Dickey-Fuller Generalised Squares (DF-GLS), Phillips-Perron (PP) test proposed by Phillips and Perron (1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) proposed by (Kwiatkowski et al. 1992). We applied the KPSS test because some series are, in fact, trend stationary instead of having unit roots (Kwiatkowski et al. 1992).

#### Cointegration Tests

##### Bayer-Hanck Cointegration Test

It is revealed that all of the variables did not follow I(1). Figure 1. Roadmap of Research Methods of the Study

cannot be applied. As a final step, the variables follow a mixed integration order, and none of the variables follows I(2). This situation is perfect for employing the auto-regressive distributed lag (ARDL) approach and

the Bayer and Hanck approach, which is based on combined cointegration.

Because of the strict pre-condition of I(1) of all series Johansen and Juselius (1990) was found inappropriate for the current study. It is to be mentioned that we found the cointegration result at mixed orders of I(1) and I(0) and none of the variables followed I(2). The prior methodologies for cointegration analysis were found to be influenced by the sequence of integration of time-series variables. Consequently, relying solely on a single test could yield uncertain outcomes (Bayer & Hanck, 2013). As a result, for examining the cointegration among the series economic growth, real exchange rate, balance of trade and inflation the advanced cointegration testing method by Bayer and Hanck (2013) is applied. This testing method is popular for the statistical outcomes' high efficiency (Bayer & Hanck, 2013).

#### Autoregressive distributed lag (ARDL) Bound Test

In order to get the robustness of the cointegration results this study also relied on auto-regressive distributed lag ARDL bound cointegration test proposed by Pesaran et al. (2001) was developed to analyze the long-run and short-run connections between variables.

#### Autoregressive distributed lag (ARDL) approach for short-run and long-run analyses

The present study uses the ARDL approach to investigate the short-term and long-term dynamic interaction among the variables real exchange rate (RER), gross domestic product (GDP), balance of trade (BoT), and Inflation (INF) in the perspective of Bangladesh. This approach is primarily developed by Pesaran and Shin (1998) and Pesaran et al. (2001). As compared to other co-integrations, the ARDL method has a couple of advantages, such as it can be used irrespective of whether the series is purely cointegrated at the I(0), I(1), or mutually and estimated small sample properties (Pesaran et al., 2001; Shahbaz et al., 2013). Following the previous study conducted by Ahmed et al., 2021 the ARDL model for interactive analysis is constructed as follows:

$$\begin{bmatrix} \Delta RER_t \\ \Delta GDP_t \\ \Delta BoT_t \\ \Delta INF_t \end{bmatrix} = \begin{bmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \\ \theta_4 \end{bmatrix} + \sum_{i=1}^q \begin{bmatrix} \lambda_{11,i} \lambda_{12,i} \lambda_{13,i} \lambda_{14,i} \\ \lambda_{21,i} \lambda_{22,i} \lambda_{23,i} \lambda_{24,i} \\ \lambda_{31,i} \lambda_{32,i} \lambda_{33,i} \lambda_{34,i} \\ \lambda_{41,i} \lambda_{42,i} \lambda_{43,i} \lambda_{44,i} \end{bmatrix} \times \begin{bmatrix} \Delta RER_{t-1} \\ \Delta GDP_{t-1} \\ \Delta BoT_{t-1} \\ \Delta INF_{t-1} \end{bmatrix} + \begin{bmatrix} \xi_{1t} \\ \xi_{2t} \\ \xi_{3t} \\ \xi_{4t} \end{bmatrix} \quad (1)$$

where the selection of optimal lags is made by multiple information criteria (AIC) for all the variables of interest provided in Eq. (1). Matrix Eq. (1) is estimated by applying the ARDL method. Once the long-run linkages are settled among the study variables, it would be useful to examine the dynamics among the real exchange rate, economic growth, balance of trade and inflation in terms of exploring causal linkages among those variables. In this regard, the tools of the short-run investigation include the lagged error-correction terms (ET<sub>t-1</sub>) and the statistical outcome of the F-statistic.

$$\begin{bmatrix} \Delta RER_t \\ \Delta GDP_t \\ \Delta BoT_t \\ \Delta INF_t \end{bmatrix} = \begin{bmatrix} \theta_1 \\ \theta_2 \\ \theta_3 \\ \theta_4 \end{bmatrix} + \sum_{i=1}^q \begin{bmatrix} \psi_{11,i} \psi_{12,i} \psi_{13,i} \psi_{14,i} \\ \psi_{21,i} \psi_{22,i} \psi_{23,i} \psi_{24,i} \\ \psi_{31,i} \psi_{32,i} \psi_{33,i} \psi_{34,i} \\ \psi_{41,i} \psi_{42,i} \psi_{43,i} \psi_{44,i} \end{bmatrix} \times \begin{bmatrix} \Delta RER_{t-1} \\ \Delta GDP_{t-1} \\ \Delta BoT_{t-1} \\ \Delta INF_{t-1} \end{bmatrix} + \begin{bmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \end{bmatrix} \times (ET_{t-1}) + \begin{bmatrix} \xi_{1t} \\ \xi_{2t} \\ \xi_{3t} \\ \xi_{4t} \end{bmatrix} \quad (2)$$

For econometric estimation firstly, we utilized unit root test for testing the order of integration of the variables. Secondly, we portrayed descriptive and correlation analysis of the variables. Thirdly, we performed the cointegration tests for checking the relationship among the variables. Fourthly, the short and long-run relationship among the variables were estimated based on Autoregressive Distributed Lag (ARDL) based short and long run analysis. Finally, the pairwise Granger Causality test was applied to check the causal relationship among the variables.

#### Granger Causality Test

Based on VAR specifications, causality equations were constructed following the development of Granger (1969) for the exploration of the directions of linkages. In this regard, a bivariate framework was employed and the model specifications are given by:

$$y_t = \varphi_0 + \sum_{i=1}^n \varphi_i y_{t-i} + \sum_{i=1}^n \omega_i z_{t-ik} + \varepsilon_{it}$$

$$z_t = \varphi_0 + \sum_{k=1}^r \varphi_k z_{t-k} + \sum_{k=1}^r \omega_k y_{t-k} + \varepsilon_{kt}$$

Where  $i= 1, 2, \dots, n$  and  $k=1, 2, \dots, r$ . In a subsequent manner,  $n$  and  $r$  indicate the optimal lag length opted by the VAR model. Null hypothesis ( $\omega_i = \omega_k = 0$ ) of Granger-based causality testing is examined compared to the alternative hypothesis ( $\omega_i \neq \omega_k \neq 0$ ).

### 5. Results

Prior to conducting the main analysis, this study conducted a descriptive statistical analysis of the variables that were selected. Furthermore, the statistical techniques of Pearson pairwise and Spearman rank correlations were employed to demonstrate the presence of collinearity among the variables. The examination of descriptive statistics reveals that the average gross domestic product (GDP) of Bangladesh is estimated to be 127.20 (75.53) billion US dollars, with a corresponding standard deviation of 75.53 (Table 2).

Variable	Observation	Mean	Std. Dev.	Min	Max
GDP	37	127.20	75.53	45.00	305.00
BOT (bn\$)	37	-7.53	8.25	-36.89	1.45
INF (CPI)	37	87.12	56.49	24.28	215.86
RER (LCU/\$)	37	60.35	41.56	14.69	147.57

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER)

Furthermore, the mean values for BOT and CPI are seen to be -7.53 (8.25) billion US\$ and 87.12 (56.49), respectively (Table 2). Additionally, the findings of this survey indicate that the average real exchange rate is 60.35 LCU per US dollar (Table 2). Moreover, Fig. 2 shows the annual trend of BOT, RER, GDP and INF in Bangladesh. It clearly shows that, GDP, RER, INF and BOT are increasing over the years in Bangladesh.

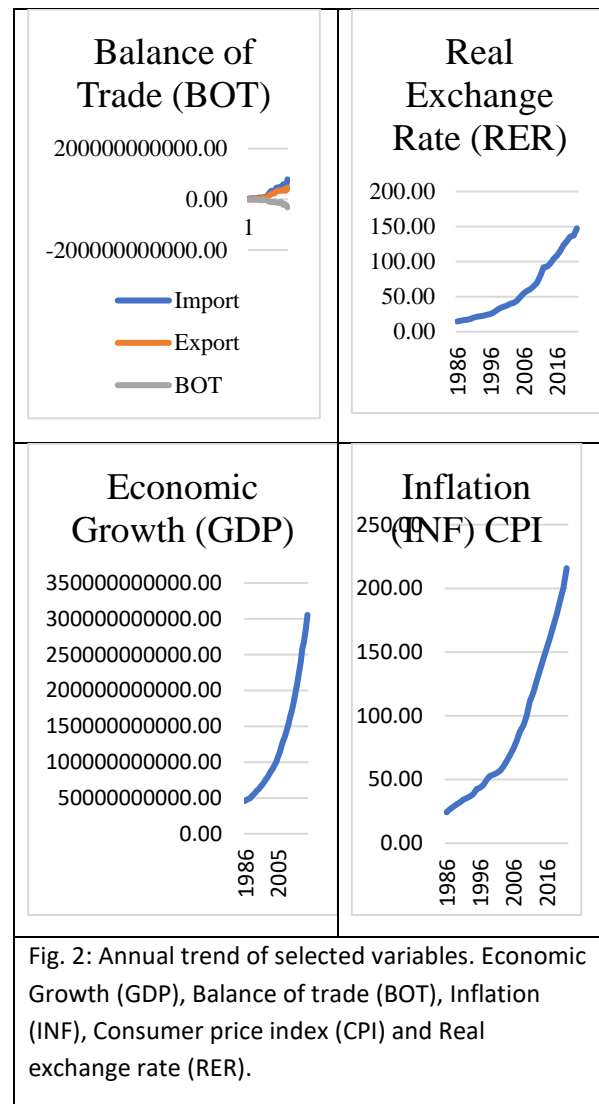


Fig. 2: Annual trend of selected variables. Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER).

### Results of Correlation Test

The statistical analysis in Table 3 utilizes the Pearson test and Spearman rank test to evaluate the correlations between economic growth, real exchange rate, balance of trade, and inflation. The results obtained from these tests are found to be robust. Both approaches yielded nearly identical results. This study identified significant relationships among the variables economic growth, real exchange rate, balance of trade and inflation (Table 3). The variables of inflation and economic growth exhibit a high degree of correlation (Table 3).

Table 3. Correlation coefficient result

Variab les	GDP	RER	BOT	INF
GDP	1.000			

Pearson Correlation	RER	0.996 *	1.000		
	BOT	- 0.969 *	- 0.954 *	1.000	
	INF	0.998 *	0.997 *	- 0.966 *	1.000 0
Spearman Rank Correlation	GDP	1.000			
	RER	1.000 *	1.000		
	BOT	- 0.963 *	0.963 *	1.000	
	INF	1.000 *	1.000 *	0.963 *	1.000 0

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER). \* p<0.05

The variables economic growth, real exchange rate and inflation have high degree of positive association. On the other hand, the variables, balance of trade, economic growth and real exchange rate have high negative association.

### Results of Stationarity Test

The results of the stationarity test for the time series of economic growth, real exchange rate, balance of trade, and inflation in natural logarithmic form are presented in Table 4. The analysis includes both level and first difference terms. Table 4 demonstrates that the variables of economic growth, balance of trade, and inflation exhibited a unit root process during their level phase. This conclusion is determined by three outcomes of hypothesis testing. The null hypothesis of the ADF-GLS technique, which posits that time series follow a random walk, is not shown to be statistically significant and hence cannot be rejected. The null hypothesis of the Phillips-Perron technique, which posits that time series data adhere to a unit root process, is not shown to be statistically significant and hence cannot be rejected. The null hypothesis of the KPSS technique, which assumes a stationary time series, is rejected as the ultimate criteria. In contrast, it

can be shown that the real exchange rate stayed constant during the level phase, indicating a stationary behavior characterized by an I(0) process. By employing the first-order difference approach, it was observed that all non-stationary variables reverted to a stationary state. The three stationary variables may be referred to as integrated of order 1 (I(1)).

**Table 4 : Results of unit root analysis (in both level and first difference analysis)**

Variables	DF-GLS		PP		KPSS	
	Trend & Intercept	Lev 1 <sup>st</sup> Difference	Trend & Intercept	Lev 1 <sup>st</sup> Difference	Trend & Intercept	Lev 1 <sup>st</sup> Difference
lnGDP	-	-	-	-	0.22	0.
	1.769	4.170***	1.857	6.996***	4	0.076**
lnBOT	-	-	-	-	0.22	0.
	1.323	6.524***	1.619	7.572***	9	0.062**
lnINF	-	-	-	-	0.24	0.084
	1.325	2.911	1.466	4.669***	8	0.0084***
lnRER	-	-	-	-	0.10	0.
	2.301*	4.849***	2.030*	4.334***	8**	0.096**

'ln' shows natural logarithm

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER).

\*p < 0.10, \*\*p < 0.05, \*\*\*p < 0.01

### Results of Cointegration Tests

#### Results of Bayer and Hanck's Combined Cointegration

Table 5 shows the estimation of Fisher statistical values for EG-JS and EG-J-Ba-Bo testing procedures. According to the test procedure, if estimation-based Fisher statistical values surpass Bayer-Hanck's (2013) critical values null hypothesis (non-existence of cointegration) is subject to rejection. Based on the estimated values EG-JS (8.994) and EG-J-Ba-Bo (23.277) and critical values EG-JS (10.63 at 5% level) and (8.071 at 10% level)

EG-J-Ba-Bo (21.635 at 5% level) and (16.253 at 10% level) the economic growth model confirmed the long-run linkage among the stated variables GDP, RER, BOT and INF. Similarly, the BOT model and INF model confirmed the long-run relationship among the variables BOT, GDP, RER and INF and INF, RER, GDP and BOT respectively. On the other hand, the cointegration was not confirmed by the RER model based on the estimated Fisher value of EG-JS but the model confirmed the long-run linkage in RER model based on Fisher estimation of EG-J-Ba-Bo test.

**Table 5. Results of Bayer and Hanck's Combined Cointegration**

Functional form of estimated equations	EG-JS	EG-J-Ba-Bo	Cointegration
$GDP_t = f(RER_t, BOT_t, INF_t)$	8.994*	23.277**	Existent
$RER_t = f(GDP_t, BOT_t, INF_t)$	7.583	23.184**	Existent
$BOT_t = f(GDP_t, RER_t, INF_t)$	11.447**	23.446**	Existent
$INF_t = f(GDP_t, RER_t, BOT_t)$	10.807**	21.653**	Existent
Critical Values	EG-JS 10.637	EG-J-Ba-Bo 20.486	

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER).

Bayer-Hanck critical values at 5% level (\*\*p<0.05 and \*p<0.10)

**Results of ARDL Cointegration Test**

Based on the decision rule, if the estimated F-statistic values surpass the upper bound's critical value, the null hypothesis of no cointegration will be rejected. Empirical estimation of the ARDL bound test showed the three out of four models (GDP, BOT and INF) proved the existence of cointegration linkage. The estimated values of the F-statistic for the three models (7.562,

5.687 and 5.484) those are higher than the critical values of upper bound. In contrast, the model of the real exchange rate confirmed the nonexistence of cointegration.

**Table 6. ARDL Bound Test Results**

Functional form of estimated equations	Estimated F-Stat.	Cointegration
$GDP_t = f(RER_t, BOT_t, INF_t)$	7.652**	Existent
$RER_t = f(GDP_t, BOT_t, INF_t)$	2.146	Inconclusive
$BOT_t = f(GDP_t, RER_t, INF_t)$	5.687**	Existent
$INF_t = f(GDP_t, RER_t, BOT_t)$	5.484**	Existent
Critical Values	Lower bound Upper bound	3.23 4.35

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER).

Pesaran et al. (2001) critical values for ARDL bound test at 5% level (\*\*p<0.05)

**Results of Long-Run Estimates**

**Long-Run Estimates of Economic Growth (GDP) Model**

Considering the long-run estimates of the economic growth model, the variable inflation only demonstrated a positive and significantly influence on the economic growth. In addition the variables real exchange rate and balance of trade demonstrated positive but insignificant impact on the economic growth. Table 7 reveals that the variable inflation presented strong effect (1.05) to economic growth of Bangladesh. The empirical results exhibited that 1% increase in the price level is anticipated to increase the economic growth by 1.05% in the long run. A study conducted by Manamperi, 2013 investigated the long run relationship between inflation and economic growth among the BRICS countries. The results found a positive

long-run relationship between inflation and economic growth for the country India.

**Table 7. ARDL Based Long-Run Estimation Results**

Variable	GDP Model	RER Model	INF Model	BOT Model
ln(GDP)	-	-0.092	0.257	3.012*
ln (INF)	1.050*	0.173*	-	-1.793
ln (RER)	0.131	-	0.527**	2.720**
ln (BOT)	0.117	1.403*	-	-
C	2.611*	1.070	-3.221	35.00

'ln' shows natural logarithm

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER).

\*p < 0.10, \*\*p < 0.05, \*\*\*p < 0.01

**Long-Run Estimates of Real Exchange Rate Model**

The long-run estimates of the economic real exchange rate model reveals that, the variables inflation and balance of trade demonstrated a positive significantly influence on the real exchange rate respectively. In addition the variables economic growth demonstrated negative but insignificant impact on the real exchange rate. Table 7 reveals that the variable balance of trade presented stronger effect (1.40) to real exchange rate depreciation of Bangladesh. The empirical results exhibited that 1% increase in the balance of trade is anticipated to increase the real exchange rate by 1.40% in the long run. In addition, the variable inflation showed a mild long run effect (0.173) on the real exchange rate of Bangladesh. In Mexico, a study based on ARDL model found that there is a bidirectional causality between inflation and exchange rate in the long run (Deka and Dube, 2021).

**Long-Run estimates of Inflation Model**

Long run estimates of inflation model shows that, the variables real exchange rate and balance of trade demonstrated a positive and negative effect on the inflation respectively. In addition, the variable

economic growth demonstrated positive but insignificant impact on the real exchange rate. The long run coefficient of real exchange rate and balance of trade variables 0.527 and -0.133. It means that a 1% increase in the real exchange rate will increase the inflation by 0.527% in the long run. In contrast, a 1% increase in the balance of trade will decrease the inflation rate by 0.133% in Bangladesh. A study conducted on Bangladesh found that there is a significant long run linkage between import and inflation (Mukit et al., 2013). In another long-run analysis, Mukit and Shafiullah showed that 1% increase in imports and in exports will increase inflation by 3.21 and 1.91% respectively in Bangladesh.

**Long-Run Estimates of Balance of Trade Model**

Table 7 shows the long-run estimates of the balance of trade model. The estimated long-run coefficient of the balance of trade model and the statistical significance shows that the variable economic growth and real exchange rate induced positive and significant influence on the trade balance of Bangladesh. The variable economic growth and real exchange rate presented a very strong effect on the trade balance. Study reveals that, if real exchange rate and economic growth are increased by 1% then trade balance will be improved by 2.72 and 3.012% respectively in Bangladesh. Pakistan's aggregate economic output is dependent on consumption spending rather than savings and thus leads toward the improvement of the balance of trade (Irfan et al., 2019).

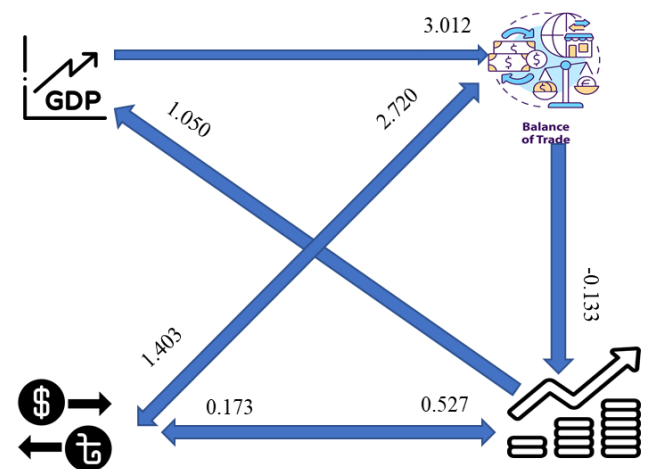


Figure 2

**Results of Short-Run Estimates**

**Short-Run Estimates of Economic Growth Model**

**Table 8. ARDL based Short-Run Estimation Result**

Variable	GDP Model	RER Model	INF Model	BOT Model
D (lnGDP)	-	0.682	0.115	-2.034*
D(lnGDP) (-1)	0.640** *	-0.707	-	-
D(lnGDP) (-2)	0.250	-	-	-
D (lnINF)	0.116	0.837** *	-	- 3.163**
D (lnINF) (-1)	-	-0.455*	0.550** *	-1.410
D (lnINF) (-2)	-	-	-	3.362**
D (lnRER)	0.015	-	0.237** *	1.842** *
D (lnRER) (-1)	-	0.984** *	-	-
D (lnRER) (-2)	-	-0.257	-	-
D (lnBOT)	-0.009	0.047*	-	-
D (lnBOT) (-1)	-0.004	-	0.037**	0.325**
D (lnBOT) (-2)	0.022**	-	-0.032*	-
R-squared	0.999	0.998	0.999	0.970
ECT (-1)	- 0.111**	- 0.272**	- 0.450** *	- 0.675**
Prob(F-statistic)	0.000	0.000	0.000	0.000

'ln' shows natural logarithm

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER).

\*p < 0.10, \*\*p < 0.05, \*\*\*p < 0.01

Table 8 presents the Autoregressive Distributed Lag (ARDL) based short-run estimation results for the models of Gross Domestic Product (GDP), Real Exchange Rate (RER), Inflation (INF), and Balance of Trade (BOT). The table lists the changes in natural logarithm values of GDP, INF, RER, and BOT over various lags, with corresponding coefficients indicating their short-run relationships. Notably, significant coefficients are marked with asterisks, indicating different levels of statistical significance (p < 0.10, p < 0.05, p < 0.01). The R-squared values suggest a strong fit for the models, ranging from 0.970 to 0.999, and all models show statistically significant results with p-values of 0.000 for the F-statistic. The Error Correction Term (ECT) values indicate the adjustment speed towards long-run equilibrium for each model.

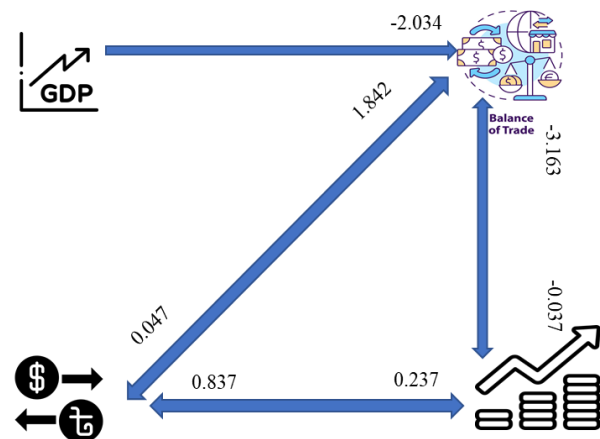


Figure 3

**Granger Causality Result**

**Table 9. Pairwise Granger Causality Estimation Result**

Null Hypothesis	$\chi^2$	Decision	Causality Direction
ln(GDP) does not Granger Cause ln(RER)	0.038	Accept	lnGDP ≠ lnRER
ln(RER) does not Granger Cause ln(GDP)	0.178	Accept	

In(GDP) does not Granger Cause In(BOT)	11.868	Reject	InGDP <-> InBOT
In(BOT) does not Granger Cause In(GDP)	4.690	Reject	
In(GDP) does not Granger Cause In(INF)	5.101	Reject	InGDP <-> InINF
In(INF) does not Granger Cause In(GDP)	3.674	Reject	
In(RER) does not Granger Cause In(INF)	0.850	Accept	InRER <-> InINF
In(INF) does not Granger Cause In(RER)	5.264	Reject	
In(RER) does not Granger Cause In(BOT)	0.447	Accept	InRER ≠ InBOT
In(BOT) does not Granger Cause In(RER)	1.615	Accept	
In(BOT) does not Granger Cause In(INF)	0.983	Accept	InINF ≠ InBOT
In(INF) does not Granger Cause In(BOT)	2.535	Accept	

'ln' shows natural logarithm

Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER). In(INF), while In(INF) Granger causes In(RER).

Table 9 shows the results of the pairwise Granger causality tests among the natural logarithm values of Gross Domestic Product (GDP), Real Exchange Rate (RER), Inflation (INF), and Balance of Trade (BOT). The table outlines null hypotheses regarding the absence of Granger causality between each pair of variables, along with the corresponding chi-square ( $\chi^2$ ) statistics and decisions to accept or reject these hypotheses. The results indicate that In(GDP) Granger causes In(BOT)

and In(INF), suggesting a bidirectional causality between In(GDP) and In(BOT), and In(GDP) and In(INF). In contrast, In(RER) does not Granger cause In(BOT) or In(INF). The findings highlight the complex interdependencies among these economic variables. (See Figure1 also)

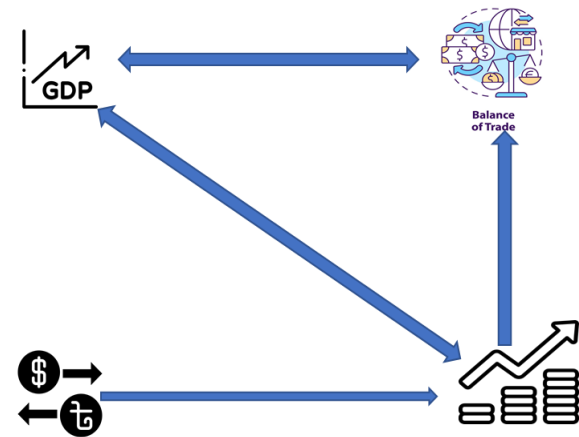


Figure 4

**Table 10. Diagnostic Tests**

Models	Tests	$\chi^2$	Probability
GDP	Breusch-Godfrey LM	1.11	0.291
	Breusch-Pagan-Godfrey	0.22	0.638
	Jarque-Bera Test	1.162	0.559
RER	Breusch-Godfrey LM	0.04	0.949
	Breusch-Pagan-Godfrey	1.60	0.205
	Jarque-Bera Test	1.39	0.499
BOT	Breusch-Godfrey LM	0.63	0.428
	Breusch-Pagan-Godfrey	0.77	0.381
	Jarque-Bera Test	1.49	0.474

INF	Breusch- Godfrey LM	0.247	0.619
	Breusch- Pagan- Godfrey	0.26	0.608
	Jarque-Bera Test	0.82	0.662

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Economic Growth (GDP), Balance of trade (BOT), Inflation (INF), Consumer price index (CPI) and Real exchange rate (RER).

Table 10 summarizes the diagnostic test results for the models of Gross Domestic Product (GDP), Real Exchange Rate (RER), Balance of Trade (BOT), and Inflation (INF). Each model underwent three diagnostic tests: the Breusch-Godfrey Lagrange Multiplier (LM) test for autocorrelation, the Breusch-Pagan-Godfrey test for heteroskedasticity, and the Jarque-Bera test for normality of residuals. The chi-square ( $\chi^2$ ) statistics and associated probabilities are reported for each test. All tests indicate no significant issues with autocorrelation, heteroskedasticity, or non-normality in the residuals across the models, as evidenced by the high p-values (ranging from 0.205 to 0.949). These results suggest that the models meet the assumptions necessary for reliable inference.

## 6. Discussion

The findings of this study contribute to the understanding of the intricate dynamics among the real exchange rate, economic growth, inflation, and balance of trade in Bangladesh. The positive correlation observed between economic growth and inflation aligns with Ahmed (2010) and Sumon and Miyan (2017), who indicated that moderate inflation can be conducive to economic expansion, provided it remains within a manageable threshold. The long-run coefficient of inflation on GDP (1.05) underscores the significant role that inflation plays in stimulating growth in the Bangladeshi context, suggesting that policymakers could leverage controlled inflation to foster economic development.

Conversely, the negative association between the balance of trade and economic growth, evidenced by the high correlation coefficient (-0.969) and confirmed by the long-run estimates, reflects the ongoing challenges in Bangladesh's trade dynamics. This finding resonates with Uddin et al. (2014) and Razzaque et al.

(2017), who noted that while exchange rate depreciation might enhance trade balance in theory, the actual experience in Bangladesh has been mixed. The negative impact of inflation on the balance of trade, as indicated by a long-run coefficient of -0.133, further complicates this relationship, suggesting that inflationary pressures could hinder trade performance, especially in an economy with a high import dependency. The study's results on the real exchange rate demonstrate a complex interaction with economic growth and inflation. The significant positive relationship between the balance of trade and the real exchange rate suggests that favorable trade conditions may lead to currency appreciation, enhancing economic stability. However, the long-run analysis revealing a mild effect of inflation on the real exchange rate indicates that inflationary pressures could lead to depreciation, counteracting potential benefits. This finding is particularly pertinent given the cautions raised by Khan (2021) regarding external shocks and their implications for Bangladesh's exchange rate stability.

The results of the stationarity and cointegration tests affirm that the variables under consideration are interconnected in the long run. The confirmation of cointegration among GDP, RER, BOT, and INF implies that these variables move together over time, suggesting a need for integrated policy approaches that consider their mutual influences. The ARDL bounds test further corroborates this relationship, demonstrating the presence of long-term linkages among these economic variables. Furthermore, the nuanced effects observed in the short-run estimates highlight the complexity of economic interactions. For instance, the short-run dynamics reveal a lagged positive impact of inflation on economic growth, suggesting that changes in inflationary pressures may not have immediate effects on growth trajectories. This echoes the findings of Hossain et al. (2012), indicating that the economic context plays a critical role in mediating the effects of inflation on growth.

## 7. Conclusion

The analysis of the intricate relationships among the real exchange rate, economic growth, inflation, and the balance of trade in Bangladesh highlights significant interdependencies and dynamic interactions among these variables. The findings indicate that while inflation has a positive impact on economic growth within certain thresholds, the exchange rate plays a

crucial role in influencing both economic performance and trade balance. However, challenges such as inflationary pressures and trade deficits persist, necessitating a comprehensive policy approach that harmonizes the various macroeconomic factors. The need for further research, particularly on external shocks and their effects, remains critical in shaping effective economic strategies. By addressing these complexities through coordinated policies, Bangladesh can foster sustainable economic growth, effectively manage inflation, and enhance its trade performance in the global market.

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