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Estimating the Exchange Rate Volatility and its Impact on International Trade Flow: Evidence from Bangladesh

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Abstract:

This study investigates the impact of exchange rate volatility on Bangladeshi export and import flows using an Autoregressive Distributed Lag (ARDL) bounds testing approach. The study period is from 2012 to 2022 using monthly data. The study has considered the real exchange rate, level of economic activity (GDP) for major Bangladeshi trading partners, and real exchange rate volatility as key determinants of Bangladeshi export level. Again, for determining the factors of Bangladeshi import level, the level of Bangladeshi economic activity (GDP), real exchange rate, and real exchange rate volatility are considered to be the explanatory variables. The findings reveal a statistically significant negative impact of exchange rate volatility on Bangladeshi exports, confirming theoretical predictions of increased uncertainty discouraging exporters. Additionally, the level of economic activity in major importing countries and the real exchange rate significantly influence export levels. However, import flows are primarily driven by the real exchange rate, with no significant impact observed from exchange rate volatility. Model diagnostics indicate potential instability in short-run coefficients for both models, warranting further investigation. These results offer valuable insights for policymakers, such as managing exchange rate volatility and promoting economic growth in key trading partners can bolster Bangladeshi exports. Additionally, focusing on domestic policies that stimulate import demand might be more effective than addressing volatility for managing overall trade flows. This research paves the way for further exploration of the complex relationship between exchange rate volatility and trade flows in Bangladesh, informing the development of effective strategies for sustainable trade expansion.

Keywords: Exchange Rate, Trade Flows, Volatility, Autoregressive Distributive Lag (ARDL).

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1.0 Introduction

After Bangladesh achieved her independence in 1971, the country adopted a highly controlled monetary, fiscal and industrial policy with a special focus on trade

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protectionism through internal, import-substituting trade policy and a fixed exchange rate regime. Unfortunately, subsequent macroeconomic performance was not pleasing in terms of GDP growth, industrial production, inflation, employment, budget deficit and trade balance deficit. Thus, in order to achieve sustained economic growth and speedy development, Bangladesh shifted from a highly controlled inward-looking regime towards a more liberalized free market-oriented regime. Since the mid-1980s, most of the trade and industrial policies were designed to be more liberalized to achieve higher growth in the export sector. Competitiveness in the international market, facilitating export-oriented industries, tariff reductions, access to international markets, and inspiring imports of intermediate capital goods were the main objectives that the government wanted to ensure while formulating exchange rate and trade policies. The policy started its motion in the early 1990s by a large-scale liberalization through a huge reduction in tariff rates and quantitative restrictions or quotas, and convertibility in exchange rates. The liberalized trade policy adopted by Bangladesh was consistent with the idea of "enhanced structural adjustment facility" (ESAF) of the International Monetary Fund and the World Bank and the Uruguay Round Accord of the World Trade Organization (WTO). Successive Governments also reassured their commitment to develop a more liberal trade regime under this accord. Hence, the trade balance pattern of Bangladesh has shown improvements over time with some instability in between.

As part of successive reforms, Bangladesh entered into a floating exchange rate regime with deregulated characteristics in May 2003 which was previously maintained under managed, pegged and currency-weighted basket method of exchange rate system. Market players for the first time were set free from the intervention of the government or Bangladesh Bank and allowed to fix the exchange rate from the interaction of market forces. The market initially reacted positively to the change in the foreign exchange regime. But later on, the fear that the flexible exchange rate would have its hostile consequences started showing its momentum. The local currency started to depreciate and become more volatile on and off under the flexible exchange rates regime since 2003. And this depreciation coupled with a major increase in the price levels both at consumer and producers' levels and as supported by Babatunde and Kehinde, (2016) in their research who said that during periods of volatility in the exchange rate, the inflation rate would be high. It also directly or indirectly caused the trade to be volatile in terms of its earnings and volume. However, while initially it was believed that trade flows would be shaken by exchange rate volatility or uncertainty, an opposite scenario was also observed. Monetary policy, foreign exchange reserve, trade deficit, international political situations, and manipulation by international traders also caused the exchange rate to be volatile. Empirical literature by Bahmani-Oskooee and Hegerty (2007) and Yakub et al. (2019) supports the negative and positive effects of the volatility of exchange rate on trade flows and their bilateral relationship. Recently in 2022-23, particularly in recent months in Bangladesh, we can see a highly volatile exchange rate resulting from the causes mentioned. Depletion of foreign exchange reserves, reduction in export earnings, vulnerable global political situation, impact of monetary policy implementation of global countries mostly USA etc. has broken all previous records of exchange rate depreciation. Policymakers are reviving import policies; the exchange rate is also interfered with by Bangladesh Bank to avoid this vulnerability. But both exchange rate and trade flows are fluctuating substantially. Thereby we feel it a necessity of time to investigate the issue further. The objective of this paper thereby we set is to test the hypothesis, "How volatile and persistent the exchange rate in Bangladesh is? And how the volatility in exchange rate affects the international trade flows?"

In this study, we used the Autoregressive Distributive Lag (ARDL) approach of co-integration to assess the short-run and long-run relationship between weighted average exchange rate volatilities on export and import volumes using monthly data. We hope that our study will provide firsthand evidence to help policy formulation for the overall management of exchange rates and its greater impact on trade and provide information that could guide more studies on the subject. The paper is organized as follows. Section 2 focuses on the literature on exchange rates and trade flows. Section 3 discusses the data and methodology employed in the study. Empirical findings are presented in Section 4 and finally, Section 5 concludes the study.

2.0 Literature Review

Both real and nominal exchange rates have been volatile far and wide since the fixed exchange rate of the Bretton Woods system was abolished in 1973. Exchange rate volatility inevitably depresses the volume and earnings of international trade by enhancing the uncertainty of trading activity. Numerous empirical analyses have been conducted to find the effect of exchange rate volatility on international trade flows. However, empirical results from these researches are quite inconclusive. Varying analytical results of the effects of exchange rate volatility on the international trade flows might be attributed to varying underlying assumptions, proper specification of the model, proxies chosen for exchange rate volatility, choice of sample period and the difference in country settings (developed versus developing).

Early research (1970-1990) on the effect of exchange rate volatility on international trade, including studies by Clark (1973), Baron (1976), and Bahmani-Oskooee (1986), generally shows a negative correlation between exchange rate uncertainty and trade. However, other studies, such as those by Hooper and Kohlhagen (1978) and Cushman (1983), found no significant effect, indicating mixed findings across the literature.

Barkoulas et. al (2002) investigated the impact of exchange rate volatility on trade volume and its variability by using a partial equilibrium approach and showed that the direction and magnitude of importers' and exporters' ideal trading activities depend on various sources of uncertainty like micro and macroeconomic shocks, factors driving the exchange rate process, or a noisy signal from improvements in policy. They provided a justification for the inconsistent empirical evidence in the literature by showing that exchange rate volatility emanating from micro and macroeconomic shocks and the fundamental factors reduces the variability of trade flows, while volatility arising out of noisy signals of policy improvements increases the variability of trade flows.

The impact of exchange rate volatility differs significantly in terms of the country settings i.e. whether the country under consideration is developed/industrialized, newly industrialized or developing. It is argued that exchange rate volatility shows a weak but positive impact on industrialized nations' trade flows whereas it shows an inverse and prominent effect on newly industrialized countries' trade flows. Baum et al. (2004), utilizing a monthly data set of 13 countries on their bilateral real exports for the period from 1980 to 1998, used a nonlinear specification and showed that the effect of exchange rate volatility on trade is non-linear and complex.

A study by Grier and Smallwood (2007) covered a sample of 9 developed and 9 developing countries to evaluate how uncertainty in foreign income and real exchange rates affect international trade. Their empirical analysis reveals that uncertainty in the real exchange rate has a negative and significant effect on export growth for 6 of the 9 developing countries in their sample, while it has a statistically insignificant impact for most of the developed countries incorporated in the study. Uncertainty in foreign income has shown a more significant and larger influence on trade than that of real exchange rates for both developed and developing countries under the study.

Baum and Caglayan (2009) conducted an empirical analysis on a dataset of Eurozone countries, other industrialized countries and newly industrialized countries for the period from 1980 to 2006 by employing a bi-variate GARCH-M methodology. They researched the relationship between exchange rate volatility and the mean and variance of trade flows and showed that exchange rate volatility has a positive and significant impact on the volatility of bilateral trade flows. According to their analysis, a one percentage point increase in exchange rate volatility leads to an eight percentage point increase in trade volatility. These results differ evidently for trade flows between industrialized countries and newly industrialized countries.

Empirical research on the effect of exchange rate volatility on international trade is not that much rich for less developed economies. This might be because of insufficient time series data, [Azaikpono et al. (2005), Vergil (2002)]. But exchange rate volatility affects the trade flows robustly in the case of less developed economies because of the lower level of financial development. A number of researches measured the effect of exchange rate volatility on foreign trade in less developed and emerging economies. Arize et al. (2000) did an empirical investigation on the impact of real exchange-rate volatility on the trade flows of 13 less developed countries. The study showed that an increase in the volatility of the real exchange rate has a significant negative effect on export demand in both the short-run and the long-run in each of the less developed economies under study. They suggested that these effects may cause a reallocation of resources by market participants at a significant level.

Ekanayake & Chatrna (2010) examined the impact of exchange rate uncertainty on exports of Sri Lanka with its major trading partners. Employing a generalized ARCH-type model (GARCH) the authors generated a measure of exchange rate volatility. They also used data for sectoral trade to identify whether the effect of exchange rate volatility differs according to the types of goods traded. The findings of this paper suggest that the effect of exchange rate volatility differs among different groups of goods traded but unfortunately, it remains tough to firmly establish the nature of the relationship between the variables.

Sarfaraz and Ouyang (2015) examined the effect of exchange rate volatility on trade flows in the case of China, Pakistan and India. The authors used the time series data from 1980 to 2013 and applied the Autoregressive Distributive Lag (ARDL) bound test approach of co-integration to estimate the short and long run relationship between the variables for the study period. Their findings suggested that exchange rate volatility is negatively related to the exports of China in the short run while positively related in the long run. However, in the case of Pakistan and India, the authors arrived at opposite findings. For these two countries, exchange rate volatility is negatively related to the total volume of trade both in the short run and long run.

The empirical evidence regarding the effect of exchange rate volatility on international trade flow in the context of Bangladesh as a developing economy is rare and inconclusive. Most of the empirical research works in the Bangladesh context shed light on estimation of export demand functions, [Kabir (1988), Ahmed et al. (1993), Bayes, et al. (1995)]. Ahmed (2009) in his empirical study on Bangladesh investigates the volatility of exchange rate and its impacts on international trade growth. The study shows that volatility in the exchange rate has a negative and statistically significant effect on trade both in the short run and long run especially on trade with Western European and North American countries. Hassan et al. (2016) have examined the long run and short run relationship of the Real Effective Exchange Rate (REER) on real export earnings of Bangladesh and found a long run relationship, not short run, with a negative impact of REER on real export earnings in Bangladesh.

Another recent study by Ali and Hasan (2018) also assessed the nexus between exchange rate volatility and the trade balance of Bangladesh with four different emerging economies i.e. Malaysia, Indonesia, South Africa and Mexico for the period from 2012 to 2017. Using the ARCH Heteroskedasticity test for volatility measure, the study found that except for Mexico, the other three countries have a positive association between exchange rate and balance of trade. This study also attempted to identify the bi-directional causality. Bangladesh and Mexico have uni-directional causality from exchange rate to balance of trade whereas Indonesia has uni-directional causality from balance of trade to exchange rate with Bangladesh. However, South Africa has been observed to have bi-directional causality and Malaysia is found to have no causality between the variables, however.

From the literature reviewed above, it is obvious that studies that examined the impact of exchange rate volatility on international trade flows are few in the case of Bangladesh. We hope this study will contribute to the existing literature in terms of methodology used, variables employed and updated period covered. This study incorporates the first logical analysis that measures volatility using the generalized autoregressive conditional heteroskedasticity (GARCH) and then takes the volatility series to the Autoregressive Distributive Lag (ARDL) approach of co-integration to assess the short run and long run relationship between weighted average exchange rate volatilities on export and import volumes for monthly basis for the period, July-2011 to June-2023. We hope monthly data frequency will make our empirical findings more robust particularly will help to capture the recent volatile movement in the exchange rate series.

3.0 Methodology

Before starting our analysis on the effects of exchange rate volatility on international trade we have to define proxies that capture the volatilities of the exchange rate and trade flow series. We will employ a standard deviation of the moving average of the log of real exchange rate to estimate these volatility measures as followed by (Klassen 2004; Dell'Ariccia 1999). This strategy is useful to estimate internally consistent conditional variances of both series which we will use as proxies for exchange rate and trade flow volatility. Prior to the estimation of the GARCH-M system, we will scrutinize the time series properties of the data to determine the order of integration of each series. We will subject these series to a rigorous analysis of their order of integration. Next, we will explore whether those exchange rate and trade flow series that exhibit I (1) characteristics exhibit a long-run cointegrating relationship by the ARDL (Autoregressive Distributed Lag) bounds testing approach developed by Pesaran et al. (2001) and estimate the short-run dynamics using ARDL Error Correction model.

For this purpose, the variable data are collected from the IMF's International Financial Statistics, Bangladesh Economic Review (latest Issue), Direction of Trade Statistics (latest Issue) published by IMF, and data collected from Bangladesh Bank (central bank of Bangladesh). Nominal exports of Bangladesh to the USA and some other major trading partners defined in the US Dollars will be used which will be deflated by the U.S.A. consumer price index to define them in real terms. Bangladesh liberalized its exchange rate policy in May 2003. The sample period from 2012 to 2022 is chosen to minimize the specification problems stemming from the change in exchange rate policies of Bangladesh as well as to ensure consistent data availability. However, the variable data is monthly collected, except for the Gross Domestic Product (GDP) data. The GDP data is available on a quarterly basis, and they are converted to monthly data using the quadratic match average frequency conversion method (Yakub et al., 2019). The data are collected for a period from 2012 to 2022.

Based on the previous literature, we have developed the Bangladeshi export and import demand models. The main determinants of international trade flows are the level of economic activity presented by GDP, the real currency (USD-BDT) exchange rate, and the volatility of the real exchange rate (Bahmani-Oskooee, and Aftab, 2017). The model specifications can be presented as follows:

$$LnX_{i,t}^{BD} = \alpha_0 + \alpha_1 LnY_t^{GDPW} + \alpha_2 LnREX_t + \alpha_3 LnV_t + \varepsilon_t \quad (1)$$

$$LnM_{i,t}^{BD} = \beta_0 + \beta_1 LnY_t^{GDPBD} + \beta_2 LnREX_t + \beta_3 LnV_t + \mu_t \quad (2)$$

Here, equation (1) represents the Bangladeshi export demand model, or it can be referred to as the global demand (major importing countries) for Bangladeshi export products.

Where, $LnX_{i,t}^{BD}$ is the Bangladeshi export (of commodity i) to the major importing countries from Bangladesh expressed in natural logarithm. It is considered to depend on the level of economic activity (GDP) of the major importing countries shown by Y^{GDPW}, the real USD-BDT exchange rate REX, and the volatility of the real (USD-BDT) exchange rate, V. Again, in equation (2), $M_{i,t}^{BD}$ represents the Bangladeshi import (of commodity i) which is considered to depend on the level of Bangladeshi economic activity (GDP) shown by Y^{GDPBD}, the real (USD-BDT) exchange rate REX, and its corresponding volatility, V. All the explanatory variables are expressed in the natural logarithm form. Any increase in the economic activity of a country is expected to generate more commodity imports. For this reason, the estimates of α_1 in (1) and β_1 in (2) are expected to be positive. Nevertheless, the expected outcome may also be negative if the economic activity (GDP) increases due to the increase of import-substitute commodity production (Bahmani-Oskooee, and Aftab, 2017; Bahmani-Oskooee, 1986). The definition of real exchange rate is expressed as the US Dollar equivalent Bangladeshi Taka. So, any increase in the exchange rate (depreciation of BDT) should stimulate Bangladeshi exports and negatively affect Bangladeshi commodity imports. So, the estimates of α_2 in (1) are expected to be positive and the estimates of β_2 in (2) are expected to be negative. Lastly, the estimates of real exchange rate volatility expressed in α_3 (1) and β_3 in (2) could be expected to be positive or negative.

These estimates capture the long-run relationships between the variables. Next, both equations need to be expressed in an error-correction format such that it is possible to understand the short-run effects. In this regard, the ARDL (Autoregressive Distributed Lag) bounds testing approach developed by Pesaran et al. (2001) has made it possible to provide the short-run and long-run associations among the variables in a single step.

To assess the stationarity of the time series variables, the study applied the Augmented Dickey-Fuller (ADF) test. The ADF regression for the model is as follows-

$$\Delta Y_t = \text{constant} + \beta_1 Y_{t-1} + \sum_{i=1}^{n} \beta i \Delta Y_{t-i} + \beta_{n+1}.\text{time} + \epsilon_t$$

where $\Delta Y_t = Y_t - Y_{t-1}$

The optimal lag length was chosen using the rule $n^{0.3333}$, where n is the sample size. The model tested for the significance of the time trend, lagged differences, and the constant, step-by-step, retaining only significant terms in the final model. Based on the final specification, the ADF test was run to determine whether the time series was stationary (I (0)). If the null hypothesis of a unit root was not rejected, the test was applied to first-differenced data.

If the data series are found to be stationary at different orders (stationarity both at level and first difference), then it is essential to run a cointegration test to determine a long-run association. However, the use of the Johansen cointegration test is not valid in this regard. Pesaran et al. (2001) suggested an alternative cointegration test known as the Bounds test to be used. The null hypothesis is that there is no level relationship among the variables. The test relies on comparing the F-statistic calculated from the data to the bounds on critical values that vary according to the number of variables included. Bounds test to be done on level, not 1st difference. Log form of data can be used in this regard. And rejection can be done at 10%, 5%, and 1% significance levels.

If F>CV for the upper bound I (1), then there is cointegration (long run relationship). It is possible to reject the null hypothesis and go ahead with the estimation of the long-run model; error correction model (ECM). On the contrary, if F<CV for the lower bound I (0), then there is no cointegration (no long run relationship). It is not possible to reject the null hypothesis and thus the short-run model- autoregressive distributed lag model (ARDL) can be estimated. If the F-statistics falls between the lower bound I (0) and the upper bound I (1), then the test is considered inconclusive. Following confirmation of long-run cointegration between the variables, the ARDL framework enables the estimation of both long-run and short-run coefficients. Optimal lag lengths for each variable are determined using the Schwarz Information Criterion (SIC).

4.0 Results and Discussion

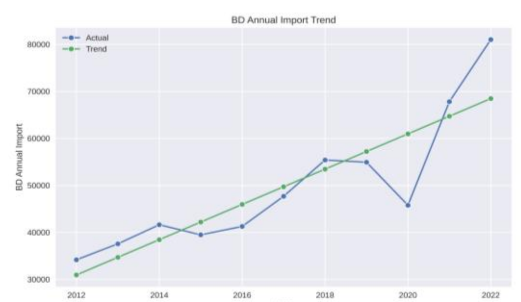
The summary statistics in Table-1 provide key insights into the major research variables over the 2012–2022 period.

Table-1 : Summary Statistics of Key Variables

Variables	Mean	Standard Deviation	Coefficient of Variation	Minimum	Maximum
Annual Import	49703.31	14205.47	28.58%	34173.2	81028.27
Annual Export	36274.68	8092.597	22.31%	25127.1	54695.37
BDT-USD Exchange Rate	82.14444	4.299149	5.23%	77.61341	91.64829
BD GDP	284844.3	111304.2	39.08%	133356	460201

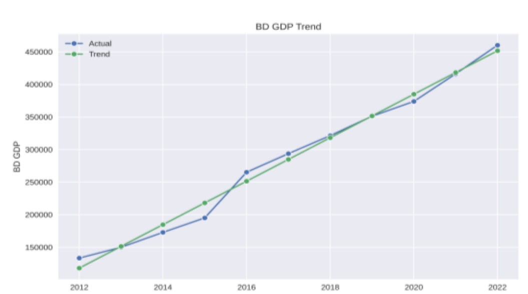
The average annual import value of Bangladesh is USD 49,703.31 million, with a notable standard deviation of 14,205.47, indicating substantial variability in import levels. Exports average USD 36,274.68 million, with lower variation compared to imports. The average annual BDT-USD exchange rate shows an average of 82.14 with a relatively low deviation (4.30), ranging from 77.61 to 91.65, reflecting a moderate degree of exchange rate stability. However, this is true for the annual exchange rate, unlike the monthly exchange rate, which is more volatile over the period. Finally, the Bangladeshi GDP showed considerable variation, highlighting the country's economic growth over the decade.

Figure-1 : Historic Trends of Key Variables



Bangladeshi Annual Import

Bangladeshi Annual Export



Bangladeshi Annual GDP

BDT/USD Exchange Rate

There are various ways to measure the exchange rate volatility as argued in the literature. However, the researchers did not agree on the best possible method to represent volatility. Among the different measures, Dell'Ariccia (1999) uses a statistical measure called the standard deviation to quantify the variability of the log of real exchange rate over time. Klassen (2004) expands on the standard deviation measure by calculating a moving average of monthly log real exchange rate changes, providing a smoother picture of volatility over time. Additionally, ARCH/GARCH models offer a more dynamic approach, capturing how volatility itself fluctuates (Asteriou, et al., 2016; Clark et al., 2004; Sauer, and Bohara, 2001).

There are two components of the GARCH model, such as the mean model and the variance model. Residual derived from the mean model equation is used to generate variance equation. If the model has both clustering volatility as well as an Arch-effect, only then it is possible to run the ARCH/GARCH model. Firstly, the residual of the mean model needs to be estimated.

Figure-2 : Exchange Rate Residuals

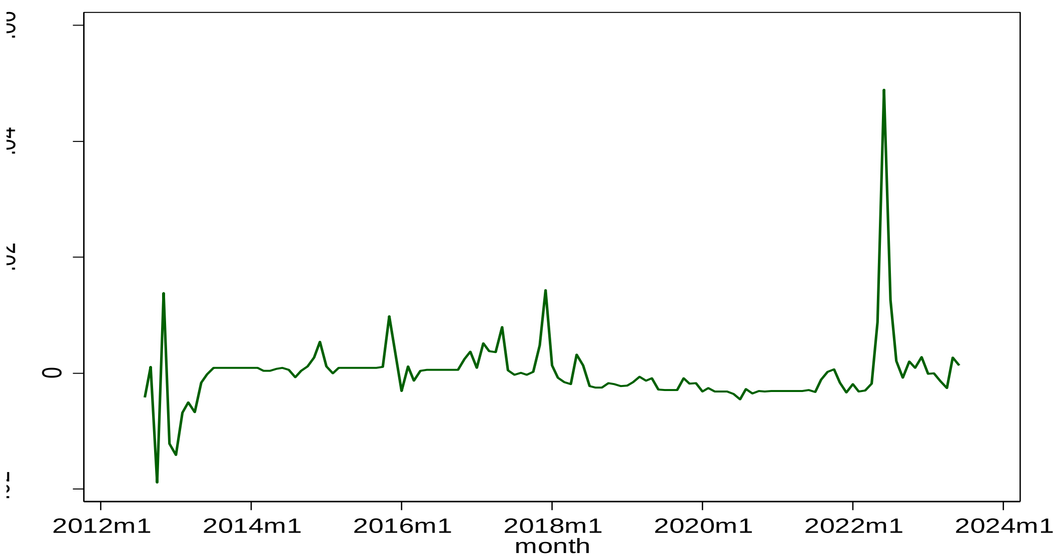


Figure-2 shows that there is clustering volatility in the residual; periods of low volatility are followed by low volatility for a prolonged period. It can be observed between the first month of 2014 to the first month of 2022. So, the residual (error term) is conditionally heteroskedastic. However, the behavior may be different in the initial months of 2022, where the period of high volatility is not consistently followed by high volatility. Upon consideration, the presence of ARCH-effect is not found here, so the volatility of the model cannot be represented using the ARCH/GARCH model.

Considering the ARCH/ GARCH approach is not applicable to this study, precisely quantifying exchange rate volatility remains a challenge. However, previous studies have found success utilizing the standard deviation of the moving average of the real exchange rate's logarithm. Therefore, to estimate volatility in this context, this approach is used by calculating the standard deviation of the moving average of logarithms for the real (effective) exchange rate of BDT in terms of US Dollar (Shaikh, and Hongbing, 2015).

The data variables need to be stationary in order to go forward with the model. The study has used Augmented Dickey Fuller (ADF) test to check for unit root to determine the order of integration. The stationarity test results are shown as follows in Table-2.

Table-2 : Results of Unit Root Tests

Variables	Test for Unit Root in	Augmented Dickey-Fuller Test Constant, With Trend		Remarks
		t- value	Critical Value	
LNBDE	Level	-5.993(1) ***	-4.028	Stationary
LNGDPW	Level	-5.401(1) ***	-4.028	Stationary
LNBDI	Level	-3.339(1) *	-3.145	Non-stationary
D.LNBDI	1st Difference	-12.302(1) ***	-4.028	Stationary at L (1)
LNBDGDP	Level	-2.459(1)	-3.145	Non-stationary
D.LNBDGDP	1st Difference	-8.944(1) ***	-4.028	Stationary at L (1)
LNRER	Level	-2.951	-3.146	Non-stationary
D.LNRER	1st Difference	-6.115(1) ***	-4.030	Stationary at L (1)
LNVOL	Level	-6.617(1) ***	-4.030	Stationary

(***), (**), and (*) indicates the statistical significance at 1%, 5% and 10% levels respectively.

The lag length is in parentheses.

Table-2 shows that LNBDE, LNGDPW, and LNVOL are stationary at level at 1% level of significance. The other three variables LNBDI, LNBDGDP, and LNRER are stationary at first difference L (1) at 1% level of significance. If the data series are found to be stationary at different orders (stationarity both at level and first difference), then it is essential to run a cointegration test to determine a long-run association. However, the use of the Johansen cointegration test is not valid in this regard. If all the variables were integrated at the same level (or first difference), then the vector error correction model (VECM) would be appropriate (Musa, 2021). The study will go forward with the ARDL model in order to carry out the co-integration test. Pesaran, et al. (2001) suggested an alternative cointegration test known as the Bounds test to be used. The Bounds test needs to be conducted on the level form of a data series. It is possible to reject the null hypothesis at 10%, 5%, or 1% significance level.

When running the tests using the ARDL model, the lag structure is shown and thus suggesting the model of ARDL (2,0,0,0) for both scenarios. A crucial assumption for the Bounds test is that the errors of the models (equations) need to be serially independent (Pesaran, et al., 2001). It may also be critical to the choice of optimal lags for the model variables (Thuy et al., 2019). In this study, the Breusch-Godfrey LM test is used to test the presence of serial correlation. The findings suggest that the null hypothesis of no serial correlation cannot be rejected at 10% significance level for model 1. In the case of model 2, the null hypothesis cannot be rejected at 1% significance level. Thus, both models are suitable for the cointegration test.

Table-3 : Results of Bounds Test

Variables	Number of Regressors	Sample Size	F Test Value	Critical Values Bounds					
Model	**k**	**n**	F-Statistic	**10%**		**5%**		1%	
				I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
ARDL-1 (2,0,0,0)	3	132	26.199	2.72	3.77	3.23	4.35	4.29	5.61
ARDL-2 (2,0,0,0)	3	132	1.982	2.72	3.77	3.23	4.35	4.29	5.61

Table-3 shows that in the case of model 1, the F-statistics is greater than the Critical Value at 1% significance level for the upper bound I (1). So, the null hypothesis is rejected. As the data series for model 1 are cointegrated, they are expected to exhibit a long-run relationship. So, this supports the presence of level relationships among the Ln of Bangladeshi exports, the Ln of GDP of the exporting countries, the Ln of the real exchange rate, and the LN of the real exchange rate volatility. So, it means that despite any short-run shocks affecting the individual series movement, the variables are likely to converge in the long-run as time progresses. Hence, the model can be used for both long-run and short-run estimations. On the other hand, the F-statistics of model 2 is lower than the Critical value at 10% significance level. The null hypothesis cannot be rejected, implying no long-run relationship for this model. So, we need to estimate the short-run autoregressive distributed lag model (ARDL) only.

Table-4 : Error Correction Model Result for Model 1

Dependent Variable LNBDE	Coefficients	Standard Error	t-statistics	p-value
C	-45.9529	6.206383	-7.40	0.000
Adjustment	-1.01222	.10353	-9.78	0.000
LNGDPW	2.09593	.22029	9.51	0.000
LNRER	-1.67967	.29878	-5.62	0.000
LNVOL	-.016049	.00745	-2.16	0.033
R-squared	0.5031	F-statistic	49.15	
Adjusted R-squared	0.4834	Prob(F-statistic)	0.0000	
Durbin-Watson Stat	2.09135			

The error correction model results from Table-4 suggest that all independent variables can significantly explain the variation in Bangladeshi exports. The association between the volatility measure and the exports is significant at 5% significance level. The level of global economic activity and real exchange rate can explain the level of exports at 1% significance level. The coefficient of LNGDPW is +2.096 approximately; indicating that the LN of GDP of major Bangladeshi exporting countries has a positive impact on the LN of Bangladeshi exports. The negative coefficient (-1.679) of LNRER implies that the depreciation of Bangladeshi currency with respect to US Dollar significantly accounts for any increase in the level of Bangladeshi exports. The approximate negative coefficient (-.0161) of LNVOL suggests that for 1% increase in the overall volatility in the exchange rate can result in a decrease in exports by as much as .02%. The empirical research has justified this decrease in exports to higher exchange rate volatility creating a more unpredictable environment for exporters. Increased volatility in exchange rates raises adjustment costs for exporters, such as the sunk costs associated with irreversible investments. This uncertainty and risk discourage the risk averse producers from expanding production for the global market, ultimately reducing export volume. In some cases, the exporters favor selling their products in domestic markets (Thuy et al., 2019; Aurangzeb et al., 2005; Perée, and Steinherr, 1989; Clark, 1973). The adjustment in the error correction model result for the model is -1.012, which means that for every 1% deviation of the dependent variable (LNBDE) from its long-run equilibrium level, the model predicts that LNBDE will adjust back towards equilibrium by 1.01222% in the following period. The Durbin-Watson statistic for the model is 2.09. It suggests that the errors in the model are not auto correlated. Overall, the error correction model result for the model suggests that there is a statistically significant relationship between the deviation of LNBDE from its long-run equilibrium level and the change in LNBDE. The model explains a moderate amount of the variation in LNBDE, and the errors in the model are not auto correlated.

Table-5 : ARDL Model (4,4,2,1) Result for Model 1

Dependent Variable LNBDE	Coefficients	Standard Error	t-statistics	p-value
C	-76.15324	9.9774	-7.63	0.000
LNBDE (4)	-.25889	.08886	-2.91	0.004
LNGDPW (4)	-3.8706	1.5092	-2.56	0.012
LNRER (2)	3.0651	1.4029	2.18	0.031
LNVOL (1)	-.00147	.00744	-0.20	0.844
R-squared	0.7543	F-statistic	25.22	
Adjusted R-squared	0.7244	Prob(F-statistic)	0.0000	
Durbin-Watson Stat	1.9409			

(ARDL short run lag is found by VARSOC output using the AIC, FPE, HQIC, and SBIC criterion.)

Table-5 depicts the ARDL model (4,4,2,1) results for Model 1. It shows the model has an R-squared of 0.7543, indicating it explains 75.43% of the variation in LNBDE. This can be considered a good fit for an ARDL model. In terms of the error correction term, the coefficient is -0.2589, which is statistically significant at the 1% level. This indicates a long-run equilibrium relationship between LNBDE and its past values. The negative coefficient implies that when LNBDE deviates from its equilibrium level, it will adjust back towards equilibrium by 0.2589% in the following period. Moreover, all the independent variables, LNGDPW, and LNRER have a statistically significant relationship with the dependent variable. However, the equilibrium relation with the LNGDPW does not correspond in the expected direction.

Table-6 : ARDL Model (3,4,2,1) Result for Model 2

Dependent Variable LNBDI	Coefficients	Standard Error	t-statistics	p-value
C	.60676	.38827	1.56	0.121
LNBDI (3)	.18293	.09349	1.96	0.053
LNBDGDP (4)	.32341	1.0631	0.30	0.762
LNRER (2)	1.69938	1.0411	1.63	0.105
LNVOL (1)	-.00501	.00544	-0.92	0.360
R-squared	0.8160	F-statistic	39.56	
Adjusted R-squared	0.7953	Prob(F-statistic)	0.0000	
Durbin-Watson Stat	1.90046			

(ARDL short run lag is found by VARSOC output using the AIC, FPE, HQIC, and SBIC criterion.)

Table-6 shows the ARDL model (3,4,2,1) output. The R-square of 0.816 suggests that the output can explain 81.60% of the variation in LNBDI. The error-correction term has a coefficient of 0.183, and it is statistically significant at the 5% level. It indicates a long-run equilibrium relationship between LNBDI and its previous values. The positive coefficient implies that when LNBDI deviates from its equilibrium level, it will adjust back slowly towards equilibrium by 0.18% in the subsequent period. Among the explanatory variables, only the LN of the Real Exchange rate is significant at 10% level. The coefficient of around 1.70 indicates that a 1% increase in the LNRE is associated with a 1.70% increase in LNBDI. So, overall, the LNBDI has a statistically significant relationship with its previous values and the real exchange rate. Deviations from equilibrium are corrected slowly, with LNBDI adjusting back towards equilibrium by about 0.18% per period. The real exchange rate has a positive impact on LNBDI in the long run, while the Bangladeshi GDP and the exchange rate volatility do not appear to have a significant impact.

Table-7 : Result of White's Test for Heteroskedasticity

Model	Chi-Square	p-value
Model 1	127.42	0.2403
Model 2	116.41	0.1560

The white's test for heteroskedasticity output from Table-7 shows that the probability value in both models is greater than 0.10. The scenarios do not represent any statistically significant outcome to reject the null hypothesis. So, it is evident that the models do not have any heteroskedasticity problem.

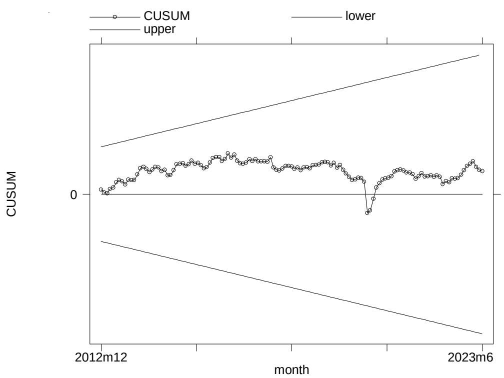
T-test and F-test are conducted to determine if there is a significant difference between the means and variances of the two periods for each variable respectively. The null hypothesis for the t-test and F-test is that there is no difference between the means and the variances correspondingly.

Table-8 : T-Test and F-test Statistics

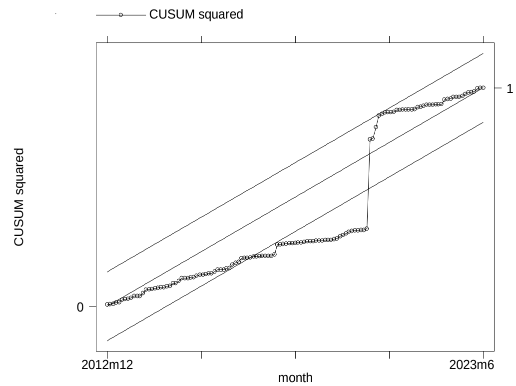
Variables	t-statistic	F-statistic
Annual Import	-3.543**	10.477**
Annual Export	-3.097**	8.473**
BDT-USD Exchange Rate	-3.771***	12.387***
BD GDP	-5.476***	28.945***

Table-8 shows that both the t-tests and F-tests indicate significant differences in the means and variances of Bangladeshi annual import and export, the corresponding Bangladeshi-US Dollar exchange rate, and the Bangladeshi GDP between the two periods (2012-2016 and 2017-2022). The outcome suggests that there have been potential structural changes and varying volatility patterns, which have influenced the average levels and fluctuations of these variables over time. However, the use of natural logarithms for economic variables in this study should help to address these issues through stabilizing variability, reducing the impact of fluctuations and heteroskedasticity (Lütkepohl, and Xu, 2012). It also normalizes skewed distributions and smooths out large values, improving comparability between periods. This transformation is expected to enhance the robustness of the model, especially when accounting for potential structural changes and shifts in volatility across different periods.

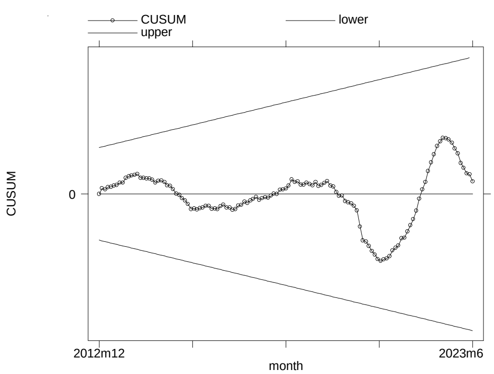
Figure-3 : CUSUM and CUSUM of Squares Statistics



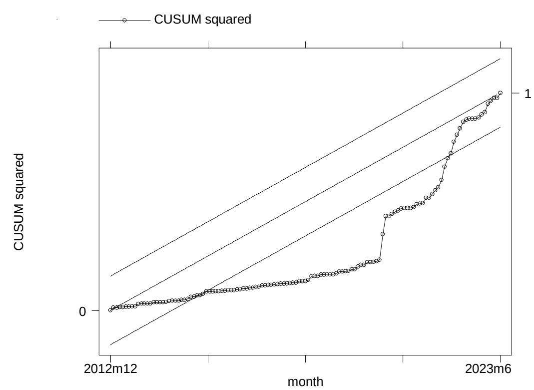
1(a)



1(b)



2 (a)



2 (b)

In this segment, the stability of the model's short-run dynamics as well as the long-run coefficients are assessed through CUSUM and CUSUMSQ ((Thuy et al., 2019; Brown et al., 1975). It can be observed from Figure-3 that the estimated models can be considered to be stable when the recursive residuals remain within the upper and lower bounds. Alternatively, if the residuals do not remain within the bounds (two critical lines), the models can be measured to be unstable. Initially, the CUSUM test estimates the sum of errors over time to spot any changes in the model's parameters. The CUSUM of squares monitors the cumulative sum of squared recursive residuals (errors) over time to identify abrupt changes in the model's coefficients. Figure-1(a) and Figure-2(a) show that the graph of CUSUM statistics for model 1 and model 2 are stable over the study period. The recursive residuals stayed within the critical bounds of 5% significance level. So, the estimated parameters are stable for the period under consideration. However, the CUSUM of squares shown in Figure-1(b) and Figure-2(b) do not provide satisfactory outcomes. The cumulative sum of squared recursive residuals for both models do not remain within the critical bounds during the period. So, it is not possible to conclude on any undisputed structural stability. The estimated results are not stable over time.

As far as the model diagnostics are concerned, the long-run parameters are found to be stable. However, it showed that the short-run coefficients in both models infer potential instability. The observed shifts in means and volatilities could suggest that the time series data may follow distinct trends and display varying degrees of uncertainty across the periods. This necessitates the use of models that account for structural changes and varying volatilities, such as regime-switching models or models with structural breaks. Policymakers should consider these changes when designing policies to manage exchange rate volatility and promote economic growth. Additionally, the increased volatility in certain periods highlights the need for robust risk management strategies to mitigate the impact of economic fluctuations on trade flows.

5.0 Conclusion

The study has investigated the impact of real exchange rate volatility on Bangladeshi export and import flows using an ARDL bounds testing approach. As per the findings of the study, the exchange rate volatility has shown a statistically significant negative impact on Bangladeshi exports, as expected. This outcome confirms the theoretical argument that higher volatility increases uncertainty and discourages exporters (Rahman et al., 2020). A rise in exchange rate volatility discourages exports, suggesting most exporters or producers of international goods are risk-averse. This volatility creates uncertainty about future exchange rates, making international sales riskier and less attractive than domestic ones, ultimately hurting exports. The level of economic activity (GDP) in major importing countries of Bangladeshi products and the real exchange rate significantly influence Bangladeshi product exports. A higher GDP in importing countries leads to increased demand for Bangladeshi products in the international market, while a depreciation of the Bangladeshi Taka makes exports more competitive as well. When BDT strengthens against USD, Bangladeshi exports become more expensive in USD terms, potentially leading to lower export earnings as foreign buyers prefer cheaper options (Alam, 2022). In the International market, the high-income Western countries and developing countries like Bangladesh play contrasting roles. While Western countries excel in advanced technologies, they still pursue diverse foreign goods and fuel international trade. Bangladeshi economy, specializing in labor-intensive products, finds a ready market in these wealthier nations. One produces advanced technologies, while the other offers labor-intensive goods and both sides have additional import needs, creating a dynamic flow of international trade. For the past five fiscal years, Bangladesh has secured around 75% of its exports to the European Union and North American region, whose national income is comparatively higher.

On the contrary, the level of Bangladeshi imports is positively correlated with the real exchange rate but not significantly impacted by the corresponding exchange rate volatility. The positive association between the real exchange rate and the level of Bangladeshi imports may be attributed to taking financial benefits through increasing the level of exports. Bangladesh needs to import most of the raw materials/ intermediary goods of its major exporting sector-readymade garments. The increase in the level of exports should come at the cost of an increase in the costly intermediary goods purchase, as well as expensive fuel from the international market. This outcome suggests that other (domestic) factors have a stronger influence on Bangladeshi imports than exchange rate uncertainty.

Moreover, Bangladesh's export and import items show diverse price elasticities that influence their sensitivity to exchange rate volatility and price fluctuations. For instance, primary Bangladeshi exports like ready-made garments, jute products, leather, and fish products have lower price elasticity due to consistent international demand, especially from higher-income markets with established consumption patterns. On the other hand, key Bangladeshi import items such as rice, wheat, dairy products, and edible oil demonstrate higher price elasticity, as their demand within Bangladesh may vary with price changes and availability. The dependency on imported inputs for export production, especially within the RMG sector, further complicates Bangladesh's trade landscape, as exchange rate volatility impacts the cost structure and profitability of exports, while also affecting input sourcing stability.

Further investigation taking into consideration the line of export and import may be warranted for future research. These findings offer valuable insights for policymakers in Bangladesh. Managing exchange rate volatility through interventions or diversification strategies could enhance export competitiveness and stabilize export earnings. Additionally, focusing on domestic policies that manage the import demand might be more effective in managing overall trade flows than addressing exchange rate volatility (Razzaque, Bidisha, and Khondker, 2017). Policymakers should consider elasticity variations across product lines to ensure that trade policies are responsive to the nuanced impacts of volatility on different sectors, balancing import needs with export aspirations. The current research lays the groundwork for further exploration of the multifaceted relationship between exchange rate volatility and trade flows in Bangladesh.

References

Ahmed M. (2009), *"Exchange Rate Volatility and International Trade Growth: Evidence from Bangladesh",* MPRA Paper No. 19466.

Ahmed, M., Haque, N., and Talukder, S. I. (1993), "Estimating Export Demand Function for Bangladesh: An Application of Co-integration and Error Correction Modeling", The Bangladesh Development Studies, 21, 89-104.

Akhtar, M., and Hilton, R. S. (1984), "Effects of Exchange Rate Uncertainty on German and U.S. Trade", *Federal Reserve Bank of New York Quarterly Review*, 9, 7-16.

Alam, M.Z., 2022. Most Influential Factors Affecting International Trade Flows: Bangladesh Context. *Journal of Entrepreneurship & Business*, *10*(1).

Asteriou, D., Masatci, K. and Pılbeam, K., 2016. Exchange rate volatility and international trade: International evidence from the MINT countries. *Economic Modelling*, *58*, pp.133-140.

Aurangzeb, A., Stengos, T. and Mohammad, A.U., 2005. Short-run and long-run effects of exchange rate volatility on the volume of exports: A case study for Pakistan. *International Journal of Business and Economics*, *4*(3), p.209.

Aziakpono, M., Tsheole, T. & Takaendasa, P., 2005. Real exchange rate and its effect on trade flows: New evidence from South Africa. http://www.essa.org.za.

Arize C, Osang T, , Slottje D. J 2000. Exchange Rate Volatility and Foreign Trade: Evidence from thirteen LDCs, *Journal of Business and Economic Statistics*, 18, 10–17.

Babatunde, A. A., & Kehinde, I. V. (2016). The impact of monetary policy on price stability in Nigeria. *Global Journal of Economics and Business Administration*, 1(2), 14-26.

Bahmani-Oskooee, M. (1986). Determinants of international trade flows: Case of developing countries. *Journal of Development Economics*, 20(1), 107–123. https://doi.org/10.1016/0304-3878(86)90007-6

Bahmani-Oskooee, M. and Aftab, M., 2017. On the asymmetric effects of exchange rate volatility on trade flows: New evidence from US-Malaysia trade at the industry level. *Economic Modelling*, *63*, pp.86-103.

Bahmani-Oskooee, M., & Hegerty, S. W. (2007). Exchange rate volatility and trade flows: A review article. *Journal of Economic Studies*, 34(3), 211–255. https://doi.org/10.1108/01443580710772777

Barkoulas J, Baum C. F, , Caglayan M 2002. Exchange rate effects on the volume and variability of trade flows, *Journal of International Money and Finance*, 21, 481–496.

Baron D. P 1976. Fluctuating exchange rates and pricing of exports, *Economic Inquiry*, 14, 425–438.

Baum C. F, Caglayan M, , Ozkan N 2004. Nonlinear effects of exchange rate volatility on the volume of bilateral exports, *Journal of Applied Econometrics*, 19, 1–23.

Baum C. F, Caglayan M 2009. The volatility of international trade flows and exchange rate uncertainty

Bayes. A. M., Hossain. I., and Rahman, M. (1995), "Independent Review of Bangladesh's Development External Sector, Centre for Policy Dialogue", Dhaka, Bangladesh.

Brown, Robert L., James Durbin, and James M. Evans. 1975. Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society Series B* 37: 149–92.

Chowdhury, A. R. (1993), "Does Exchange Rate Volatility Depress Trade Flows? Evidence from Error-Correction Models", *The Review of Economics and Statistics*. 75, 700-706.

Clark P. B 1973. Uncertainty, exchange risk, and the level of international trade, *Western Economic Journal*, 11, 302–313.

Clark, P.B., Wei, S.J., Tamirisa, N.T., Sadikov, A.M. and Zeng, L., 2004. A new look at exchange rate volatility and trade flows. In *A New Look at Exchange Rate Volatility and Trade Flows*. International Monetary Fund.

Cushman D 1983. The effects of real exchange rate risk on international trade, *Journal of International Economics*, 15, 45–63.

Dickey, D.A., and Fuller, W.A. (1979), Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of American Statistical Association*, 74, 427-431.

Dr. Mohammad Bayezid Ali and Md. Nazmul Hasan**:** The impact of exchange rate volatility on balance of trade: Evidence from selected emerging economies, *Journal of Business Studies*, vol. XXXIX , no.1 , pp. 99-111, 2018.

Ekanayake, E. & Chatrna, Dasha. (2010). The Effects of Exchange Rate Volatility on Sri Lankan Exports: An Empirical Investigation. *Journal of International Business and Economy*. 11. 51-68. 10.51240/jibe.2010.1.3.

Engle, R. and C. Granger. (1987), Co-integration and Error Correction: Representation, Estimation and Testing. Econometrica. 55. 251-276.

Gotur, P. (1985), "Effects of Exchange Rate Volatility on Trade: Some further Evidence", IMF Staff Papers, 32, 475-512.

Grier K. B, Smallwood A. D 2007. Uncertainty and export performance: Evidence from 18 countries, *Journal of Money, Credit and Banking*, 39, 965–979.

Hassan, R., Chakraborti, S., Sultana, S. and Rahaman, M. (2016). The Impact of Real Effective Exchange Rate on Real Export Earnings in Bangladesh. Working Paper Series WP No. 1605. Monetary Policy and Research Department, Bangladesh Bank.

Hooper, P., and Kohlhagen, S. W. (1978), "The Effects of Exchange Rate Uncertainty on the Price and Volume of International Trade", *Journal of International Economics*, 8, 483-511.

Kabir, R. (1988), "Estimating Import and Export Demand Function: The case of Bangladesh", The Bangladesh Development Studies, 115-127.

Lütkepohl, H. and Xu, F., 2012. The role of the log transformation in forecasting economic variables. *Empirical Economics*, *42*, pp.619-638.

Musa, N., 2021. Impact of exchange rate volatility on inflation in Nigeria. *Journal of Contemporary Research in Business, Economics and Finance*, *3*(1), pp.26-38.

Perée, E. and Steinherr, A., 1989. Exchange rate uncertainty and foreign trade. *European Economic Review*, *33*(6), pp.1241-1264.

Rahman, M.H., Majumder, S.C. and Hossain, M.N., 2020. The impact of exchange rate volatility on export and import in Bangladesh. *European Online Journal of Natural and Social Sciences*, *9*(2), pp.pp-411.

Razzaque, M.A., Bidisha, S.H. and Khondker, B.H., 2017. Exchange rate and economic growth: An empirical assessment for Bangladesh. *Journal of South Asian Development*, *12*(1), pp.42-64.

Sauer, C. and Bohara, A.K., 2001. Exchange rate volatility and exports: regional differences between developing and industrialized countries. *Review of International Economics*, *9*(1), pp.133-152.

Shaikh, Sarfaraz & Hongbing, Ouyang. (2015). Exchange Rate Volatility and Trade Flows: Evidence from China, Pakistan and India. *International Journal of Economics and Finance*. 7. 121. 10.5539/ijef.v7n11p121.

Thuy, V.N.T. and Thuy, D.T.T., 2019. The impact of exchange rate volatility on exports in Vietnam: A bounds testing approach. *Journal of Risk and Financial Management*, *12*(1), p.6.

Vergil, H., 2002. Exchange rate volatility in Turkey and its effects on trade flows. *Journal of Economic and Social Research*, 4 (1), pp. 83-99.

Yakub, M. U., Sani, Z., Obiezue, T. O., & Aliyu, V. O. (2019). Empirical investigation of exchange rate volatility and trade flows in Nigeria. Central Bank of Nigeria Economic and Financial Review, 57(1), 25-46.