# An Empirical Analysis of Exchange Rate Volatility and International Trade in Bangladesh, India, and Pakistan

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**Abstract:**

This paper investigates the role of exchange rate volatility in explaining international trade flows of three South Asian countries, Bangladesh, India, and Pakistan. By using the data from 2012 to 2024 on a monthly basis and an Autoregressive Distributed Lag (ARDL) bounds testing procedure, the above research studies the short run and long run relationships between exchange rate volatility and trade activities (exports and imports) taking into account the differences in the economic system and the exchange rate regimes of these nations. Consistent with the earlier findings focused solely on Bangladesh (Lima & Islam, 2023), the GARCH model estimations for Bangladesh show relatively brief fluctuations in exchange rate volatility compared to the more persistent patterns observed for India and Pakistan. This reinforces the notion of a comparatively more stable exchange rate environment in Bangladesh over the period. Finally, bounds testing establish presence of long run cointegration between exchange rate volatility and level of trade flows for Bangladesh and India, whereas it is not the case for Pakistan's import model. The results from ARDL and ECM show the different trade dynamics that exist in each of the countries: Bangladesh has a positive and strong association of GDP and import demand; the Indian exports are negatively affected by exchange rate depreciation. In addition, the study shows that dynamics of adjustment to long run equilibrium vary and that India has a fast corrective response to equilibrium deviation in its import sector. The research provides a case for policy responses specific to each country; stabilization of exchange rates; India and Pakistan; and ensuring the relatively stable environment in Bengal. This paper adds to the literature on the complicated relationship between trade and exchange rate volatility with up-to-date empirical evidence for the dynamic South Asian context.

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

**DOI:** https://www.doi.org/10.61607/JFB.V21N1-2.A11

**Article Info:** Submission Date: June 16, 2024; Acceptance Date: November 27, 2024

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## 1.0 Introduction

Academic study has intensely examined the connection between exchange rate volatility and international trade because it affects emerging market economies. The variability of exchange rates between different currencies creates uncertainties in foreign trade operations while currency valuation changes against international standards. The cost competitiveness of exports and imports becomes uncertain because of which exporters and importers must alter their decision-making processes. The understanding of these developments forms a base for policymakers who create trade and monetary policies.

In South Asia, Bangladesh, India, and Pakistan act as significant players in regional and global trade. These nations demonstrate diverse exchange rate volatility levels due to the implementation of different exchange rate systems and creation of economic policies together with their exposure to external market impacts. In 2003 Bangladesh started using market-supplied exchange rates that determine currency worth through the adoption of a flexible exchange rate system. Moving away from fixed exchange rates has become the common practice in India and Pakistan yet they take different measures to control their currency volatility. Economists still debate about how currency exchange rate movement affects the international trade within these countries.

Multiple studies about exchange rate volatility have generated inconsistent findings regarding trade activities. A couple of them indicates that volatile conditions reduce trade activities because erratic costs create market uncertainty which deteriorates export-import transactions. The trade balance between Pakistan and its trading partners faces a statistically verified decrease because of exchange rate volatility according to research. Exchange rate risks can push organizations to adopt hedging plans which protect them from price fluctuation risks according to multiple studies. Research within the South Asian Association for Regional Cooperation area comprising Bangladesh India and Pakistan discovered exchange rate uncertainty did not generate similar results for trade movements throughout the region. The effect appeared specific to regional and time-related circumstances.

The three neighbouring countries Bangladesh, India, and Pakistan have shared economic structures combined with diverse characteristics which impact their trade response to exchange rate volatility. Export activities in the textile and garment sector support most of Bangladesh's economic activities because this industry brings substantial export revenue to the nation. The Indian economy ships multiple types

of products to the global market such as information technology services, pharmaceuticals and engineering goods products. Textiles together with agriculture and surgical instruments make up the main export basket of Pakistan. Each country should examine its economic dependency on individual sectors since this determines how sensitive its trading activities become during the time of exchange rate changes.

Each of these countries adopts different tactics regarding their responses to exchange rate volatility. Department of Reserve Bank of India routinely operates in the foreign exchange market through interventions which seek to control volatility and improve export performance. The RBI declared export competitiveness of the Indian rupee remains unaffected by its exchange rate interventions since the country's merchandise export sector demonstrated durability against real exchange rate variations in recent years. The shift towards a floating exchange rate system led Bangladesh Bank to establish a hands-off approach regarding currency exchange rate decisions which permits market forces to determine the rate. Central Pakistani financial institutions participate in currency stabilization measures when the exchange rate becomes volatile.

While previous empirical efforts have explored aspects of exchange rate volatility and trade in South Asia, including a focused study on Bangladesh (Lima & Islam, 2023), the assessment of exchange rate volatility influence on international trade due to conflicting evidence between these three countries requires a more comprehensive and in-depth analysis across the region. This study investigates the degree of exchange rate volatility along with their influence on export-import trade activities in these countries. The study utilizes an Autoregressive Distributed Lag (ARDL) bounds testing approach to determine short-run and long-run trade flow effects from exchange rate volatility via monthly data analysis between 2012 and 2022.

The research outcomes will offer useful information that benefits decision-makers in these countries. The discovery of exchange rate volatility-trade flow relations will help governments design strategies activating measures from exchange rate stabilization and offering support to vulnerable sectors exposed to volatile exchange rates. Through this comparative research approach researchers will identify effective methods which neighbouring countries can adopt to strengthen their trade operations under exchange rate volatility.

This research aims to enhance current discussions about exchange rate volatility and international trade evaluation through extensive investigation of its effects on the economies of Bangladesh, India and Pakistan. The research investigates these

relationships to provide direct policy suggestions which can result in more stable trade environments in the South Asian economic region.

## 2.0 Literature Review

Grier and Smallwood (2007) used a research design that included 9 developed nations together with 9 developing countries to determine how foreign income and real exchange rate volatility shapes international trade. The statistical analysis from Grier and Smallwood (2007) demonstrates that uncertainty in real exchange rates negatively influences export performance in six developing countries among their total sample of nine nations yet produces zero results for most developed markets analyzed in the paper. Foreign income uncertainty produces larger effects on trade when compared to currency exchange rates regardless of country development status within the studied area.

The bi-variate GARCH-M technique enabled Baum and Caglayan (2009) to perform empirical research on Eurozone countries and other industrial and newly industrialized countries across 1980-2006. The authors investigated how exchange rate volatility affects trade flow mean and variance and discovered that exchange volatility produces statistically significant positive outcomes on trade volatility. Exchange rate volatility increases by a single percentage point which results in a forty-eight-percentage point rise in trade volatility according to their study. Evidence shows completely different patterns between industrialized countries and newly industrialized countries when it comes to trade exchange.

The relationship between exchange rate volatility and international trade has been a subject of extensive economic inquiry, driven by the profound implications for national economies. Theoretical postulations present a mixed view: while some theories suggest that exchange rate volatility introduces uncertainty, thus discouraging trade (via increased transaction costs and reduced profitability expectations) (Kenen & Rodrik, 1986; Clark, 1973), others argue that it could stimulate trade, for instance, by encouraging risk-taking behavior for higher potential returns, or by providing opportunities for arbitrage (Ethier, 1973; Hooper & Kohlhagen, 1978).

Empirical studies globally have yielded heterogeneous results, reflecting differences in methodologies, economies under study, and time periods. For instance, Gagnon (1993) found that exchange rate volatility negatively affects US exports, while Koray and Lastrapes (1989) reported similar adverse effects on German exports. Bahmani-

Oskooee and Hegerty (2007) provided a comprehensive review, noting that the relationship often varies by country and trade partner.

Within the context of developing and emerging economies, particularly in South Asia, research remains crucial due to the region's increasing integration into the global economy and diverse exchange rate management policies. Studies on Pakistan, such as those by Gulzar and Saeed (2012) have identified a negative impact of exchange rate volatility on trade flows, consistent with the uncertainty hypothesis. Sarfaraz and Ouyang (2015) conducted a study on exchange rate volatility impact on trade flows between China, Pakistan and India. The authors conducted their analysis with time series data from 1980 to 2013 to determine the short- and long-run relationships between the variables through the Autoregressive Distributive Lag (ARDL) bound test approach of co-integration. The research indicates that Chinese export volumes have an inverse correlation when measuring short-term exchange rate fluctuations but demonstrate a positive relationship during long-term assessments. The researchers detected contrasting results regarding this relationship in their studies of Pakistan together with India. Both Pakistan and India demonstrate that exchange rate volatility produces negative results on their overall trade volume across the short run and long run. For India, emerging as a global economic powerhouse, the evidence is similarly mixed. Sharma and Rajput (2018) found that exchange rate volatility adversely affects India's exports to various trading partners, while others, like Kaur and Kaur (2015), have highlighted the varying sensitivities of different sectors.

Empirical research on the effect of exchange rate volatility on international trade in the context of Bangladesh as a developing economy has historically been limited and inconclusive. While studies such as Hassan et al. (2015) and Ali and Hasan (2018) have examined specific aspects for Bangladesh, a recent study by Lima and Islam (2023) provided a more focused investigation into the impact of exchange rate volatility on Bangladeshi export and import flows using an ARDL bounds testing approach and monthly data from 2012 to 2022. Their findings revealed a statistically significant negative impact of exchange rate volatility on Bangladeshi exports, consistent with theoretical predictions, but observed no significant impact on import flows from volatility, with imports primarily driven by the real exchange rate. Building on this, the number of studies analyzing how exchange rate volatility affects international trade flows remains very limited for the three countries of Bangladesh, India, and Pakistan comprehensively.

Despite these insightful, country-specific investigations, including our recent empirical contribution on Bangladesh (Lima & Islam, 2023), a significant lacuna remains in the literature. A comparative analysis that simultaneously examines the dynamic and heterogeneous effects of exchange rate volatility on the international trade flows of these three distinct South Asian economies—Bangladesh, India, and Pakistan—is evidently absent. Such a comprehensive, multi-country study is not merely an aggregation of individual findings; it is essential for a robust justification of the findings from our prior study on Bangladesh by comparing its unique trade dynamics against those of its regional counterparts. This comparative approach, utilizing the advanced ARDL and GARCH methodologies, is critical to unraveling the nuanced interplay between their divergent exchange rate regimes, unique economic structures, and trade compositions within a unified analytical framework. This research, therefore, endeavors to bridge this critical gap by not only providing a deeper and updated empirical analysis, which brings updated 2011-2023 data to analyze trade balance variations between Pakistan and India and Bangladesh, but also by justifying the reasons behind the observed findings, thereby offering a more holistic understanding of the policy implications necessary for navigating a volatile global economic landscape.

## 3.0 Methodology

An analysis of exchange rate volatility effect on international trade flows needs definitions of the proxies of exchange rate volatility and international trade flows. The volatility estimation utilizes the standard deviation of the moving average of real exchange rate log transforms according to Klassen (2004) and Dell'Ariccia (1999). Internal consistency among conditional variances gets established through this method and produces volatility data suitable for exchange rates and trade flows.

Following established practices in the literature, including our prior work (Lima & Islam, 2023), this study utilizes Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models to estimate exchange rate volatility because they accurately represent how exchange rate volatility changes over time. Similarly, we will explore the exchange rate volatility-trade relationship in the long run using the Autoregressive Distributed Lag (ARDL) bounds testing approach from Pesaran et al. (2001), a methodology also employed in our previous research on Bangladesh's trade dynamics. The ARDL model proves to be effective in the scenario where regressors exist as I (0), I (1) or both forms simultaneously. The results of the bounds test will show if exchange rate volatility creates a relationship with the movement of trade flows.

A passing result from bounds testing will guide us to use the ARDL Error Correction Model for short-run and long-run effect estimation. Through the ECM we can analyze the time-dynamic process of long-run equilibrium deviation adjustments. The export and import demand functions appear as follows:

$$Ln\mathrm{X}_{i,t} = \alpha_0 + \alpha_1 Ln\mathrm{Y}_t^{GDPW} + \alpha_2 \mathrm{LnREX}_t + \alpha_3 \mathrm{LnV}_t + \varepsilon_t \quad (1)$$

$$Ln\mathrm{M}_{i,t} = \beta_0 + \beta_1 Ln\mathrm{Y}_t^{GDP} + \beta_2 \mathrm{LnREX}_t + \beta_3 \mathrm{LnV}_t + \mu_t \quad (2)$$

where:

- $Ln\mathrm{X}_{i,t}$ represents exports from Bangladesh, India, and Pakistan to major trading partners (expressed in natural logarithms), depending on global economic activity $\mathrm{Y}_t^{GDPW}$, the real exchange rate $\mathrm{REX}_t$, and exchange rate volatility $\mathrm{V}_t$.
- $Ln\mathrm{M}_{i,t}$ represents imports into Bangladesh, India, and Pakistan, depending on domestic GDP $\mathrm{Y}_t^{GDP}$, the real exchange rate $\mathrm{REX}_t$, and exchange rate volatility $\mathrm{V}_t$.
- The expected signs of coefficients align with economic theory: positive $\alpha_1$ and $\beta_1$ (higher GDP leads to more trade), positive $\alpha_2$ and negative $\beta_2$ (currency depreciation boosts exports but reduces imports), while $\alpha_3$ and $\beta_3$ may have mixed signs based on empirical findings.

The Augmented Dickey-Fuller (ADF) test is used to test for stationarity of the data series for unit roots. The specified ADF regression is:

$$\Delta \mathrm{Y}_t = \text{constant} + \beta_1 \mathrm{Y}_{t-1} + \sum_{i=1}^{n} \beta i \Delta \mathrm{Y}_{t-i} + \beta_{n+1}.\text{time} + \epsilon_t$$

Where $\Delta \mathrm{Y}_t = \mathrm{Y}_t - \mathrm{Y}_{t-1.}$ Also, the n0.3333 rule is chosen to determine the optimal lag length, whenever n is the sample size. In the case of integration of variables at different orders, the ARDL bounds test is applied to investigate cointegration.

The dataset used in this study is provided by the IMF sources (IMF's International Financial Statistics, Bangladesh Economic Review (latest issue), Direction of Trade Statistics (latest issue) as well as data from central banks of Bangladesh, India and Pakistan. Real terms are obtained by converting nominal trade values in terms of U.S consumer price index. To guarantee consistent data availability and to avoid specification problem due to policy changes, the sample period ranges from 2012 to 2024 is used.

The methodology adopted in this research designed to provide the estimation of exchange rate volatility and its effect on international trade flows between, among Bangladesh, India and Pakistan in the long run and the short run using autoregressive distributive lag (ARDL) and ECMs.

## 4.0 Results and Discussion

In this section, the focus shifts from the theoretical and methodological framework to what the data actually reveal about exchange rate volatility and trade flows in Bangladesh, India, and Pakistan. The results are presented step by step, beginning with the GARCH estimates of exchange rate volatility. These findings help us understand how persistent or short-lived currency fluctuations are in each country. Once the volatility patterns are established, the discussion moves on to the ARDL bounds testing and the Error Correction Model, which together provide evidence on both the long-term equilibrium relationships and the short-term adjustments between exchange rate movements and trade flows.

Table-1 reports the results of the fitted GARCH models for both nominal and real effective exchange rates. These estimates form the basis for interpreting the dynamics of exchange rate volatility across the three economies.

**Table-1: Results of Fitted GARCH models**

| **Dependent Variable** | **Nominal Exchange Rate (LN_ER)** | | | **Real Effective Exchange Rate (LN_REER)** | | |
|---|---|---|---|---|---|---|
| **LN_ER, LN_REER** | **Bangladesh (1,1)** | **India (2,1)** | **Pakistan (1,0)** | **Bangladesh (1,1)** | **India (3,3)** | **Pakistan (1,0)** |
| **C** | 4.4402*** (1.7e+04) | 4.2978*** (1199.14) | 156.9985*** (236.01) | 5.6336*** (2559.91) | 4.5997 *** (2358.91) | 4.5928*** (1209.47) |
| **ARCH** | 1.1475*** (3.92) | .6307** (2.24) | 1.0263** (2.10) | .9852*** (3.59) | -.0166 (-0.68) | .9647*** (3.10) |
| **GARCH** | -.00076 (-0.01) | .4326*** (3.47) | | .0335 (0.26) | 1.0406*** (11.39) | |
| **Variance Constant** | 3.38e-07 (1.23) | .00005 (0.78) | 8.0567 (1.21) | .00009 (1.39) | -.000014 (-0.25) | .00035*** (3.35) |

These results are important for international trade flows due to the direct effect of exchange rate volatility in export and import dynamics. In a case of Bangladesh, the nominal exchange rate is GARCH (1,1) and real effective exchange rate is ARCH (1), where volatility dies out relatively fast. It indicates that exporters and importers in Bangladesh may temporarily face uncertainty in exchange rate but it is also less

prone to over a prolonged period. For this reason, the trade flows may be less affected by long term exchange rate instability and a relatively stable trading environment encouraged.

For the nominal exchange rate in India, the volatility is GARCH (2,1), i.e., greater persistence in volatility. Fluctuations in exchange rates could persist through one, or more, of these periods creating definite uncertainty among exporters and importers because of the risks associated with international trade. This persistent volatility effect is reinforced by a GARCH (1,1) process for the real effective exchange rate. Businesses may delay transaction or look for hedging mechanism to decrease the risk of exchange rate uncertainty, discouraging higher trade activities.

Considering Pakistan, it is found that the nominal exchange rate follows an ARCH (1) process, thus exchange rate shocks are a short run phenomenon and do not have significant long-lasting effects on trade flows. Nevertheless, the real effective exchange rate's volatility is described approximately by a more complicated GARCH (3,3) model with nonzero autocorrelation terms, implying persistence in volatility. But that too can have mixed effects: short term volatility may not affect trade much, but long-term volatility will bring instability which will make exporters and importers unable to plan pricing and investment strategies.

Overall, the evidence suggests that countries with higher exchange rate volatility, particularly India and Pakistan, face greater uncertainty in their trade environment. Such instability can increase the risks and costs of cross-border transactions, discourage investment, and reduce trade competitiveness. In contrast, Bangladesh's exchange rate appears less volatile, creating a more predictable setting for international trade. Given these findings, policymakers in the region should aim to reduce excessive fluctuations in exchange rates and promote effective risk-management strategies, so that trade flows and long-term economic growth are less vulnerable to sudden shocks.

**Table-2: Results of Bounds Test using Exchange Rate**

| | **Variables** | **Sample Size** | **F Test Value** | |
|---|---|---|---|---|
| | **Model** | **n** | F-Statistic **(Nominal)** | F-Statistic **(Real Effective)** |
| **Bangladesh** | ARDL-Export (3,2,0,0) (3,2,2,0) | 144 | 5.697 | 7.314 |
| | ARDL-Import (3,4,0,1) (3,4,0,2) | 142 | 4.771 | 7.786 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **India** | ARDL-Export (3,3,1,1) (2,3,0,1) | 113 | | 5.282 | | 6.470 | |
| | ARDL-Import (1,1,1,0) (1,1,0,1) | 115 | | 66.906 | | 66.085 | |
| **Pakistan** | ARDL-Export (2,0,0,0) (3,0,0,0) | 118 | | 7.633 | | 6.026 | |
| | ARDL-Import (2,0,0,0) (2,0,0,0) | 118 | | 2.256 | | 3.319 | |
| | **Critical Values Bounds** | | | | | | |
| | | **10%** | | **5%** | | 1% | |
| | | I (0) | I (1) | I (0) | I (1) | I (0) | I (1) |
| | | 2.72 | 3.77 | 3.23 | 4.35 | 4.29 | 5.61 |

The Bounds Test results reveal there is long-run cointegration relationship between exchange rate volatility and trade flows (exports and imports) of Bangladesh, India and Pakistan. F-statistics formed by comparing the LN_ER and the LN_REER with critical value bounds at 10%, 5%, and 1% levels are presented in Table-2. Large values of the F-statistic indicate that there exists a long run relationship (I (1)), while small values of the F-test implies that there is no cointegration (I (0)).

In case of Bangladesh, F-statistics of the export model (5.70 and 7.31) are more than the 5% upper bound (4.35 and 5.61) indicating a long run relationship between exchange rate volatility and exports. Likewise, the F-statistics (4.771 and 7.786) of the import model also exceed the critical values, and therefore, provide strong evidence of cointegration. For the case of India, the F-statistics for export model (5.282, 6.470) lies above the critical bounds and hence a long run relationship exists. The most noteworthy result, however, is seen in India's import model, where F-statistics are 66.906 and 66.085, very high and therefore offering indisputable support for the fact that exchange rate volatility has a profound long-term effect on imports.

The F-statistics associated with nominal exchange rate is more than the upper bound; thus, there is a strong long run relationship with the export model for

Pakistan. But some evidence is found (at least in the long run) for the real effective exchange rate (6.026). On the other hand, the F-statistics (2.256 and 3.319) do not cross upper critical bound in the import model thereby implying no significant long run relationship between exchange rate volatility and imports in Pakistan.

The cointegration of Bangladesh and India is strong, which implies that import and export are correlated with exchange rate fluctuation, and ultimately stable exchange rate policies are needed for the purpose of trade facilitation. The mixed results of this paper suggest that exchange rate volatility is seen to have large impacts on exports and lower impacts on imports relative to Pakistan. The result justifies the use of Error Correction Model (ECM) and ARDL model to analyze the short run and long run effect of exchange rate volatility on trade.

**Table-3: Error Correction Model Result for Model 1 (Export)**

| **Dependent Variable** | **Nominal Exchange Rate** | | | **Real Effective Exchange Rate** | | |
|---|---|---|---|---|---|---|
| **LN_Export** | **Bangladesh** | **India** | **Pakistan** | **Bangladesh** | **India** | **Pakistan** |
| **C** | .9524** (2.10) | 1.1559 ** (2.21) | 1.7487*** (3.49) | 1.7541 (1.47) | 4.3997* (1.88) | .9044** (2.03) |
| **Adjustment** | .2761*** (3.51) | .2539 *** (2.91) | .2961*** (3.24) | .2742*** (3.59) | .2550*** (2.87) | .2282*** (2.61) |
| **LNPartnerGDP** | -3.3309** (-2.16) | 2.1547 *** (3.63) | .7662*** (4.01) | -2.6513** (-1.76) | 2.4707*** (4.22) | .8440*** (4.21) |
| **LNER** | 2.0757 (0.96) | -1.8164 ** (-2.55) | .0867** (2.18) | -2.7179** (-2.51) | -.2089 (-0.43) | -.0778 (-0.17) |
| **VOL** | .7640 (0.64) | -2.1807 (-1.62) | .00063 (0.43) | -.6029 (-0.47) | -41.929*** (-4.74) | .0125 (0.02) |
| **R-squared** | 0.7652 | 0.7918 | 0.6844 | 0.7819 | 0.7983 | 0.6910 |
| **Adjusted R-squared** | 0.7513 | 0.7691 | 0.6703 | 0.7655 | 0.7807 | 0.6742 |
| **F-statistic** | 55.00 | 34.91 | 48.58 | 47.68 | 45.30 | 41.01 |
| **Prob (F-statistic)** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **Durbin-Watson Stat** | 2.0479 | 2.0631 | 2.0843 | 1.9936 | 1.9794 | 2.0719 |
| **Mean Absolute Percentage Error (MAPE)** | 1.4559 | .7547 | .9270 | 1.3960 | .7357 | .9228 |

The short run dynamics and speed of adjustment of exports to exchange rate movements in Bangladesh, India and Pakistan is shown from the Error Correction Model (ECM) results of Model 1 (Export) shown in Table-3. In this model, export volume (LN_Export) is taken as the dependent variable and analyzed in terms of the nominal exchange rate (LN_ER) as well as the real effective exchange rate (LN_REER).

Almost for all the cases, the constant term (C) is statistically significant and it shows a stable relationship in the short run. Moreover, applying a negative and highly significant adjustment coefficient, the models indicate how the speed at which deviations from the long run equilibrium are corrected. Deviations of the export from the equilibrium levels react rather quickly to exchange rate volatility shocks: the values are ranging between 0.228 to 0.296. This is indicated by a higher speed of adjustment in Pakistan (0.296), which implies that its export sector is more responsive than the export sectors of Bangladesh and India.

The effects are mixed with GDP (LNPartnerGDP). It has negative impact on exports (–3.33, –2.65) of Bangladesh which means when trading partners' economies grow, Bangladesh's exports fall, perhaps as a result of changing demand patterns. By contrast, the coefficient is positive and extremely significant for India and Pakistan, implying that increased economic growth of trading partners increases the export demand of these latter countries.

Impacts of the exchange rate movements (LNER) are diverse. Within India, the coefficient on the real depreciation is negative and significant (-1.816), a result consistent with India's high import dependency for production, whereby a depreciation of the nominal exchange rate reduces export, probably because it does not increase export competitiveness. However, this impact is positive and weak for Pakistan. There is no significance of nominal exchange rate coefficient for Bangladesh, which may suggest that exchange rate fluctuations do not have a strong short-term influence on exports. The country with a negative impact on Bangladesh, under LN_REER, is Bangladesh (-2.71), while results for India are statistically insignificant.

India's real effective exchange rate shows a highly significant negative impact (-41.929) of exchange rate volatility (VOL) that suggest to a great extent that exchange rate uncertainty reduces Indian exports. However, Bangladesh and Pakistan have an insignificant volatility measure indicating that fluctuations in the exchange rate do not have a major effect on export levels at the short term.

The $R^2$ values are between 0.684 and 0.798, and thus, the model explains a large portion of the variation in exports. The model's robustness is confirmed by the fact that the adjusted R-squared values are close to the R-squared values. All the F-statistics are significant at 1 percent (p-value = 0.0000) supporting the model overall. Statistics of the Durbin–Watson is near 2, which indicate that there is no severe autocorrelation. The model's predictions are found as reasonably accurate, the smallest MAPE values recorded for the India model.

The results from these show that stability of the exchange rate is vital for generating exports in the South Asian economies. An important negative influence of volatility on India's real effective exchange rate indicates that Indian exporters are exposed to substantial exchange rate risks. While Bangladesh's exports are more resilient to volatility, the negative effect of exporting to trading partner GDP suggests that external demand factors are of key importance. Other results related to Pakistan suggest a relatively balanced impact associated with the exchange rate, but speed of adjustment indicates sensitivity to shocks.

**Table-4: ARDL Model Result for Model 1 (Export)**

| **Dependent Variable** | **Nominal Exchange Rate (LN_ER)** | | | **Real Effective Exchange Rate (LN_REER)** | | |
|---|---|---|---|---|---|---|
| **LN_Export** | **Bangladesh (4 3 2 1)** | **India (3 4 1 2)** | **Pakistan (4 4 2 2)** | **Bangladesh (4 3 4 1)** | **India (3424)** | **Pakistan (4 4 0 1)** |
| **C** | 1.1022** (2.09) | 1.1935** (2.18) | 1.3871** (1.99) | 1.3271 (1.05) | 4.1271 (1.37) | .6863 (1.50) |
| **LNPartnerGDP** | 1.2409 (0.78) | .6980 (1.00) | -1.0182* (-1.75) | 1.3497 (0.87) | .3451 (0.49) | -1.2394** (-2.20) |
| **LNREER** | -1.0263 (-0.43) | -1.7903** (-2.46) | .2219 (0.46) | .5335 (0.51) | -.2917 (-0.32) | -.2335 (-0.51) |
| **VOL** | 1.2451 (0.97) | .6691 (0.45) | .0002 (0.13) | 1.7576 (1.32) | -70.8587 (-1.26) | -.0157 (-0.03) |
| **R-squared** | 0.7673 | 0.7925 | 0.7328 | 0.7848 | 0.8055 | 0.7232 |
| **Adjusted R-squared** | 0.7439 | 0.7650 | 0.6923 | 0.7594 | 0.7727 | 0.6906 |
| **F-statistic** | 32.72 | 28.79 | 18.10 | 30.87 | 24.59 | 22.21 |
| **Prob(F-statistic)** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **Durbin-Watson Stat** | 2.0182 | 2.00008 | 1.9794 | 2.0172 | 1.9613 | 2.0435 |
| **Mean Absolute Percentage Error (MAPE)** | 1.4465 | .760001 | .9069 | 1.3953 | .7297 | .9042 |
| **(ARDL short run lag is found by VARSOC output using the AIC, FPE, HQIC, and SBIC criterion.)** | | | | | | |

The ARDL Model Results for Model 1 (Export), as shown in Table-4, is used to ascertain the export and exchange rate relationship of Bangladesh, India, and Pakistan with help of two exchange rate variables that include nominal exchange rate (LN_ER) and real effective exchange rate (LN_REER). This model incorporates both short and long run effects as these effects do have an impact on how the export performance is driven by exchange rate fluctuations and volatility. Exchange rates, trading partner GDP and volatility are found to play a role in determining the flow of trade, according to the estimated coefficients.

All models show a positive constant term (C) which is statistically significant in most cases indicating a level of exports unrelated to exchange rate changes. The effect of trading partner GDP (LNPartnerGDP) is fluctuating across countries. In both the nominal and real effective models, it has a negative and significant effect for Pakistan both (-1.018 and – 1.239) indicating that an increase in trading partner GDP does not necessarily mean its exports will increase. The reason could be because of structure of Pakistan's exports, which may not be correlating with increment in demand from other countries. In contrast, the effects are mixed and, on the whole, statistically insignificant for Bangladesh and India, suggesting that other factors may for the most part dominate in contributing to export growth.

For instance, the effects of changes of real effective exchange rate (LNREER) and nominal exchange rate (LN_ER) are mixed. We have used the nominal exchange rate, which has an extremely negative effect (-1.790), and so exchange rate depreciation hurts exports as they become more expensive to intermediate imports. But, for Bangladesh and Pakistan, here these effects are mostly negligible, implying a slightly weaker relationship between exchange rate movements and export performance. The results do not highlight the importance of exchange rate volatility (VOL) in explaining changes in exports, except in the case of India's real effective exchange rate model where VOL rises by -70.85 but it is significantly negative suggesting adverse export impacts of large exchange rate fluctuations.

Goodness-of fit measures such as $R^2$ and Adjusted $R^2$ measure a very good explanatory power of the models with values between 0.69 and 0.80. Overall, the models are found to be robust as the F-statistics are significant (p-values = 0.0000). Moreover, there appear to be no big autocorrelation problems according to the Durbin Watson statistic. However, the lower MAPE values suggest that India is relatively easier to predict than Bangladesh and Pakistan, both with regard to the politician's majority in percentage (as modelled) and election winner (as indicated by the error).

The results indicate that exchange rates do have some impact on exports but that these results are highly contingent on country and specification. Exports of India appear to be more sensitive to exchange rate fluctuations, while Pakistan's exports are negatively affected by trading partner GDP. In case of Bangladesh, while the previous work (Lima & Islam, 2023) identified a statistically significant negative impact of exchange rate volatility on Bangladeshi exports, the current analysis shows that Bangladesh's export performance appears, to a large extent, detached from changes in the exchange rate suggesting that other factors in the structure of the trade flows matter more.

**Table-5: Error Correction Model Result for Model 2 (Import)**

| **Dependent Variable** | **Nominal Exchange Rate** | | | **Real Effective Exchange Rate** | | |
|---|---|---|---|---|---|---|
| **LN_Import** | **Banglades h** | **India** | **Pakistan** | **Bangladesh** | **India** | **Pakistan** |
| **C** | .7221** (2.15) | .0106 (1.09) | .8659* (0.56) | 3.6905*** (3.81) | -1.3641 (-0.66) | .8940** (2.22) |
| **Adjustment** | .2470*** (3.19) | -.4016*** (-4.62) | .3066 *** (3.53) | .2787*** (3.72) | -.4246*** (-4.76) | .31381*** (3.74) |
| **LNGDP** | 7.024306** * (2.78) | 1.2647*** (2.80) | 2.2338* (1.96) | 7.9915*** (3.27) | 1.3954*** (3.09) | 2.0602* (1.83) |
| **LNER** | 1.952623 (1.26) | -1.1424* (-1.82) | -.0875 (-0.24) | -.4739*** (-3.47) | .3417 (0.80) | -.6822 (-1.43) |
| **VOL** | 1.312845 (1.54) | 1.4607 (1.50) | .0009 (0.55) | -1.5391* (-1.82) | -11.9448 (-1.57) | -.8665 (-1.39) |
| **R-squared** | 0.8564 | 0.2767 | 0.7575 | 0.8680 | 0.2662 | 0.7658 |
| **Adjusted R-squared** | 0.8442 | 0.2366 | 0.7467 | 0.8557 | 0.2254 | 0.7553 |
| **F-statistic** | 70.46 | 6.89 | 69.98 | 70.69 | 6.53 | 73.23 |
| **Prob (F-statistic)** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **Durbin-Watson Stat** | 1.8322 | 2.024365 | 2.133816 | 1.848357 | 1.901581 | 2.090108 |
| **Mean Absolute Percentage Error (MAPE)** | 1.001545 | 138.7279 | 1.063606 | .9624942 | 134.6433 | 1.042008 |

The Error Correction Model (ECM) results of Model 2 (Import) shown in Table-5 states that the country and exchange rate measure variation is significant and pronounced. In both nominal and real effective exchange rate specifications the LNGDP is consistently positive and statistically significant suggesting that higher GDP is strongly associated with greater import demand and Bangladesh has the highest responsiveness (7.0 – 8.0) compared to India (1.3) and Pakistan (2.1 and 2.2). The constant coefficients are significant for Bangladesh but they have marginal significance in case of Pakistan in few cases; the constant of India is not significant, indicating that the baseline level of imports may differ across these economies. Finally, India measured as having a significantly negative (approximately –0.40) adjustment term which captures the speed of return to equilibrium following a deviation, so also achieves a robust corrective response. While the positive adjustment coefficients for Bangladesh and Pakistan (0.25–0.31) are unanticipated as they imply that deviations from equilibrium do not clear quickly, but instead persist; we provide new evidence that these adjustment coefficients are plausible and, in some cases, necessary. In the case of LNER coefficient, it exhibits mixed effects; for India this has a negative coefficient, which is marginally significant under nominal measure, while for Bangladesh it is significantly negative under real effective specification, indicating an inverse relationship between this variable and import demand in some cases. Generally, the VOL variable holds no significant effect, apart from in Bangladesh under the real effective measure with a negative and marginally significant effect which suggests that greater volatility may reduce the level of imports. In the case of Bangladesh and Pakistan, the R-squared values are high (around 0.85), which shows that model varies fairly well; however, in the case of India the lower R-squared values along with extremely high MAPE indicate that model explains import variation much less in India.

**Table-6: ARDL Model Result for Model 2 (Import)**

| **Dependent Variable** | **Nominal Exchange Rate (LN_ER)** | | | **Real Effective Exchange Rate (LN_REER)** | | |
|---|---|---|---|---|---|---|
| **LN_Import** | **Bangladesh (3 3 2 1)** | **India (4 4 1 1)** | **Pakistan (2 4 2 2)** | **Bangladesh (3 3 4 1)** | **India (4 4 2 4)** | **Pakistan (4 4 0 1)** |
| **C** | .6848804* (0.70) | .0110703 (1.11) | 1.038953** (2.10) | 2.440395** (2.37) | .192026 (0.07) | .8527958** (2.06) |
| **LN_GDP** | 11.72481*** (4.88) | .5361362 (0.59) | 5.517965* (1.73) | 10.94967*** (4.62) | .6807697 (0.77) | 4.73154 (1.48) |
| **LN_ER** | -.4958277 (-0.29) | -1.124513* (-1.70) | -.3048802 (-0.59) | 1.506625** (2.01) | -1.317458* (-1.69) | -.5007794 (-1.02) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **VOL** | 1.143635 (1.24) | -.8468354 (-0.65) | .0025042 (1.42) | .9737065 (1.02) | -89.25796* (-1.86) | .6551079 (1.00) |
| **R-squared** | 0.8489 | 0.3117 | 0.7801 | 0.8597 | 0.3827 | 0.7790 |
| **Adjusted R-squared** | 0.8349 | 0.2204 | 0.7518 | 0.8443 | 0.2711 | 0.7578 |
| **F-statistic** | 60.86 | 3.41 | 27.56 | 56.01 | 3.43 | 36.66 |
| **Prob (F-statistic)** | 0.0000 | 0.0002 | 0.0000 | 0.0000 | 0.0001 | 0.0000 |
| **Durbin-Watson Stat** | 2.168782 | 2.019197 | 2.056934 | 2.231387 | 135.8893 | 2.064819 |
| **Mean Absolute Percentage Error (MAPE)** | 1.003985 | 130.9192 | 1.005285 | .9713801 | 1.961514 | 1.037703 |
| **(ARDL short run lag is found by VARSOC output using the AIC, FPE, HQIC, and SBIC criterion.)** | | | | | | |

The results from the ARDL model shown in Table-6 exhibit important cross–country differences on the determinants of import demand. In the nominal exchange rate specification, the constant term for Bangladesh and Pakistan becomes statistically significant and implies that there are distinct baseline levels of imports, while it is not significant for India. It is then found that a robust and highly significant positive coefficient (about 11.72 or 10.95 respectively under the different exchange rate specification) on GDP (LN_GDP) exists for Bangladesh, a powerful and significant positive correlation between economic size and import demand, which weakens or becomes statistically insignificant for both India and Pakistan under both specifications. On the one hand, the coefficient of the exchange rate variable (LN_ER) is negative and marginally significant in the India nominal regression (–1.12), implying that a negative movement of the exchange rate could reduce import volumes; on the other hand, import volumes do not show significant reactions to the exchange rate movements in Bangladesh and Pakistan. Regarding Bangladesh's import model, the absence of a significant short-run impact from exchange rate volatility, as indicated by our current results, reinforces the findings from the prior research (Lima & Islam, 2023). This suggests that for Bangladesh, other factors, such as domestic economic activity (GDP) and the real exchange rate, remain the primary drivers of import flows, making them less susceptible to exchange rate fluctuations compared to exports. In the case of imports under the real effective exchange rate specification, LN_ER remains positively significant for

Bangladesh (around 1.51) and negatively significant for India (approximately -1.32) thus exhibiting different exchange rate pass through effects on imports of these economies. Although the volatility measure (VOL) is usually insignificant, a marginally negative effect is found in the real effective specification for India that can be interpreted as higher uncertainty modestly dampening import activity. Bangladesh and Pakistan both are showing a high value of R-squared around 0.85 and 0.78 respectively, with a low Mean Absolute Percentage Error (MAPE) value of around 1%, which shows high explanatory power and accurate forecast. On the contrary, India's nominal model is less robust with a low R-squared (0.31) and extremely high MAPE (approximately 130.92%), suggesting that India's nominal model may be underspecified or that underlying data are of poor quality for India. Moreover, Durbin-Watson statistics for most of the specializations suggest no major autocorrelation issues, but the measurement of India's real effective model yields an unusually high value.

## 5.0 Conclusion

In conclusion, the empirical analysis of exchange rate volatility and its impact on international trade flows in Bangladesh, India, and Pakistan reveals substantial cross-country heterogeneity, with critical implications for both policy formulation and academic understanding of open-economy dynamics. The GARCH model estimations indicate that Bangladesh experiences relatively short-lived volatility in its nominal and real effective exchange rates. Specifically, the nominal exchange rate in Bangladesh follows a GARCH(1,1) process, while the real effective exchange rate is modelled as an ARCH(1) process. This suggests that any shock to the exchange rate dissipates quickly, thereby fostering a relatively stable trading environment in which exporters and importers are less exposed to prolonged uncertainty (Bollerslev, 1986). Conversely, India's exchange rate volatility is characterized by greater persistence. The nominal exchange rate follows a GARCH(2,1) process, and the real effective exchange rate exhibits a GARCH(1,1) behavior, implying that fluctuations can persist over multiple periods. This prolonged volatility may compel firms to adopt hedging strategies or delay transactions, thus potentially curtailing trade activities (Engle, 1982). Pakistan presents a mixed picture: while the nominal exchange rate shocks are predominantly short-run phenomena—as indicated by the ARCH(1) process—the real effective exchange rate follows a more complex GARCH(3,3) model with nonzero autocorrelation terms, suggesting that persistent volatility could have adverse long-term implications on trade flows.

The long-run cointegration analysis via the Bounds Test further corroborates these findings. For Bangladesh and India, the F-statistics in both export and import models surpass the upper critical bounds, confirming the existence of a robust long-run relationship between exchange rate volatility and trade flows (Pesaran, Shin, & Smith, 2001). Particularly striking is the case of India's import model, where exceedingly high F-statistics underscore a profound long-term effect of exchange rate movements on import volumes. In contrast, while Pakistan's export model shows evidence of cointegration with the nominal exchange rate, the import model does not cross the upper critical bound, implying that exchange rate volatility might not have a significant long-term impact on Pakistan's import activities.

Error Correction Model (ECM) estimations provide further insight into the short-run dynamics of trade adjustment. The ECM results for exports demonstrate that deviations from the long-run equilibrium are corrected relatively quickly across all three countries, as evidenced by significant adjustment coefficients ranging from approximately 0.228 to 0.296. Notably, Pakistan's export sector exhibits the highest speed of adjustment, indicating a higher sensitivity to exchange rate shocks compared to its counterparts in Bangladesh and India. However, when considering import flows, the ECM results reveal divergent patterns. In India, the adjustment coefficient is significantly negative (approximately –0.40), signaling a robust corrective response. Conversely, the positive adjustment coefficients for Bangladesh and Pakistan suggest that deviations from equilibrium persist longer than anticipated, a finding that merits further investigation into country-specific structural factors.

The ARDL model results reinforce these insights by integrating both short- and long-run effects. In the export models, while trading partner GDP exhibits mixed impacts—with a negative influence for Bangladesh and a positive effect for India and Pakistan—the sensitivity of exports to exchange rate movements is more pronounced in India. Here, a significant negative coefficient in the real effective exchange rate model implies that exchange rate depreciation adversely affects export competitiveness, likely due to India's import-dependent production structures. For Bangladesh and Pakistan, the relationship between exchange rate fluctuations and exports appears more muted, suggesting that other factors may play a dominant role in driving export performance. Similarly, in the import models, a robust positive association between GDP and import demand is observed in Bangladesh, whereas India and Pakistan display weaker relationships, indicating that domestic economic size is a stronger determinant of import levels in Bangladesh.

These findings underscore the importance of stable exchange rate policies and effective risk management strategies to mitigate the adverse effects of volatility on trade flows. Policymakers in India and Pakistan, in particular, should consider interventions that dampen persistent exchange rate fluctuations to enhance trade competitiveness and foster economic growth (Obstfeld & Rogoff, 1995). Simultaneously, the relatively stable exchange rate environment in Bangladesh presents an opportunity to further consolidate its trade flows by reinforcing policies that sustain this stability. Overall, this research not only substantiates the critical link between exchange rate volatility and trade flows in South Asia but also highlights the need for tailored policy responses that account for the distinct economic structures and volatility dynamics inherent in each country.

Both the prior (Lima & Islam, 2023) and current research consistently find a statistically significant negative impact of real exchange rate on exports. This is the most critical area for policy intervention. The government and the central bank should prioritize measures to mitigate the risks faced by exporters due to exchange rate uncertainty. This could include offering risk-hedging mechanisms, providing forward-exchange facilities at favorable rates, or implementing export credit insurance schemes. Policies aimed at stabilizing the nominal exchange rate during periods of high volatility should be considered to protect export-oriented firms, particularly those with thin profit margins.

The paper, in contrast to the inconclusive findings of the prior study, reveals a significant negative effect of real volatility on imports. This new insight suggests that while Bangladesh's import sector may get resilient in the long term, short-term shocks can still disrupt supply chains. Policymakers should focus on communication strategies to manage market expectations during volatile periods. This could help prevent firms from making abrupt and potentially costly decisions to postpone or delay import orders, thereby ensuring the continuity of essential raw material and capital goods inflows.

Our analysis confirms that imports are primarily driven by real economic variables, such as the real effective exchange rate (REER), and not by long-run exchange rate volatility. This validates the importance of macroeconomic stability. Policies should continue to focus on managing inflation, maintaining a competitive real exchange rate, and fostering a strong domestic economy (as reflected by GDP), which are the true long-run drivers of import demand.

Our analysis shows that India's exports are negatively affected by exchange rate depreciation, a finding likely linked to the country's dependence on imported inputs for its export-oriented sectors. Policymakers should implement targeted strategies to enhance the competitiveness of India's export sector beyond currency movements. This includes incentivizing value-addition within the country, promoting technological upgrades, and reducing the reliance on imported raw materials. Efforts to stabilize the exchange rate should be cautious, as an overvalued currency could harm competitiveness. The focus should be on creating a stable, predictable policy environment.

The GARCH model for India shows a persistent level of volatility, suggesting that firms are operating in a continuously uncertain environment. The Reserve Bank of India (RBI) and the government should enhance financial literacy and provide more accessible and affordable hedging instruments to small and medium-sized enterprises (SMEs). This would empower firms to manage their own exposure to exchange rate risk, rather than relying solely on macroeconomic policy interventions.

On the other hand, Pakistan's exports are found to be negatively affected by the GDP of its trading partners, suggesting a high degree of dependence on economic conditions in specific destination markets. Policymakers should actively pursue a strategy of export diversification, both in terms of destination markets and product mix. Reducing concentration on a few trading partners can make Pakistan's export sector more resilient to external economic shocks. Trade agreements and promotional campaigns in new and emerging markets are crucial for this.

The absence of a significant long-run relationship between exchange rate volatility and imports in Pakistan's model indicates that other factors may be more dominant. Future research and policy analysis should investigate these alternative drivers. This could include factors like energy prices, commodity prices, internal economic policies, or structural issues related to import dependencies. Understanding these drivers is essential for developing effective policies to manage trade deficits without relying on exchange rate manipulation.

The significant cross-country trade relationships within South Asia mean that instability in one country's currency can impact its neighbors. A coordinated effort to maintain regional exchange rate stability could benefit all three economies. The heterogeneity of the findings underscores the need for continued, high-quality, and updated empirical research. Regional institutions could foster collaboration among researchers to share data and standardize methodologies, leading to a more consistent and robust understanding of the region's trade dynamics.

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