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# Impact of Imported Capital Goods on Manufacturing Exports in Bangladesh

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***Abstract***

*This study examines the effect of imported capital goods on manufacturing exports in Bangladesh using annual time series data from FY1991 to FY2023. The ARDL (auto-regressive distributed lag) bound test approaches were applied to investigate the symmetric relationship between manufacturing exports, imported capital goods, exchange rate, and trade openness. The results of the empirical analysis suggest that imported capital goods and trade openness have a positive influence on manufacturing exports. On the other hand, the econometric relationship gives the evidence that exchange rate depreciation has a negative impact on manufacturing exports. Finally, we recommend that the government should implement a comprehensive trade policy with a particular focus on the import policy for capital goods. This will help to improve the manufacturing export performance as a growth driver of the economy.*

**Keywords:** Manufacturing Exports, Imported Capital Goods, Exchange Rate, Trade Openness

**JEL Classification:** C32, F13, F31, F41, O33

## 1. Introduction

The theory of import-led growth posits that by importing capital goods, a developing country can enhance its output and exports by leveraging technological advantages and innovative manufacturing techniques (Alfarajat & Masron, 2023). Our research investigates how the import of capital goods contributes to the expansion of manufacturing exports in Bangladesh. In developing nations, the industrial sector heavily relies on imported capital goods due to limited access to capital and technological

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advancements (Bekes & Harasztosi, 2020). Importing capital goods significantly benefits developing countries by transferring technology and enhancing manufacturing techniques from developed nations (Liao et al., 2023). International trade facilitates this benefit, enabling innovation in manufacturing that developing countries often lack due to resource limitations. However, there is a significant movement of capital from poorer to wealthier countries due to inadequate trade liberalization amidst global imbalances (Prasad et al., 2007). Production in developing countries has been hampered by a lack of capital goods resulting from flawed trade mechanisms, impeding their ability to export manufactured goods (Harrison & Rodriguez-Clare, 2010). Like other developing countries with limited technological resources, the importance of imported capital goods in manufacturing exports has become increasingly relevant in Bangladesh's policy discussions in recent years. This shift is largely due to the country's growing reliance on imported capital technologies for its economic development.

Bangladesh experienced significant development in manufacturing exports since 1980 following the economic liberalization. This economic growth was mainly driven by the increased ready-made garment (RMG) exports, and the economy started to experience export-led economic development (Swazan and Das, 2002). During the 1990s, liberalizing international trade resulted in the economy enjoying consistent output growth of approximately 6 percent over the past three decades (Robert & Wacker, 2023). Bangladesh faces a relative disadvantage in the production of capital goods due to limited resources and inadequate technological progress. As a result, the country heavily depends on imported capital goods to meet its demand for such commodities from foreign sources. Following the initiation of export-oriented economic growth, there has been a rise in the importation of capital goods to sustain the ability to export to international markets (Rahman et al., 2023).

In FY2023, the economy's overall exports amounted to approximately 56 billion US$, with RMG exports accounting for over 47 billion US$. The export growth rate was recorded at 6.28 percent, while the growth rate for RMG exports was 10.27 percent. The economy's import volume in FY2023 is approximately 69 billion US$. Capital goods imports accounted for around 24 billion US$. During FY2023, the proportion of total exports to GDP was 13.21 percent, while the proportion of total imports to GDP was 16.27 percent. Approximately 84 percent of the country's overall exports are accounted for RMG exports. The proportion of imported capital goods in the total import payments is 34.78 percent (BB, 2024). It can be assumed that imported capital goods, such as machinery and other equipment, positively influence a country's manufacturing production, exports, and economic development.

Since the last decade of the previous century, many economic reform projects have been introduced to enhance flexibility in international trade and expedite the achievement of exports and trade objectives. At that time, the World Bank provided support in initiating the

financial sector reform program (WB, 2016). In 2003, the foreign exchange policy was modified to introduce exchange rate flexibility due to the heavy reliance of the economy's manufacturing exports on imported commodities (IMF, 2023). The country's economic development has been facilitated by the importation of capital goods, which has allowed the transfer of knowledge and technology and improved manufacturing techniques. This has been further supported by the deployment of cheap labor in manufacturing that increases the country's exports. The sustained backing for export promotion has bolstered the economy's industrial production, while various incentives have facilitated the industrial output through imported capital goods. The country's rising manufacturing exports have contributed to its strong foundation. In 2008, the global economic crises had a relatively minimal impact on the country's financial and industrial sectors (Ali & Islam, 2010).

The Asian tiger countries, such as South Korea, Malaysia, Thailand, and Singapore, have successfully achieved industrial development and exports by importing capital goods (Bozkurt and Karakoy, 2022). Acquisition of technological know-how and development of human resources is facilitated by imported capital technology from developed countries (Weiss, 2005). In line with these countries' experiences, capital goods imported from abroad are crucial in driving the country's industrial development and boosting exports, contributing to overall economic growth. In adopting modern machinery and technological improvements, the economy depends on increased imports of capital goods. On the other hand, the economy has to prioritize developing its human resources to keep up with technological advancements. Undoubtedly, it could be realized that imports of capital goods could spur industrial growth and facilitate technology transfer and human resource development for an economy like Bangladesh. So far, there is limited research on the correlation between imported capital goods and manufacturing exports in Bangladesh.

The primary reason for conducting this study is that, after gaining independence, the nation has relied heavily on imported food and finished consumer products. The government has implemented export and financial liberalization policies to boost industrial production and started importing capital goods. Although the country's manufacturing sector benefits from low-cost labor, it gradually relies on imported capital goods to increase production. According to economic rationales stated in endogenous growth theory, relying solely on labor without technological capital is insufficient for production competitiveness. Technology plays a vital role in increasing labor productivity and, eventually, improving manufacturing exports. In this context, it has been recognized that the rising use of imported capital goods in export-oriented sectors depicts a connection between imported capital goods and manufacturing exports in Bangladesh. Since the country's economic progress is being driven by manufacturing export growth, manufacturing exports can be fostered through the increasing use of technological capital and better manufacturing techniques (Sultanuzzaman et al., 2019). This progress would also lead to the development of technological and human capital. In this regard, identifying the influence of imported capital goods on manufacturing export performance in Bangladesh is essential.

This study examines the long-term relationship between manufacturing exports and the importation of capital goods in understanding the role of technological advancements in industrial export growth. This study uses the import-oriented growth model strategies to examine the association among manufactured exports, imported capital goods, exchange rates, and trade openness. We utilize annual time-series data from FY1991 to FY2023 and apply the ARDL bound test approach to uncover symmetric connection among the metrics studied. Our study uses the dynamic multiplier effect to analyze how manufacturing exports respond to shocks from various variables, thereby stabilizing long-term relationships.

The remaining part of this work is organized as follows: Section 2 summarizes the existing literature to gain insights into the relationship between imported capital goods and exports, theoretically and empirically. Section 3 presents the data, variables, and techniques used in the empirical analysis. Section 4 shows the results of the econometric analysis. Finally, Section 5 provides concluding remarks and discusses policy implications.

## 2. Literature Review

### 2.1. Theoretical Underpinnings

Imported commodities have a vital role in transferring technology across nations and can contribute to long-term economic development, as proposed by endogenous growth theories and import-led growth theories. Imported capital and technology in international trade have significant potential to acquire foreign technological expertise, enhance domestic output, and facilitate engagement and integration between the home nation and its foreign partner (Ram, 1990; Grossman & Helpman, 1991). The advancement of technology in the production process primarily stems from the transfer of international capital from developed to developing nations. The level of technology cannot be internally generated in developing countries due to insufficient technological knowledge and investment (Todaro & Smith, 2009). Low-income nations can enhance production efficiency by incorporating advanced and innovative technology inputs from foreign capital and other goods. This is because industries in these countries cannot expand production just by collecting physical capital, as they experience declining returns. (Herrerias & Orts, 2013).

In low-income nations, the advanced technology inputs resulting from the research and innovation investment of the advanced country are comparatively more affordable than the alternatives created within the country. Therefore, these countries enhance their production and capital accumulation efficiency by utilizing sophisticated capital products imported from other countries (Lee, 1995). Importing capital goods enables countries to implement effective production processes through resource allocation that promotes optimal production (Coe et al., 2009). In addition, using new production processes and creating a

wide range of products can enhance domestic competition among industries in the economy, leading to enhanced worldwide competitiveness in production (Carbaugh, 2005). Output growth in an open economy is comparatively higher when utilizing imported capital goods than domestically manufactured commodities (Liao et al., 2023).

The efficient production of firms in the economy through imported goods incentivizes other firms to adopt technology that improves the export potential of the entire economy. This allows for acquiring innovative and technical knowledge from foreign equipment, increasing short-term production efficiency and long-term sustainable production capacity as the economy absorbs technological advancements (Mody & Yilmaz, 2002; Damijan et al., 2014). Advanced economies exhibit higher capital intensity while developing economies rely more on labor intensity (Setyari et al., 2016). Lower-income countries can enhance their productivity by importing capital goods primarily driven by technological innovations in developed countries (Mazumdar, 2001).

### 2.2. Empirical Evidence

Researchers from different countries have recently focused on the spread of technology through imports and examined the connection between imported capital goods and economic development and export performance. They have employed various growth theories and trade theories to study this link. Research is carried out to analyze the influence of exports, imports, remittances, and investments on the economic growth of various countries, particularly those in the developing world. Mazumder (2001) argues that 85% of the capital goods in less developed countries are sourced from advanced economies. This study demonstrates that imports have significantly impacted productivity change in developing economies, as evidenced by the panel econometric analysis conducted on a sample of developing countries. This study aligns with the findings of Lee's (1995) study, which utilized cross-country data. Thangavelu and Rajaguru (2004) conducted a study using data from India, Indonesia, Malaysia, Philippines, Singapore, and Taiwan. They discovered that importing capital goods promotes industrial output and economic growth. Similarly, Awokuse (2007, 2008) found the same conclusion in European transition economies and some South American countries, respectively.

Shi (1998) emphasizes the crucial role imported foreign technology has played in China’s industrialization since the 1950s. Similarly, Fan and Hu (2008) point out that introducing imported capital goods has significantly boosted productivity among Chinese firms. Furthermore, Herrerias and Orts (2011) provide evidence that the process of industrialization in China has been accelerated by technological advancements driven by these imported capital goods. Foreign technology and capital goods positively impact India’s manufacturing sector, driving economic growth (Hasan, 2002). Rijesh (2021) also finds that foreign capital goods boost production and exports. Furthermore, trade liberalization facilitates technology transfer through these imports. Likewise, Hye et al.

(2013) provide empirical evidence supporting the significant contribution of imported capital goods to the economic development of South Asian countries. Additionally, Panta et al. (2021) demonstrate that imports positively impact Nepal's short-term economic growth.

### 2.3. Evidence from Bangladesh

In the context of Bangladesh, the current literature offers limited evidence regarding the performance of imports and industrial exports. Nevertheless, other research has investigated the correlation between exports, imports, and economic growth. Moreover, these studies have produced inconsistent findings, with no conclusive evidence regarding the connection between imports and exports. Dawson (2006) examines the correlation between Bangladesh's exports, imports, and GDP. He analyzes data from 1973 to 2003 and discovers a negative connection between imports and GDP. Ahmed and Uddin (2009) examine the relationship between remittance, exports, imports, and GDP from 1976 to 2005. They find that imports positively correlate with GDP in the short term but have no meaningful association in the long term.

Hossain et al. (2009) analyze data from 1973 to 2009 to investigate the correlation between exports, imports, and economic growth. The study concludes that there is no significant connection between imports and economic growth. However, exports are positively associated with imports in the long and short run. Paul (2011) replicates these findings when analyzing the correlation between exports, imports, and economic growth using annual data from 1979 to 2010. This analysis demonstrates that exports have a positive and significant relationship with long-term economic growth, while imports do not have any discernible impact on economic growth. In their study, Wahab et al. (2017) analyze the correlation between the import of capital machinery and industrial output growth. They use annual data from 1980 to 2014 and discover a significant positive relationship between imported capital machinery and long-term output growth. However, they find that importing capital machinery does not contribute to industrial output growth in the short term. Using time series econometric techniques, Miyan and Biplob (2019) identify a positive relationship between exports, imports, and economic growth in Bangladesh. They also reveal a short-run linkage from exports to growth and from growth to imports. Conversely, the study by Selvanathan et al. (2020) demonstrates both export-led growth and growth-led export in Bangladesh. Additionally, it identifies some evidence of import-led growth and growth-led import in the Bangladesh economy. Similarly, Zayed et al. (2020) emphasize that exports and imports are important determinants of economic growth in Bangladesh, with exports directly influencing growth and imports having an indirect effect. Islam et al. (2022) highlight that, like many other least-developed countries (LDCs), export-led economic growth has no significant implications for the long-term period of the Bangladesh economy.

The research conducted in Bangladesh has yielded inconclusive findings about the correlation between imports and economic growth. Furthermore, no study has established a correlation between the importation of capital goods and the exportation of manufactured goods in the economy. All studies aimed to determine the symmetrical relationship by collectively examining the periods before and after the reforms. Imported capital goods facilitate the growth of manufacturing production and exports through technology diffusion, as described in the import-led growth theory or endogenous growth theory. Conducting research is crucial to analyze the correlation between imported capital goods and manufacturing exports following the era of reforms. It is essential to evaluate symmetric econometric method. Bangladesh lacks research regarding the impact of imported capital goods on manufacturing exports, specifically regarding technology transfer and technical production efficiency. No previous studies have addressed this research objective. The current study aims to fill this gap by analyzing the effects of imported capital goods on manufacturing exports using symmetric time series approach.

## 3. Methodology and Data

### 3.1. Model Specification

This paper presents a model that illustrates the direct relationship between the importation of capital goods and the promotion of exports in the manufacturing sector of import-dependent developing economies. The model suggests that by improving technology and providing adequate capital goods, exporting industries in these economies can experience growth in their export activities. This idea can be explained through the principles of endogenous growth theory and import-led growth theory.

In developing countries with abundant labor, there is an opportunity to expand a primary production framework focused on exports, positioning the country to leverage exports as a driver of economic growth. This framework depends on imported goods to enhance capital and technical efficiency. Additionally, various domestic and external factors, such as exchange rates and trade openness, also influence the export performance of these economies. We suggest specifying the model based on inputs and demand and supply factors. The export function can be defined based on import-oriented export growth in the following way (Awokuse, 2007).

$$EXP = f(ICG, ER, TO) \quad (1)$$

The expression above illustrates the correlation between manufacturing exports (EXP) and other explanatory factors, such as imported capital goods (ICG), exchange rate (ER), and trade openness (TO). This functional orientation can also be called import-oriented exports in developing countries that heavily depend on imported inputs in manufacturing. The econometric specification of the above model can be written in the following form.

$$lnEXP_t = \alpha_0 + \alpha_1 lnICG_t + \alpha_2 lnER_t + \alpha_3 TO_t + \varepsilon_t \quad (2)$$

Where lnEXP is the log of manufacturing exports volume (million US$), lnICG is the log of imported capital goods volume (million US$), lnER is the log of the nominal exchange rate (BDT/US$), TO is the trade openness measured by the trade to GDP ratio (%).

We design the model by considering manufacturing exports as an endogenous variable that responds to exogenous variables, such as imports of capital goods, as well as other control factors of internal and external variables, such as exchange rate and trade openness, as those factors could strongly influence demand and supply side phenomena in determining manufacturing exports. The specified econometric model focuses on the relationship between imported capital goods and manufacturing exports, where the parameters of all exogenous factors are assumed to take the expected positive signs.

### 3.2. Methods

Our study uses the auto-regressive distributed lag (ARDL) model to examine the cointegrating relationship among the variables in the specified econometric model. Our study intends to discover the symmetric connection between manufacturing exports and imported capital goods in Bangladesh. Initially, we examine whether the time series data exhibits any potential non-stationary issues by performing the unit root tests, including the Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, and Zivot and Andrews test. In practice, to apply ARDL, variables must be integrated into different orders, which mean variables show the mixed order of integration where none of the variables would be stationary or integrated at more than order 2; if the variables are integrated into more than order 2, the ARDL produce ineffective results. The pretesting of stationarity is not mandatory for applying the ARDL in examining cointegration among variables. The ARDL approach suggested by Pesaran et al. (2000, 2001), can handle the cointegration among the variables when the variables show different orders of integration. These methods give a robust estimation in cointegration even for small observations, like smaller than 30 observations. As these models assume that there is no response from the endogenous variable to the exogenous variables at the level relationship, these approaches are free from the endogeneity problem of the exogenous variable (McNown et al., 2018). In the bounds test approach of ARDL model, the cointegrating relationship or long-run connection is confirmed if the estimated F-statistic value exceeds the upper critical bound at the statistically significant level. The long-run relationship and short-run dynamics with possible error correction are estimated once the cointegration relationship is established. After estimating the relationship among the variables, several diagnostic tests are conducted to check the robustness of both the ARDL model. Basically, the usual ARDL model can be written in the following form.

$$lnEXP_t = \alpha_0 + \sum_{i=0}^{p} \alpha_{1i} lnEXP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} lnICG_{t-i} + \sum_{i=0}^{m} \alpha_{3i} lnER_{t-i} + \sum_{i=0}^{l} \alpha_{4i} TO_{t-i} + \varepsilon_t \quad (3)$$

The ARDL bound test model takes the long-run relationship suggested by Pesaran et al. (2001) and is applied in this study to examine the connection between manufacturing exports and imported capital goods, depicted as follows.

$$\Delta lnEXP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta lnEXP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta lnICG_{t-i} + \sum_{i=0}^{m} \alpha_{3i} \Delta lnER_{t-i} + \sum_{i=0}^{l} \alpha_{4i} \Delta TO_{t-i} + \beta_1 lnEXP_{t-1} + \beta_2 lnICG_{t-1} + \beta_3 lnER_{t-1} + \beta_4 TO_{t-1} + \varepsilon_t \quad (4)$$

In the above-stated equation, $\alpha_{1i}$, $\alpha_{2i}$, $\alpha_{3i}$, $\alpha_{4i}$ are the coefficients of the short-term dynamic relationship and $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$ are the parameters of the long-term cointegrating relationship. The ARDL bound test approach justifies the null hypothesis of no cointegration among variables, that is $H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$, If the estimated F test rejects the null hypothesis of no cointegration, it demonstrates the presence of a long-term relationship. After that, the appropriate lag lengths for the ARDL model are selected using the AIC (Akaike Information Criterion). In the existence of a long-term relationship, the short-run dynamics are calculated with the error correction mechanism, where the stability of the long-term connection is adjusted after the short-term shocks. The error correction model in the ARDL approach is depicted in the following form, as Pesaran et al. (2001) suggested.

$$\Delta lnEXP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta lnEXP_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta lnICG_{t-i} + \sum_{i=0}^{m} \alpha_{3i} \Delta lnER_{t-i} + \sum_{i=0}^{l} \alpha_{4i} \Delta TO_{t-i} + \gamma ECT_{t-1} + \varepsilon_t \quad (5)$$

In the error correction mechanism, the coefficient of the ECT, γ reflects the dynamic adjustment to long-term stability from any short-term shocks. The short-term coefficients in the error correction mechanism are integrated by the adjusted error correction movement toward long-run equilibrium without losing any disequilibrium points in the long-term stability. The significant and negative value of the ECT coefficient validates the short-run causality through the significant values of the coefficients of the different regressors. The robustness of the ARDL bound test approach is then justified by using several diagnostic tests of the estimated residuals, like autocorrelation, normality, heteroscedasticity, model specification, and structural stability tests. Additionally, our analysis applies the dynamic ordinary least squares (DOLS) technique for model estimation to verify the robustness of the empirical relationship.

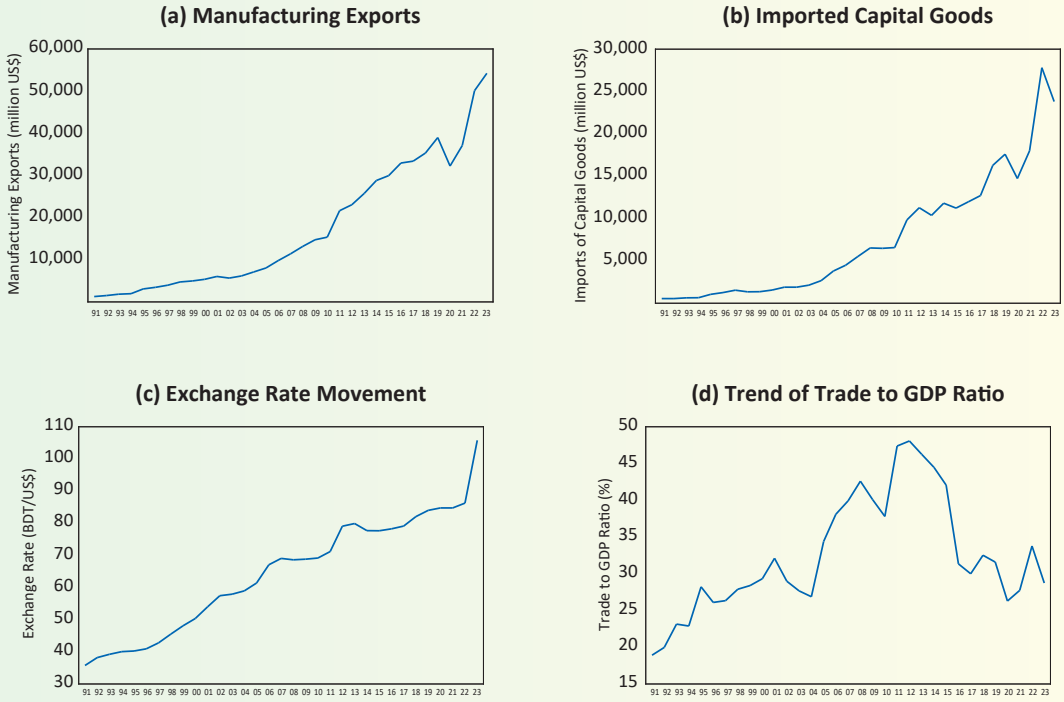
Lastly, the dynamic multiplier effects are estimated to diagnose the response of the endogenous variables from the different shocks of the regressors.

### 3.3. Data and Variables

This study utilizes the annual time series data from FY1991 to FY2023 to investigate the relationship between imported capital goods and manufacturing exports. The data for all indicators included in this analysis have been collected from the Bangladesh Bank database

(Bangladesh Bank Quarterly). The response variable, like manufacturing exports (EXP), is measured by the total volume of exports of manufacturing goods (million US$). In the regressors, the imported capital goods (ICG)are measured by the total volume of imports of the capital machinery and other capital goods (million US$), the exchange rate (ER) is measured by the nominal exchange rate (BDT/US$), and the trade openness (TO) is measured by the trade to GDP ratio (%).The historical movement or trend of the study variables is shown in the following Figure 1(a-d).

**Figure 1. (a) Manufacturing Exports, (b) Imported Capital Goods, (c) Exchange Rate Movement, (d) Trend of Trade to GDP Ratio**




Source: Author's estimation using E-views 10.

In examining the impact of imported capital goods on manufacturing exports, all the study variables like EXP, ICG, and ER are transformed into natural logarithms except for the TO, as expressed in the Trade to GDP ratio (%). The following Table 1 shows the summary statistics of the study variables. The statistical features of the study variables indicate that the mean and median values are reasonably close to each other for almost all the variables, while the mean of each variable lies between the maximum and minimum values with considerable standard deviation. The skewness and kurtosis values of the variables range

from -3 to +3. The Jarque-Bera (J-B) test reveals that all variables come from normal distribution as the probability of the J-B test value fails to reject the null hypothesis of the normality assumption.

**Table 1. Descriptive Statistics**

| | lnEXP | lnICG | lnER | TO |
|---|---|---|---|---|
| Mean | 9.2630 | 8.3343 | 4.1229 | 32.4215 |
| Median | 9.3366 | 8.6121 | 4.2283 | 29.9997 |
| Maximum | 10.902 | 10.2342 | 4.6623 | 48.1109 |
| Minimum | 7.0875 | 6.2304 | 3.5744 | 18.8898 |
| Std. Dev. | 1.1148 | 1.2287 | 0.2987 | 7.8965 |
| Skewness | -0.2975 | -0.2333 | -0.3626 | 0.4701 |
| Kurtosis | 1.9382 | 1.7438 | 1.9197 | 2.3148 |
| Jarque-Bera | 2.0368 | 2.4690 | 2.3277 | 1.8610 |
| Probability | 0.3611 | 0.2909 | 0.3122 | 0.3943 |
| Observations | 33 | 33 | 33 | 33 |

Source: Author's estimation using E-views 10.

## 4. Empirical Results

### 4.1. Unit Root Test

Our study applies Augmented Dicky Fuller (ADF), Phillips-Perron (PP), and Zivot and Andrews unit root tests to identify the stationarity of the variables. The stationarity of variables has been checked at their level and at their first difference, and it has been illustrated in Table 2. The results from the ADF test and PP test show that the variables are integrated at order one. The results of the Zivot and Andrews test for examining the stationarity with any structural break are summarized in Table 3. All the variables show stationarity at their level. From the outcomes of the unit root tests, we find that variables are integrated at either level, I(0), or first difference, I(1), and none of the variables are integrated at order 2, I(2). Hence, our analysis can examine the long-term connection among the study variables by applying the ARDL framework.

**Table 2. Unit Root Test (ADF and PP Tests)**

| | At Level | | | At First Difference | |
|---|---|---|---|---|---|
| Variables | ADF test p-value | PP test p-value | Variables | ADF test p-value | PP test p-value |
| lnEXP | 0.3350 | 0.2523 | lnEXP | 0.0000 | 0.0000 |
| lnICG | 0.2553 | 0.0323 | lnICG | 0.0000 | 0.0007 |
| lnER | 0.8817 | 0.8905 | lnER | 0.0188 | 0.0000 |
| TO | 0.3055 | 0.2951 | TO | 0.0003 | 0.0003 |

**Table 3. Structural break unit root test (Zivot and Andrews test)**

| Variables (At Level) | t-statistic | p-value | Break Period | Results |
|---|---|---|---|---|
| lnEXP | -4.9653 | 0.0852 | 2018 | Stationary |
| lnICG | -2.3282 | 0.0111 | 2004 | Stationary |
| lnER | -3.8384 | 0.0153 | 2013 | Stationary |
| TO | -4.4402 | 0.0003 | 2016 | Stationary |

Source: Author's estimation using E-views 10.

### 4.2. ARDL Model Estimation

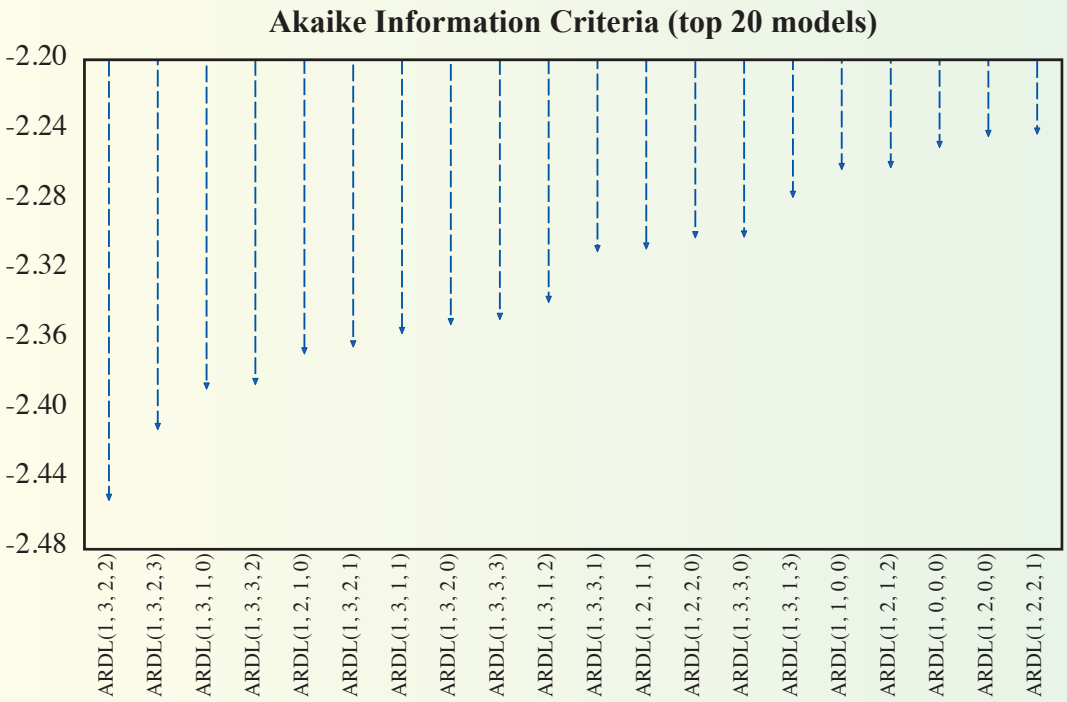
Our analysis applies the bound test method to investigate the long-term cointegration among the variables. The results of the F test using the bound test approach are incorporated in Table 4. The estimated value of the F-statistic exceeds the upper bound of the critical value at the 1% level, which means the long-term cointegrating relationship among the variables exists. Now, for selecting the appropriate lag length for the ARDL model, we use the AIC (Akaike Information Criterion),where the lowest value of AIC chooses the optimal combination of the optimal lag length of the variables from the different combinations of the 64 regressions. The results of the optimal lag length section for the ARDL model using AIC are depicted in Figure 2. The figure incorporates the least 20 combinations of the lag lengths of the different variables using AIC, where the lowest value of the AIC suggests that the lag structure of the specified model is ARDL (1,3,2,2).

**Table 4. Results of the ARDL Bound Test**

| F-Bounds Test | | | Null Hypothesis: No levels relationship | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | 5.6762 | 10% | 2.37 | 3.20 |
| | | 5% | 2.79 | 3.67 |
| | | 2.5% | 3.15 | 4.08 |
| | | 1% | 3.65 | 4.66 |

Source: Author's estimation using E-views 10.

**Figure 2. Optimal Lag Length Selection**




Source: Author's estimation using E-views 10.

We apply OLS regression on the ARDL (1,3,2,2) model to estimate the long-run cointegration. The long-term relationship among the variables is demonstrated in Table 5, and the estimated cointegration shows that the long-run association among manufacturing exports, imported capital goods, exchange rate, and trade-to-GDP ratio are statistically significant. The parameters of the imported capital goods and trade to GDP ratio

demonstrate a positive association with manufacturing exports at 1% and 5% levels, while the parameter of exchange rate indicates a negative correlation with manufacturing exports at 10% level. In the long-term association, both imported capital goods and trade to GDP ratio positively influence manufacturing exports. An 1 percent increase in imported capital goods increases the manufacturing exports by 1.06 percent, whereas a 1 percent increase in trade openness measured by the trade to GDP ratio increases the manufacturing exports by 0.58 percent. The exchange rate negatively influences manufacturing exports over the long-term period. An 1 percent rise in the exchange rate causes the decline of manufacturing exports by 0.95 percent.

**Table 5. Results of the Long-Term Relationship**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| lnICG | 1.0608 | 0.0864 | 12.276 | 0.0000 |
| lnER | -0.9487 | 0.3706 | -2.5594 | 0.0197 |
| TO | 0.0057 | 0.0031 | 1.8549 | 0.0801 |
| C | 4.2253 | 0.8053 | 5.2463 | 0.0001 |

Source: Author's estimation using E-views 10.

Now, the error correction mechanism has been applied to estimate the parameters of short-run relationships along with the parameter of the dynamic adjustment to long-run relationship from the short-run disequilibrium. Table 6 represents the estimated short-run coefficients along with the coefficient of the error correction term (ECT). The highly statistically significant and negative value of the ECT parameter demonstrates that the dynamic convergence process from the short-run disequilibrium to the long-run equilibrium connection is consistent. In comparison, 76 percent of the disequilibrium is adjusted to the long-term stability by a year from the short-run shocks of the explanatory variables. Moreover, the parameters of the short-run dynamic changes have statistical significance values that support the short-run association of the relationship among manufacturing exports, imported capital goods, exchange rate, and trade to GDP ratio to the long-run cointegration.

In dynamic relationships, the imported capital goods, exchange rate, and trade-to-GDP ratio significantly influence manufacturing exports in the short run.

**Table 6. Short-Run Dynamics and Error Correction Estimates**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(lnICG) | 0.6871 | 0.0780 | 8.8059 | 0.0000 |
| D(lnICG(-1)) | -0.2976 | 0.1063 | -2.7979 | 0.0119 |
| D(lnICG(-2)) | -0.3454 | 0.1165 | -2.9651 | 0.0083 |
| D(lnER) | 0.8417 | 0.3036 | 2.7720 | 0.0126 |
| D(lnER(-1)) | 1.2148 | 0.4384 | 2.7710 | 0.0126 |
| D(TO) | -0.0074 | 0.0039 | -1.8796 | 0.0764 |
| D(TO(-1)) | -0.0098 | 0.0039 | -2.5029 | 0.0222 |
| ECT/CointEq(-1)* | -0.7693 | 0.1306 | -5.8896 | 0.0000 |

Source: Author's estimation using E-views 10.

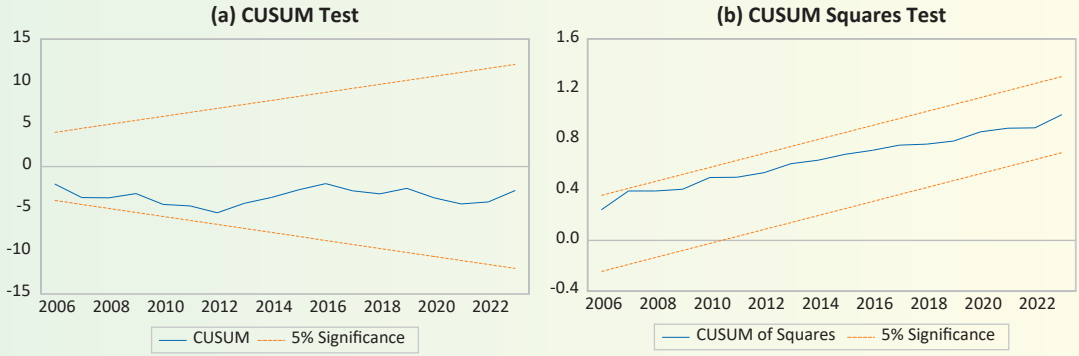
The robustness of the ARDL estimation has been checked through different diagnostic tests to examine the residuals' autocorrelation, normality, and heteroscedasticity assumptions. Moreover, the model specification and the structural stability have been examined to justify the validity of the ARDL estimation. The results of the different diagnostic tests, including the model specification test, are illustrated in Table 7. The Breusch-Godfrey serial correlation LM test demonstrates that the residuals are free from autocorrelation as the test statistic fails to reject the null hypothesis of serial correlation. The ARCH test confirms that the disturbances have no heteroscedasticity issue as it accepts the null hypothesis of homoscedasticity. The Jarque-Bera normality test illustrates that the residuals follow the normal distribution. The Ramsey RESET test demonstrates that the model has no specification error. The structural stability test of the ARDL model is depicted in Figure 3. The CUSUM test and CUSUM squares test show that the estimated value of recursive residuals is ranged within the boundary of a 5% significant level, and those tests reveal that the ARDL estimations are structurally stable and there are no issues for the structural break in the long-term relationship.

**Table 7. Results of Diagnostic Tests**

| Test | Test Statistic | Prob. |
|---|---|---|
| Breusch-Godfrey Serial Correlation LM Test | F-statistic = 1.7749 | 0.1951 |
| Jarque-Bera Normality Test | J-B = 1.0644 | 0.5872 |
| ARCH Test for Heteroscedasticity | F-statistic = 0.4471 | 0.5094 |
| Ramsey RESET Test | F-statistic = 0.1694 | 0.6857 |

Source: Author's estimation using E-views 10.

**Figure 3. (a) CUSUM Test, (b) CUSUM Squares Test**




Source: Author's estimation using E-views 10.

Our analysis includes an estimation of the empirical relationship using the DOLS method to verify the robustness of the ARDL estimation. The results from the DOLS estimation, as shown in Table 8, indicate a highly significant positive association between imported capital goods and manufacturing exports. Additionally, this estimation provides evidence of a negative relationship between the exchange rate and manufacturing exports. The findings from the DOLS estimation are largely consistent with those of the ARDL estimation, further establishing the robustness of the baseline estimation.

**Table 8. Results of DOLS Estimation**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LnICG | 0.9827 | 0.2063 | 4.7617 | 0.0002 |
| LnER | -0.3607 | 0.6570 | -0.5490 | 0.0815 |
| TO | 0.3698 | 0.9789 | 0.4024 | 0.1866 |
| C | 2.6987 | 1.1710 | 2.3046 | 0.0341 |

Source: Author's estimation using E-views 10.

Our empirical results of the relationship between manufacturing exports, imported capital goods, exchange rate, and trade openness using ARDL model reveal a positive influence of imported capital goods on manufacturing exports in the long run, while in the short-run, the relationship between manufacturing exports and imported capital goods are also consistent with the long-run cointegration. In the long run, the exchange rate negatively influences manufacturing exports. In the short run, the influence of the exchange rate on manufacturing exports is also consistent with the long-run connection. The trade openness measured by the trade-to-GDP ratio shows a positive impact on manufacturing exports in

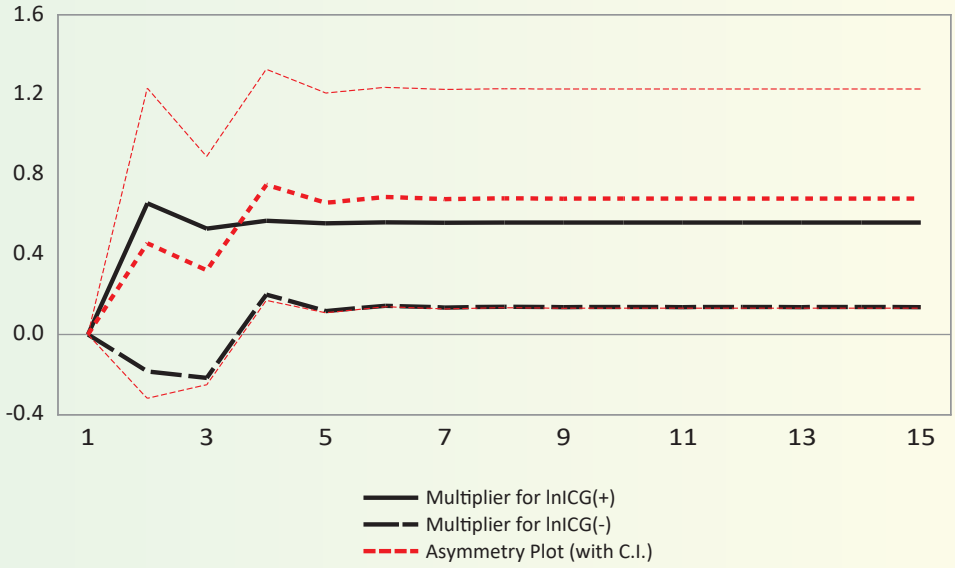
the long run as well as in the short run. The positive influence of the imported capital goods and trade-to-GDP ratio on manufacturing exports, as shown by the findings of our empirical analysis, is consistent with the outcome of the studies, such as Hasan (2002), Hye et al. (2013), Wahab et al. (2017), Panta et al. (2021) and Rijesh (2021). As long of the scarcity of empirical research on this ground in Bangladesh, we compare the results of our study with the outcome of the previous research (Hossain et al., 2009; Paul, 2011) that found a negative relationship between imports and economic growth in Bangladesh while exports and economic growth show the positive association. The results of our analysis are somewhat inconsistent with previous studies that found a negative relationship between imports and economic growth. Our study also indicates the negative relationship between exchange rate and manufacturing exports in the long run and in the short-run association, which is inconsistent with the economic theory that exchange rate depreciation has a favorable association with exports.

The dynamic multiplier effects of imported capital goods, exchange rate, and trade-to-GDP ratio on manufacturing exports are estimated and represented in Figures 6-8. Figure 6 illustrates that in the dynamic multiplier of imported capital goods on manufacturing exports, when imported capital goods rise, the manufacturing exports also rise. On the other hand, when imported capital goods decrease, manufacturing exports also decline. The fluctuation of the negative shock of imported capital goods to manufacturing exports is higher than the positive shocks. Furthermore, the representation also depicts that the positive and negative shocks of imported capital goods on manufacturing exports stabilized in around 5 years.

Figure 7 demonstrates the dynamic multiplier of the exchange rate to manufacturing exports. From this demonstration, we can see that negative shocks of exchange rate have a positive effect on manufacturing exports, whereas the positive shocks of exchange rate are negatively associated with manufacturing exports. The negative shocks are more prominent than the positive shocks, and the fluctuation of the negative shocks is higher than the positive shocks of the exchange rate to manufacturing exports. The stabilization of the negative and positive shocks of the exchange rate to manufacturing exports is around 5 years.

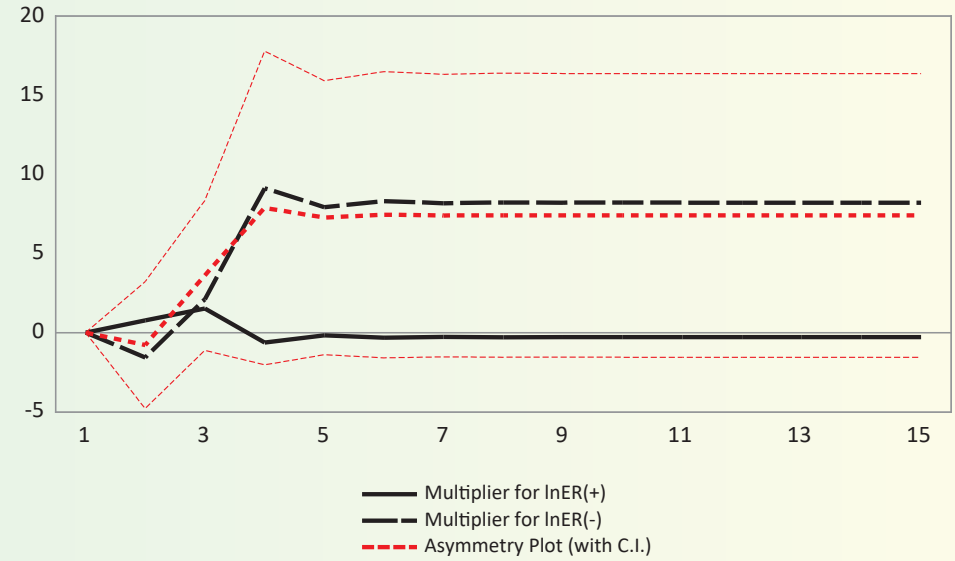
Figure 8 illustrates the dynamic multiplier of trade to GDP ratio on manufacturing exports. This illustration shows that when the trade-to-GDP ratio increases, the manufacturing exports also increase, and when the trade-to-GDP ratio decreases, the manufacturing exports also decline. The impact of positive shocks on manufacturing exports is higher than the negative shocks, whereas the fluctuation in positive shocks is also greater than the fluctuation in negative shocks of trade to GDP ratio on manufacturing exports. The graph also reveals that the positive shocks of trade to GDP ratio on manufacturing exports stabilized in around 8 years while the negative shocks stabilized a bit earlier, around 4 years.

**Figure 6. The Dynamic Multiplier of Imported Capital Goods to Manufacturing Exports**



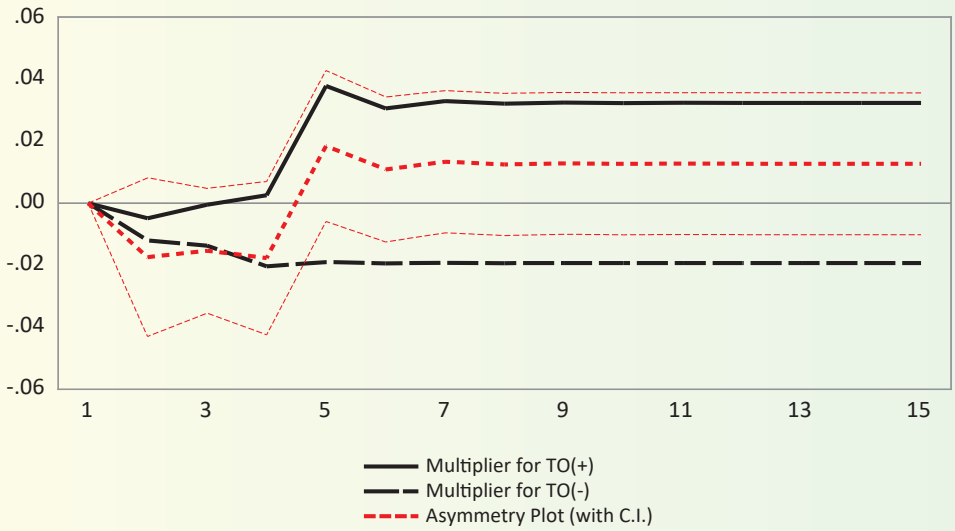

Source: Author's estimation using E-views 10.

**Figure 7. The Dynamic Multiplier of the Exchange Rate to Manufacturing Exports**




Source: Author's estimation using E-views 10.

**Figure 8. The Dynamic Multiplier of Trade to GDP Ratio to Manufacturing Exports**




Source: Author's estimation using E-views 10.

## 5. Conclusions and Policy Implications

This empirical study examines the symmetric linkage among the manufacturing exports, imported capital goods, exchange rate, and trade-to-GDP ratio in the context of Bangladesh's economy. The findings of the econometric analysis have supported the positive influence of imported capital goods and trade openness measured by the trade-to-GDP ratio on manufacturing exports. However, this study also reveals the negative impact of the exchange rate on manufacturing exports. The exchange rate depreciation negatively impacts manufacturing exports in Bangladesh, which is somewhat inconsistent with the economic theory. However, in Bangladesh, the depreciation of the nominal exchange rate is closely related to high inflation and fluctuation of interest rates (Chowdhury, 2022). The high inflation increases the input materials cost and labor cost, and the increasing interest rate also reduces investment in the private sector, which can hamper manufacturing exports. On the other hand, the rapid depreciation of the exchange rate has an adverse effect on the imported raw materials of the exporting sector, as the country's exports heavily rely on imported intermediate goods. That is why the exchange rate depreciation has adversely impacted the manufacturing exports in Bangladesh. This finding also creates room for investing in how exchange rates adversely impact manufacturing exports through high inflation and high interest rates in the context of Bangladesh.

Our study finds evidence that imported capital goods and trade openness are crucial to

expanding manufacturing exports in Bangladesh. In developing countries like Bangladesh, where limited capital technologies, including insufficient advanced manufacturing processes, technological capital adoption could have been achieved through imported capital goods from abroad. This provides the required technological transfer and support for human capital development; deploying the technological production equipment through imported capital goods has increased the manufacturing output and exports with the suitable combination of labor and technology in manufacturing. The liberalization of trade is crucial as it broadens the scope of exports and also widens the scope of imports of required materials, including capital machinery that is required for the manufacturing exports of the countries that have the comparative disadvantage of producing the capital technologies.

Although the manufacturing industries in Bangladesh are heavily labor-intensive, increasing production with export competitiveness, the manufacturing industry should properly adopt the technological capital mainly imported from abroad. The government, as well as policymakers, should think about the comprehensive import policies for capital goods that are required for increasing manufacturing exports. The proper policy measures should also be initiated for human capital development as the transferred technologies used in production from imported capital goods need a skilled workforce. So, investment in skilled workforce development is a prerequisite for increased export performance in manufacturing through imported capital goods. A weaker currency is typically seen as advantageous for exports. However, our analysis of Bangladesh indicates that currency depreciation negatively impacts export promotion. Therefore, policymakers should establish effective strategies to maintain exchange rate stability while appropriately managing inflation and interest rates.

However, this empirical study also has some limitations. In examining the connection between imported capital goods and manufacturing exports, this analysis has not considered macroeconomic variables like inflation, interest rate, and financial development directly to identify their impact on manufacturing exports in the long run causal effect. Considering these variables, further study could be conducted to more precisely explain the symmetric causal impact of imported capital goods on manufacturing exports. Moreover, our study utilizes time series data to reveal the connection among the variables on this issue; future studies could consider panel data to analyze the cross-country comparison for countries with similar economic structures along with Bangladesh. Further study by considering the different data with more explanatory factors and incorporating different methodologies could mitigate the research gap of the present study.

## References

Ahmed, H. A., & Uddin, M. G. S. (2009). Export, imports, remittance and growth in Bangladesh: An empirical analysis. *Trade and Development Review, 2*(2), 79-92.

Alfarajat, M. H., & Masron, T. A. (2023). The effect of trade facilitation measures on import in developing countries. Applied Economics, 1–17. https://doi.org/10.1080/00036846.2023.2274310

Ali, M. M., & Islam, A. M. (2010). Macroeconomic impacts of the global financial crisis on the Bangladesh economy. *Savings and Development, 34*(3), 305–342. http://www.jstor.org/stable/41803648

Awokuse, T. O. (2007). Causality between exports, imports, and economic growth: Evidence from transition economies. *Economics Letters, 94*(3), 389-395. https://doi.org/10.1016/j.econlet.2006.08.025

Awokuse, T. O. (2008). Trade openness and economic growth: is growth export-led or import-led?.*Applied Economics,* 40(2), 161-173. https://doi.org/10.1080/00036840600749490

BB. (2024). *Bangladesh Bank Quarterly, October-December, 2023, Volume XXI, No. 2.* Bangladesh Bank. Dhaka, Bangladesh.

Bekes, G., & Harasztosi, P. (2020). Machine imports, technology adoption, and local spillovers. *Review of World Economics, 156,* 343-375. https://doi.org/10.1007/s10290-019-00365-y

Beyer, R. C., & Wacker, K. M. (2024). Good enough for outstanding growth: The experience of Bangladesh in comparative perspective. *Development Policy Review, 42*(2), e12750. https://doi.org/10.1111/dpr.12750

Bozkurt, T., & Karakoy, C. (2022). International trade review of Asian Tigers countries (2000-2020). *Journal of Process Management and New Technologies, 10*(1-2), 52-69. https://doi.org/10.5937/jpmnt10-37249

Carbaugh, R. (2005). International Economics (10th edit.). *Thomson Southwestern.*

Chowdhury, M. (2022). Do Interest Rate and Inflation Matter for Exchange Rate Fluctuation in Bangladesh? An ARDL Approach. *Asian Journal of Economics and Empirical Research, 9*(2), 67-72.https://doi.org/10.20448/ajeer.v9i2.4055

Coe, D. T., Helpman, E., & Hoffmaister, A. W. (2009). International R&D spillovers and institutions. *European Economic Review, 53*(7), 723-741. https://doi.org/10.1016/j.euroecorev.2009.02.005

Damijan, J. P., Konings, J., & Polanec, S. (2014). Import churning and export performance of multi-product firms. *The World Economy, 37*(11), 1483-1506. https://doi.org/10.1111/twec.12196

Dawson, P. J. (2006). The export–income relationship and trade liberalisation in Bangladesh. *Journal of Policy Modeling, 28*(8), 889-896. https://doi.org/10.1016/j.jpolmod.2006.04.005

Fan, C. S., & Hu, Y. (2008). Imports of capital goods and enterprise performance: a firm-level analysis in China. *Applied Economics Letters, 15*(5), 391-394. https://doi.org/10.1080/13504850600690004

Grossman, G. M., & Helpman, E. (1991). *Innovation and growth in the global economy.* Cambridge: MIT Press.

Harrison, A., & Rodríguez-Clare, A. (2010). Trade, foreign investment, and industrial policy for developing countries. *Handbook of development economics, 5,* 4039-4214. https://doi.org/10.1016/B978-0-444-52944-2.00001-X

Hasan, R. (2002). The impact of imported and domestic technologies on the productivity of firms: panel data evidence from Indian manufacturing firms. *Journal of Development Economics, 69*(1), 23-49. https://doi.org/10.1016/S0304-3878(02)00051-2

Herrerias, M. J., & Orts, V. (2011). Imports and growth in China. *Economic Modeling, 28*(6), 2811-2819. https://doi.org/10.1016/j.econmod.2011.08.025

Herrerias, M. J., & Orts, V. (2013). Capital goods imports and long-run growth: Is the Chinese experience relevant to developing countries? *Journal of Policy Modeling, 35*(5), 781-797. https://doi.org/10.1016/j.jpolmod.2013.02.006

Hossain, M. A., Haseen, L., & Jabin, N. (2009). Dynamics and causality among exports, imports and income in Bangladesh. *The Bangladesh Development Studies, 32*(2), 101-113.

Hye, Q. M. A., Wizarat, S., & Lau, W. Y. (2013). Trade-led growth hypothesis: An empirical analysis of South Asian countries. *Economic Modelling, 35,* 654-660. https://doi.org/10.1016/j.econmod.2013.07.040

IMF. (2023). Bangladesh: *Toward greater exchange rate flexibility.* International Monetary Fund. NW Washington, DC USA.

Islam, M. F., Hasan, F., Islam, S. S., &Sajbir, S. I. (2022). Is Export-led Economic Growth Significant in LDCs?: Evidence from Bangladesh. *AIUB Journal of Business and Economics, 19*(2), 93-108.

Lee, J. W. (1995). Capital goods imports and long-run growth. *Journal of Development Economics, 48*(1), 91-110. https://doi.org/10.1016/0304-3878(95)00015-1

Liao, H., Wang, D., Van Assche, A., & Du, J. (2023). Do capital goods imports improve the quality of regional development? Evidence from Chinese cities. *Journal of Innovation & Knowledge, 8*(4), 100435. https://doi.org/10.1016/j.jik.2023.100435

Mazumdar, J. (2001). Imported machinery and growth in LDCs. *Journal of Development Economics, 65*(1), 209-224. https://doi.org/10.1016/S0304-3878(01)00134-1

McNown, R., Sam, C. Y., & Goh, S. K. (2018). Bootstrapping the autoregressive distributed lag test for cointegration. *Applied Economics, 50*(13), 1509-1521. https://doi.org/10.1080/00036846.2017.1366643

Miyan, M. S., & Biplob, M. N. K. (2019). Revisiting exports, imports and economic growth nexus: Empirical evidence from Bangladesh (1981-2017). *Modern Economy, 10*(2), 523-536.https://doi.org/10.4236/me.2019.102036

Mody, A., & Yilmaz, K. (2002). Imported machinery for export competitiveness. *The World Bank Economic Review, 16*(1), 23-48. https://doi.org/10.1093/wber/16.1.23

Panta, H., Devkota, M. L., & Banjade, D. (2022). Exports and imports-led growth: Evidence from a small developing economy. *Journal of Risk and Financial Management, 15*(1), 11. https://doi.org/10.3390/jrfm15010011

Paul, B. P. (2011). Revisiting export-led growth for Bangladesh: A synthesis of cointegration and innovation accounting. *International Journal of Economics and Finance, 3*(6), 3-15. http://dx.doi.org/10.5539/ijef.v3n6p3

Pesaran, M. H., Shin, Y., & Smith, R. J. (2000). Structural analysis of vector error correction models with exogenous I (1) variables. *Journal of Econometrics, 97*(2), 293-343. https://doi.org/10.1016/S0304-4076(99)00073-1

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289-326. https://doi.org/10.1002/jae.616

Prasad, E., Rajan, R., & Subramanian, A. (2007). The paradox of capital. *Finance and development, 44*(1).

Rahman, P., Zhang, Z., & Musa, M. (2023). Do technological innovation, foreign investment, trade and human capital have a symmetric effect on economic growth? Novel dynamic ARDL simulation study on Bangladesh. *Economic Change and Restructuring, 56*(2), 1327-1366. https://doi.org/10.1007/s10644-022-09478-1

Ram, R. (1990). Imports and Economic Growth: A Cross-Country Study. *Economia Internazionale/International Economics, 43*(1), 45-66.

Rijesh, R. (2021). Liberalization, import of capital goods, and industrial exports: Evidence from Indian manufacturing sectors. *Global Journal of Emerging Market Economies, 13*(1), 81-103. https://doi.org/10.1177/2393957520974787

Selvanathan, S., Jayasinghe, M., & Selvanathan, E. A. (2020). Exports, imports and sustainable economic growth in Bangladesh. *Climate Adaptation for a Sustainable Economy: Lessons from Bangladesh, an Emerging Tiger of Asia,* 195-218.

Setyari, N. P. W., Rustariyuni, S. D., &Aswitari, L. P. (2016). Capital intensity, openness, and the economic growth of the ASEAN 5. *Journal of Indonesian Economy and Business, 31*(3), 260-278.https://doi.org/10.22146/jieb.23268

Shi, Y. (2012). *Chinese firms and Technology in the Reform Era.* Routledge.

Sultanuzzaman, M. R., Fan, H., Mohamued, E. A., Hossain, M. I., & Islam, M. A. (2019). Effects of export and technology on economic growth: Selected emerging Asian economies. *Economic research-EkonomskaIstrazivanja, 32*(1), 2515-2531.https://doi.org/10.1080/1331677X.2019.1650656

Swazan, I. S., & Das, D. (2022). Bangladesh's emergence as a ready-made garment export leader: an examination of the competitive advantages of the garment industry. *International Journal of Global Business and Competitiveness, 17*(2), 162-174. https://doi.org/10.1007/s42943-022-00049-9

Thangavelu, S. M., & Rajaguru, G. (2004). Is there an export or import-led productivity growth in rapidly developing Asian countries? A multivariate VAR analysis. *Applied Economics, 36*(10), 1083-1093. https://doi.org/10.1080/0003684042000246795

Todaro, M.P. & Smith, S.C. (2009). *Economic Development.* 10th Edition, Pearson Education Limited, London.

Wahab, M. A., Sultana N. N., & Hoque M. R. (2017). Capital machinery import and industrial output growth in Bangladesh: A cointegration analysis. B*ank Parikrama, XLII*(3-4), 95-121.

WB. (2016). *The World Bank in Bangladesh.* The World Bank. NW Washington, DC USA.

Weiss, J. (2005). *Export growth and industrial policy: Lessons from the East Asian miracle experience* (No. 26). ADBI Discussion Paper.

Zayed, N. M., Islam, M. R., Shahi, S. K., Neloy, A. H., & Meem, I. T. (2020). The Dynamics of Relationship among Export, Import and Economic Growth in Bangladesh. *Dynamics, 3*(4).