Journal of Economic Cooperation and Development, **44**, 4 (2023), 191-220

# Does capital machinery import promote export in Bangladesh?

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## ABSTRACT

This study aims to examine the empirical interrelationship between capital goods and machinery imports and manufacturing exports of Bangladesh over the period of January 2000 to December 2017. To investigate the issue, we applied ARDL Bounds Testing approach, Impulse Response Function (IRF) and bi-variate Granger Causality techniques. The estimated results indicate that capital goods and machinery imports have significant impact on the manufacturing exports in both short and long runs. The IRF technique shows that shock created by the capital goods and machinery imports has impact on the manufacturing exports up to 25 months. Further, Granger Causality analysis indicates a uni-directional causality running from the level of capital goods and machinery imports to manufacturing export level. Precisely, the results of this study confirm that the imported capital goods and machinery are a source of comparative advantage and help to increase the manufacturing exports of Bangladesh.

## ملخص

تهدف هذه الورقة إلى دراسة العلاقة المتبادلة التجريبية بين السلع الرأسمالية وواردات الآلات وصادرات التصنيع لبنغلاديش خلال الفترة الممتدو بين يناير 2000 و ديسمبر 2017. وللبحث في القضية، طبقنا نهج اختبار الحدود باعتماد الانحدار الذاتي للإبطاء الموزع **(ARDL)** ودالات الاستجابة للقوى الدافعة **(IRF)** وأساليب غرانجر السببية ثنائية التعدد. وتشير النتائج المقدرة إلى أن واردات السلع والآلات الرأسمالية لها تأثير كبير على صادرات الصناعة التحويلية على المدى القصير والطويل. وتُظهر تقنية دالات الاستجابة للقوى الدافعة أن الصدمة التي أحدثتها السلع الرأسمالية وواردات الآلات لها تأثير على صادرات التصنيع حتى 25 شهرا.وزيادة على ذلك، يشير


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تحليل غرانجر السببي إلى وجود علاقة سببية وحيدة الاتجاه تمتد من مستوى واردات السلع الرأسمالية والآلات إلى مستوى التصدير في قطاع التصنيع. وعلى وجه التحديد، تؤكد نتائج هذه الدراسة أن السلع والآلات الرأسمالية المستوردة هي مصدر ميزة نسبية وتساعد على زيادة صادرات بنغلاديش من الصناعات التحويلية.

## ABSTRAITE

Cette étude vise à examiner l'interrelation empirique entre les importations de biens d'équipement et de machines et les exportations manufacturières du Bangladesh sur la période allant de janvier 2000 à décembre 2017. Pour étudier la question, nous avons appliqué l'approche de test des limites ARDL, la fonction de réponse impulsionnelle (IRF) et les techniques de causalité de Granger bi-variées. Les résultats estimés indiquent que les importations de biens d'équipement et de machines ont un impact significatif sur les exportations manufacturières à la fois à court et à long terme. La technique IRF montre que le choc créé par les importations de biens d'équipement et de machines a un impact sur les exportations manufacturières jusqu'à 25 mois. En outre, l'analyse de causalité de Granger indique une causalité unidirectionnelle allant du niveau des importations de biens d'équipement et de machines au niveau des exportations manufacturières. Précisément, les résultats de cette étude confirment que les biens d'équipement et les machines importés sont une source d'avantage comparatif et contribuent à accroître les exportations manufacturières du Bangladesh.

**Keywords:** Capital Machinery Imports; Manufacturing Exports; and Bangladesh.

**JEL Codes:** C22; F14; and O53.

## 1. Introduction

A strong manufacturing sector has grave importance for sustained economic growth as it is the source of employment, and potentially favourable trade balance. Investment in capital goods is one of the key contributors to build long-run economic capabilities of such manufacturing sector. Such investment is necessary not only for exporting sectors but also for development of the domestic economic foundation and self-reliance (Simpson, 2001). So, non-investing in capital goods and machinery can inhibit national economic and export growth as well as trade balance. However, required capital goods, machinery, equipment and accessories are sometimes not produced within the national boundary (Arawomo, 2014) because developing countries are heavily endowed with labour resources but have high scarcity and no comparative advantage in capital goods production. Therefore, a developing country needs to install them by importing from other countries especially from the developed countries with higher capabilities.

Additionally, importing capital goods also means importing of updated technology. Because importing high productivity input from developed countries brings knowledge and technological spillovers to the developing economies. Therefore, imports of capital machinery can help a developing country for its long-run growth as well.

Employment generation through boosting up the export-oriented industries is a very common phenomenon for the developing countries. This idea has achieved very much popularity particularly among China and some Southeast Asian countries (Felipe and Lim, 2005). Bangladesh is also following this step almost for the last two decades or more along with prudential management of internal economy. However, it seems that Bangladesh largely fails to achieve the intended target in this regard. Here the list of exportable commodities and services is not so large though the country has achieved a remarkable success in exporting and gaining specialization in the Ready Made Garments (RMG) sector. The country is a giant RMG exporter in the world market, which constitutes about 80 percent of total present export basket (Adnan et al., 2015).

Bangladesh government provides various facilities to exporters in importing capital goods and machinery to boost up exports, increase employment and facilitate foreign currency earnings. Therefore, it is

imperative to examine whether such facilities are incurring any benefit in earning foreign currency or, in other words, whether it is successful to increase the exports of the economy. It is also now widely discussed issue that the offer of such ultra-benefits to the exporters is ultimately causing negative income distributional impact in the economy, i.e. such benefits are given to the exporters by a serious sacrifice of the other sectors of the economy (Min et al., 2015). Therefore, this study has an utter importance especially for Bangladesh. To the best of our knowledge, until now this kind of study is lacking not only in Bangladesh, but also in the literature of other developing countries. Hence, this study is an effort to fill up this gap. Therefore, our work is pioneer and a topical innovation in the economic literature. We believe the research findings of this paper will provide a clear guideline to the planners and policy makers of Bangladesh and other developing countries to formulate and execute the right policies for their respective economies.

Against this backdrop, our aim is to investigate the empirical relationships between accumulated capital machinery through imports and manufacturing exports of Bangladesh. Therefore, the objectives of the study are as follows:

1. To know the efficacy of the provided facilities for capital machinery imports (or capital accumulation) in export promotion.
2. To check if the capital goods and machinery imports of exporting sector and manufacturing exports are co-integrated.
3. To assess the form of causal relationship (no direction, uni or bi-directional i.e., whether ‘supply-leading’ or ‘demand-following’, or feedback relationship) between imports of capital goods and machinery and manufacturing exports.

We have ordered the remaining parts of the paper as follows. An overview of Bangladesh exports is noted in section 2. Section 3 focuses on existing similar literature. Section 4 outlines the data and methodology of the research. The results and analysis are composed in the section 5. Finally, conclusion and policy implications are set in section 6.

## 2. Exports of Bangladesh: A Brief Overview

In 1980, the export volume of Bangladesh was less than one billion US dollars whereas it is about 30 billion US dollars in 2017. This phenomenal increase of export becomes possible due to shifting of export items from agricultural products to manufacturing products and the RMG in particular. While the share of the RMG in export basket is almost zero percent in 1980, it is almost 90 percent in 2017. The dominance of manufacturing growth is also clear by the composition of national income. The contributions in GDP by agriculture and manufacturing sectors were more than 30 percent and less than 10 percent in 1970s while they are now 17 percent and 35 percent, respectively. Before 1990s, Bangladesh economy was run by the protectionist ideology. As a result heavy import duty was imposed with a view to import substitution or to save import spending. To adjust with the rest of the world a massive reform of the economy has done for the sake of structural adjustment of the economy in early 1990s. As a result, slashing down of both
tariff and non-tariff barriers of the economy and a sudden increase of trade openness or liberalization is happened. It is noted that Bangladesh export basket is still not so large. Though various fiscal and monetary steps have been taken over the period, export diversification has yet to be taken place. However, the composition share of exports have been massively changed (see Table 1).

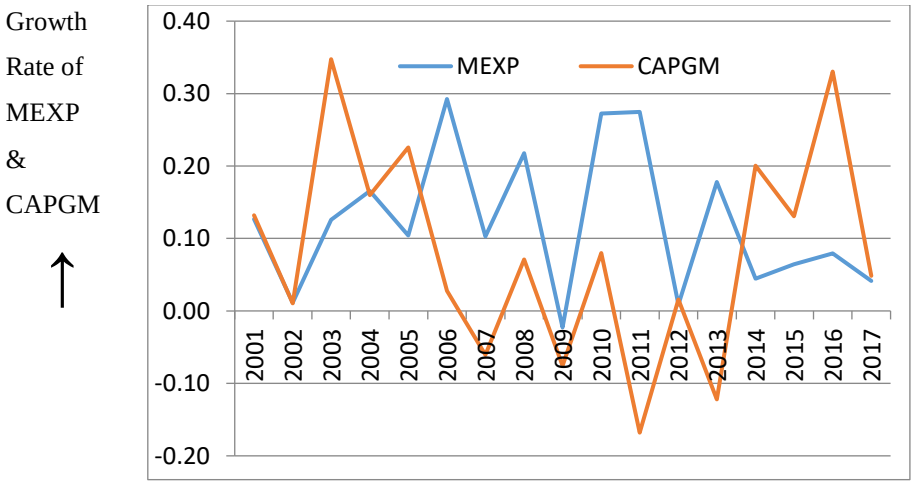
**Table1:** Contribution of Different Sectors in Bangladesh Exports (Figures in Million US$)

| Year | Jute & Jute Goods | Leather and Leather Goods | Frozen Foods | **RMG** | EPZs (mainlyRMG) | **Total** | Percentage of RMG & EPZs | Capital Machinery Import |
|---|---|---|---|---|---|---|---|---|
| 1980 | 524.11 | 88.92 | 38.74 | **00.71** | 29.20 | **781.42** | 3.82% | 3490.15 |
| 1985 | 486.24 | 76.28 | 86.45 | **98.63** | 72.51 | **900.43** | 19.00% | 6292.24 |
| 1990 | 396.63 | 157.35 | 155.30 | **558.54** | 86.54 | **1402.02** | 46.00% | 14184.05 |
| 1995 | 330.35 | 219.07 | 330.35 | **1859.56** | 345.55 | **3284.05** | 67.14% | 29112.13 |
| 2000 | 295.48 | 149.54 | 356.57 | **3092.24** | 979.76 | **4901.34** | 83.08% | 95675.42 |
| 2005 | 352.08 | 252.62 | 404.64 | **5235.33** | 1681.66 | **7984.15** | 86.63% | 165223.51 |
| 2010 | 718.65 | 350.54 | 462.55 | **9695.84** | 3317.74 | **14727.76** | 88.36% | 247747.28 |
| 2015 | 797.87 | 396.05 | 512.64 | **20057.25** | 7306.09 | **29111.35** | 93.99% | 488631.62 |
| 2020 | 1120.45 | 432.36 | 857.49 | **31456.38** | 12432.75 | 46299.43 | 94.79% | 624583.43 |

Note: EPZs- Export processing zones
Source: Monthly Economic Trends, Various Issues, Bangladesh Bank

The two gigantic world markets: European Union and North America have more demand for the RMG of Bangladesh. Further, US dollar and EURO are conventionally vehicle currencies in the international trading system. Therefore, (the so-called managed floating) exchange rate with the US dollar is artificially kept much depreciated for the sake of export business with those areas. It is true that the RMG sector uses labour input intensively in the production process. However, due to the increase of labour cost day by day, Bangladesh is compelled to increase capital labour ratio in the RMG sector to keep the price competitive in the world market. Therefore, due to the above-mentioned sheer exposure of the RMG sector in Bangladesh economy and ceaseless growing of labour cost, the country needs to increase the capital goods and machinery imports. These goods are also imported for backwardly linked manufacturing firms of the RMG industry. The government and the central bank introduce different schemes to expedite the RMG based industries. It is widely believed that as Bangladesh has abundant surplus labour and the RMG is a labour intensive product, the country has high comparative advantage on the RMG sector. Besides, countries like Vietnam, China and India are losing their comparative advantage in the RMG sector because of increased labour cost. In this backdrop Bangladesh has come ahead to explore its comparative advantage for this sector and the country is doing well in its' target.

**Figure 1:** Trends of manufacturing exports and capital goods and machinery imports growth rate in Bangladesh

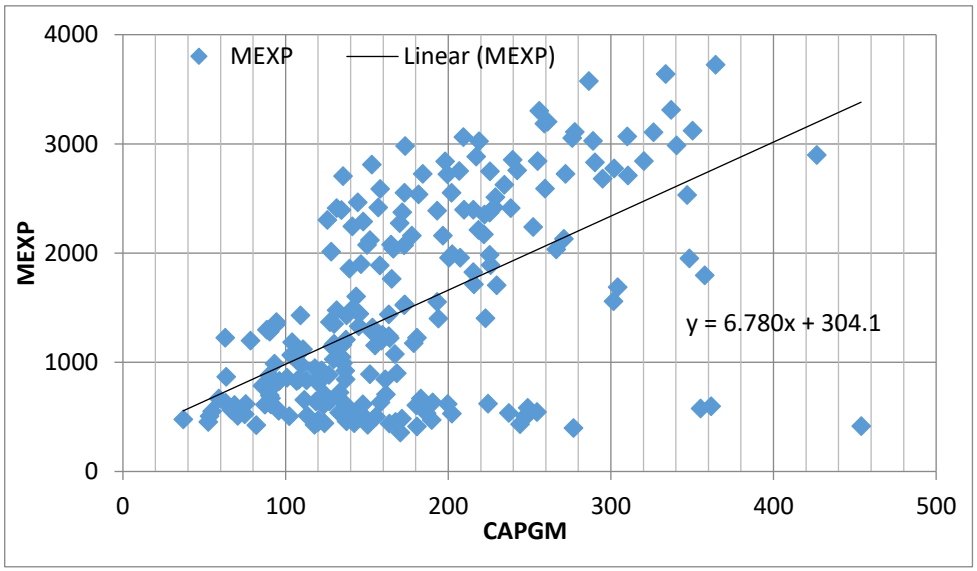



Note: MEXP- manufacturing exports; CAPGM-capital goods and machinery imports

Therefore, it is anticipated that import of capital goods and machinery by the RMG sector increases the export of RMG products. Also, there is a probability of having similar trend between capital goods and machinery imports and manufacturing products export as shown in Figure 1. The correlation coefficient between these two variables is 0.96. From the visual inspection of Figure 1, the year-by-year periodic growth of the import of capital goods and machinery and Bangladesh manufacturing exports has maintained impressive and steady progress, displaying a somewhat similar pattern in movement, which reveals a close association and probable link to each other. The curves are also exhibiting coherence with our conjecture.

The bi-variate relationships between import of capital goods and machinery and Bangladesh manufacturing exports is also displayed by figure 2 with a single variable linear regression equation. That is, apparently all the indications of trends and co-movements of this couple of variables are supporting our hypothesis that they may have strong positive causal relationship.

**Figure 2:** Trends in MEXP and CAPGM in Bangladesh



## 3. Literature Review

There are plenty of theoretical evidence of having positive relationship between capital accumulation and economic growth. First, Domar (1946) show that domestic savings converted into investment can help the economic growth. Therefore, investment in capital goods and thus accumulation of capital can promote economic growth. Further, Lewis (1956) pointed out that an economy in pre-developing stage has two sectors: agricultural sector and industrial sector. Rural based agricultural sector has unlimited and surplus labour. On the other hand, manufacturing sector stepwise multiplies capital and extracts the surplus input from the stockpile agricultural sector to make the accumulated capital inputs functional. When the surplus labour from agricultural sector is entirely imbibed by the industrial sector, the economy will be reached in a steady state sustainable condition. Furthermore, Solow (1957) has noted that as long as capital formation is positive, a country will have a positive growth rate. He also opines that developing countries can acquire benefits by accumulating capital through importing them. Likewise, the study of Goh and Olivier (2002) shows that imports of capital machinery by developing countries have a long-run positive effect on the long-run growth.

Barro (1991) believes that growth rate in a developing country increases relatively better by the imported overseas sophisticated capital goods than domestically produced capital goods. That is, if the ratio of foreign and domestic capital goods is increased, GDP growth would be significantly increased in a developing country. In addition, he points out that relatively cheaper goods imported from overseas countries capital accumulation process also gets higher efficiency and thus have higher growth incurring effects for such emerging countries. Supporting his position Romer (1991) point out that importing capital goods and inputs through liberal external sector increases growth of LDCs under the aegis of their wider range of varieties and have extra productivity of intermediate goods or inputs.

In light of classical theories, the first empirical study to investigate the contribution of foreign capital investment to income and export growth was conducted by Mini (1968) who uses data of Italy and finds the evidence of a positive correlation between foreign capital machinery installation and income and export growth. After that seminal paper, a significant number of articles flourished across the world to see whether

foreign capital goods import has any influence on income and/or export growth of home country. By applying Classical to Solow model and subsequently endogenous growth models economists have failed to reach to any consensus on this issue, which means that the ultimate effects are time and country specific, not generalized. We shall review here some remarkable works of the existing literature.

Now we shall focus on some recent study in this important issue.

Dulleck and Foster (2007) examine impact of equipment import from advanced countries on growth for 55 developing countries. According to their findings, accumulation of capital is essential for rapid economic growth, but the respective country must have capable human capital to operate the imported equipment. They find a very complex relationship between imported equipment and growth. Generally, the relationship between imported equipment and growth is lowest, and often negative, for countries with low levels of human capital, highest for countries within an intermediate range, and somewhat in between for countries with the highest level of human capital.

Contrasting Dulleck and Foster (2007), Nowak et al. (2007) have reached in an opposite conclusion. By examining the hypothesis of imports of foreign capital goods for raising the level of capital formation to increase the economic growth they conclude that the role of capital goods imports to promote the exports and overall economic growth does need to have high standard human capital for the capital goods importing countries of their sample. This model highlights a mechanism of international transmission of economic growth from the advanced economies to the developing economies through trade and terms-of-trade movement without any technological progress, research, and development (R&D) activity or accumulation of human capital.

The study of Fan and Hu (2008) reveals that firms using higher-level of foreign capital goods and machinery have higher productivity than the firms have higher domestic capital goods and machinery. Using the data of 998 manufacturing Chinese firms for the period of 1998-2001, they reached the decision that capital goods imported from OECD counties have the higher productivity than those of other countries. The findings of Veeramani (2008) for 113 developing and developed countries indicate that import of capital goods has long-run positive impacts over the time period of

1995-2005. Showing econometric evidence, she claims that even in the case of the countries with substantially higher initial productivity, capital goods imported from foreign countries eventually lead to a better GDP and export growth for them. Thus, she decides that technological spillover effect can be bidirectional between develop and developing countries regardless their development status.

Later, Cavallo and Landry (2018) investigated the impact of investment through capital equipment import on the productivity of specific firms of United States. The results show that capital accessories imports have vital influence in the increase of productivity growth of those firms. Their results also show that the US economy might lose 20 percent of its growth without imported capital. Furthermore, Zhuang and St. Juliana (2010) explore the relationship between capital expenditure with income and trade growth by resorting the traditional Solow (1957) model to define the determinants of development. Their estimates show that the growth of per capita GDP and trade is positively related to capital expenditure.

Subsequently, Lagares (2013) investigates the growth effects of imported and domestic capital goods for the 32 South American countries. He uses yearly data of 1960-2010. He finds that capital goods import has significant impact on the GDP and trade growth for those countries. In next, Arawomo (2014) also investigates the relationship between imported capital goods and exports level for Nigerian economy for the period of 1970-2012. His finding reveals that manufacturing exports and capital goods imports are co-integrated. Using unrestricted error correction model (UECM)-bounds test and Error Correction Model (ECM) he finds that capital goods imports has both short-run and long run impact on the manufacturing exports of Nigeria.

Cavallo and Landry (2018) have tested the hypothesis whether capital-goods imports is really a source of growth for the U.S. economy. To understand this phenomenon, they build a neoclassical growth model with international trade in capital goods in which agents face exogenous paths of total factor and investment-specific productivity measures. They use observed prices to understand the underlying sources of output growth in the U.S. economy. Their findings suggest that the model explains well the dynamics of investment and U.S. output. They show that capital-goods imports have contributed 14 percent to growth in U.S. output per hour

since 1975, and U.S. output-per-hour growth could have been 18 percent lower without the capital-goods imports technology since 1975.
Ho (2018) investigates the sources of economic growth in Thailand during the period 1975 to 2014. The study identifies that one of the important sources of Thai economic growth is accumulated capital stock. The results show that, both in the short and long run, along with human capital physical capital too exerts a positive and significant impact on output.

Lian et al. (2019) attempt to investigate the impact of price decrease on capital good accumulation and economic growth for 40 advanced and emerging market economies for the period of 1995–2011. They show that the decline in the relative price of tradable capital goods provided a significant impetus to the capital deepening. Further, this deepening of machinery and equipment, in turn, drives the faster productivity growth in the exporting sectors relative to the rest of the economy, which induced domestic producers to lower prices and increase their efficiency.

Shah et al. (2020) have emphasized the relationship among capital formation, economic growth, exports, and imports in case of Pakistan scenario using time series data from 1976 to 2015. By time series analysis through Johansen Co-integration, VECM and Granger Causality techniques they have checked the relationships among gross fixed capital formation, exports, imports, and economic growth. The results from this study show that the exports, imports, real GDP and gross fixed capital formation have a long run relationship and are co-integrated. They conclude that GDP does not granger cause with the export and import while export and imports do granger cause with the GDP in the long run. Finding of the study also displays that physical capital formation has no impression over GDP.

Malefane (2021) examines the causal relationship between capital stock gathered by FDI, exports and economic growth in Lesotho during the period 1980 to 2019 using the vector error correction model and the Toda-Yamamoto (1995) method. The Toda-Yamamoto Granger Causality test result shows that although there is unidirectional causality from FDI generated capital stock to exports, there is no evidence of significant causality from exports to FDI nor between exports and economic growth. By this way the paper reaches in decision from sustainability perspective that the lack of a significant causal effect from FDI capital stock to economic growth suggests that Lesotho's economic policy has not

significantly transformed the economy to bring about significant growth-enhancing effects.

Against the backdrop of the above studies, this research improves the existing empirical knowledge in a number of ways: firstly, while except Shah et al. (2020) existing literature mostly focuses on developed countries, our study focuses on a purely developing country. Secondly, they mostly use panel data from across firms or countries but our one focuses on time series data for a single country. Thirdly and most importantly, most of the literature focuses on aggregate macroeconomic data whereas our data are from two specific sectors: capital goods and machinery import and manufacturing exports only. We have used such disaggregated data, as aggregate data can have aggregation bias, resulting fault directional results. In such a case, the problem arises as different sector may respond differently to changes of their capital goods and machinery shares, and this is completely ignored if aggregate data are used in the analysis. Therefore, our paper has a basic difference from the papers reviewed here due to the use of particular sectoral level data. Fourthly, we have used monthly data implying the more observations while earlier studies mostly used annual data. We have also explored both short and long-run relationship while earlier studies mostly concentrated on the long-run linkages. Using higher frequency data in research has several benefits against the lower frequency data. Ferrari and Ters (2016) note that using data with large time interval has complication to concentrate the exact impact of a single policy, and to over through the effects of overall market reactions or separating from other shocks arisen from another policy change initiated simultaneously. If the data frequency is very high and study period is very short empirical research can easily cut off the impacts emerged from the change of a targeted or policy variable. They also add that dealing with data of limited time horizon certainly allows the researchers to eradicate the noise of the data originated from other or unintended external force disturbing influence. Fifthly, we have used Impulse Responsive Function (IRF) for the deeper analysis of the issue, which is ignored by the past studies.

## 4. Data and Methodology

### 4.1. Variables and Data

Our dependent variable is manufacturing exports (MEXP) and independent variable is capital goods and machinery imports (CAPGM). To explore the short and long-run dynamics and probable causal relationship between two variables, researchers employed the level form. Employing a series or variable in the original or level form certainly carries a direct knowledge pertaining to current and past movement path of the variable, which ultimately helps to get the variable insights for the future moving path of the used variables. Thus, we can get simple and easy understanding about the co-movements of the variables.

We have used the monthly time series data of capital goods and machinery imports and manufacturing exports for the period of 2000-2017 totally 216 months. Data values are in US$. The data are compiled from the various issues of Economic Trends published by the central bank of Bangladesh.

### 4.2 Autoregressive Distributed Lag (ARDL) Bounds Testing Approach

According to our main target. ARDL model takes the following economic model:

$$MEXP_t = \boldsymbol{\alpha} + \boldsymbol{\beta}\, CAPGM_t + \boldsymbol{\varepsilon}_t \quad \text{.....(1)}$$

Where MEXP and CAPGM are describing the variables noted in previous connotations. Further, $\alpha$ and $\beta$ are the intercepts and the coefficient of explanatory variable.

ARDL bound test formulated by Pesaran and Shin (1999) and Pesaran et al. (2001) is always used to look for the existence of co-integration between the series of target to examine if this couple of series has long-run relationship or both short-and long-run dynamics.

The basic form of ARDL model used is as follows:

$$MEXP_t = \beta_0 + \sum_{i=1}^{p} \beta_i MEXP_{t-i} + \sum_{i=0}^{q_1} \gamma_i CAPGM_{t-i} + \varepsilon_t \dots\dots\dots\dots (2)$$

Where $\varepsilon_t$ is a "good-behaved" random "error term" i.e., $\varepsilon_t$ is serially uncorrelated and follows normal distribution.

To conduct the bound test for co-integration, the above model is modified as follows:

$$\Delta MEXP_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta MEXP_{t-i} + \sum_{i=0}^{q} \gamma_i \Delta CAPGM_{t-i}$$
$$+\theta_0 MEXP_{t-1} + \theta_1 CAPGM_{t-1} + \varepsilon_t \dots\dots\dots\dots \quad \dots (3)$$

By looking at the equation (3) it is very clear that it is a special sort of error correction model (ECM) in which short-run coefficients are not restricted to any fixed past periods or lags.

ARDL model selects the lags (Maximum values of p and q) by resorting on different information criteria (such as AIC, HQIC, SIC etc.)

Here the tested hypothesis would be

$H_0$: No co-integration exists between MEXP and CAPGM.

$H_1$: Co-integration exists between MEXP and CAPGM.

The test is conducted here by using the F-test for the joint significance of all coefficients of the lagged periods, that is,

$H_0$: $\theta_0 = \theta_1 = 0$

$H_1$: $\theta_A \neq 0, \theta_1 \neq 0$

This test is not similar to the usual F-test we know, and usual F-table does not contain any critical values for mixed I(1) and I(0) variables. However, matter of hope is that Pesaran et al. (2001) develops special types of critical values for two bound for the asymptotic distribution of the F-statistic. They have provided an F-table for two extreme bounds i.e., lower, and upper bounds for various situations for different degrees of freedom (k+1). However, for cross checking it can also be compared with

the calculated F-value with the lower and upper bounds critical values table constructed by Narayan (2005).

In ARDL bound testing process, lower bound tests that whether all variables are I(0), and similarly upper bound checks that whether all variables are I(1). If the computed F-statistic is smaller than the lower bound, it is proved that all variables are I(0) and by definition co-integration technique is not applicable for such a variable set. Similarly, if the computed F-statistic is higher than the upper bound, then, it is confirmed that the considered variables are co-integrated. However, if the computed F-statistic falls within the two limits, no conclusion can be drawn about co-integration status of the used variables. ARDL technique is not a reliable technique in this case to search the probable co-integration between/among the variables.

Further, Giles (2013) has introduced a cross checking technique to provide further evidence about the ARDL bound testing co-integration technique which is as follows:

Here the null hypothesis

$H_{0\backslash}$: $\theta_0 = 0$, and

$H_1$: $\theta_A < 0$

In this case, if the test statistic of the coefficient of $MEXP_{t-1}$ (i.e., $\theta_0$ ) in equation (3) is numerically higher than the upper bound of ARDL bound testing above (i.e., I(1) bound) constructed by Pesaran et al. (2001), this will reconfirm the previous decision that variables are co-integrated. However, if t-statistic is less than the lower bound (i.e., I(0) bound) , all variables are stationary at level form i.e., I(0). In which case researchers can rely on OLS technique for their estimation and subsequently for reaching to the decision.

To reach in decision about short-run relationship ARDL model uses the following error correction model (ECM)

$$\Delta MEXP_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta MEXP_{t-i} + \sum_{i=0}^{q_1} \gamma_i \Delta CAPGM_{t-i} + \alpha ECT_{t-1} + \varepsilon_t \dots\dots\dots \qquad \dots\dots (4)$$

Where, ECT denotes error correction term that gives a direct measurement of adjustment speed of going back to the long-run equilibrium for any shock arises from the short-run changes. In this case, if coefficient of ECT ($\alpha$) is negative and significant long-run causal relationship will be confirmed. Additionally, nature of the short-run causal relationship will be decided by the significance status of the coefficients of other explanatory variables (like $\beta_i$ and $\gamma_i$ etc.).

One of the most important assumptions of ARDL model is that error terms of the equation (3) should be free from autocorrelation and must follow normal distribution. We have relied on both "Q-statistic" and LM test introduced by Breusch (1978) and Godfrey (1978) for autocorrelation. Additionally, we have conducted JB test to reach to a decision about normal distribution of error terms. Further, for Heteroscedasticity, we have relied on Breusch, Pagan and Godfrey test. In principle ARDL model should be "dynamically stable". This stability is tested by CUSUM and CUSUMSQ tests.

### 4.3 Granger Causality Test

After having correlation between two variables, it is essential to see the direction of causality, which can be done by the Granger (1969) causality test. Accordingly, we perform a bi-variate Granger Causality test between variables considered under an augmented Vector Autoregression (VAR) framework, with appropriate lag selected by AIC.

The functional form of this bi-variate regression functions are as follows:

$$Y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots\ldots\ldots + \alpha_n Y_{t-n} + \beta_1 X_{t-1} \ldots\ldots\ldots + \beta_n X_{t-n} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$X_t = \gamma_0 + \gamma_1 x_{t-1} + \ldots\ldots\ldots + \gamma_n X_{t-n} + \delta_1 Y_{t-1} + \ldots\ldots\ldots + \delta_n Y_{t-n} + \eta_t \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Here, the reported F-statistics are the Wald-statistic for the joint hypothesis of

$$\beta_1 = \beta_2 = \ldots = \beta_n = 0 \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$\delta_1 = \delta_2 = \ldots = \delta_n = 0 \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

for equation (5) and (6) respectively. The equation (7) is the null hypothesis that "X does not granger cause Y" and equation (8) is the null hypothesis that "Y does not granger cause X", respectively.

## 5. Estimated Results and Analysis

Our selected model is ARDL[1] (4, 4). E-views has given us an optimal ARDL model with lag length both MEXP and CAPGM is 4.

As per as the diagnostic tests are concerned, the model with lag length of 4 for each variable is of highly good fit. A high $R^2$ (0.8990) and an adjusted $R^2$ (0.8934) means that this model fits very well. About 90% variation of dependent variable is explained by the chosen explanatory variables and lags. The DW stat. is equivalent to 2 (i.e., 2.0322) means that error term does not suffer from autocorrelation. Moreover, the calculated F-stat. (161.2145) is significant at 1%, which means that the fitted model is not nonsense at all. These findings are reinforced by other tests too [the test statistics of autocorrelation LM test formulated by Breusch (1978) and Godfrey (1978) (table 2), Heteroscedasticity test designed by Breusch and Pagan (1979), and Godfrey (1978), and JB test for normality of error terms which are $\chi^2$ distributed and statistically insignificant even at 10% level of significance] meaning that our model does not suffer from autocorrelation, heteroscedasticity, and non-normality of the error terms.

**Table 2:** Tests for autocorrelation, heteroskadasticity and normality of error terms

| Test Name | $\chi^2$ | Probability |
|---|---|---|
| Serial Correlation LM test by Breusch and Godfrey | 1.07560 | 0.5840 |
| Heteroskedasticity test by Breusch, Pagan and Godfrey | 6.3389 | 0.1752 |
| Normality test by Jarque-Bera | 3.1653 | 0.2158 |

The Q-Statistics with 30 lags in Table 3 below also shows that all the spikes are within the range in both the cases, re-affirming that the errors are Serially Independent. The Q-stat. up to 30 lags in table 3 bellow also shows that errors terms are serially independent as every spike is within the borders. Therefore, the diagnostic test confirms that our model is very sound and estimated model is very reliable to reach in the decision about hypothesis.

**Table 3:** Q-Statistics result

Sample: 1999M07 2017M12
Included observations: 216
Q-statistic probabilities adjusted for 3 dynamic regressors

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob* |
|---|---|---|---|---|---|---|
| | | 1 | -0.019 | -0.019 | 0.0758 | 0.783 |
| | | 2 | -0.032 | -0.032 | 0.2996 | 0.861 |
| | | 3 | -0.052 | -0.054 | 0.9088 | 0.823 |
| | | 4 | 0.029 | 0.026 | 1.0901 | 0.896 |
| | | 5 | 0.081 | 0.079 | 2.5698 | 0.766 |
| | | 6 | 0.007 | 0.009 | 2.5807 | 0.859 |
| | | 7 | 0.002 | 0.011 | 2.5821 | 0.921 |
| | | 8 | 0.014 | 0.022 | 2.6257 | 0.956 |
| | | 9 | 0.143 | 0.143 | 7.3089 | 0.605 |
| | | 10 | -0.049 | -0.049 | 7.8606 | 0.642 |
| | | 11 | -0.021 | -0.015 | 7.9659 | 0.716 |
| | | 12 | 0.020 | 0.030 | 8.0605 | 0.780 |
| | | 13 | 0.009 | -0.006 | 8.0781 | 0.838 |
| | | 14 | -0.062 | -0.087 | 8.9793 | 0.832 |
| | | 15 | -0.008 | -0.003 | 8.9946 | 0.878 |
| | | 16 | -0.057 | -0.062 | 9.7484 | 0.879 |
| | | 17 | 0.064 | 0.047 | 10.708 | 0.871 |
| | | 18 | 0.110 | 0.096 | 13.580 | 0.756 |
| | | 19 | -0.003 | 0.026 | 13.582 | 0.808 |
| | | 20 | -0.096 | -0.081 | 15.784 | 0.730 |
| | | 21 | -0.001 | 0.009 | 15.784 | 0.782 |
| | | 22 | -0.003 | -0.013 | 15.786 | 0.826 |
| | | 23 | -0.058 | -0.069 | 16.609 | 0.828 |
| | | 24 | -0.018 | -0.030 | 16.687 | 0.862 |
| | | 25 | -0.047 | -0.029 | 17.224 | 0.873 |
| | | 26 | -0.050 | -0.085 | 17.835 | 0.882 |
| | | 27 | 0.073 | 0.051 | 19.147 | 0.865 |
| | | 28 | -0.096 | -0.084 | 21.463 | 0.806 |
| | | 29 | -0.050 | -0.029 | 22.101 | 0.816 |
| | | 30 | 0.038 | 0.033 | 22.458 | 0.837 |

### 5.1 ARDL Bounds Test and Cross Checking

As the model is justified by all diagnostic tests, we can now proceed to co-integration test by ARDL bound testing technique. Since the obtained value of F-stat. is 7.789 (significant at 1% level of significance), according to the rule of ARDL bound testing method we can reach to the decision that our two variables MEXP and CAPGM are co-integrated. This decision was also valid for both of the Pesaran et al. (2001) and Narayan (2005) methods as the upper bounds are 5.58 and 5.91

respectively by them. As the value of the computed F-statistic exceeds the upper bound tabulated values, it is an evidence of a long-run relationship between the time-series of our model at 1% level of significance.

Further, $MEXP_{t-1}$ has a t-statistic of -4.650. Pesaran et al. (2001) have constructed bounds for the I(0) and I(1) at 1% significance level as [-3.96, -4.26]. Since the calculated t-statistic for $MEXP_{t-1}$ is less than the lower bound (-4.26), it bolsters the inference that there is a long-run equilibrium relationship between MEXP and CAPGM.

### 5.2 Long and Short-Run Dynamics

Since the co-integrated relationship between MEXP and CAPGM is confirmed by the ARDL model, we can go ahead to search the short run dynamics. The long-run coefficient of CAPGM is 1.3240, significant at 5% level, as t-statistic and p-values are 2.4459 and 0.0155 respectively. The coefficient is significant for the variable CAPGM, which also indicates that it has positive long-run influence on the MEXP. The short-run causality results in ARDL (4, 4) framework are presented in Table 4.

**Table 4:** Estimates of ECM.

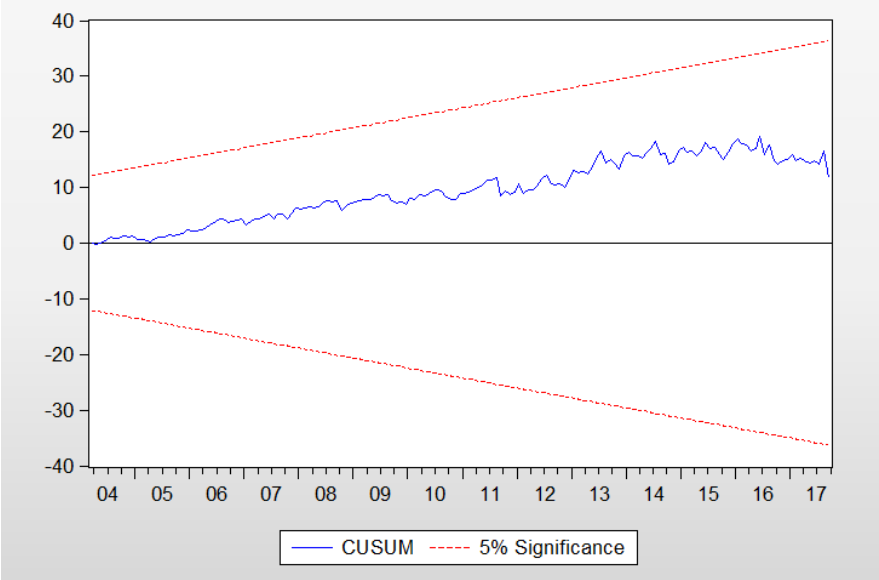
| Variable | Coefficient | Prob. |
|---|---|---|
| D(MEXP(-1)) | -0.514260*** | 0.0000 |
| D(MEXP(-2)) | -0.145180 | 0.1195 |
| D(MEXP(-3)) | -0.158024* | 0.0553 |
| D(MEXP(-4)) | 0.058024 | 0.2553 |
| D(CAPGM) | 1.324016** | 0.0155 |
| D(CAPGM(-1)) | 0.395181 | 0.6081 |
| D(CAPGM(-2)) | 0.839672 | 0.2447 |
| D(CAPGM(-3)) | 0.229268 | 0.6861 |
| D(CAPGM(-4)) | 3.529268*** | 0.0061 |
| C | 18.48861 | 0.7507 |
| CAPGM(-1) | 1.001091* | 0.0885 |
| EXPT(-1) | 0.099940** | 0.0352 |
| D(@TREND()) | 0.170235*** | 0.0000 |
| CointEq(-1) | -0.861007*** | 0.0002 |

(*, ** and *** denote statistical significance at the 10%,5%and1% levels, respectively)

The results confirm the long-run co-integrating relationship by the one period lagged error correcting term cointEq(-1) i.e., ECT's coefficient which is significant even at 1% level of significance with expected negative sign. Additionally, ECT's coefficient is about -0.86 meaning that disequilibrium declines to the long-run equilibrium is fairly reasonable speed of 86% in per period i.e., in one month (as our data is monthly).

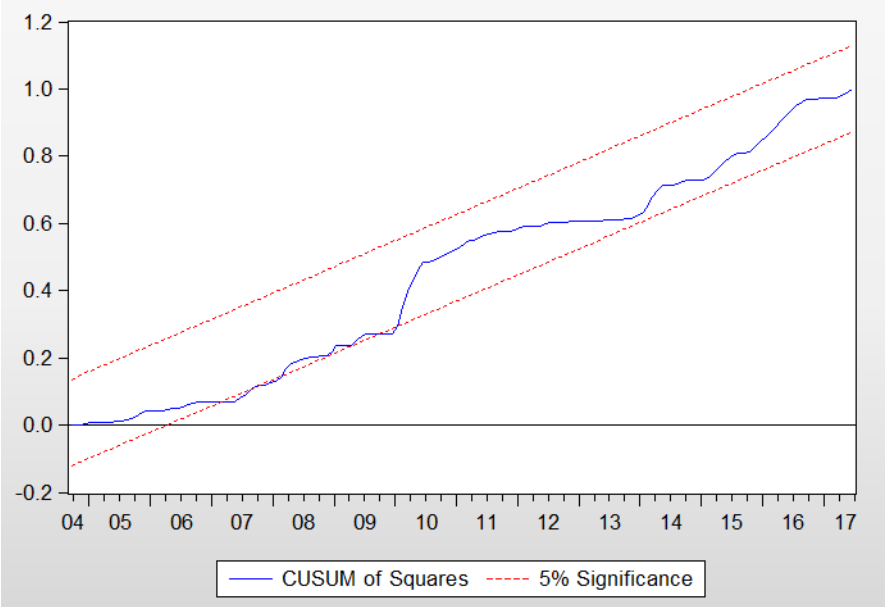
From the Table 3, it is also seen that CAPGM has positive and significant influence in short-run growth, which is ensured by fourth lagged value's positive sign and level of significance (1%). This is the same with its long-run impacts, which is positive (Table 3). Therefore, capital goods and machinery import promotes the exports of manufacturing products in Bangladesh.

**Figure 3:** Plot of CUSUM Tests




To establish the robustness of the findings the stability of model is tested. To conduct such test for the long-run parameters of the results usually researchers depend on CUSUM test and CUSUMSQ test proposed by Pesaran and Pesaran (1997). Graphical representation of these two tests is portrayed in figure 3 and 4 respectively. Since both in CUSUM and CUSUMSQ test show that our model is stable in the long-run within the bounds of 5% critical levels, we can be confirmed the parameters constancy and model's stability at large.

**Figure 4:** Plot of CUSUMS Square Tests

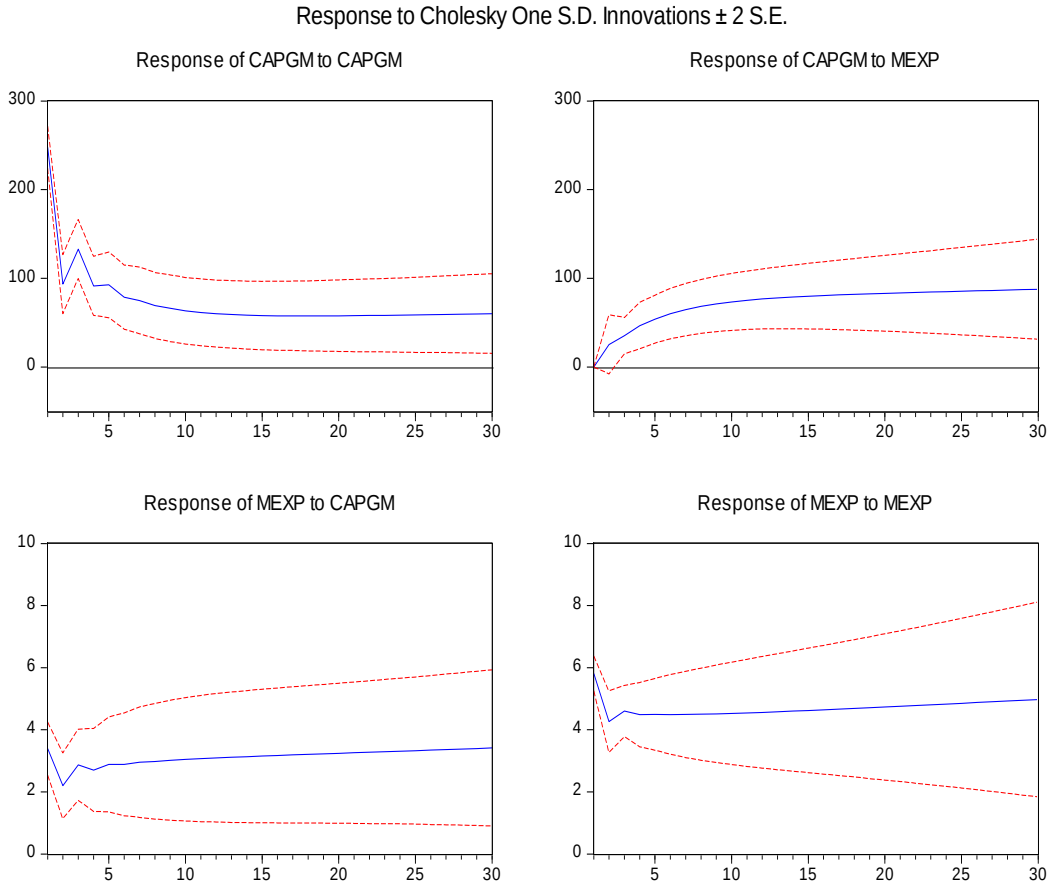



### 5.3 Impulse Response Function (IRF)

The graphical view of impulse response function by Cholesky S.D. method is shown in Figure 5:

To understand the short-run dynamics associated with the model we also resort to IRF. The shock creates positive impact on the manufacturing exports (MEXP) immediately after its generation. We detect that imports of capital goods and machinery (CAPGM) have impact on the MEXP up to 25 months. After that, the impact dies out. It also means that the one CAPGM import shock generates up to 85 million US dollars on the MEXP.

**Figure 5**




## 5.4 Granger Causality Test

To be confirmed about the relationship between capital goods imports (CAPGM) and manufacturing imports (MEXP) we also conducted Granger Causality test which indicates that CAPGM causes MEXP but not vice versa. The Granger causality test results are noted in Table 5.

**Table 5:** Granger Causality Tests

| Observation 222 | Dependent Variable | |
|---|---|---|
| | **MEXP** | **CAPGM** |
| MEXP | - - - | 1.9261 |
| CAPGM | 5.2822*** | - - - |

*** denotes statistical significance at the 1% level.

## 6. Conclusion and Policy Implications

The analysis is performed to explore whether the capital goods and machinery imports (CAPGM) has any impact on the manufacturing exports (MEXP) of Bangladesh. The ARDL bound testing approach and subsequent cross-checking confirms the long-run co-integration or equilibrium relationship between CAPGM and MEXP; and the former has significant positive influence on the latter. Nearly 86 percent of disequilibrium converges to the long-run equilibrium just in one period. The IRF response analysis shows that a shock generated in the CAPGM now will have positive impact on the MEXP up to next 25 months. Moreover, Granger causality analysis results indicate the existence of uni-directional causality running from CAPGM import to the MEXP. The estimated model has also passed all the diagnostic tests and has found as stable.

It is an established fact of development theories that one of the important factors of economic growth is capital goods acquired by a country which can be earned either by a direct investment in capital goods and machinery or by acquiring such goods through foreign sources. This is because investing in capital procurement generally increases production capacity of an economy by adding additional production facilities and boosting operational efficiency. Additional and improved capital goods increase labour productivity by making production plants more productive and efficient because such investment in capital goods allows for more research and development and increases the capital-labour ratio. Newer

stockpile of accessories leads more products being produced in a faster rate. Since labour becomes more efficient, this increased efficiency of production process leads to a higher economic growth. Thus, investment in capital goods makes a significant impact on economic growth.

Population density in Bangladesh is extremely high. Most of the population is within the age range of 14-49, meaning that major portion of the population is within the labour force. Besides, wage rate is stagnant at very low level compared to the other countries in the world. Such backdrops also confirm that country is abundant with labour inputs. The country is burdened with Lewis (1956) type surplus labour due to the shortage of capital goods. Since Bangladesh is a labour abundant country labour intensive technology should be used to provide enough employment facility for the mass people of the country. However, it seems the country is suffering from acute capital shortage to ensure enough employment facility. If enough capital goods are supplied to this country with the technological spillover, the country will be able to use labour inputs in productive sector, which will ultimately stimulate economic growth of the country. Since the economist across the world are searching the sources of growths of the developing countries, this paper contributes in that searching endeavour by adding a new source of growth which is importing overseas capital goods either by domestic entrepreneur or by in the form FDI or by foreign assistance or by all.

The estimated long and short-run results indicate that the manufacturing exports can be amplified by setting more capital and raw materials in industrial plants of Bangladesh either through own financing, foreign direct investment, and even by foreign aids or grants. Further, Granger causality test concludes that importing capital products help and cause manufacturing exports directly through the increased supply of essential foreign efficient inputs for the manufacturing production process for overseas markets.

The findings further imply that Bangladesh should continue its efforts for continuous supply of financial, monetary, and fiscal facilities to ease the import of capital goods and machinery, as the country is still needy for capital machinery. In addition, the country is not rich in terms of land, mineral and agricultural resources, and is unable to make big investment in research and development of capital goods and machinery production. So if the country wants to boost the economy and generate employment

for its vast young unemployed surplus labour through the export leading growth policy, it should pay proper attention to continue establishing new industrial plants and building proper infrastructure because infrastructure and human resources promote manufacturing production which will ultimately contribute to the greater growth of national income. Thus, increasing capital goods and machinery stockpile through import can also be an effective strategy for poverty reduction in the country. Analysis of the result of this study can be further extended to some peripheral indication or notion that establishing production plants of backwardly linked inputs or capital goods and raw materials to ensure uninterrupted supply of exports sector accessories for the export-oriented industries would also help to increase the much-desired manufacturing exports.

Note: [1]Before estimation we test unit root of MEXP and CAPGM by augmented Dickey-Fuller (ADF) test and results are I(0) and I(1), respectively. Therefore, the variables are definite and mixer of *I(*0) and *I(1).*This mix order of integration of the variables justifies the use of the ARDL approach. However, as required by the ARDL bound testing technique developed by Pesaran and Shin (1999) and Pesaran et al. (2001), the results of the ADF unit root testing confirm that none of the variable is *I(2).*

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