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Trade structure and industrial output: A disaggregated level analysis for Bangladesh

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ABSTRACT

This study examines the effect of trade structure on the gross output of 10 industrial sectors in Bangladesh's economy and focuses on analyzing it at a disaggregate level. The disaggregation is followed at a sector level, which includes all manufacturing industries for 26 years from 1995-2020. This paper explicitly focuses on five trade structure variables: (i) Intra-industry trade (IIT) (ii) Extra-trade and Intra-trade (EIT) (iii) Ratio of FDI to total trade (RFDIT) (iv) Number of trading partners (NTP), and (v) Revealed comparative advantage (RCA). By using the panel estimation technique, the study finds that IIT, RCA, and RFDIT positively influence industrial output, whereas EIT and NTP negatively influence the output levels. To better capture the Bangladesh government's preferential trade promotion policy, the study further augments the model by adding a dummy variable called Highest Priority Sectors (HPS). Interactions between HPS and trade structure variables are made in order to investigate the varying effects of trade structure variables on Non-HPS and HPS. The findings of this study will open the path for future studies in this field as well as help policymakers and regulators to shed light on expected future policies related to trade structure and government trade policy.

Contribution/ Originality: This is the first study in Bangladesh that uses disaggregated levels of data to examine the impact of trade structure on industrial sector output. This study will assist policymakers in making future decisions related to trade structure and the government's trade promotion policy for various industry sectors.

1. INTRODUCTION

There has been much discussion about how international trade affects economic growth. Theoretical literature has shown that international trade contributes to economic growth, but empirical results may or may not confirm these predictions. The empirical trade literature has done a thorough investigation into the possible relationship between trade and economic growth. Research in this field often examines the relationship between trade openness and real GDP (Gross Domestic Product) growth and asks whether countries with greater openness experience higher rates of output growth (Ahmed & Sattar, 2004; Nath & Al Mamun, 2004; Salinas & Aksoy, 2006; Yanikkaya, 2003). On the one hand, a group of research works analyzes which channels of trade can help the economy, such as capital accumulation, foreign knowledge, network connectivity, economic infrastructure, product differentiation, and quality of the product (Andersen & Babula, 2009; Beaton, Cebotari, & Komaromi, 2017; Dai & Hu, 2018; Huchet-Bourdon, Le Mouël, & Vijil, 2018; Madsen, 2009; Wacziarg & Welch, 2008). On the other hand, another group of studies

analyses the effect of trade on other economic aspects such as income distribution along with growth (Dollar & Kraay, 2001; Li, Loungani, & Ostry, 2017; Nath & Al Mamun, 2004).

Recently, the relationship between trade structure and economic growth at the country level has become a growing field of study; still, there is a paucity of studies on the aforementioned relationship. Some of the pertinent works are discussed here. Natural resource abundance, a trade structure variable, has a positive effect on economic growth, while export concentration has a negative effect (Lederman & Maloney, 2003). Export specialization and industry advancement positively impact growth; however, the impact of structural changes in imports on growth remains unclear (Kali, Méndez, & Reyes, 2007). Industry advancement is related to export specialization and has a positive effect on growth; however, structural change in imports and its effect on growth is not clear (Wörz, 2005). Various trade structure variables, including export and import performance in relation to factor endowments, the ratio of primary goods export to GDP, product differentiation, the ratio of FDI to trade, and export concentration measures, are demonstrating significant positive effects on growth (Sohn & Lee, 2010). Research on China found a significant relationship between export structure and growth of per capita GDP, which includes 222 cities in China (Shao & Liu, 2011). The import of capital goods gives access to new knowledge and skills and indirectly helps the growth of a country (Rodrik, 1989a, 1989B). Depending on the adopted definition, different trade structure variables impact the growth of per capita income in different ways. Measures based on trade shares in GDP find adverse effects of primary goods on growth, whereas measures based on trade specialization find positive effects on growth from high-skill and technology-intensive manufactures (Deb, 2022). All existing literature solely examines the impact of trade structure on the economy at an aggregate level. This paper fills the gap by examining the trade structure at a disaggregate level for 10 industrial sectors of Bangladesh.

After a thorough review of the literature, it is clear that different definitions exist for the characteristics of trade structures. UCNTAD (UN Trade and Development) provides one definition, characterizing trade structures based on the nature of trading partners, specifically the "Global North" and "Global South." Here North refers to developed economies, and South refers to developing economies. According to UNCTAD, intra-trade is the trade between countries belonging to a similar group, and extra-trade is the trade between countries belonging to a different group (UNCTAD, 2022). Based on this definition, there can be three global trade flows. These are (i) North and South, (ii) North-North, and (iii) South-South. Here, we consider North-North and South-South trade as intra-trade, while we consider North and South trade as extra-trade. The literature has also given attention to intra-industry trade as a characteristic of trade structure (Deb, 2022; Elhanan Helpman, 1999; Lederman & Maloney, 2003). The Grubel-Lloyd Index (Grubel & Lloyd, 1975) typically represents intra-industry trade, which is the volume of trade between similar industries. When the value of this index is higher, this means a higher intra-industry trade, and lower values are associated with lower intra-industry trade.

Trade structure is also defined based on the number of trading partners and the concentration of trade among the trade partners. Every country acquires knowledge through research and experience. However, there are differences among the countries in terms of acquired knowledge. Therefore, trade between countries indirectly transfers knowledge to their trading partners. The technology spillover depends upon the amount of trade and the number of trading partners. A country gains more new ideas when it's trading partners increase, as each country can contribute to the advancement of technological knowledge. By adapting this technology, it helps to increase productivity (Kali et al., 2007). Lederman and Maloney (2003) have defined trade structure based on natural resource abundance, export concentration, and intra-industry trade and linked these concepts with growth. Other researchers have also defined the FDI-to-trade ratio and identified comparative advantage as a trade structure variable, in addition to other trade structure variables (Deb, 2022; Sohn & Lee, 2010). Trade structure, which may be summed up as the nature of a country's trade, often consists of the following features: 1. International trade flows 2. Intra-industry trade; 3. Trade concentration. 4. Number of trading partners 5. The ratio of FDI to trade and 6. Revealed comparative advantage.

There are few empirical measurements of trade structure or trade patterns at a disaggregate level because the majority of studies on trade structure are at the aggregate level. In terms of policy, it is crucial to comprehend the trade structure at a disaggregate level; for instance, various industries may respond differently to different trade structure effects on industry-level growth. Understanding these differences should yield better policy implications. This research is innovative in the following ways: (i) It is using the trade structure data at the disaggregate level and analyzing the effect it has on industrial output, which includes 10 industrial sectors of Bangladesh for 26 years (ii) this study includes possible trade structure variables that may have an effect on industrial output (iii) this study includes 'Highest Priority Sectors', which captures the Bangladesh government's preferential trade promotion policy and fits them into industry sectors to see whether there are any differences in the effect of trade structures on output between 'Highest Priority Sectors' and 'Non-Highest Priority Sectors.'.

In essence, this study examines the following trade structure variables for 10 industrial sectors in Bangladesh, encompassing all manufacturing industries from 1995 to 2020. The study examines the following trade structure variables: (i) Intra-industry trade (IIT), (ii) Extra-trade and Intra-trade (EIT), (iii) Ratio of FDI to total trade (RFDIT), (iv) Number of trading partners (NTP), and (v) Revealed comparative advantage (RCA). Disaggregate-level data allows for the identification of important features, including the impact of intra-industry trade, intra-trade and extra-trade, the ratio of FDI to trade, the number of trading partners, and revealed comparative advantage on the output of manufacturing industries. Additionally, it provides insight into the "Highest Priority Sectors" of Bangladesh, which serve as targets for the government's preferential trade promotion policy. By utilizing various trade structures and industry sector-level data, it becomes possible to understand significant elements that are not achievable with aggregate-level data.

Utilizing a panel random effects estimator, this paper finds that IIT, RCA, and RFDIT positively affect the output, which is in line with the existing findings. On the other hand, we observe that NTP and EIT exert a negative influence on the output. This study includes a dummy variable capturing the Highest Priority Sectors (HPS) and Non-Highest Priority Sectors (Non-HPS), and interaction expansions are made with trade structure variables. It is observed that trade structures differently affect the output of industrial sectors when compared between HPS and Non-HPS. Our results are robust in the presence of alternate econometric specifications.

The following sections comprise the remaining paper: Section 2 is theoretical background that explains the conceptual considerations defining the anticipated empirical link between our trade structure variables and the output. Section 3 describes the trade structures and industrial sectors of Bangladesh. Section 4 discusses empirical methodology. Section 5 delves into the empirical results, while the final section serves as the conclusion.

2. THEORETICAL BACKGROUND

Here, we divide the theoretical background into two parts: the first part discusses the general theoretical background of how trade could affect a country's economy, and the second part theoretically links the trade structure variables of this study.

(a) According to previous theoretical literature, trade has the potential to positively impact a country's output and growth. Comparative advantage dictates that a country gains benefits when it produces goods with a relatively abundant supply of production factors. Thus, a less developed country can leverage its cheap production factors, such as labor, to produce labor-intensive products, while a developed country can leverage its knowledge and skill to produce advanced industrial goods, giving it a relative advantage over less developed countries. The Heckscher-Ohlin (HO) model states a labor-intensive country can benefit from exporting labor-intensive products and importing capital-intensive products, and a capital-intensive country can benefit from exporting capital-intensive products and importing labor-intensive products. The Stolper-Samuelson theorem demonstrates that trade enhances the real return of the factor, particularly for relatively higher-priced goods.

Grossman and Helpman explain the relationship between trade and economic growth. They explain how trade could positively affect economic growth by causing technological spillover, which ultimately increases competitiveness, productivity, and earnings (Grossman & Helpman, 1991). The monopolistic competition trade model with heterogeneous firms and endogenous productivity theoretically supports a positive relationship between trade and output. Trade liberalization increases competition among existing firms, allowing only more efficient firms to survive in international trade, while less efficient firms either exit or continue to produce for the domestic market (Melitz, 2003). Liberalization policies can have a better impact on growth compared to trade protectionist policies. Research shows that countries that prioritize trade liberalization policies experienced faster growth compared to those that prioritize restrictive trade policies (Krugman & Obstfeld, 2009). We find a positive relationship between export variety and productivity. With export variety, a higher export-GDP ratio will achieve higher growth in terms of GDP per capita (Feenstra & Kee, 2008; Feenstra, 2010).

However, not all research supports a positive outcome or a positive relationship between trade and growth. According to another study, these relationships can have both positive and negative effects (Vlastou, 2010). At the beginning of globalization, it increases wages for high-skilled workers and increases income inequality, but with the increase in supply of skilled labor and firm upgrades, inequality reduces over time (Aghion, Howitt, Howitt, Brant-Collett, & García-Peñalosa, 1998). The analysis includes heterogeneous firms and finds that more productive firms pay higher wages based on productivity level, while gradual trade liberalization initially increases wage inequality and later decreases it (Helpman, Itskhoki, & Redding, 2010). Anderson (2011) employs a model to demonstrate how trade openness exacerbates income inequality by widening the income gap across industries, thereby compelling workers to select a specific sector for skill acquisition. The effects of trade are low and even negative for those countries that are less diversified and produce low-quality export products compared to the countries producing higher-quality products (Huchet-Bourdon et al., 2018).

(b) This part discusses the concepts of trade structure variables theoretically. The first trade structure variable is intra-industry trade. Higher intra-industry trade allows the countries to benefit from product differentiation and economies of scale, which in turn increases productivity and facilitates economic growth (Elhanan Helpman, 1981, 1999; Krugman, 1979). Intra-industry trade can influence research and development, innovation, and market structure, including markup, economies of scale, and variety, all of which ultimately impact total factor productivity and economic growth (Rasekhi & Ramezani, 2017). However, the impact of intra-industry trade on economic growth can differ depending on a country's level of development. This study employs the intra-industry trade index (Grubel & Lloyd, 1975). Two trade structure variables, namely intra-trade and extra-trade, as well as the number of trading partners, share similar theoretical backgrounds. Every country acquires knowledge through research and experience. However, there are differences among the countries in terms of acquired knowledge. Therefore, trade between countries indirectly transfers knowledge to their trading partners. The technology spillover depends upon the amount of trade and the number of trading partners. A country gains more new ideas when it's trading partners increase, as each country can contribute to the advancement of technological knowledge. By adapting this technology, it helps to increase productivity. Furthermore, the increased number of trading partners can also increase the potential market size for domestic producers, and both the effects are expected to support growth. The expanded size of the potential market attracts both foreign and domestic investments, and this investment plays a significant role in technological diffusion and innovation (Grossman & Helpman, 1991). With the increase in the number of trading partners, it increases the number of potential competitors for the local market, which in turn can lead to higher productivity and economic growth (Boubakri & Cosset, 1998; Vickers & Yarrow, 1991).

The fourth trade structure variable in this study is the ratio of FDI to trade. Foreign Direct Investment (FDI) not only contributes to capital formation but also influences the growth of an economy in two distinct ways. In one way, FDI can enhance the adoption of new production processes and technologies through technological spillover, while in another, it fosters knowledge transfers through labor training and skill adoption (Mahembe & Odhiambo,

2014). FDI can be significant for a country's economic growth by increasing the investable capital and by technological spillover (Barro & Sala-I-Martin, 1995; Grossman & Helpman, 1991; Herzer & Klasen, 2008). You can determine the composition of foreign direct investment to trade by using the ratio of FDI to trade. Comparative advantage, the final trade structure variable, reveals its relationship to comparative advantage. A country will benefit from comparative advantage if it produces goods that have a relatively abundant supply of factors of production. According to the Heckscher-Ohlin (HO) model, an increase in trade could affect the growth positively. According to HO theory, a labor-intensive country can benefit from exporting labor-intensive products and importing capital-intensive products, and a capital-intensive country can benefit from exporting capital-intensive products and importing labor-intensive products. Balassa (1965) proposed the revealed comparative advantage index, based on the Ricardian and Heckscher-Ohlin models of comparative advantage.

The aforementioned literature and theoretical background briefly discuss the various ways in which trade can impact a country's economy. These include technological and other spillovers, economies of scale, and product differentiation. Local firms gain greater access to the global market, creating opportunities for more efficient firms. Additionally, comparative advantage aids in the efficient allocation of domestic resources. Overall, trade can boost competition and efficiency, leading to a wider variety of goods and services for consumers. Since the aggregate output level is the culmination of all disaggregated output levels, we should begin our analysis at the disaggregate level to gain a deeper understanding of the potential impact of trade structures on Bangladesh's economy. Based on the above discussions, Figure 1 illustrates the potential relationship between trade structure and the gross output of industrial sectors and also explores whether trade structure significantly influences the 'Highest Priority Sectors'.

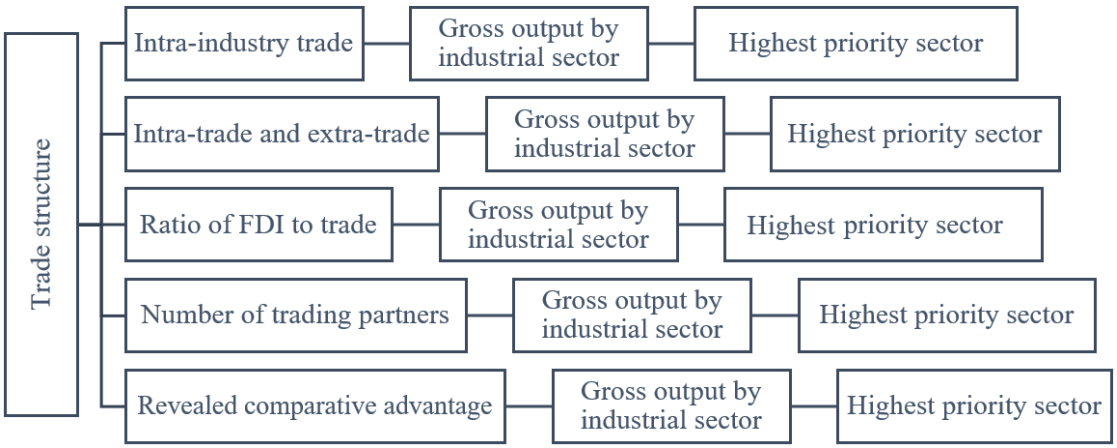

Figure 1. Trade structure and industrial output.

3. TRADE STRUCTURE AND INDUSTRIAL SECTORS OF BANGLADESH

3.1. Trade Structure of Bangladesh

This work focuses on the following trade structure variables for Bangladesh: (i) Intra-industry trade (ii) Intra-trade and extra-trade, (iii) Ratio of FDI to trade (iv) Number of trading partners (v) Revealed comparative advantage. The following concepts are briefly discussed below:

3.1.1. Intra-Industry Trade

In this work one of the trade structure variables is intra-industry trade. Intra-industry trade (IIT) index is measured by the following formula:

$$IIT_{jt} = 1 - \frac{|X_{jt} - M_{jt}|}{X_{jt} + M_{jt}} \qquad (1)$$

Where X and M are the exports and imports, respectively, of industrial sectors, and j ranges from 1 to 10, indicating the 10 industrial sectors in this work. The value of IIT ranges between 0 and 1. When the value of IIT is

0, it indicates that a country solely engages in exports or trade. When IIT is 1, it indicates fully intra-industry trade, or export and import are equal. This index is also known as the Grubel and Lloyd (1975) index of intra-industry trade.

The following two figures (Figure 2 and Figure 3) are showing the IIT index for 10 industrial sectors of Bangladesh for the years 1998 and 2018, respectively. Variation among the sectors and variation with time can be observed from here.

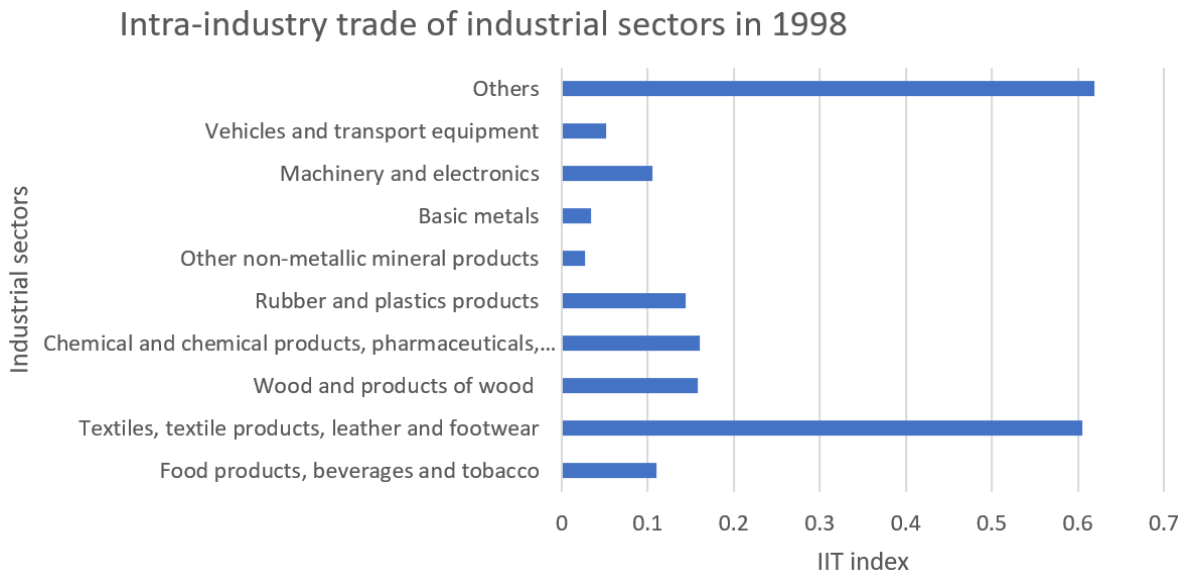

Figure 2. IIT index for 10 industrial sectors in 1998.

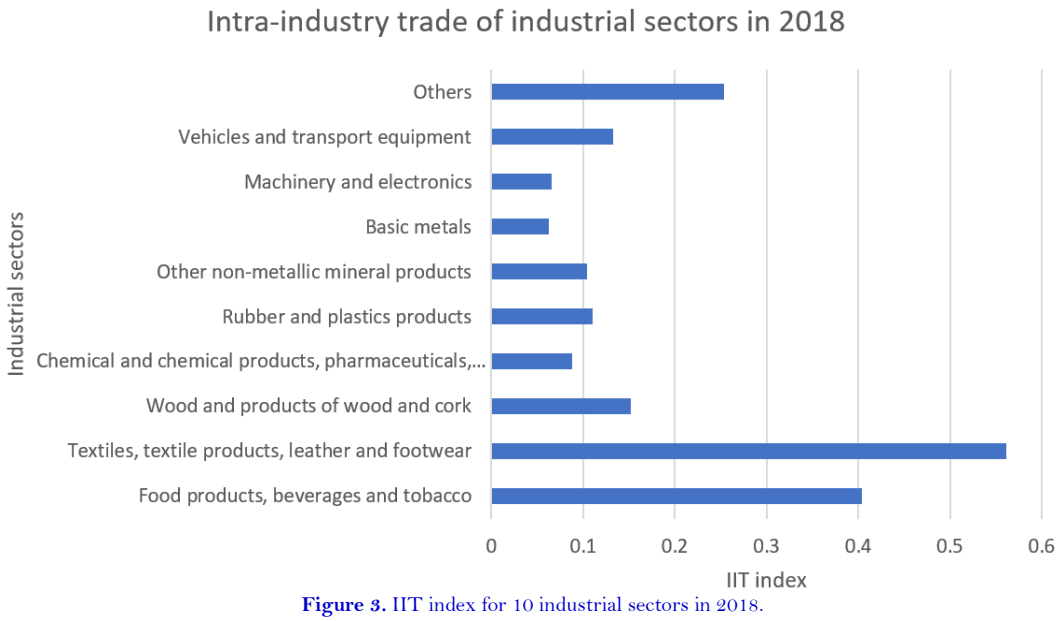

Figure 3. IIT index for 10 industrial sectors in 2018.

3.1.2. Intra-Trade and Extra-Trade

This work incorporates intra-trade and extra trade, as defined by UNCTAD (2022) as a trade structure variable. In the case of Bangladesh, we will examine South-South intra-trade and South-North extra-trade. This work employs the extra-intra trade ratio for empirical analysis.

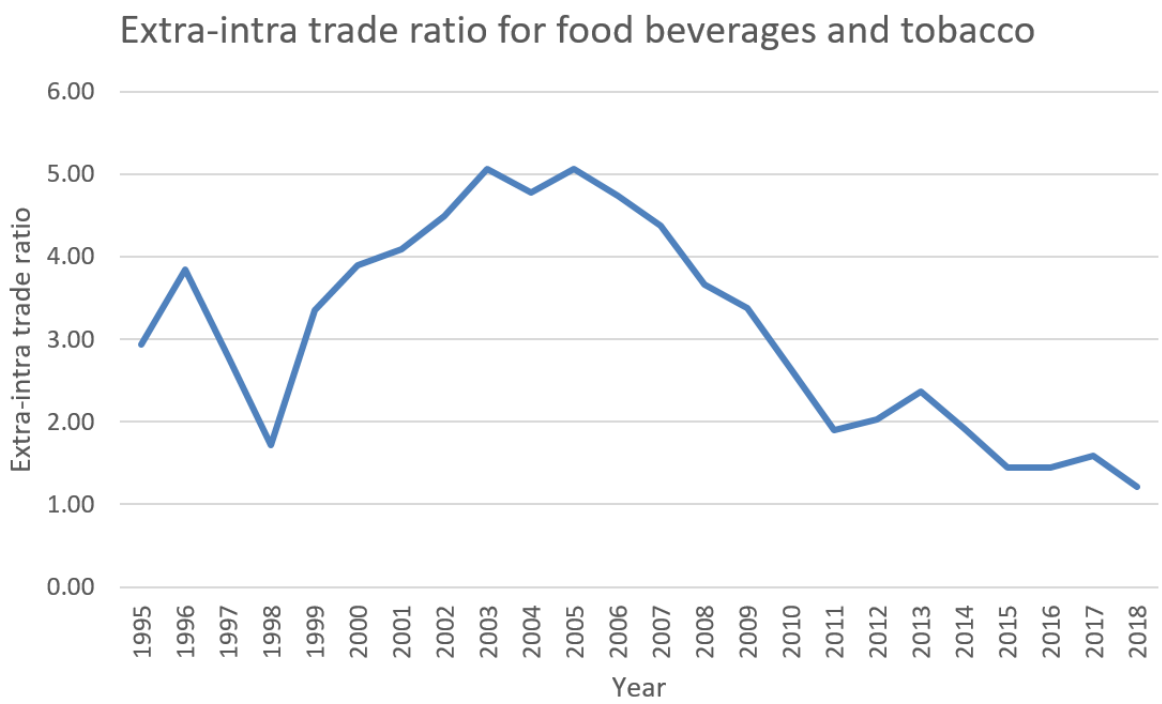

Figure 4. Extra-intra trade ratio (Food industry).

Figures 4 and 5 illustrate the extra-intra trade ratio for the food products, beverages, and tobacco sector and the textile, leather, and footwear sector, respectively. Here, extra trade indicates South-North trade, or the trade occurring between Bangladesh and the developed world, and intra trade indicates South-South trade, or the trade occurring between Bangladesh and the developing world. We observe downward trends for both sectors despite the fluctuations.

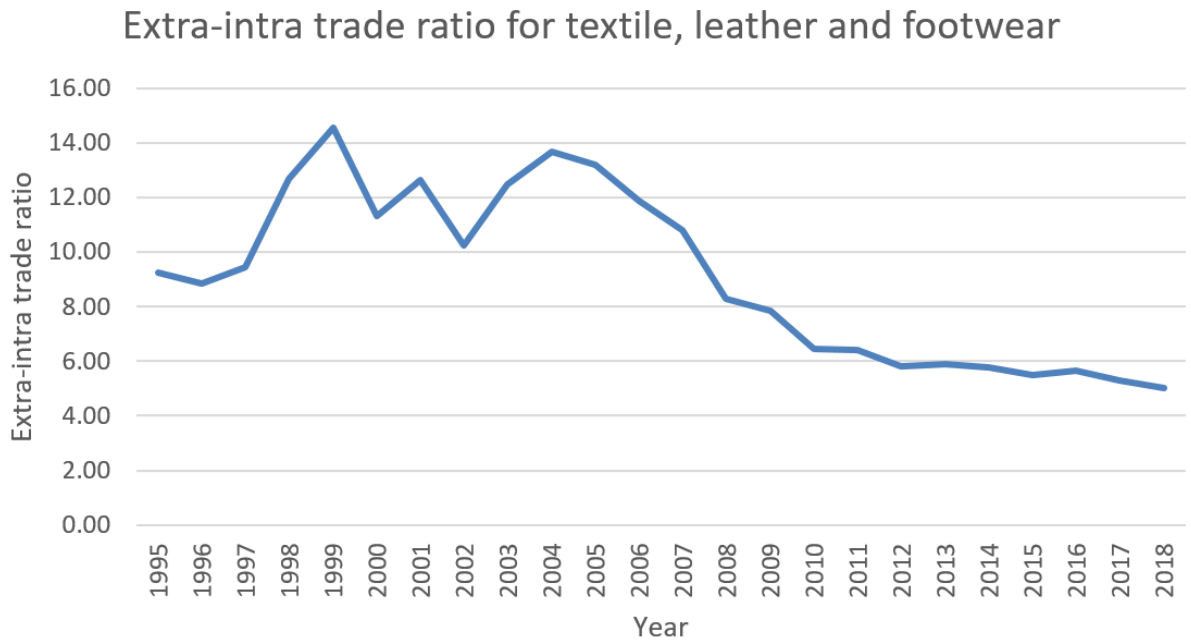

Figure 5. Extra-intra trade for textile and related industries.

3.1.3. Ratio of (Foreign Direct Investment) FDI to Trade

By using the ratio of FDI to trade, it is possible to get the composition of foreign direct investment on trade. We measure this variable by comparing the FDI in industrial sector j to the trade in the same industrial sector j. This variable can be measured using the following expression:

$$RFDI_{jt} = \frac{fdi_{jt}}{X_{jt}+M_{jt}} \qquad (2)$$

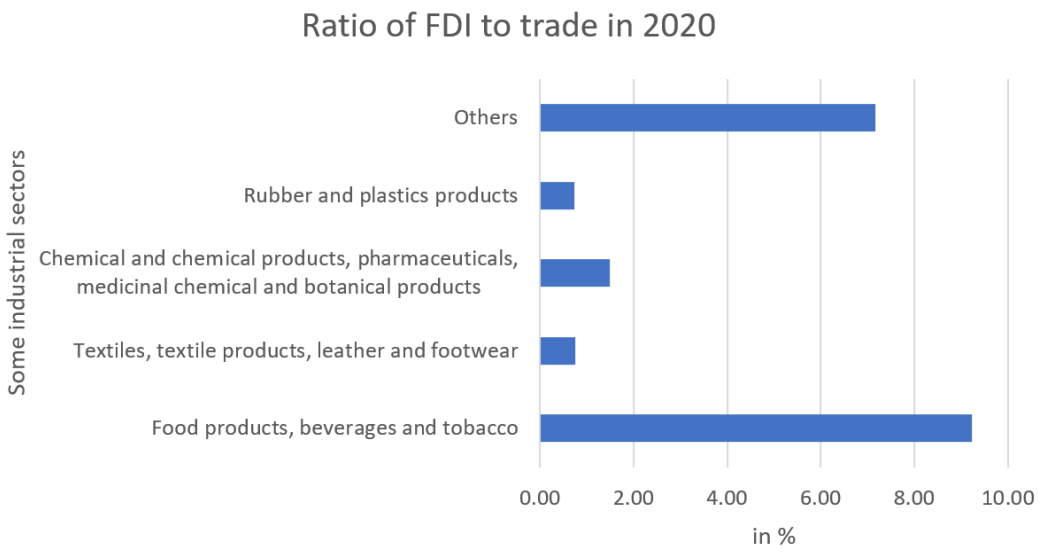

Figure 6. Ratio of FDI to trade for some industrial sectors in Bangladesh in 2020.

Figure 6 presents the ratio of FDI to trade as a percentage for some of the 10 industrial sectors for the year 2020.

3.1.4. Number of Trading Partners

Bangladesh has been experiencing globalization for the past three decades, with the number of trading partners changing quickly in the first two decades and then slowing down in the last decade. The number of trading partners also varies across industries.

Figure 7. No. of trading partners (Food and related industries).

Figures 7 and 8 depict the trading partner count for the food products, beverages, and tobacco sector, as well as the textile, leather, and footwear sector, respectively. For the first two decades, the number of trading partners

increased for both sectors; however, after that, it slowed down for the food products, beverages, and tobacco sector and decreased for the textile, leather, and footwear sector.

Figure 8. No. of trading partners (Textile and allied industries).

3.1.5. Revealed Comparative Advantage

In this work, the revealed comparative advantage index is used. The revealed comparative advantage index was proposed by Balassa (1965) which is based on Ricardian and Heckscher-Ohlin models of comparative advantage, and for this work can be expressed by the following formula:

$$RCA_{jt} = \frac{X_{jt}^{B}/X_{tt}^{B}}{X_{jt}^{w}/X_{tt}^{w}} \qquad (3)$$

Where X_{jt}^{B} = Export of industrial sector j by Bangladesh at time t.

X_{tt}^{B} = Total export by Bangladesh at time t.

X_{jt}^{w} = Export of industrial sector j by world at time t.

X_{tt}^{w} = Total world.

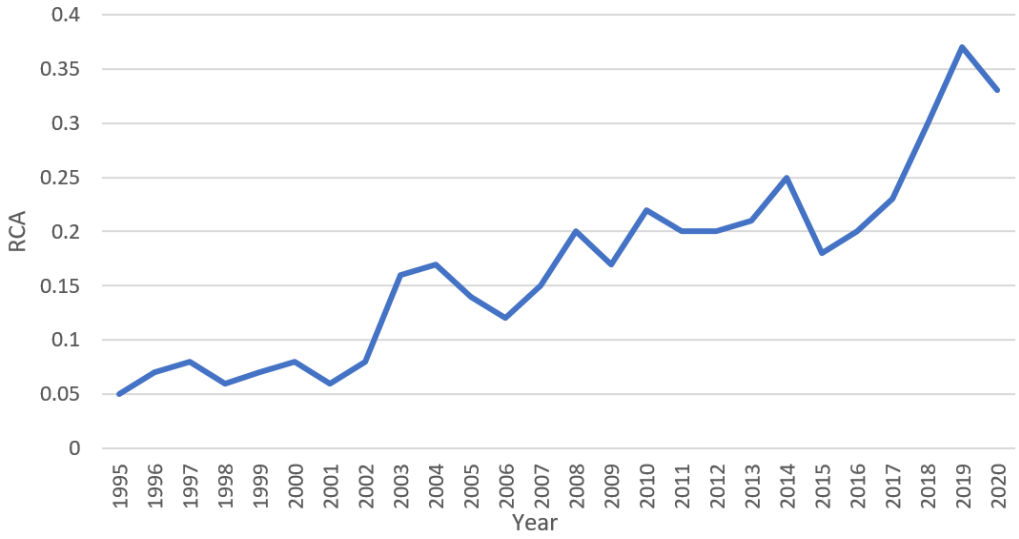

Figure 9. RCA of food products, beverages and tobacco.

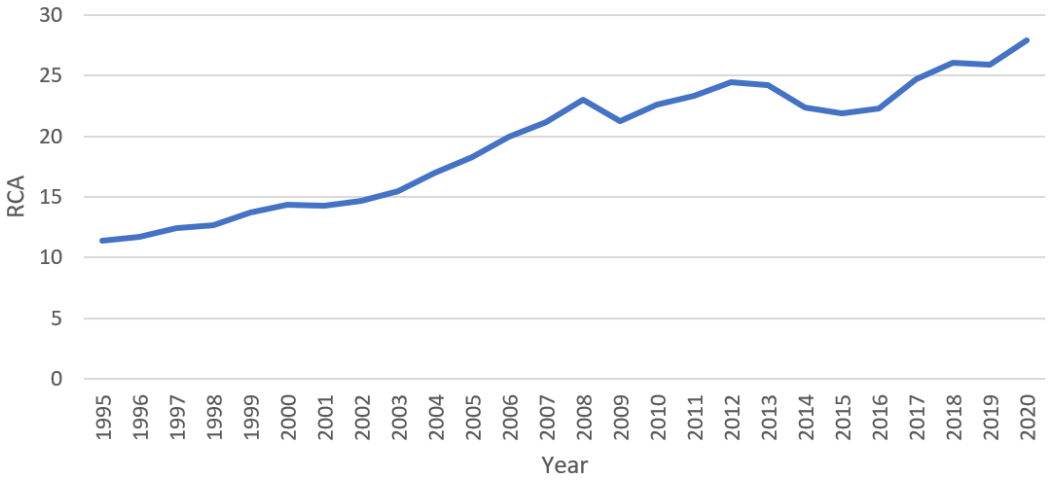

Figure 10. RCA of textile, textile product, leather and footwear.

Figure 9 and 10 illustrate the trends in the Return on Assets (RCA) for food products, beverages, and tobacco, as well as the RCA for textiles, textile products, leather, and footwear, from 1995 to 2020. The graphs above showcase two industrial sectors from a total of ten, demonstrating how the RCAs fluctuate over time and across different industries. If the values of RCA are less than 1, then the sector has a comparative disadvantage, and if the values of RCA are greater than 1, then the sector has a comparative advantage.

This work includes labor and capital as control variables in addition to the trade structure variables mentioned above.

3.1.6. Labor Supply (ls)

People ages 15 and older who provide labor for the production of goods and services within a specified period are classified as labor supply. This work utilizes the labor supply from the industrial sector.

3.1.7. Gross Capital Formation (GCF)

Gross capital formation includes an addition to the fixed assets of the economy plus net changes in the level of inventories. Data are in constant 2015 prices, expressed in U.S. dollars.

3.2. Structure of Gross Output by Industrial Sector in Bangladesh

This study primarily focuses on industry sectors using disaggregate-level data. We classify industry sectors into 10 categories. Table 1 presents these sectors.

Table 1. Industrial sector.

Sl.no.	Industry sector	Sl.no.	Industry sector
1	Food products, beverages, and tobacco	6	Other non-metallic mineral products
2	Textiles, textile products, leather, and footwear	7	Basic metals
3	Wood and products of wood	8	Machinery and electronics
4	Chemical and chemical products, pharmaceuticals	9	Vehicles and transport equipment
5	Rubber and plastic products	10	Others

Note: The brown color group are outside of HPS.

Industrial sectors 1, 2, 4, 5 and 9 are under Highest Priority Sectors (HPS), and the remaining sectors are outside Highest Priority Sectors (HPS) and treated as non-HPS in this work.

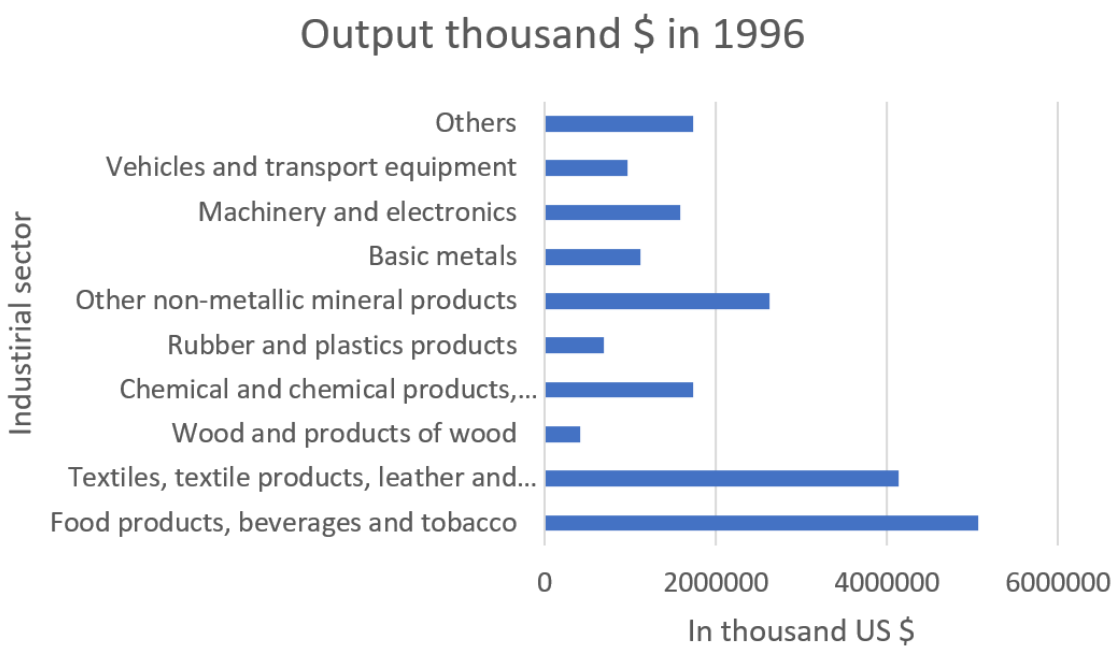

Figure 11. Output of 10 industrial sector of Bangladesh in 1996.

Figures 11 and 12 present the output level of the 10 industrial sectors in Bangladesh, expressed in thousand US$, for the years 1996 and 2018, respectively.

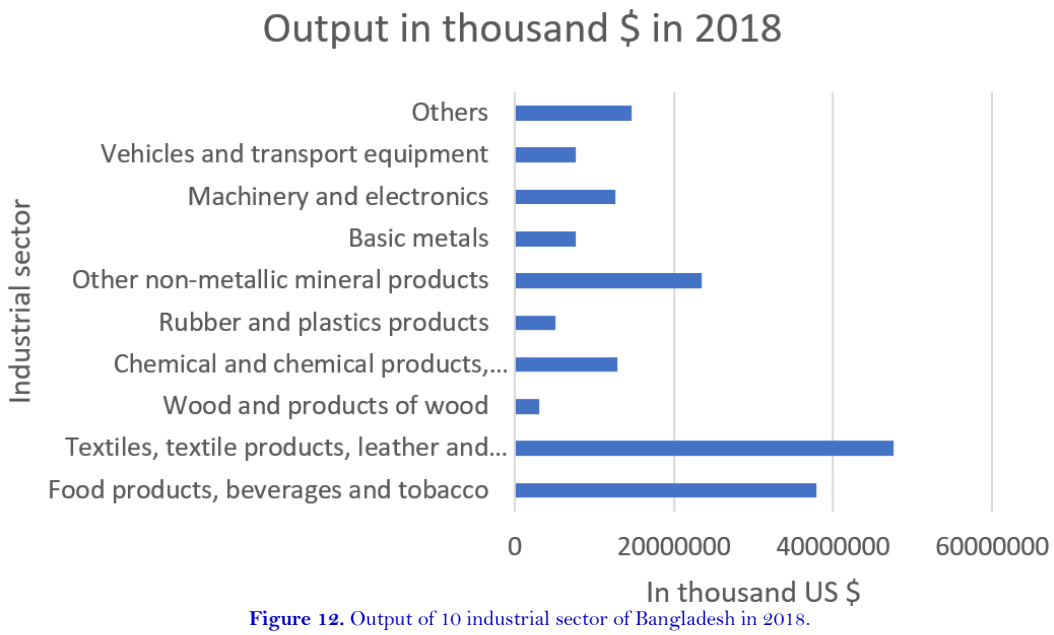

Figure 12. Output of 10 industrial sector of Bangladesh in 2018.

The benefit of using data at the industrial sector level is that it helps to understand the effect of trade structure on these sectors more deeply. The Ministry of Commerce of Bangladesh has formed the Business Promotion Council with a joint initiative between the government of Bangladesh and the private sector under the Companies Act 1994 to increase export diversification, quality of products, acquiring advanced technologies, improving compliance requirements, and marketing. They have classified the product and service sector into two groups, which are the Highest Priority Sectors (HPS) and Special Development Sectors (SDS). This study includes HPS for its analysis, which is discussed below:

3.2.1. Highest Priority Sectors (HPS)

This study incorporates 'Highest Priority Sectors' into its analysis to examine the impact of trade structure variables on them. The definition of 'Highest Priority Sectors' is provided as follows:

Table 2 shows the Highest Priority Sectors (HPS): The highest priority sectors are those that possess unique export potentials, yet certain constraints prevent their proper utilization. This category includes the following 13 sectors:

Table 2. Highest priority sectors.

Sl.no.	Name of highest priority sector	Sl.no.	Name of highest priority sector
i	High value-added readymade garments, denim, and garment accessories	viii	Ship and ocean-going fishing trawler
ii	Software and IT enabled services, ICT products	ix	Furniture
iii	Pharmaceutical products	x	Home textiles and terry towels
iv	Plastic products	xi	Home furnishing
v	Footwear (Leather, non-leather and synthetic) and leather products	xii	Luggage
vi	Jute products	xiii	Active pharmaceutical ingredients and laboratory reagents
vii	Agro-products and agro-processed products		

The Ministry of Commerce collaborates with the Business Promotion Council to establish these categories. These categories remain more or less the same over the different policy years (Export Policy, 2018). Although these categories do not align with the industry sectors, it is possible to roughly align the HPS sectors with the industrial sectors to capture government interventions and observe the impact of trade structures. This can be achieved by interacting trade structure variables with a dummy variable based on HPS, where a value of 1 indicates membership in HPS and 0 indicates non-membership. Although there are some minor changes in the facilities provided to the HPS over different policy years, in general, the facilities are as follows: The facilities offered to the HPS include (i) loans at reduced interest rates; (ii) income tax rebates; (iii) subsidies consistent with WTO agreements; (iv) air transport facilities at concessionary rates; (v) facilities to set up backward linkage industries; (vi) assistance in production, marketing, and exploring foreign markets; and (vii) initiatives to attract foreign investment. This work treats the sectors not included in HPS as non-HPS.

4. METHODOLOGY

The main focus of this study is to see the effects of trade structures on the gross output of industrial sectors in Bangladesh. For this purpose, 10 industrial sectors are included for analysis along with the main variables of interest, which are trade structure variables. All these trade structure variables are used at the disaggregate level based on the 10 industrial sectors of Bangladesh. In addition to these trade structure variables, we also consider labor and capital as control variables. The time period of this analysis is from 1995 to 2020.

4.1. Empirical Strategy for Analysis at Industrial Sectors Level

In the classical production function, output level is a function of capital and labor. It can be expressed as:

$$Y = f(L, K) \qquad (4)$$

Where Y is output level, L is labor and K is capital.

There is a significant amount of literature on trade and growth where it starts with the Cobb-Douglas production function/neoclassical production function, and then it is extended by including other factors (Awokuse, 2008; Fatima, Chen, Ramzan, & Abbas, 2020; Keho, 2017; Raghutla, 2020). Similarly, this work starts with the Cobb-Douglas Production function. Cobb-Douglas production function can be written as:

$$Y_t = AL_t^{\beta_l} K_t^{\beta_k} \quad (5)$$

Based on earlier research and theoretical background which has been discussed earlier, trade structure variables are included in the function which are as follows:

$$Q_t = AL_t^{\beta_l} K_t^{\beta_k} TS_t^{\beta_{ts}} \quad (6)$$

Here TS_t is the vector of trade structure variables. Equation 6 can be expressed in the following way:

$$lnQ_{jt} = \beta_0 + \beta_l lnL_t + \beta_k lnK_t + \beta_{ts} lnTS_{jt} + u_{jt} \quad (7)$$

We use the following variables in this study. The study uses trade structure variables such as intra-industry trade, measured by the Grubel and Lloyd (1975) ratio of extra-trade and intra-trade, the ratio of FDI to trade, the number of trading partners, and revealed comparative advantage, measured by the revealed comparative advantage index (Balassa, 1965). The control variables are gross capital formation (k) and labor supply (l). In detail, the model that is used for estimation at the industrial sector level of analysis looks like this following equation:

$$lO_{jt} = \beta_0 + \beta_1 iit_{jt} + \beta_2 eit_{jt} + \beta_3 rfdit_{jt} + \beta_4 lntp_{jt} + \beta_5 lrca_{jt} + \beta_6 ll_t + \beta_7 lk_t + u_{jt} \quad (8)$$

Where,

lO_{jt}= Log output by sector at industrial level.

Here j refers to sector and t refers to time.

iit_{jt}= Intra-industry trade index.

eit_{jt}= Ratio of extra-trade and intra-trade.

$rfdit_{jt}$ = Ratio of FDI to trade.

$lntp_{jt}$ = Log of number of trading partners.

$lrca_{jt}$= Log of revealed comparative advantage.

ll= Log of labor supply in industrial sector.

lk = Log of gross capital formation (Constant 2015 US$), and u_{jt}= The error term.

4.2. Main Hypotheses for this Study

We have collected and constructed data appropriately for all these five trade structure variables across 10 industrial sectors at the same disaggregate level. The data set reveals that the values of trade structure variables fluctuate both over time and across industries. Theory supports all these trade structure variables, suggesting they could significantly impact Bangladesh's industrial output. However, the effect may vary across industries. Table 3 presents the study's hypotheses, their correlation with output, and their predicted sign.

Hypothesis$_1$: Intra-industry trade has a positive effect on gross output by industrial sector.

Hypothesis$_2$: Extra-trade - intra-trade ratio has a positive effect on gross output by industrial sector.

Hypothesis$_3$: Ratio of FDI to trade has a positive effect on gross output by industrial sector.

Hypothesis$_4$: Number of trading partners has a positive effect on gross output by industrial sector.

Hypothesis$_5$: Revealed comparative advantage has a positive effect on gross output by industrial sector.

Table 3. Trade structure variables and their expected signs.

Independent variables name	Link to output	Expected sign.
Intra-industry trade	Through product differentiation and economies of scale	+
Extra-trade - intra-trade ratio	Higher ratios indicate higher trade is occurring with the developed (North) economies relative to developing (South) economies	+
Ratio of FDI to trade	Capital formation, labor skill development, and technological spill over	+
Number of trading partners	Getting new ideas for a country is greater when the number of trading partners increases because each country can contribute to technological knowledge	+
Revealed comparative advantage	Existence of comparative advantage is expected to help the respective sector of an economy	+

By adding a dummy variable, we can extend the baseline model to examine the impact of 'Highest Priority Sectors' (HPS) on the gross output level. We categorize the industrial sectors here based on HPS.

By including this, it is possible to see whether HPS have any effect on the industrial sector output level.

$$lO_{jt} = \beta_0 + \beta_1 iit_{jt} + \beta_2 eit_{jt} + \beta_3 rfdit_{jt} + \beta_4 lntp_{jt} + \beta_5 lrca_{jt} + \beta_6 ll_t + \beta_7 lk_t + \beta_8 dummyhps + u_{jt} \quad (9)$$

Where, $dummyhps =$ a dummy variable that takes the value 1 if the industrial sector is in the highest priority sector list and 0, otherwise.

The second extension of the base line model is made to find whether trade structure variables have an impact on HPS. This is captured by including interaction terms in the equation. The interactions are between trade structure variables and a dummy variable based on HPS.

$$lO_{jt} = \beta_0 + \beta_1 iit_{jt} + \beta_2 eit_{jt} + \beta_3 rfdit_{jt} + \beta_4 lntp_{jt} + \beta_5 lrca_{jt} + \beta_6 ll_t + \beta_7 lk_t + \beta_8 dummyhps + \beta_{9i} ts_{jt} \times dummyhps + u_{jt} \quad (10)$$

Where ts_{jt} = Vector of trade structure variables.

This study employs a panel data method. The temporal data in this study are the yearly data from Bangladesh from 1995 to 2020, with 10 industrial sectors serving as units. The general regression model of panel data can be written as follows:

$$Y_{it} = \beta_0 + \beta_1 X_{it,1} + \beta_2 X_{it,2} + \cdots + \beta_k X_{it,k} + v_{it} \quad (11)$$

Where $i = 1, \ldots\ldots\ldots, N$ (Different units).

$t = 1, \ldots\ldots, T$ (Period of time).

β_0 = Intercept.

β_k = Coefficients of each explanatory variable.

v_{it} = Composite error term.

Composite error term can be expressed as $v_{it} = \alpha_i + u_{it}$.

Where α_i = Cross-sectional unit specific error.

and u_{it} = Idiosyncratic error.

The unobserved unit-specific factors could minimize the omitted variable bias by decomposing the error terms into two parts. Therefore, we can write Equation 11 as follows:

$$Y_{it} = \beta_0 + \beta_1 X_{it,1} + \beta_2 X_{it,2} + \cdots + \beta_k X_{it,k} + \alpha_i + u_{it} \quad (12)$$

We refer to this equation as the error component model. Here it is unobserved, time invariant, and very difficult to measure (Baltagi, 2008; Greene, 2003; Gujarati & Porter, 2003; Wooldridge, 2015). In our case, for the industry sectors, there also may be some unobserved factors that are unknown.

Panel data offers several advantages, including a significant increase in sample size and the ability to analyze repeated cross-sectional data, making them ideal for studying change dynamics. Despite these significant advantages, we still need to address issues that arise in cross-section data, such as heteroscedasticity, and time series data, such as autocorrelation. There are several estimation techniques to address these problems, and among these, the two most prominent are (i) fixed effects model (FE) and (ii) random effects model (RE) (Gujarati, Porter, & Gunasekar, 2012). This work specifically addresses the unit root problem that may arise in time series data. One advantage of RE over FE is its ability to include variables such as gender, religion, ethnicity, or any other time-invariant variables for a given subject, a feature that usual FE eliminates and cannot measure (Gujarati et al., 2012; Wooldridge, 2015).

This study chooses the RE estimator over the FE estimator for two reasons: (i) it enhances the baseline model by incorporating a time-invariant dummy variable that reflects the government of Bangladesh's preferential policy, and it expands the interactions between trade structure variables and a dummy variable using HPS. The FE estimator eliminates the dummy and does not significantly alter the signs and values of the baseline model's parameters. The "Robustness Check" section provides a comparative representation of RE and FE parameters, along with an explanation. Put differently, results are robust in the presence of an alternate method of estimation.

5. EMPIRICAL RESULTS AND DISCUSSIONS

We check for high correlation among the variables before running the regression. The following table shows the correlation matrix of key variables. Table 4 reveals a strong correlation (0.98) between the labor and capital variables. Therefore, to mitigate the multicollinearity issue, the regression analysis solely considers labor as one of these two variables. Also, intra-industry trade and revealed comparative advantage have been used alternatively in estimation because (a) they are 80% correlated, (b) using both variables together could make other variables insignificant due to multicollinearity, and (c) neither of these variables should be dropped because they are used to explain things.

Table 4. Correlation matrix of key variables.

Variables	lo_{jt}	iit_{jt}	eit_{jt}	$rfdit_{jt}$	$lntp_{jt}$	$lrca_{jt}$	ll_t	lk_t
lO_{jt}	1.0000							
iit_{jt}	0.3680	1.0000						
eit_{jt}	-0.1489	0.360	1.0000					
$rfdit_{jt}$	0.1760	0.2327	0.1466	1.0000				
$lntp_{jt}$	0.3812	0.2499	0.0502	-0.0814	1.0000			
$lrca_{jt}$	0.5683	0.8000	0.3013	0.0463	0.3688	1.0000		
ll_t	0.6487	-0.0171	-0.3589	-0.0507	0.6787	0.1497	1.0000	
lk_t	0.6673	-0.0159	-0.3659	-0.0267	0.6449	0.1588	0.9866	1.0000

Given that this panel data comprises time series spanning 26 years, it is necessary to verify the stationary property of each variable. If the variables become stationary at their first difference, the model can use their stationary first difference. The Levin-Lin-Chu panel unit root test can be used to test the stationary property. The panel unit root test is done by the Levin-Lin-Chu panel unit root test. Table 5 reveals that the variables, the log of output, intra-industry trade, extra-intra trade (North-South trade ratio), ratio of FDI to trade, log of number of trading partners, log of revealed comparative advantage, and log of labor supply remain stationary at the same level. Therefore, we will incorporate these variables into the equation in level form.

Table 5. Panel unit root test.

Variables		At level	At first difference	Comments
		Levin-Lin-Chu statistics	Levin-Lin-Chu statistics	
Dependent variable	lO_{jt}	-4.02***	--	Stationary
Explanatory variables (Trade structure)	iit_{jt}	-3.23***	--	Stationary
	eit_{jt}	-3.3***	--	Stationary
	$rfdit_{jt}$	-3.90***	--	Stationary
	$lntp_{jt}$	-6.99***	--	Stationary
	$lrca_{jt}$	-1.65**	--	Stationary
Control	ll_t	-6.62***	--	Stationary

Note: *** and ** indicate significance at the 1% and 5% level respectively.

Table 6 outlines the results of the baseline specification. Column (1) and Column (2) present the results of the specification, which alternately uses RCA and IIT for running the regressions.

Table 6. Result of baseline specification.

Particulars	(1)	(2)
Ln (RCA)	0.082*** (0.016)	-
IIT	-	0.307** (0.123)
EIT	-0.009** (0.003)	-0.007** (0.003)
RFDIT	0.007** (0.003)	0.005 (0.004)
Ln (NTP)	-1.116***(0.095)	-1.152*** (0.098)
Ln (Labor)	2.039*** (0.054)	2.121*** (0.054)
Obs.	260	260
R- squared (Overall)	0.552	0.443

Note: *** and ** indicate significance at the 1% and 5% level respectively.

$$lO_{jt} = 16.39 - 0.009^{**}eit_{jt} + 0.007^{**}rfdit_{jt} - 1.12^{**}lntp_{jt} + 0.083^{***}lrca_{jt} + 2.04^{***}ll_t \quad (13)$$

The results of Column (1) indicate a positive impact of comparative advantage on industrial output. A 1 percent increase in comparative advantage (RCA) positively affects industrial output by 0.08 percent. This result aligns with the concept of comparative advantage, the HO model, and a recent study that discovered a positive correlation between RCA and GDP per capita (Deb, 2022). The estimated equation clearly demonstrates a negative and significant coefficient for the variable EIT. This indicates that higher trade with the North compared to the South results in a decline in industrial output. To be more specific, a 1 percent additional increase in EIT will likely decrease the output by 0.009 percent. This result is different from the anticipated result, which expects higher trade with developed countries will contribute more to the technological spillover and economic growth. One of the reasons for this outcome may be the greater geographical proximity of Bangladesh to South countries, and significant import dependency on these countries may be causing this coefficient to be negative. Put differently, relatively greater trade with South countries compared to North countries results in a positive effect on Bangladeshi industrial output.

As expected, RFDIT has a positive and significant effect on industrial output. This result is expected according to the theory discussed earlier and is also consistent with other works (Li & Liu, 2005; Sohn & Lee, 2010). Empirics reveal that a 1 percent increase in RFDIT is associated with a 0.007 percent increase in industrial output. Unexpectedly, the number of trading partners has a negative impact on industrial output. 1 percent increase in number of trading partners is associated with a 1.11 percent decline in industrial output. This result stands in contrast to the findings of Kali et al. (2007). One possible reason for this discrepancy could be the inclusion of both import and export countries in the calculation of trading partners: a greater reliance on import countries could potentially negatively impact industrial output. Consistent with our expectations, labor supply has a positive impact on industrial output. 1 percent increase in labor supply is associated with a 2.04 percent increase in the industrial output. The results of Column (2) include IIT as an alternate variable instead of RCA and indicate a positive association with output. A 1 percent increase in the intra-industry trade index is associated with a 0.31 percent increase in industrial output, which is consistent with theories (Elhanan Helpman, 1981, 1999; Krugman, 1979) and empirical studies (Deb, 2022; Lederman & Maloney, 2003). The signs associated with all other variables from Column (1) are consistent, and the respective magnitudes are almost identical. This reiterates that our findings are robust in the presence of an alternate specification.

$$lO_{jt} = 16.13 + 0.31^{**}iit_{jt} - 0.007^{**}eit_{jt} + 0.005rfdit_{jt} - 1.15^{***}lntp_{jt} + 2.12^{***}ll_t \quad (14)$$

5.1. Estimated Extended Model

This is the first attempt in Bangladesh to analyze the impact of trade structure variables on industrial output using disaggregated-level data. In order to enhance the analysis's significance, this study incorporates the 'HPS' variable to measure the government policy support for various sectors. The primary goal of this extension is to examine the potential differences in effects of trade structure variables on sectors receiving preferential trade promotion support from the Bangladesh government.

The methodology section explains how we augmented the model with the HPS variable and interacted with all the trade structure variables. Table 7 displays the results. Now, the RCA variable represents the effect of RCA on the output of non-HPS, and the interaction, Ln (RCA)✕HPS, represents the difference in the effect of RCA on non-HPS and HPS. The sign associated with RCA is positive, indicating that the effect of RCA on non-HPS is positive. The interaction term is positive, indicating that the effect is higher on HPS compared to non-HPS. The result shows that the effect is almost double that of the non-HPS sector.

The sign associated with IIT indicating the effect of IIT on Non-HPS is negative. However, the interaction term is positive, indicating that the effect of IIT is higher on HPS compared to non-HPS. To be precise, one additional percentage increase in IIT results in a 3.668 percent increase in output of the HPS.[1] In Column (1), the sign associated with EIT indicates a positive effect of EIT on Non-HPS. The interaction term is negative, indicating that the effect is lower on HPS compared to non-HPS.

Recalling the results of baseline and noticing that EIT has an overall negative effect on the output. It appears that this finding is consistent when the sectors are HPS because the sign of the effect on HPS is negative with a magnitude of -0.02.[2] For NTP in Column (1) and Column (2), only the effect on non-HPS sectors is negative and significant. There is no conclusive evidence of the difference between Non-HPS and HPS. Looking at the coefficients of FDI in Column (1), we observe that FDI has a positive effect on both Non-HPS and HPS; however, the effect is higher on HPS compared to non-HPS.

Table 7. Result of extended specification.

Particulars	(1)	(2)
Ln (RCA)	0.182** (0.062)	-
Ln (RCA)✕HPS	0.174** (0.067)	-
IIT	-	-1.831**(0.573)
IIT ✕HPS	-	5.499***(0.637)
EIT	0.025** (0.012)	0.063*** (0.015)
EIT ✕HPS	-0.045** (0.015)	-0.062*** (0.018)
RFDIT	0.024*** (0.017)	0.054*** (0.019)
RFDIT ✕HPS	0.035* (0.021)	-0.006 (0.023)
Ln (NTP)	-1.384*** (0.221)	-1.155*** (0.233)
Ln (NTP) ✕HPS	-0.116 (0.253)	0.246 (0.259)
Ln (Labor)	2.087*** (0.134)	2.319*** (0.137)
HPS	1.145(1.235)	-1.462 (1.203)
R- squared (Overall)	0.765	0.739

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level respectively.

This analysis concludes that most trade structure variables (IIT, RCA, RFDIT) have a higher impact on output level when sectors are under the Bangladesh government's preferential policy, which is called HPS. We find no significant difference between HPS and other sectors in the number of trading partners. Only in the case of EIT is the effect of this variable found to be higher on non-HPS. As explained earlier, the greater geographical proximity of Bangladesh to South countries and significant import dependency on these countries might be causing this kind of result.

5.2. Robustness Check

As a robustness check, we also run the specification (Equation 8) with a fixed effects estimation technique, and the parameters are almost identical both in terms of sign and magnitude. The results are shown below in Table 8.

[1] This follows the calculation: -1.831 + 5.499 = 3.668.

[2] This follows the calculation: 0.025 - 0.0455 = -0.02.

Table 8. Comparison between RE and FE estimators.

Particulars	Random effects		Fixed effects	
	(1)	(2)	(3)	(4)
Ln (RCA)	0.082*** (0.016)	-	0.077*** (0.016)	-
IIT	-	0.307** (0.123)	-	0.291** (0.123)
EIT	-0.009** (0.003)	-0.007** (0.003)	-0.009** (0.003)	-0.007** (0.003)
RFDIT	0.007** (0.003)	0.005 (0.004)	0.007** (0.003)	0.005 (0.004)
Ln (NTP)	-1.116*** (0.095)	-1.152*** (0.098)	-1.123*** (0.095)	-1.156*** (0.098)
Ln (Labor)	2.039*** (0.054)	2.121*** (0.054)	2.046*** (0.054)	2.123*** (0.054)
Obs.	260	260	260	260
R- squared (Overall)	0.552	0.443	0.542	0.441

Note: *** and ** indicate significance at the 1% and 5% level respectively.

As previously mentioned, this study has expanded the interaction between trade structure variables and a time-invariant dummy variable based on 'HPS', enhancing the baseline model. The FE estimator eliminates the dummy, making it impossible to infer the differential effects of trade structure variables on industrial output. Therefore, we prefer the RE estimator over the FE estimator. Table 8 demonstrates that selecting the FE estimator does not significantly alter the signs and values of the baseline model's parameters. Put differently, results are robust in the presence of an alternate method of estimation.

6. CONCLUSION

This study employs trade structure variables to examine the impact on the gross output of industrial sectors in Bangladesh's economy, conducting a disaggregate analysis. Many empirical studies analyze trade volumes and measures of trade openness at the aggregate level, while this study focuses on trade structures and conducts disaggregate analyses using different industrial sectors. The results found in this study are intriguing. This study employs five trade structure variables: (i) intra-industry trade (IIT), (ii) extra-trade and intra-trade (EIT), (iii) ratio of FDI to total trade (RFDIT), (iv) number of trading partners (NTP), and (v) revealed comparative advantage (RCA). Out of these five trade structure variables, three (IIT, RCA, and RFDIT) have a positive and significant effect on industrial output. Based on these results, the Bangladeshi government can consider more supportive policies that will help increase IIT and attract FDI to industrial sectors. Bangladesh has revealed a comparative advantage (RCA) for the sectors of textiles, textile products, leather, and footwear, which are also the sectors earning a significant portion of foreign currency for Bangladesh. We should pay particular attention to the industries that fall under this sector.

The effect of the trade structure variable EIT is found to be negative and significant. This indicates that higher trade with the North compared to the South results in a decline in industrial output. One reason for this outcome could be Bangladesh's greater geographical proximity to South countries, and the significant import dependency on these countries could be contributing to the negative effect. Put differently, relatively greater trade with South countries compared to North countries results in a positive effect on Bangladeshi industrial output. In such cases, Bangladesh's intra-trade or South-South trade should receive special attention. Bangladesh successfully negotiated several regional trade and economic agreements, which include the South Asian Free Trade Area (SAFTA), the Asia-Pacific Trade Agreement (APTA), and the Bay of Bengal Initiative for Multi-Sectoral, Technical and Economic Cooperation (BIMSTEC). Besides these, Bangladesh signed its first bilateral Preferential Trade Agreement (PTA) with Bhutan in December 2020 while it is in discussions with several countries for PTAs and Free Trade Agreements (FTAs). Top import partners of Bangladesh are China, India, Singapore, Hong Kong, and Indonesia, which belong to Intra-trade or South-South trade in the case of Bangladesh. Trade with these countries should receive special

preference. Another trade structure variable, NTP, has a negative impact on industrial output. We have already observed a saturation of NTP in the last decade. Given the outcome of NTP, we should prioritize vertical diversification, pursue intensive margins, or enhance our current trade.

The analysis of the extended model reveals that most trade structure variables, such as IIT, RCA, and RFDIT, significantly influence the output level in sectors that fall under the preferential policy of the Bangladeshi government or are part of the 'HPS.' Therefore, the Bangladesh government should persist in providing the same facilities to the 'HPS' as it has done for the past two decades while also considering the inclusion of potential other industries under the HPS.

6.1. Data Source

For the variables used in this work, the following data sources are used: Output for industrial sectors (BBS, 2022; WITS, 2023) intra-industry trade index is calculated based on industrial sector-wise export and import data (BBS, 2022; WITS, 2023) ratio of intra-trade and extra-trade (CEPII, 2023; UNCTAD, 2022) ratio of FDI to trade is calculated based on industrial sector wise FDI and export and import (Survey Report on Foreign Direct Investment (FDI) in Bangladesh, 2021; Trade Map, 2023) the number of trading partners (BBS, 2022; CEPII, 2023) revealed the comparative advantage index (UNCTADSTAT, 2023) labor and capital (World Development Indicators, 2023).

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