The Textile-Clothing Industry of Bangladesh:
A Demand–Supply Review with Asian Competitors

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Abstract

　　The objective of this paper is to investigate the demand-supply structure of the textile-clothing industry (TCI) of Bangladesh in comparison to China, Indonesia, India, and Viet Nam. These countries are the top five clothing-exporting nations in the world, and together they control 91% of clothing exports in the Asian region. The paper applies structural decomposition approach for the demand-side analysis, whereas vertical specialization (VS) and linkage approach are used for the supply-side analysis using national and regional input-output tables for 2000 and 2011 at constant 2000 prices. The results show that the contribution of final demand has outplayed the technical change effect, whereas export contribution and domestic demand expansion have played the growth roles. The technical effect from 2000 to 2011 in the TCI is the highest in China (22%), followed by Viet Nam, India, Bangladesh, and Indonesia. VS in Viet Nam (53%) is the highest, and the lowest is in China (7%). The industry's output multiplier for Bangladesh in 2011 is 3.19, which is smaller than that of both China and Viet Nam. The paper concluded that the demand-supply linkage of the TCI in Bangladesh is stronger than that of India and Indonesia.
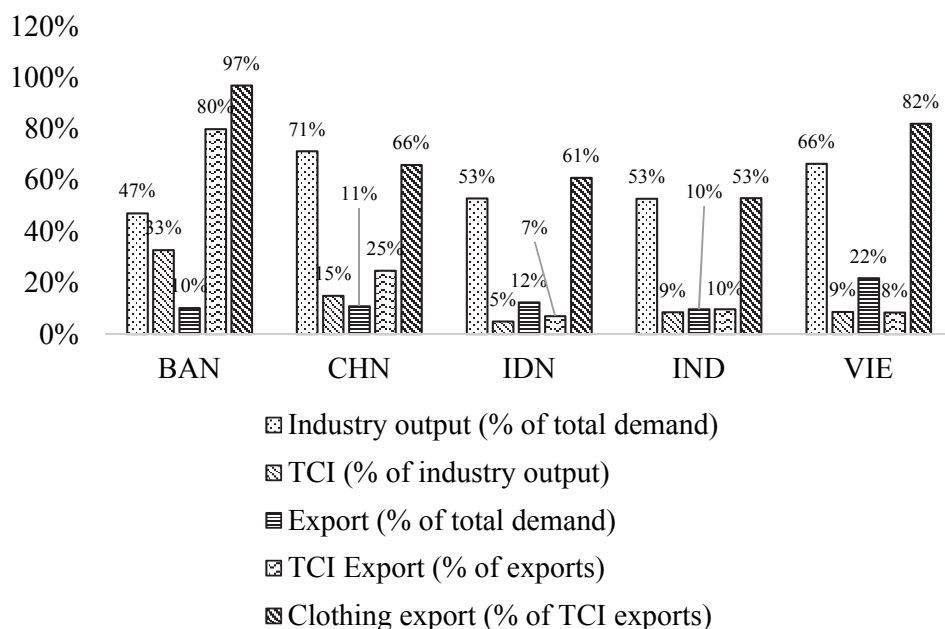
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1. Introduction

The textile-clothing industry (TCI)[1] is the gateway of choice for most developing countries in their quest to step into industrialization (Kim, Traore, & Warfield, 2006). The TCI was a very important industry for the early industrialization of today's developed economies such as the United Kingdom (UK), the United States (US), Japan, etc. The TCI is the primary grounds of development in most Asian countries such as Korea, Taiwan, Hong Kong, etc. (Chen et al., 2017; Gereffi, 1999). As manufacturer-exporters, those belonging to the Asian TCI are crucial to the global clothing market. In recent decades, a significant amount of apparel manufacturing has shifted to Asia, particularly China, which has become the leading exporter of clothing, followed more recently by Bangladesh (Taplin, 2014). The conclusion of the Multi-Fiber Agreement (MFA) has become a development boon for Asia (Heron, 2006). Asian manufacturers have experienced trade diversion, especially in textiles and apparel, through new regionalism beyond initial predictions (Frankel & Wei, 1995). According to the World Trade Organization (WTO) database, China, Bangladesh, Hong Kong, Viet Nam, India, and Indonesia are the top six clothing exporters in the world market and these countries are competitors to each other in the Asian region.

Industry output (% of total demand)
TCI (% of industry output)
Export (% of total demand)
TCI Export (% of exports)
Clothing export (% of TCI exports)

Figure 1 The output structure of the TCI in 2011
Source: Authors' calculation based on IOT 2011

International clothing market shares of China, Bangladesh, Viet Nam, India, and Indonesia are 36%, 6.2%, 5.6%, 4%, and 2%, respectively, of the US $450 billion market in 2016.

Bangladesh's economy is the smallest among the aforementioned clothing makers in the Asian region, but its economy is more dependent on the TCI compared to other economies. Figure 1 depicts the shares of output in the industrial structure of the economies concerned. The role of TCI is the uppermost in Bangladesh (33%), followed by China (15%), Viet Nam (9%), India (9%), and Indonesia (5%). When we look at the TCI export exposure in the export basket, we find that 80% of the export in Bangladesh is TCI exports, followed by China, India, Viet Nam, and Indonesia. The composition of clothing in the TCI exports of every country is much higher than textiles, which are 97%, 66%, 61%, 53%, and 82%, respectively, for Bangladesh, China, Indonesia, India, and Viet Nam. India, Indonesia, and China produce a lot of primary textiles[2]. As a result, the clothing exports to TCI exports ratio in India, Indonesia, and China is lower compared to Viet Nam and Bangladesh.

These five manufacturer-exporters sell the final output of the TCI (i.e., clothing) to the common consumer market, which primarily consists of the US and EU. Bangladesh exports 79% of clothing exports to the US and EU, India exports 60%, Indonesia exports 73%, China exports 44%, and Viet Nam exports 68% to these markets. So, these Asian manufacturer-exporters are also competitors to each other.

Bangladesh is one of the textile-clothing dominated low-income countries in the world. The TCI of Bangladesh is the only source that is helping the country to grow rapidly (Agarwal, Kaur, & De, 2017). Due to low cost abundant labor, TCI creates a competitive position in the world market for Bangladesh. This industry employs 5 million people. The value-added contribution of the industry accounted for 11.2% to the gross domestic product (GDP), and 50% to the manufacturing sector's value-added in 2016 (Masum & Inaba, 2018). In addition to the private initiatives and foreign direct investment (FDI)[3], the government is supporting the industry with fiscal and non-fiscal incentives[4]. Its competitive position among its Asian competitors seems lucrative when we look at the export values as they have soared from nearly nil in 1980 to $28 billion in 2016.

The most important feature of today's TCI in Bangladesh is that commodities are produced to satisfy the demand of the developed countries' consumers. The producers sell their finished goods to the branded retailing companies like Zara, Tesco, Uniqlo, Walmart, etc. (Appelbaum & Gereffi, 1994; Gereffi, 1999). In the global clothing trade market, the

retailers and brand merchandisers are playing a dominant role (R Nayak & Padhye, 2015). The low value-added part is done by the producers in low-income countries and high value-added part remains to the branded retailers. Bangladesh is comprised primarily of branded manufacturers, but the relationship between retailers-distributors and manufacturers in the demand-supply structure is not direct. There is an intermediary who requires 1–4% of the invoice value. Many of the intermediaries are controlled by foreign dealers (Masum, 2016).

The Bangladeshi TCI has successfully achieved industrial (functional) upgrading. Now, it faces great challenges in the social upgrading of the industry (Alam & Natsuda, 2016). Although developed countries have shifted the production process[5], the consumer market is controlled by them through branded retailers. So, the demand-side of the industry is controlled by the branded retailers and third-party negotiators like Li & Fung[6]. These retailers place order to the manufacturing factories, and manufacturing factories follow the order specifications (Masum, 2016). As a result, the manufacturers become exporters only. But the structural dimension of the demand-side is not yet clear to manufacturing countries like Bangladesh for sustainable growth of the clothing business. On the other hand, the supply-side of the manufacturers is also not independent. The supply-side is dependent on the availability of order (demand) from the branded retailers or trading firms. As the industrial structure of Bangladesh is heavily dependent on the TCI, the structural analysis on this industry becomes indispensable. Moreover, TCI of Bangladesh is competing with the other Asian manufacturers because the buyers (order providers) are common[7] for all clothing manufacturers in Asia. The WTO database shows that Asian countries produce 60% of global clothing exports, and the five Asian countries[8] are responsible for 91% of Asian clothing exports.

This research work gives emphasis on the structural dimension of the demand-side[9] and supply-side[10] of the TCI in Bangladesh with a comparison to other Asian countries. This work reveals out the role of technology[11] and final demand in the growth path of the TCI under demand-side analysis of input-output framework. Either only demand from the branded retailers is the main player of growth or production technology is backing the growth of the TCI in Bangladesh. This study also analyzes the supply-side of the TCI incorporating the role of domestic raw materials, role of imported raw materials, and influence of primary factors.

There have been many research studies on the TCI in Bangladesh. The previous studies focused on several issues, and some of them are as follows. Clothing exports,

employment, and the number of factories have increased after phasing out of the MFA era (R. Ahmed, 2013). Bangladesh has a unique opportunity to restructure its domestic apparel sector by introducing new technologies and fostering domestic production linkages (Bhattacharya & Rahman, 1999). Huq et al. (2014) studied the social sustainability of Bangladesh's clothing industry in regard to suppliers. A work on knowledge-based productivity in low-tech industries found that, in the clothing sector, higher education of managers, licensing, and R&D raise productivity (Goedhuys, Janz, & Mohnen, 2013). A study on factory disasters in Bangladesh suggested that the insatiable appetite for fashionable goods merely feeds a retail system that was set up to resolve earlier supply-chain problems and ended up taking advantage of changing international trade regimes (Taplin, 2014), among other studies.

According to structural decomposition analysis of the input-output framework, the key demand-side determinants in any industry are technical effect, final demand effect, export expansion effect, import substitution effect, and domestic demand effect. The key supply-side determinants are vertical specialization (VS) ratio, input multiplier, primary factor contributions, etc. A very few studies have focused on this structure of the TCI in Bangladesh. Demand-side and supply-side analyses of the Bangladesh's TCI with a comparison to the Asian competitors in the input-output framework have not been addressed in the previous studies. The main contribution of this research is to analyze the demand-side and supply-side of the TCI across time and place. This paper makes a comparison of the TCI between Bangladesh and its Asian competitors[12] in terms of level of technical development and growth factors. The comparison is made based on structural decomposition between two periods of each country in the input-output framework.

The specific research questions to be discussed in this paper are:

1. Is technical change affecting the demand-side growth of the TCI in Bangladesh?
2. Is demand-supply structure of the TCI in Bangladesh similar to its Asian competitors?

The rest of the paper is structured as follows. Section 2 describes the data and methodology. Section 3 explains the results of the study, including the demand-side of the TCI based on decomposition techniques, the supply-side of the TCI, and a comparison among the TCI exporters based on demand-supply indicators. Finally, Section 4 concludes the paper.

2. Data and methodology

2.1 Data

We have compiled the national input-output tables (IOTs) for Bangladesh and Viet Nam from the multiregional input-output (MRIO) table of the Asian Development Bank (ADB). IOTs for China, India, and Indonesia are sourced from the World Input-Output Database (WIOD). The MRIO tables of ADB and WIOD have used the same 35-sector classifications. The databases of ADB and WIOD are in current US dollar price. We converted the current US dollar price IOTs into current local price[13] IOTs. Finally, we converted the current price IOTs into constant price[14] IOTs.

2.2 Methodology

This paper applies input-output techniques to answer the research questions. In the input-output framework, the Leontief model is known as the well-established demand-side model, whereas the Ghosh model is known as the frequently used supply-side model. Ashyrov, Paas, & Tverdostup (2018) applied the Leontief model for demand-side analysis and Ghosh model for supply-side analysis for a comparative study of blue industries between Estonia and Finland. It is the most recent application of Ghosh and Leontief models together.

The analytical framework of demand-side and supply-side on the TCI of Bangladesh and some Asian countries is shown in Figure 2. The demand-side is explained through
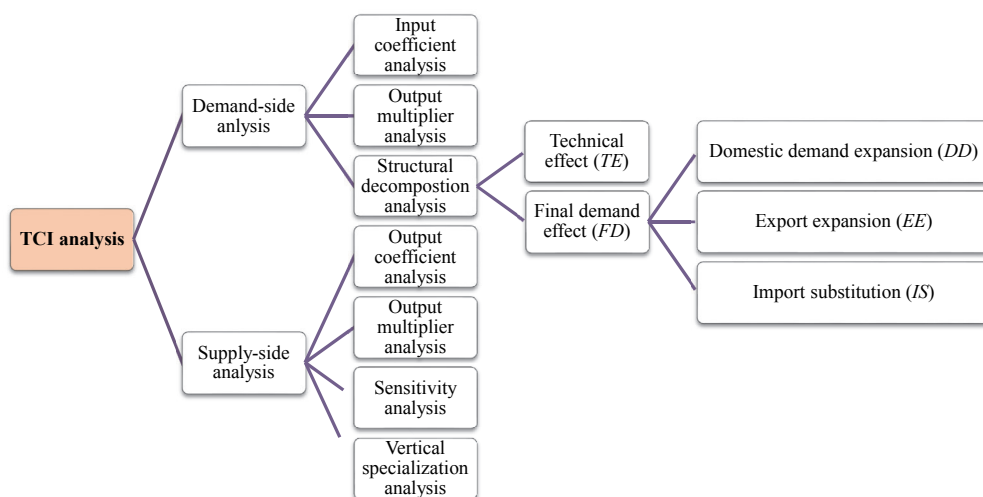

Figure 2 The analysis framework

demand-side model of Leontief. In addition to input coefficient analysis, structural decomposition analysis for demand-side explains the final demand by domestic demand roles, export roles and import substitution effect. The supply-side is explained through supply-side model of Ghosh[15]. Supply-side analysis describes output coefficients, sensitivity of the TCI, value-added integrated into exports, etc.

Here, in the demand-side, input coefficient means the amount of inputs (sector-wise) required to satisfy one unit of clothing demand, output multiplier indicates the total amount of inputs required to produce one unit of output in the clothing sector, technical effect means the effect of intermediate inputs on the TCI's output growth, final demand effect implies the effect of final consumption on TCI's output growth, domestic demand implies the role of domestic demand on the growth of the industry, export expansion implies the role of export on output growth, and finally, import substitution means the substitution of imports by domestic demand.

On the other hand, output coeffect shows the amount of inputs provided by TCI to other industries, sensitivity analysis indicates how sensitive the TCI is to the other industries, and vertical specialization specifies the amount of imported inputs of TCI integrated into export of clothing.

Demand-side analysis techniques: We analyze the effect of technical change (*TE*) and final demand change (*FD*) on the output growth in the demand-side[16] structure. For calculating *TE* and *FD*, we use the non-competitive IOT as represented in Figure 3 below.

			IMD (sector_ j)					F	TD
		1	*2*	.	.	.	*n*	*(f)*	*(x)*
	1	z_{11}	z_{12}	.	.	.	z_{1n}	f_1	x_1
	2	z_{21}	z_{22}	.	.	.	z_{2n}	f_2	x_2
Domestic	.	.	.	.	.	.	.	.	.
IMS (sector_ i)	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.
	n	z_{n1}	z_{n2}	.	.	.	z_{nn}	f_n	x_n
	1	z_{11}^{m}	z_{12}^{m}	.	.	.	z_{1n}^{m}	f_1^{m}	
	2	z_{21}^{m}	z_{22}^{m}	.	.	.	z_{2n}^{m}	f_2^{m}	
Import	.	.	.	.	.	.	.	.	
IMS (sector_ i)	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	
	n	z_{n1}^{m}	z_{n2}^{m}	.	.	.	z_{nn}^{m}	f_n^{m}	
Value–added (v̇)		v_1	v_2	.	.	.	v_n		
Total Supply (ẋ)		x_1	x_2	.	.	.	x_n		

Figure 3 The framework of input–output table

Source: Masum & Inaba (2018)

Using the framework in Figure 3 the authors calculated the input coefficients, which represented in Figure 4.

IMD, F, TD, and IMS in Figure 3 denote intermediate demand, final demand, total demand, and intermediate supply, respectively. i indicates supplying sectors, j indicates demanding sectors, $x_i = \sum_{j=1}^{n} z_{ij} + f_i$, $x_j = \sum_{i=1}^{n} z_{ij} + \sum_{i=1}^{n} z_{ij}^{m} + v_j$, $n \times n$ domestic intermediate matrix is defined as Z (elements are z_{ij}), imported intermediate matrix is termed as Z^m, f as the final demand vector, x as the total demand column vector, $\acute{v}$ as the value-added row vector, $\acute{x}$ is the total supply row vector. As a characteristic feature of the IOT, the total demand equals total supply, as in $x_i = x_j$ (Masum & Inaba, 2018).

		IMD (sector_ j)					
		1	2	·	·	·	n
Domestic IMS (sector_ i)	1	a_{11}	a_{12}	·	·	·	a_{1n}
	2	a_{21}	a_{22}	·	·	·	a_{2n}
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	n	a_{n1}	a_{n2}	·	·	·	a_{nn}
Import IMS (sector_ i)	1	a_{11}^{m}	a_{12}^{m}	·	·	·	a_{1n}^{m}
	2	a_{21}^{m}	a_{22}^{m}	·	·	·	a_{2n}^{m}
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	n	a_{n1}^{m}	a_{n2}^{m}	·	·	·	a_{nn}^{m}
Value–added (ṽ)		a_{1}^{v}	a_{2}^{v}	·	·	·	a_{n}^{v}
Total Supply (x̂)		1	1	·	·	·	1

Figure 4 The input coefficient framework
Source: Masum & Inaba (2018)

Then, a_{ij} is the input coefficients representing the input of sector i from sector j. The coefficients, in Figure 4, are defined as $a_{ij} = \frac{z_{ij}}{x_j}$, $a_{ij}^{m} = \frac{z_{ij}^{m}}{x_j}$, and $a_{j}^{v} = \frac{v_j}{x_j}$. Figure 4 denotes $n \times n$ domestic intermediate demand and supply coefficients matrix as A^d, imported intermediate supply and demand coefficients matrix as A^m.

Base on the notations and expressions in the above figures, output column vector x is defined as below in equation (i).

$$A^d x + f = x, \text{ or } x = (I - A^d)^{-1} \qquad\qquad\qquad\qquad\qquad\qquad\qquad (i)$$

As Leontief invented such analysis, this is known as the Leontief inverse[17]. The elements of this matrix are referred to as inverse matrix coefficients. When the final

demand in a sector is given, total domestic production at each sector, corresponding to the final demand, can immediately be calculated using equation (ii).

$$L^d = (I - A^d)^{-1}$$ ·· (ii)

If we define the import coefficient matrix as A^m, as A^d in case of domestic input coefficient matrix, we can get $A = A^d + A^m$. As a result of this combination, one can calculate the total effect (L) of final demand changes by taking the inverse of $(I - A)$. So, the total effect is defined as in the following equation (iii).

$$L = (I - A)^{-1}$$ ·· (iii)

For calculating *TE* and *FD*, we use the Dietzenbacher and Los (1998)[18] structural decomposition analysis model based on Leontief model as shown in equation (vi) and (v):

$$TE = \frac{1}{2}(\Delta L)(f^0 + f^1)$$ ·· (iv)

$$FD = \frac{1}{2}(L^0 + L^1)(\Delta f)$$ ·· (v)

Where **L** is the Leontief inverse (includes both domestic and import coefficients) matrix, L^0 is the base year L matrix, L^1 is the Leontief inverse for the terminal year, ΔL is the difference between L^1 and L^0, f^0 is the final demand for the base year, f^1 is the final demand for the terminal year, and Δf is the difference between f^1 and f^0. The sum of the two changes (*TE* and *FD*) is equivalent to the total changes in output.

We further decompose the final demand (*f*) into domestic demand expansion (*DE*), export expansion (*EE*), and import substitution (*IS*) in the demand-side structure. For a further decomposition of the final demand (*f*) into *DE*, *EE*, and *IS*, we apply the model of Frank Jr et al. (1975)[19] as follows:

$$\Delta f_i = (1 - \widetilde{m}_i^0) \times \Delta d_i + \Delta e_i - \Delta \widetilde{m}_i \times d_i^1$$ ································ (vi)

Here, i indicates economic sectors, Δf_i is the changes in final demand, $\widetilde{m}_i$ is the ratio of imports to domestic demand, Δd_i is the changes in domestic demand, Δe_i is the changes in exports, $\Delta \widetilde{m}_i$ is the changes (between two periods) in $\widetilde{m}_i$, $(1 - \widetilde{m}_i^0) \times \Delta d_i$ represents the *DE*

coefficient, Δe_i represents the *EE* coefficient, and $\Delta \widetilde{m}_i \times d_i^1$ represents the *IS* coefficient. Superscript ^{0} and ^{1} indicate base year and terminal year, respectively.

We also use output multiplier (*OM*) for analyzing the demand-side of the TCI[20]. *OM* measures the combined effects of the direct and indirect repercussions of a change in final demand (Steenge, 1990). The *OM* is described as domestic output multiplier (*DOM*) and imported output multiplier (*IOM*). The conceptual framework of the model we use for *OM* analysis is the same as the backward linkage analysis models in demand-side model. This model is based on the conceptual models applied by, among others, Chenery and Watanabe (1958), Hirschman (1958), Jones (1976), and Cella (1984). The models that we use in this paper are as follows:

$$DOM = \sum_{i=1}^{n} L_{ij}^{D} \quad \text{.. (vii)}$$

Here, L_{ij}^{D} represents the elements of Leontief inverse of the domestic input coefficient matrix, i.e., A^D.

To calculate the *IOM*, or backward economic leakage in other words, we use the following methodology.

$$IOM = \sum_{i=1}^{n} (L_{ij} - L_{ij}^{D}) \quad \text{.. (viii)}$$

Here, L_{ij} is the Leontief inverse of the input coefficients (*A*), which includes import input coefficients (A^M) and domestic input coefficient matrix (A^D), i.e., $A = A^M + A^D$

Supply-side analysis techniques: In 1958, Ghosh introduced the supply-side model in the field of input-output analysis. The basic assumption of the supply-side analysis is that the output distributions are stable in an economic system, meaning that if the output of sector i is, for instance, doubled, then the sales from i to each of the sectors that purchase from i will also be doubled. Instead of fixed input coefficients, fixed output coefficients are assumed in the supply-side model (Miller & Blair, 2009). The demand-side model gives us input coefficients (technical coefficients, output multiplier, etc.), and the supply-side model[21] gives us output coefficients (allocation coefficients, input multiplier, etc.). Beyers (1976) and Jones (1976)[22] state that the row sums of the supply-side model are considered to be better measures of forward linkages or input multipliers.

In Figure 5 the output coefficients are defined as $b_{ij} = \frac{z_{ij}}{X_i}$ and $b_{ij}^m = \frac{z_{ij}^m}{x_i}$, using the matrix Z and Z^m of Figure 3. These b_{ij} coefficients indicate the distribution of sector i's

outputs across sectors j that purchase interindustry inputs from i; these are frequently called allocation coefficients, as opposed to technical coefficients, a_{ij}. Final demand coefficients are defined as $b_i^f = \frac{f_i}{x_i}$.

		IMD (sector_ j)						F	TD
		1	2	·	·	·	n	(f)	(x)
	1	b_{11}	b_{12}	·	·	·	b_{1n}	b_1^f	1
	2	b_{21}	b_{22}	·	·	·	b_{2n}	b_2^f	1
Domestic	·	·	·	·	·	·	·	·	·
IMS (sector_ i)	·	·	·	·	·	·	·	·	·
	·	·	·	·	·	·	·	·	·
	n	b_{n1}	b_{n2}	·	·	·	b_{nn}	b_n^f	1
	1	b_{11}^m	b_{12}^m	·	·	·	b_{1n}^m		
	2	b_{21}^m	b_{22}^m	·	·	·	b_{2n}^m		
Import	·	·	·	·	·	·	·		
IMS (sector_ i)	·	·	·	·	·	·	·		
	·	·	·	·	·	·	·		
	n	b_{n1}^m	b_{n2}^m	·	·	·	b_{nn}^m		

Figure 5 The output coefficient framework
Source: Masum & Inaba (2018)

The Figure 5 also proves that $\sum_{j=1}^{n} b_{ij} + b_i^f = 1$. B^d denotes domestic intermediate output coefficients matrix. These coefficients relate sectoral gross production to the primary inputs, that is, to a unit of value entering the interindustry system at the beginning of the process. As correspondence to x, the $\acute{x}$ is defined as below under output coefficient framework (Masum & Inaba, 2018).

$$\acute{x}B^d + \acute{v} = \acute{x}, \text{ or } \acute{x} = \acute{v}(I - B^d)^{-1} \quad \cdots\cdots\cdots\cdots \text{(ix)}$$

where I is the identity matrix, $(I - B^d)^{-1}$ is the inverse matrix of $(I - B^d)$. This inverse matrix is known as Ghosh inverse as G^d shown in equation (x). The elements of G^d is referred to as g_{ij}^d . So,

$$G^d = (I - B^d)^{-1} \quad \cdots\cdots\cdots\cdots \text{(x)}$$

The imported output coefficient matrix is defined as B^m, as B^d in case of domestic output coefficient matrix. To calculate the total output coefficients, i.e., domestic effect and import effect, the domestic effect and import effect are combined into one matrix as $B = B^d + B^m$, which represented in the following equation (xi).

$$G = (I - B)^{-1} \quad \text{... (xi)}$$

Based on equation (xi), the model specifications for total input multiplier (*TIM*), domestic input multiplier (*DIM*) and imported input multiplier (*IIM*) are given below. *IIM* is also described as the forward economic leakage.

$$TIM = \sum_{j=1}^{n} G_{ij} \quad \text{.. (xii)}$$

Here, G_{ij} represents the elements of Ghosh inverse matrix. The elements include the domestic coefficients and imported coefficients, i.e., $B = B^M + B^D$.

$$DIM = \sum_{j=1}^{n} G_{ij}^{D} \quad \text{.. (xiii)}$$

Here, G_{ij}^{D} represents the elements of Ghosh inverse of the domestic output coefficient matrix, i.e., B^D.

To calculate the *IIM*, or forward economic leakage in other words, we use the following methodology.

$$IIM = \sum_{j=1}^{n} (G_{ij} - G_{ij}^{D}) \quad \text{.. (xiv)}$$

Here, G_{ij} is the Ghosh inverse of the output coefficients (B), which includes both import output coefficients (B^M) and domestic output coefficient matrix (B^D).

When we discuss input multiplier, we define the total forward linkage or input multiplier (*IM*) as the sum of *DIM* and *IIM*. Then, we calculate the index of the sensitivity of dispersion (*ISD*) as listed below[23] to check the sensitivity of the TCI in the economies.

$$ISD = \frac{\sum_{j=1}^{n} G_{ij}}{\frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{n} G_{ij}} \quad \text{.. (xv)}$$

Here, G indicates the Ghosh inverse matrix as it corresponds to the Leontief inverse matrix L.

We also use VS[24] as a supply-side tool to discover the domestic supply and foreign supply in TCI exports. VS is an established concept for trade in value-added/supply-side analysis[25]. For this analysis, we apply Hummels et al.'s (2001) model, which is given below in equation (xvi):

$$VS = uA^M [I - A^D]^{-1}\hat{e}$$ ·· (xvi)

Here, u is a $1 \times n$ vector of 1's, A^M is the $n \times n$ import coefficient matrix, I is the identity matrix, A^D is the $n \times n$ domestic input coefficient matrix, $\hat{e}$ is the diagonal matrix of exports, and n is the number of sectors.

3. Results and discussion

3.1 Demand-side of the TCI

The breakdown of the total demand in Bangladesh shows that 48% of the output is used for industrial production, 41% of the output is consumed domestically as final products, and the remaining 10% is exported. The lion share of the total exports is TCI exports.

The demand-side analysis of the economies reveals that around half of the total output is consumed as intermediate demand. China consumes 61%, Viet Nam consumes 48%, India consumes 41%, and Indonesia consumes 40%.

Whereas the average export volume in Viet Nam is notable, textile-clothing shares of total exports in Bangladesh are very high compared to other countries. The textile-clothing export in Bangladesh is 80%, which is in contrast to the 13% on average for other countries. As Figure 6 shows, since 2000 the TCI export share has increased approximately 2.4 times in Bangladesh, 9.2 times in China, 0.36 times in Indonesia, 0.27 times in India, and 2.7 times in Viet Nam. So, the TCI export growth in China is very high, followed by Viet Nam and Bangladesh. The export contribution, which is 10–12% for other economies, is 22% in Viet Nam's economy. Domestic demand is high in India and Indonesia. The share of TCI exports in China is also high compared to nations other than Bangladesh.

The TCI growth effects: We have divided the output growth effects into technical effect and final demand effect. Again, the final demand effect consists of domestic demand expansion, export expansion, and import substitution. Figure 7 depicts the technical effect on the output growth of the TCI from 2000 to 2011. The industry in Bangladesh has grown with the active support of foreign demand and local labor force. The technical effect is very low in Bangladesh. Normally, large firms have an advantage over small ones in regard to adopting new technology. Insofar as most of the firms in Bangladesh are of small scale, technology adoption for them remains very difficult (Yunus & Yamagata, 2012). The final demand helps grow the industry in Bangladesh. The share of the final demand growth
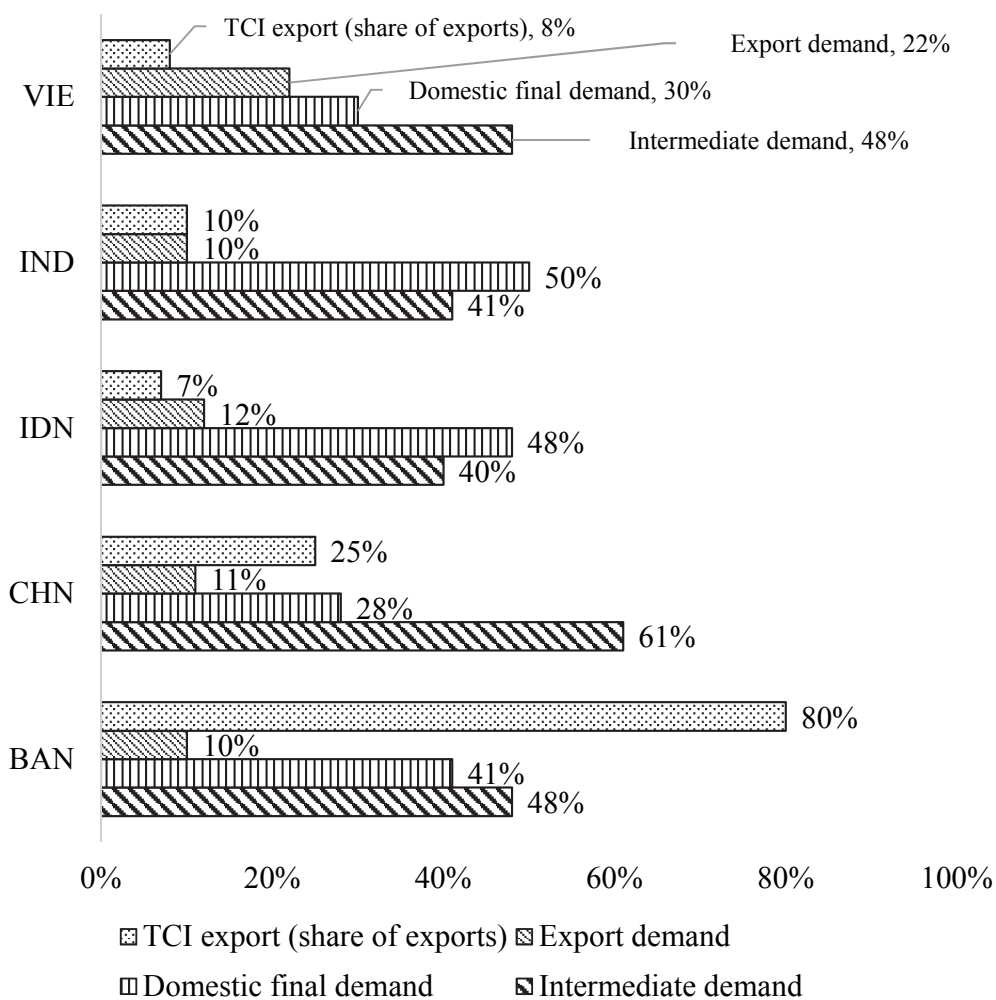
Figure 6 Demand-side of the economies in 2011 as share of total demand

Source: Input-Output Tables

Note: BAN stands for Bangladesh, CHN stands for China, IDN stands for Indonesia, IND stands for India
and VIE stands for Viet Nam. These acronyms are also used in National IOTs.

effect is 99% in Bangladesh's TCI.

The analysis shows that only China, and Viet Nam have a significantly positive
technical effect on the TCI growth[26]. On the other hand, Indonesia has had a 28% negative
technical effect on the output growth from 2000 to 2011. As China is growing fast and
moving from low-tech products to high-tech products, its technical effects are positive. Viet
Nam is also progressing with very good technical effects. Technical effect affects Viet Nam's
production growth due to technology transfer from and proximity to China. After 2000, the
production in China has focused more on value-added and branding cultivation through
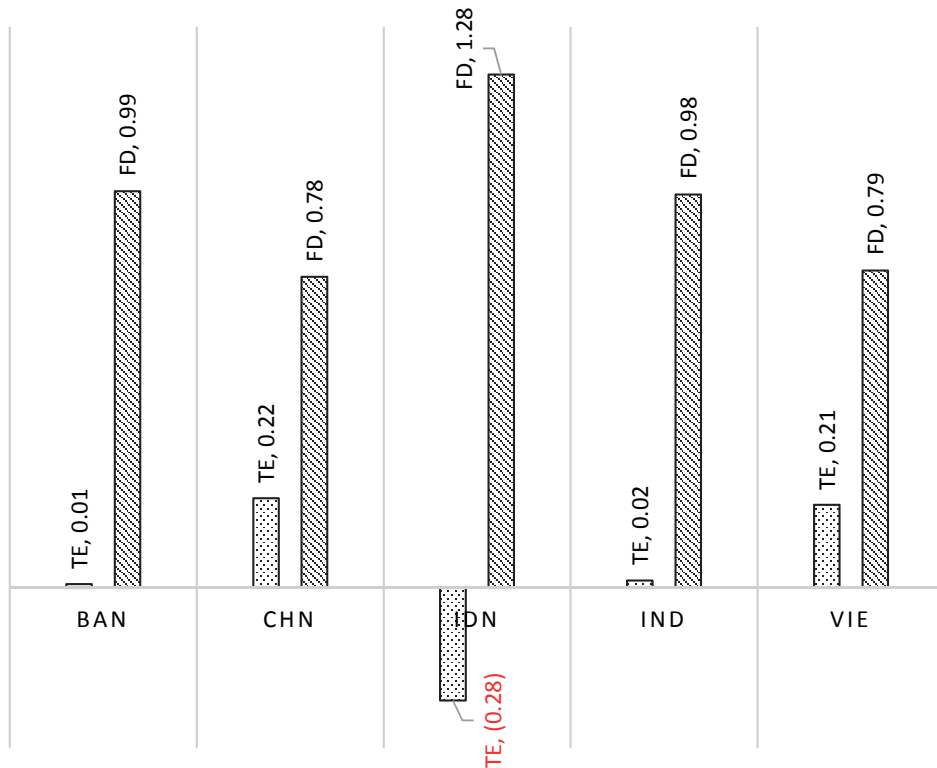
Figure 7 Technical effect (*TE*) and Final demand effect (*FD*) from 2000 to 2011

Source: Authors' calculation based on *IOT* 2000 and *IOT* 2011

Note: The *TE* is calculated using equation (iv) and *FD* is calculated using equation (v)

technology up-gradation[27] (Zhang, Kong, & Ramu, 2016). China is shifting production from basic to high-end garment products and has a shortage of skilled labor (Zhu & Pickles, 2014). However, the industry in India, Bangladesh, and Indonesia is still labor intensive. This is because these three countries are labor abundant than China and Viet Nam.

Final demand has contributed much toward TCI output changes in Indonesia, Bangladesh, and India. For China and Viet Nam, the contributions are 78% and 79%, respectively, because of high technical effect and movement toward capital-intensive production. Under ninth and tenth five-year plans (1996–2000 and 2001–2005, respectively), China made significant investments for the restructuring of its TCI using modern technologies, which were subsidized by the central government (European Commission, 2005; Gereffi, 1999). The similar development pattern followed in the previously TCI dominated economies like UK, USA, Japan, Korea, etc. Due to application of high technology and scarcity of labor, these countries lost the TCI market.

Table 1 *DE*, *EE*, and *IS* growth effects from 2000 to 2011

Countries	Domestic Demand Expansion (*DE*)	Export Expansion (*EE*)	Import Substitution (*IS*)
BAN	0.45	0.54	-0.01
CHN	0.66	0.25	-0.09
IDN	1.02	0.14	0.16
IND	0.90	0.11	0.01
VIE	0.69	0.45	0.14

Source: Authors' calculations

Note: This table is calculated using equation (vi).

Among the final demand components, export has contributed significantly to the growth path of the TCI, especially in Bangladesh and Viet Nam. The Phase out of MFA Quota in 2005 brought a boom for Bangladesh and contributed a lot towards growth in exports of clothing against skepticism (Joarder, Hossain, & Hakim, 2010; Kelegama, 2005; Majmudar, 1996; Yang & Mlachila, 2007; Yunus & Yamagata, 2012). The export statistics shows that there was a 339% TCI export growth from 2000 to 2011 and the share of export has also increased from 65% to 82% in the same period in Bangladesh (Adnan, Rakib, & Rahman, 2015). Despite the global recession in 2008–09, the growth of the TCI continued due to two factors. First, the exports of Bangladesh are almost entirely consumer goods ; and second, Bangladesh has acquired a competitive edge in the world clothing market (Taslim & Haque, 2011). Sourcing from Bangladesh increased 20% in 2009 while sourcing from China dropped 5% (F. Z. Ahmed, Greenleaf, & Sacks, 2014).

Export contributed 54%, 45%, and 25% for Bangladesh, Viet Nam, and China, respectively from the year 2000 to 2011. Export-led growth in Bangladesh is much higher than other competitors. China's TCI was also export led, but it is now moving toward domestic orientation. Since 2011 more than 80% of the TCI products have been consumed domestically (Lu & Dickson, 2015). In 2003, the domestic market of China consumed US $63.4 billion worth of clothing, and the overall domestic consumption of textile-clothing products accounts for two thirds of total production (European Commission, 2005). By the end of 2020, China will have produced US $750 billion worth of garments, half for export and the remainder for domestic use (Mirdha, 2017). However, import substitution played very insignificant roles among the countries, as shown in Table 1. The analysis shows that the domestic demand has played a greater role in Indonesia and India in regard to TCI growth due to high population and consumer market. Moreover, the textile base in these two countries is stronger than clothing base.

The output multiplier (backward effect): The output multiplier effect quantifies the effect on the entire economy arising from the initial effect of an exogenous change in any of the final demand components. It is the amount by which the initial effect is magnified (or multiplied) to become a total effect (Sim, Secretario, & Suan, 2007). When any one industry increases its production, an increased demand for inputs from all industries takes place. An industry with a higher output multiplier indicates that the expansion of that industry's production is more beneficial to the economy (Guo & Planting, 2000). The domestic multiplier effects of the TCI in Bangladesh were 2.08 times in 2000 and 2.14 times in 2011, which is above average. The average of domestic multiplier in 2000 was1.48 and in 2011 was 1.80. Thus, the effect of the TCI in Bangladesh's economy has strengthened domestically. On the other hand, the import leakage has declined from 1.07 to 1.05 times, indicating slightly increase in the domestic backward linkage to other industries. The TCI backward linkage shows small increase over time because of increasing demand. The output multiplier is directly linked with the higher final demand. As clothing demand, especially exports, has increased, the input demand including yarn, fabric, dye-chemicals, etc. has also increased. Moreover, the domestic supply capacity to satisfy the input demand has increased as reflected in declining import leakage.

The output multiplier effect of the TCI on the production of other industries in 2000 and 2011 is summarized in Table 2. In 2011, Viet Nam (2.35) had the highest domestic multiplier effect of the TCI on the overall industry of the economy. The coefficients for China, India, and Indonesia are 2.31, 1.96, and 1.57 respectively. The domestic output multiplier effect has increased in Viet Nam over time as well. The demand for clothing in Viet Nam has increased manifold as a result, the input taking from the other subsectors has increased including the imported inputs.

The import multiplier can be used to explain economic leakage, which is summarized

Table 2 The output multipliers of the TCI

Countries	Domestic Output Multiplier		Import Output Multiplier	
	2000	2011	2000	2011
BAN	2.08	2.14	1.07	1.05
CHN	2.44	2.31	1.10	1.02
IDN	1.86	1.57	1.18	1.32
IND	2.19	1.96	1.04	1.09
VIE	1.97	2.35	1.36	1.34

Source: Authors' calculations

Note: The result of *DOM* is calculated using equation (vii) and the result of *IOM* is calculated using equation (viii)

in Table 2. The *IOM* analysis reveals that the TCI of Viet Nam and Indonesia were very much susceptible to imports in 2000 and 2011. The TCI in Indonesia consumed much imported inputs rather than domestic inputs. Thus, the TCI import leakage of Indonesia has increased over time, whereas the domestic effect has declined.

3.2 Supply side of the TCI

As Figure 8 shows, 8% of the total imports were the Bangladesh TCI imports in 2011, which have increased by 1.08 times since 2000. About 87% of the total supply in Bangladesh's economy is satisfied domestically as in other economies.

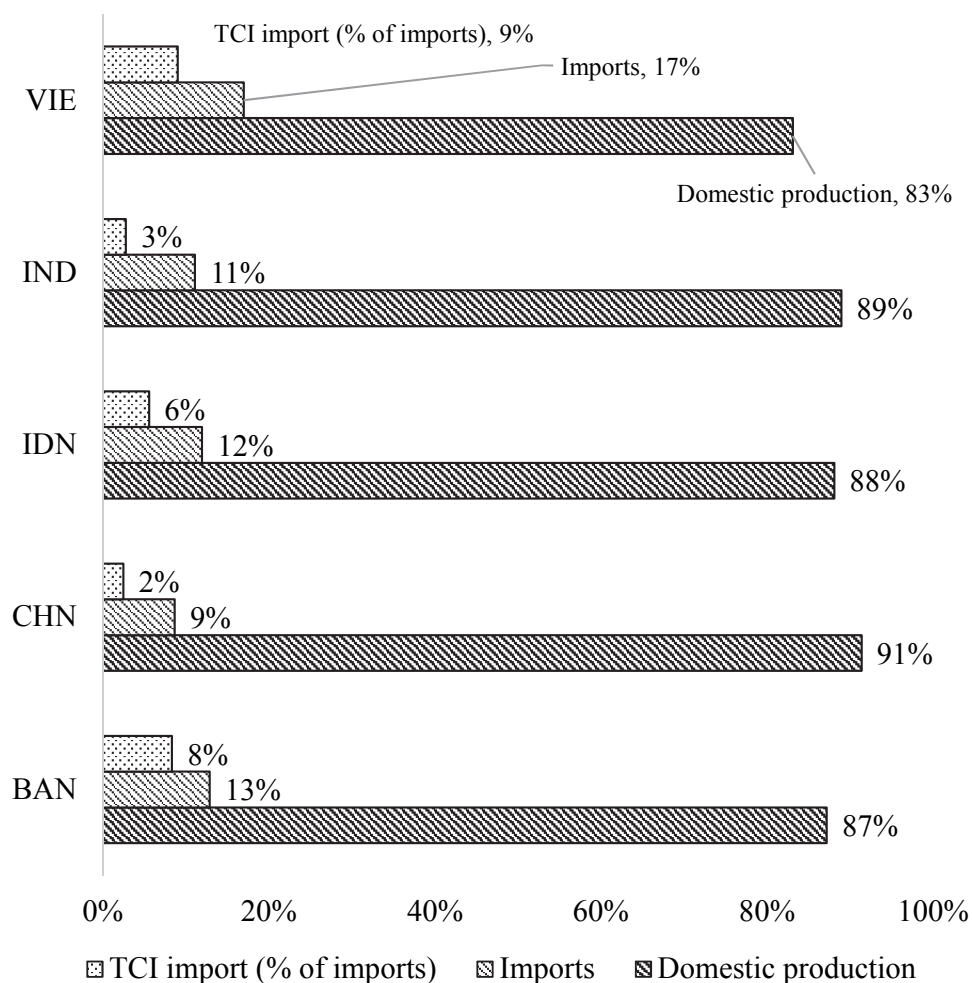As we mentioned earlier, China's economy is the largest one followed by India,

Figure 8 Supply-side of the economies in 2011 as share of total demand
Source: Input-Output Tables

Indonesia, Viet Nam, and Bangladesh in accordance with the total demand-supply value. The domestic supply dominates the economies' production. Out of the total supply, China produces 91% locally, India produces 89% locally, Indonesia produces 88% locally, and Viet Nam produces 83% domestically. The rest is imported. Thus, China imports the lowest amount, and Viet Nam imports the highest amount in terms of the percentage of the total supply in the respective economies. Meanwhile, China and India import the lowest volume of textile-clothing products, for example, 2% and 3% respectively. Indonesia, Bangladesh, and Viet Nam import 6%, 8%, and 9% of the textile-clothing supply respectively. In addition, the TCI import supply has increased in China by 1.83 times, Indonesia by 2.29 times, India by 3.05 times, and Viet Nam by 3.43 times.

   The input multiplier (forward effect): One of the most important supply-side multipliers is the *IM* or forward linkage in input-output analysis. Linkage capabilities is also associated with the application of technology in the TCI (Ernst, Ganiatsos, & Mytelka, 2003). The result indicates that Bangladesh's economy has rather strong linkage in the TCI. The forward linkage has slightly increased from 2.60 to 2.62, which means the industry is providing more inputs to the economy. The result also indicates that total input providing capacity of the TCI is much lower than input accepting capacity. So, the TCI plays important roles for backward industries than forward industries. So, the backward impact is larger than forward impact. On the other hand, the dependency of imported inputs (output leakage) has reduced. As the total effect has increased and import effect has declined, the domestic multiplier has increased. But the input providing to the other

Table 3: The input multiplier and economic leakage of the TCI

Country	Total Input Multiplier		Input Leakage		Input Multiplier Excluding Intra-TCI		Index of Sensitivity of Dispersion	
	2000	2011	2000	2011	2000	2011	2000	2011
BAN	2.60	2.62	1.06	1.05	0.08	0.07	0.94	0.69
CHN	3.07	3.58	1.09	1.01	0.53	0.76	0.94	1.02
IDN	2.46	2.57	1.02	1.31	0.04	0.17	0.95	0.93
IND	2.40	2.43	1.02	1.03	0.17	0.14	0.83	0.83
VIE*	2.89	3.44	1.25	1.35	0.22	0.64	0.57	1.06

Source: Authors' calculations

Note: Here, total input multiplier is calculated using equation (xii), input leakage is calculated using equation (xiv). The difference between the results of equation (xii) and (xiii) is represented in equation (xiv) in the methodology section. The *ISD* is calculated using equation (xv).

* There are huge changes in the TCI of Viet Nam because the TCI has just started its export orientation in 2000 (inception stage in the life cycle) and has grown significantly. Whereas, the industry in China was matured in 2000 and the industry in Bangladesh is at its growth stage.

industry has declined from 0.08 to 0.07 for Bangladesh, which indicates that TCI of Bangladesh is providing more inputs to itself, i.e., intra-industry transactions (transactions among yarn, fabric, dye-chemical, etc.) are much higher. The inter-industry dependency of the industry is notable.

The TCI forward effect of China, Indonesia, India, and Viet Nam also shows upward trend over time. In addition, input multiplier impact of China and Viet Nam was stronger than that of Bangladesh in 2011.

The Table 3 also summarizes the net input multiplier effects, which indicate the input multiplier of the TCI to the other industries excluding the impact on the industry itself (TCI). The coefficients reveal that the intra-industry impact in Bangladesh is stronger than that of other countries. The most significant impact of the TCI on other industries is in China followed by Viet Nam.

The relative importance of the industry is expressed through the index of sensitivity of dispersion (*ISD*) of Table 3. The TCI in 2000 was not a sensitive industry[28] for any economy. However, in 2011, the industry became a sensitive one for China and Viet Nam. Viet Nam experienced a dramatic change.

The vertical specialization: Vertical specialization is the share of imported inputs used for production of exported outputs. Intermediate input trade increases as a result of a vertical production network, in which countries are specialized in each production stage in the context of the international division of labor, known as VS (Uchida, 2008). The imported input shares integrated into the export of textile-clothing products of the countries are provided in Table 4.

Table 4 The VS coefficients in 2000 and 2011

Countries	Year 2000	Year 2011
BAN	0.11	0.09
CHN	0.18	0.07
IDN	0.26	0.32
IND	0.11	0.14
VIE	0.48	0.53

Source: Authors' calculations

Note: The result in this table is calculated using equation (xvi).

Viet Nam imported 53% TCI inputs against the export of the TCI final goods in 2011 followed by Indonesia (32%), India (14%), Bangladesh (9%), and China (7%). The share of imported inputs integrated into exports has increased in Indonesia by 6%, Viet Nam by 5%, and India by 3% since 2000. In addition, the imported share of exports has decreased

in China by 11% and in Bangladesh by 2%. The localization of the Chinese TCI is noteworthy followed by Bangladesh's. Meanwhile, Indonesia's and Viet Nam's TCI have become more vertical. The statistics shows that there is improvement in domestic production linkage. Masum (2016) stated that local knit fabric subsector in Bangladesh can satisfy 90% of knit fabric demand, washing-dyeing subsector can service 100% of washing demand, yarn subsector can satisfy 70% of yarn demand, and woven subsector can serve 40% of woven fabric demand.

3.3 Comparison of the TCI

The Asian textile-clothing exporters have been major beneficiaries of the freer world of trade in textiles since the implementation of the agreement on textile and clothing (ATC) replaced the MFA in 1994. This agreement was fully implemented in 2005 under the WTO multilateral trading system. Asian TCIs were afraid of the Chinese competition due to the end of the quota system. However, the imposition of safeguard quotas on China in 2006 from the US, and an offer of generalized system of preference facility to other developing nations from the EU helped other Asian exporters to grow more quickly. Moreover, Viet Nam was under US quotas negotiated in 2003 until it became a member of the WTO in late 2006 (James, 2008).

James (2008) assessed the competitiveness of the Asian exporters, which is summarized in Table 5. He concluded that Bangladesh's revealed comparative advantage (RCA) index for clothing export is much higher than those of Viet Nam, China, India, and Indonesia. On the other hand, the RCA index for textile is higher for India than it is for China, Indonesia, Bangladesh, and Viet Nam. The unit price calculation reveals that Bangladesh supplies the lowest-cost clothing to the US market followed by China, Viet Nam, Indonesia, and India. However, "Made in China" is not losing its price competitiveness. For example, from 2006 to 2014, the average unit price of US TCI imports

Table 5 The RCA indices for the TCI products of the Asian manufacturers

Country	Clothing RCA Index in 2005	Textile RCA Index in 2005	Clothing Unit Value to the US Market (US$) in 2007
BAN	27.3	1.3	2.3
CHN	3.6	2.7	3.1
IDN	2.2	2.0	3.9
IND	3.2	3.9	4.3
VIE	5.6	1.1	3.9

Source: James (2008)

from China only slightly increased from \$1.45 per square meter equivalent (SME) to \$1.46 per SME (up 0.7%), whereas the average unit price of TCI imports from the rest of the world increased from \$1.97/SME to \$2.13/SME (up 7.9%) (Lu & Dickson, 2015).

The comparative positions of the TCIs of Asian economies based on demand-supply indicators are summarized in Table 6 below. Factors such as technical change determine the ultimate gains or losses in productivity, which, in turn, determine international competitiveness (Fransman, 1986). In this paper, we find that the technical change effect is higher in China and Viet Nam than in India, Bangladesh, and Indonesia.

Export expansion has a positive relationship with the progress of a developing country, which was important in explaining the inter-country variance in GDP growth rates (Tyler, 1981). Our analysis finds that the contribution of export expansion is significant in Bangladesh, whereas Viet Nam, China, Indonesia, and India are the followers respectively. However, it seems that in the long run, domestic demand expansion makes the industry stable. Thus, in this sense, Indonesian and Indian TCIs are more sustainable than Viet Nam and Bangladesh's TCIs are.

Table 6 Demand-Supply growth effects of the economies

Indicators	BAN	CHN	IDN	IND	VIE
Demand-side					
TE	0.01(4*)	0.22 (1)	-0.28(5)	0.02(3)	0.21(2)
DE	0.45(5)	0.66(4)	1.02(1)	0.90(2)	0.69(3)
EE	0.54(1)	0.25(3)	0.14(4)	0.11(5)	0.45(2)
DOM in 2011	2.14(3)	2.31(2)	1.57(5)	1.96(4)	2.35(1)
IOM in 2011	1.05(2)	1.02(1)	1.32(4)	1.09(3)	1.34(5)
Supply-side					
VS Rate in 2011	0.09(2)	0.07(1)	0.32(4)	0.14(3)	0.53(5)
DIM in 2011	1.57(3)	2.57(1)	1.26(4)	1.40(3)	2.09(2)
IIM in 2011	1.05(3)	1.01(1)	1.31(4)	1.03(2)	1.35(5)
ISD in 2011	0.69(5)	1.02(2)	0.93(3)	0.83(4)	1.06(1)

* The numbers in the parenthesis indicate the comparative ranking of the countries.

The high backward linkages (output multiplier) may strengthen supply industries, which feed to other local firms. In addition, the linkage effects on supplier industries may reduce input costs (Markusen & Venables, 1999). Strong linkages make the industry competitive in the global market. The results in this paper show that Viet Nam had the strongest position in the backward effect measure followed by China, Bangladesh, India, and Indonesia in 2011.

On the other hand, the VS analysis reveal that China is in the top position. VS

reduces, in some cases, production costs. However, an increase in comparative advantage is not necessarily associated with an increase in specialization (Ricci, 1999). In the case of a TCI in the Asian region, the low rate of VS certifies high competitiveness[29].

The comparative analysis reveals that on the demand side, the contribution of the TCI to Bangladesh's economy is much higher compared with other economies in terms of output and exports. The driver of output growth in Bangladesh is the final demand. The decomposition of the final demand reveals that domestic demand has contributed greatly to the economies of Indonesia and India. In addition, import substitution has played a role in Indonesia's and Viet Nam's TCI growth. Meanwhile, technology has played a significant role in China and Viet Nam in recent times, whereas technical change has a limited role when it comes to TCI growth in Bangladesh. Bangladesh has reduced her dependency on imported inputs, which has increased in other countries except for China. Import dependency is high for Viet Nam and Indonesia.

Bangladesh is becoming a self-subsistence clothing manufacturer. The vertical specialization rate for Bangladesh was 9% in 2011; it was 53% for Viet Nam in 2011. The TCI's output multiplier in Bangladesh for domestic production is 2.14 times, which has improved since 2000. Meanwhile, the ratio has declined in China, India, and Indonesia, and Viet Nam has shown a significant shift. The TCI's import repercussion effect of Bangladesh has also declined from 1.07 to 1.05, indicating a drop in the dependency on imports and in the improvement of the domestic supply. The forward analysis reveals that the TCI of Viet Nam and Indonesia are very much susceptible to imports in 2000 and 2011.

Thus, in general, if we rank the comparative position based on demand-supply indicators as in Table 6, the demand-supply linkage of the TCI in Bangladesh is stronger than those in India and Indonesia. The indicators of China and Viet Nam are higher than Bangladesh's.

But in terms of economic development and industrial structuring, the economy of Bangladesh is far behind from China and Viet Nam. The development stage and industrial structure of these countries are not same. China's industrial structure has started to dominate by heavy and chemical industries. China has started to shift TCI to low wage countries like Myanmar, Cambodia, etc. So, the life cycle of TCI in China is going to be declined (in 2016 the growth rate was -7%). High technical change in TCI reflects decline of the life cycle (Masum, 2017). GDP per capita[30] indicates that economy of Bangladesh is the poorest among the five countries and very much dependent on TCI. According to input-output table 2011, the TCI's output as percentage of industrial output is 33% for

Bangladesh, which are 15%, 5%, 9%, and 9% for China, Indonesia, India, and Viet Nam respectively. The other major industries in the economy of Bangladesh are food, leather, water transport, paper and printing, etc. All the industries in Bangladesh are labor-intensive. The major industries for China in 2011 were coke, machinery, metal, chemical, transport equipment, air transport, electrical equipment, etc. The significant industries in Viet Nam's economy are machinery, metal, chemical, chemicals, equipment's, etc. For Indonesia, the mentionable industries are machinery, equipment, plastics, paper and printing, etc. For Indian economy, electrical equipment, transport equipment, coke, plastics, metal, are mentionable industries in the industrial structure.

4. Conclusions

This paper has analyzed the TCI of Bangladesh from demand-supply aspects in comparison to other Asian TCI with the input-output framework.

The first stage decomposition (decomposing growth into *TE* and *FD*) on the demand side finds that the growth of the TCI in Bangladesh from 2000 to 2011 is due to the final demand growth. The final demand growth contributes 99%, and the technical growth contributes only rarely 1%. The second-stage decomposition (decomposing *FD* growth into *EE*, *DE*, and *IS*) concludes that the growth of the final demand is mainly due to export expansion from 2000 to 2011. So, the structural decomposition analysis on the demand-side of the TCI in Bangladesh concludes that the growth of the industry is final demand driven, the role of technology is not so significant. At the same time, export expansion has contributed much to this growth race, which means that the TCI in Bangladesh is export-oriented. The average export growth rate over the last decade was 15% (Masum, 2017).

Although technology is important for modern production system, the application of technology in the TCI is not cost effective. As long as the low-cost labor is available, the industry should rely more on labor rather than technology. The experience of technology application in the TCI is not positive. The previous study concluded that technology replaced the labor in the former manufacturers like France, Germany, UK, USA, Japan, Korea, etc. Due to unavailability of labor, developed countries replaced labor-intensive production process with technology, which lead to lose the competitiveness in the consumer market. This competitive weakness forces them to relocate production process to labor abundant countries. When we analyze the technical changes with the existing competitors, it gives our industry a signal that the TCI of Bangladesh is still driven by final demand. It

supports the previous findings that the industry is order-driven (Masum, 2016). The technical change to the Viet Nam and Chinese industry is mentionable. It is the nature of the TCI that as economy grows and other industrial branches contribute to the economy, the labor-intensive industry becomes capital-driven or technology dependent. The characteristics of Chinese economy support this phenomenon. The economic nature of Viet Nam is different due to proximity to China. As a result, technical changes to Viet Nam's TCI is also high. At the same time, the recent agreement[31] between Viet Nam and other 10 pacific countries justifies its technical change. So, after China, Viet Nam is also going to be the next supply-driven manufacturer of clothing. But, the case of Bangladesh is different. It is recommended to the Bangladeshi manufacturers to keep the TCI labor dependent until some structural changes in the economy like China. The backward effect, another indicator of the demand side, of the TCI in Bangladesh has also increased over time. The paper also finds that the use of imported raw materials in TCI production in Bangladesh has declined over time. The increasing output multiplier and reducing dependency on imported inputs bring benefits for the local raw materials supplier and improves the sustainability of the TCI in the long run.

Secondly, the supply-side analysis indicates that the TCI's forward effect and leakage effect have slightly increased. In addition, the sensitivity analysis indicates that the industry is not so sensitive to the economy in 2011. The analysis also finds that the local firms can satisfy 91% of the required inputs integrated into exports into 2011. The fibre and woven subsectors are import dependent. Some initiatives from the government and industry insider is necessary to improve the fibre and woven subsector, e.g., the government should facilitate these subsectors through financial and non-financial benefits, the concerned parties should find alternative solutions like substitution of natural fibre into chemical fibre, etc. Based on the above discussion in the body of the paper on the supply side and the demand side of the TCI of Bangladesh, we can infer that the TCI of Bangladesh is a demand-driven[32] industry rather than a supply-driven one.

Finally, the comparison of the TCI of Bangladesh with the Asian manufacturers indicated that the demand-side and supply-side of the industry in every country is not similar. The demand side of Bangladesh is export driven with a low-tech production system as in India and Indonesia. The demand side of China and Viet Nam has been relatively technology driven since 2000. The domestic output multiplier indicates that the demand side of Bangladesh is almost similar to that of Viet Nam and China. However, the import leakage implies that the demand side of Bangladesh's TCI is better than Viet Nam and

Indonesia. When we compare the supply side, we find that the TCIs of China and Viet Nam are the key industries in their economic structures. However, it is not a key industry in Bangladesh, although the TCI's contribution to the national economy is much higher than other countries'. The input-leakage and vertical specialization rates also indicate that the supply side of the TCI in Bangladesh is not similar to those of other countries, especially Viet Nam. Lastly, the comparison concludes that both for the demand side and in the supply side, China and Viet Nam are ahead of Bangladesh followed by India and Indonesia as summarized in Table 6.

This paper lacks trade in value added perspective of decomposition. In future, the authors are planning to analyze the Asian TCI from trade in value added perspective.

Acknowledgement

Notes

1 The textile industry and clothing industry are considered to be two industries, but in this paper, we addressed TCI as one industry. We considered clothing as the finished product of the textile-clothing industry. Moreover, in input-output framework, it is difficult to discuss the textile and clothing industry separately. However, when we discuss TCI out of the input-output framework, we address textile and clothing as separate industries as much as possible. Here, the main purpose of the study is to analyze the structure of Bangladesh's TCI. Roughly 97% of the TCI output in Bangladesh is clothing (Masum & Inaba, 2018). To analyze the TCI of Bangladesh in comparative form, we choose four other Asian countries, which are the top four clothing exporters and competitors to Bangladesh.

2 TCI is sometimes divided into primary sector and secondary sector. The primary sector comprises yarn production, fabric production, and dye-chemical processing. The secondary sector consists of apparel production, accessory additions, packaging, etc.

3　FDI stocks in TCI are US $253, US $1221, and US $2531 million during 2000, 2010, and 2016, respectively, with a share of 20% of total FDI flows in 2016 (Bangladesh Bank, 2016).

4　The government facilitates this industry through the duty-free importing of raw materials, cash incentives, duty drawbacks, back-to-back credit, and bonded warehouses (N. Ahmed, 2009; Latifee & Kabir, 2015; Masum, 2016).

5　During the past decades, the TCIs around the globe have been trying to adjust to a rapidly changing business environment while the manufacturing bases have moved into the developing countries (Rajkishore Nayak, Padhye, Wang, Chatterjee, & Gupta, 2015). The pattern has been clearly observed in Asia over the past six decades: the successive transfer of labor-intensive industries from Europe and the United States to Japan to the Asian newly industrialized countries (Ruan & Zhang, 2014).

6　Li & Fung is one of the Asian trading firms. These firms are the element of triangular manufacturing in clothing industry. They play the role of negotiator between manufacturer and branded retailers.

7　This means that the same company place orders to manufacturers of all countries, for an example, Walmart buys clothing from Bangladesh, India, China, Viet Nam, etc.

8　The top five countries are China, Bangladesh, Viet Nam, Indonesia, and India.

9　Demand-side in the IOT framework is defined as variation and changes in the input structure of production when we take the final demand as the exogenous variable. The demand-side is explained by output multiplier, input coefficient, technical and substitution effects in the production, etc.

10　Supply-side in the IOT framework is defined as the variations and changes in output structure due to changes in primary inputs and other input supplies. The exogenous variable in the supply-side model is value added. The supply-side is explained by output coefficient, input multiplier, value added effect, intermediate input import effect, etc.

11　In input-output framework, technological change means changes in the input-output coefficients, which do not necessarily impact on total technological growth as indicated in the Solow or growth accounting (Magacho, McCombie, & Guilhoto, 2018). Rose & Casler (1996) stated that technical change is often broadly interpreted to include any factor that causes a change in a technical coefficient, such as true technological change, technical substitution and scale effects.

12　We did a comparative study of the top five clothing exporter-manufacturers, excluding Hong Kong because around 95% of textile-clothing exporting from Hong Kong is re-exporting. As per the WTO database, the export ranking of the clothing exporters is China

($161 billion), European Union ($117 billion), Bangladesh ($28 billion), Viet Nam ($25 billion), India ($18 billion), and Indonesia ($7 billion) in 2016, with annual growth of -7%, 4%, 6%, 5%, -2%, and -2% respectively.

13 We converted the US dollar value IOTs into local currency IOTs as taka for Bangladesh, dong for Viet Nam, rupee for India, rupiah for Indonesia, and yuan for China.

14 To convert the current price IOTs into constant price IOTs, we calculated sector-wise domestic deflators (35 deflators), a deflator for exports, and a deflator for imports. For many cases, due to insufficient data, we use sector-wise GDP deflators for this conversion purpose.

15 The exogenous variable for supply-side model is value added, whereas, the exogenous variable for demand-side model is final demand.

16 Analyses concerning domestic demand and exports in the input-output framework are leveled as demand-side analyses, whereas analyses concerning primary inputs, imports and value-added are described as supply-side analyses (Mayer & Flachmann, 2011).

17 The details mathematical derivation is available in Miller & Blair (2009)

18 Please see Dietzenbacher and Los (1998) and Miller and Blair (2009) for detailed mathematical derivation.

19 Please see Frank Jr et al. (1975) for detailed mathematical derivation. Frank Jr et al.'s (1975) model decomposes the ouput growth into *DE, EE*, and *IS*. We apply the same concept to decompose the *f*.

20 The multipliers that incorporate direct and indirect effects are also known as simple multipliers (Miller and Blair 2009)

21 This paper subdivides the TCI into demand-side and supply-side. As Miller and Blair (2009) discussed in detail that Leontief model explains the demand-side of the industry, whereas, Ghosh model emphasizes the supply-side. The impact of final demand changes explained in Leontief model, but the impact of primary input changes explained in Ghosh model. So, in line with our subdivision of TCI, we apply Ghosh model for supply-side analysis and Leontief model for demand-side analysis. Although input coefficient is fixed in Leontief model and output coefficient is fixed in Ghosh model, we discuss them for different purpose.

22 An early measure of *forward linkage* was also proposed, based on *A* and *L*. But this measure has been viewed with skepticism, because they are generated by a peculiar stimulus – a simultaneous increase of one unit in the gross outputs of every sector. This dissatisfaction led to the suggestion that elements from the Ghosh model would be more

appropriate as forward linkage measure (Miller & Blair, 2009). Moreover, one of the contributions of this paper is to divide the structure of the TCI into demand-side and supply-side. Demand-side is discussed under Leontief model and supply-side is mostly discussed under Ghosh model in this paper. There are many examples of suing both models together, such as, Clements, 1990; Clements & Rossi, 1991; Dietzenbacher, 1992; Dietzenbacher & Van der Linden, 1997; European Commission, 2007; Guerra & Sancho, 2010; Hewings, 1982; Song, Liu, & Langston, 2005, 2006b, 2006a; among others.

23 The idea of *ISD* was introduced by Rasmussen (1956) under Leontief model. But, we use the *ISD* concept under Ghosh model because we use this measure for supply-side analysis. Gosh model is a well-established supply-side model. Moreover, base of *ISD* analysis is input multiplier or forward linkage. At the same time, row sums of the Ghosh inverse were suggested as a better measure of normalized forward linkage or *ISD* (Miller & Blair, 2009).

24 VS is based on Leontief model and represents supply-side. VS indicates share of imported inputs integrated into exports.

25 See, for example, Dixit and Grossman (1982), Sanyal (1983), Krugman et al. (1995), Deardorff (2001), Jones (2001), and Timmer et al. (2015), among others.

26 The technical effect on the TCI growth in Bangladesh was -0.09% from 2000 to 2005 and -0.02% from 2005 to 2011 at the current market price (Masum, 2017).

27 Both horizontal and vertical technology up-gradation have taken place. According to Zhang et al. (2016), horizontal up-gradation includes training provision, new processes and material utilization, adaption to machinery and equipment, inventory control, and organizational evolution; vertical technology up-gradation includes brand creation, participation in upstream and downstream production, etc.

28 Coefficient > 1 indicates a sensitive industry (Humavindu & Stage, 2013)

29 Here, we consider that the low VS rate is better for developing countries, which reduces import costs and increases employability. The explanation varies based on the level of economic development. For developed nations, a higher VS rate is good because developed nations can outsource their production for the reduction of production costs.

30 GDP per capita (current US$) in 2017 for China, Indonesia, Viet Nam, India, and Bangladesh are $8827, $3847, $2343, $1940, and $1517 respectively (World Bank, 2018).

31 Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) has signed in March 2018 by Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Viet Nam. The purpose of CPTPP is to reduce tariff and non-tariff barriers. The deal covers a market of nearly 500 million people. Viet Nam, as a TCI

manufacturer, will be benefited much from this deal.

32 Demand-driven indicates that the production is driven by the demand generation in the economy, especially export demand. Whereas, supply driven means industry will produce output and consumer will accept as supplied by the producer.

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