論 説

A Role of Textile-Clothing Industry in the Economic Structure of Bangladesh: An Input-Output Analysis

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Abstract

Textile-clothing industry (TCI) of Bangladesh is the second largest industry after agriculture. This paper attempts to know the backward and forward economic impact of the TCI on the economy and on other individual industries in Bangladesh. To assess the direct and indirect impact, this paper applies input-output analysis technique. The paper finds that the backward multiplier impact is 3.16 times and forward multiplier impact is 3.19 times against one-unit textile-clothing demand changes in 2016. The TCI has backward economic leakage of 1.11 times in the same period. The TCI's sub-sectoral analysis reveals that backward impact of handloom subsector is notable, whereas, the forward impact of dyeing and bleaching subsector is the highest. The woven subsector has the highest input leakage (0.59). The paper recommended to improve input sharing among the subsectors.

Keywords: Textile-clothing industry, Bangladesh, backward impact, forward impact, input-output analysis
JEL classifications: D57, L67

1. Introduction

The Textile-clothing industry (TCI[1)]) of Bangladesh is playing the pivotal role towards the economic development of Bangladesh (Masum & Islam, 2014). TCI of Bangladesh, an export-oriented manufacturing industry, is one of the most important industries run by mainly private sector. The contribution of the industry to the national development is

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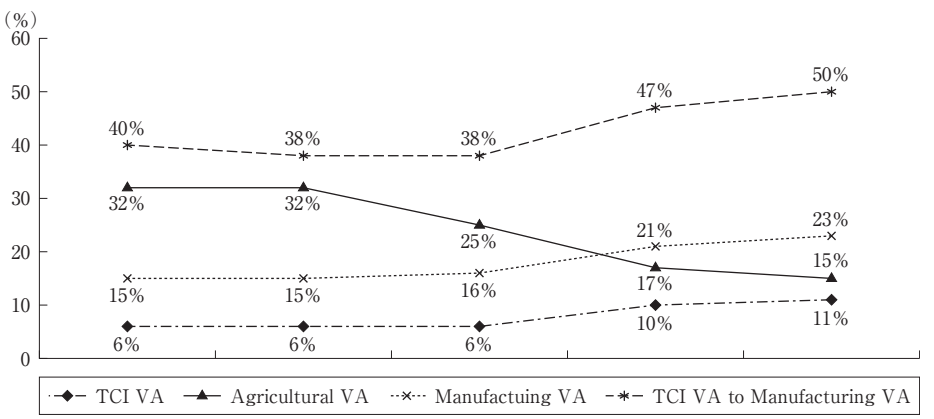
significant. The government is supporting the industry with fiscal and non-fiscal incentives along with the continuous efforts from the local and foreign private firms.

The value-added (VA)[2] contribution of TCI has increased over the last two decades from 6% in 1980 to 11.20% in 2016. The VA share to Gross Domestic Product (GDP) is second to the agriculture industry (Table A1 in the Appendix gives VA share of all industries in 2016). In the manufacturing structure, the VA share of TCI is significant i.e. 50% in 2016. The TCI was also one of the main manufacturing industries in the early period of transformation from the agrarian economy to industrial orientation.

The TCI in the manufacturing VA has captured a very big place as shown in Figure 1 above. The agricultural contribution has declined from 32% in 1980 to 15% in 2016, whereas the contribution of manufacturing sectors has increased from 15% to 23% from 1980 to 2016. The TCI has led the manufacturing sector's contribution with a range of 40% to 50% from 1980 to 2016.

Figure 1. The value-added (VA) share of TCI to GDP from 1980 to 2016 of Bangladesh

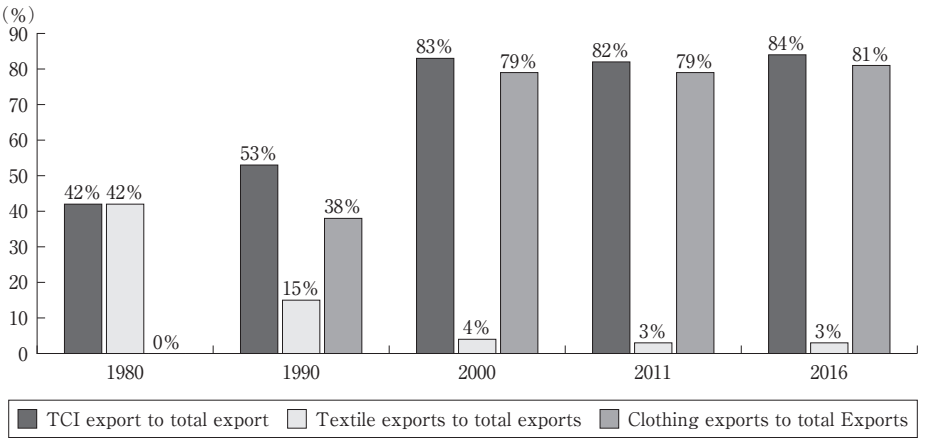


Source: Authors' calculation based on input-output tables

Moreover, the export basket of the country shows that the export contribution of TCI has increased from 42% in 1980 to 84% in 2016 as depicted in Figure 2. The composition of TCI export, i.e. textile export and clothing export has changed significantly. The share of clothing export was nil in 1980 which has increased to 81% in 2016, on the other hand, the share of textile[3] export has declined from 42% to 3% during the last three decades.

There are many research works on the TCI of Bangladesh, such as, competitiveness of TCI in the international markets (Haider, 2007); export sustainability of the industry (N. Ahmed, 2009); contribution of the industry to the Bangladesh economy (Bhattacharya, Rahman, & Raihan, 2002); backward linkages to the industry (Habib, 2016); ongoing TCI's restructuring process (Rahman, Bhattacharya, & Moazzem, 2012); lead time management of the industry with survival and growth strategies (Haque, 2009); operational disturbances of the sector (Islam, Bagum, & Rashed, 2012); export growth paradox of the industry

Figure 2. The export contribution of TCI



Source: Authors' calculation based on input-output tables

under weak governance (F. Z. Ahmed, Greenleaf, & Sacks, 2014) among other studies. But, no study has focused on the economic impact of the TCI on other industries. This paper has introduced to reveal the economic impact of the TCI. The research question of this work is given below.

> Is the backward and forward impact of the TCI stronger than those of the other industries in the economic structure of Bangladesh ?

The rest part of the paper is organized as follows. Section 2 states the methodology of the paper. Section 3 explains the results including inter and intra-industry backward-forward impacts of the TCI. Finally, section 4 concludes the paper.

2. Data and Methodology

Our analysis mainly uses input-output tables (IOT) of Bangladesh, which are based on multi-regional IOT of Asian Development Bank (MRIOT-ADB) 2011. The IOT consists of 35-sectors.[4] We apply GRAS[5] algorithm to compile IOT 2016 based on MRIOT-ADB 2011. As MRIOT-ADB 2011 has no sub-sectoral classification of the TCI, we also use IOT 2012[6] for sub-sectoral analysis.

The framework of our analysis is as follows. Final demand is taken as exogenous variable as shown in Figure 3.

Here ID, FD, TD, and IS denote intermediate demand, final demand, total demand, and intermediate supply, respectively. i indicates supplying sectors, j indicates demanding sectors, $x_i=\sum_{j=1}^{n} z_{ij}+f_i$, $x_j=\sum_{i=1}^{n} z_{ij}+\sum_{i=1}^{n} z_{ij}^{m}+v_j$, we define $n\times n$ domestic intermediate demand and supply matrix as Z (elements are z_{ij}), imported intermediate supply and

Figure 3. The framework of input-output table

		ID (*sector_j*)						*FD*	*TD*
		1	*2*	・	・	・	*n*	(*f*)	(*x*)
Domestic IS (*sector_i*)	*1*	z_{11}	z_{12}	・	・	・	z_{1n}	f_1	x_1
	2	z_{21}	z_{22}	・	・	・	z_{2n}	f_2	x_2
	・	・	・	・	・	・	・	・	・
	・	・	・	・	・	・	・	・	・
	・	・	・	・	・	・	・	・	・
	n	z_{n1}	z_{n2}	・	・	・	z_{nn}	f_n	x_n
Import IS (*sector_i*)	*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	
	・	・	・	・	・	・	・	・	
	・	・	・	・	・	・	・	・	
	・	・	・	・	・	・	・	・	
	n	z_{n1}^m	z_{n2}^m	・	・	・	z_{nn}^m	f_n^m	
Value-added ($\acute{v}$)		v_1	v_2	・	・	・	v_n		
Total Supply ($\acute{x}$)		x_1	x_2	・	・	・	x_n		

Source: Based on Miller & Blair (2009)

demand matrix as Z^m, f as the final demand column 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 $x_i=x_j$.

We define a_{ij} as the input coefficients representing the input of sector i from sector j. So, a_{11} represents the input required to produce one unit of production of sector 1 from sector 1. Similarly, in Figure 4, the expression a_{21} represents the amount of raw materials that sector 1 takes from sector 2 to produce one unit of the product.

Under the above mentioned IOT framework in Figure 3, we calculate the input coefficients of the intermediate transactions and value added.

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 $a_j^v=\frac{v_j}{x_j}$. The denominators and the numerators are taken form Figure 3. The Figure 4 justifies that $\sum_{i=1}^n a_{ij}+\sum_{i=1}^n a_{ij}^m+a_j^v=1$. We, in Figure 4, denote $n\times n$ domestic intermediate demand and supply coefficients matrix as A^d, imported intermediate supply and demand coefficients matrix as A^m.

Figure 4. The input coefficient framework

		ID (*sector_j*)					
		1	*2*	·	·	·	*n*
Domestic IS (*sector_i*)	*1*	a_{11}	a_{12}	·	·	·	a_{1n}
	2	a_{21}	a_{22}	·	·	·	a_{2n}
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	n	a_{n1}	a_{n2}	·	·	·	a_{nn}
Import IS (*sector_i*)	*1*	a^m_{11}	a^m_{12}	·	·	·	a^m_{1n}
	2	a^m_{21}	a^m_{22}	·	·	·	a^m_{2n}
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	·	·	·	·	·	·	·
	n	a^m_{n1}	a^m_{n2}	·	·	·	a^m_{nn}
Value-added ($\acute{v}$)		a^v_1	a^v_2	·	·	·	a^v_n
Total Supply ($\acute{x}$)		1	1	·	·	·	1

Source: Based on Miller & Blair (2009)

If we represent the domestic part of Figure 4 in matrix form, the look of demand-supply balancing equation would be like the following equation.

$$\begin{bmatrix} a_{11} & a_{12} & \cdot & \cdot & \cdot & a_{1n} \\ a_{21} & a_{22} & \cdot & \cdot & \cdot & a_{2n} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{n1} & a_{n2} & \cdot & \cdot & \cdot & a_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{bmatrix} + \begin{bmatrix} f_1 \\ f_2 \\ \cdot \\ \cdot \\ \cdot \\ f_n \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{bmatrix} \tag{1}$$

Here the domestic input coefficient matrix is defined as A^d, the final demand column vector is defined as f, and output column vector is defined as x as below.

$$A^d = \begin{bmatrix} a_{11} & a_{12} & \cdot & \cdot & \cdot & a_{1n} \\ a_{21} & a_{22} & \cdot & \cdot & \cdot & a_{2n} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{n1} & a_{n2} & \cdot & \cdot & \cdot & a_{nn} \end{bmatrix}, f = \begin{bmatrix} f_1 \\ f_2 \\ \cdot \\ \cdot \\ \cdot \\ f_n \end{bmatrix}, and\ x = \begin{bmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{bmatrix}$$

Thus equation (1) can be represented as $A^d x + f = x$; which can be solved for x as below:

$$x=(I-A^d)^{-1}f \tag{2}$$

where I is the identity matrix, $(I-A^d)^{-1}$ is the inverse matrix of $(I-A^d)$. This inverse is known as the Leontief inverse.[7] The elements of this matrix are referred to as inverse matrix coefficients. These resulting coefficients table indicate how much production will be ultimately induced (direct and indirect) in what industry by a demand increase of one unit in a certain industry. Once the inverse matrix coefficients are calculated, the simultaneous equations as in equation (1) do not need to be solved independently. When the final demand in a sector is given, total production at each sector, corresponding to the final demand, can be immediately calculated using equation (3).

$$L^d=(I-A^d)^{-1} \tag{3}$$

As we mentioned early we define the import coefficient matrix as A^m, as A^d in case of domestic input coefficient matrix. When we calculate the total input coefficient, i. e., domestic effect and import effect, we combine the domestic effect and import effect into one matrix as $\mathrm{A}=\mathrm{A}^{\mathrm{d}}+\mathrm{A}^{\mathrm{m}}$. As a result of this combination, we get 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 (4).

$$\mathrm{L}=(\mathrm{I}-\mathrm{A})^{-1} \tag{4}$$

2.1 Backward Impact Analysis Technique

The below equations describe the total backward impact (BI) and domestic backward impact (DBI) of the TCI. The similar models are discussed as backward and forward linkages in Chenery and Watanabe (1958); Hirschman (1958); Jones (1976); Cella (1984); among others.

$$BI_j=\sum_{i=1}^{n} l_{ij} \tag{5}$$

$$DBI_j=\sum_{i=1}^{n} l_{ij}^d \tag{6}$$

Here l_{ij} indicates elements of Leontief inverse matrix (L), and l_{ij}^d indicates the domestic elements of the Leontief inverse matrix (L^d).

The following formula is used to calculate the economic leakage of backward impact (EL_BI).

$$\mathrm{EL\_BI}=[\mathrm{I}-(A^d+A^m)]^{-1}-[\mathrm{I}-A^d]^{-1} \tag{7}$$

Here, $[\mathrm{I}-(A^d+A^m)]^{-1}$ represents L, and $[\mathrm{I}-A^d]^{-1}$ represents L^d.

Figure 5. The output coefficients framework

		ID (*sector_j*)						*FD*	*TD*
		1	*2*	·	·	·	*n*	(*f*)	(*x*)
Domestic IS (*sector_i*)	*1*	b_{11}	b_{12}	·	·	·	b_{1n}	b_1^f	1
	2	b_{21}	b_{22}	·	·	·	b_{2n}	b_2^f	1
	·	·	·	·	·	·	·	·	·
	·	·	·	·	·	·	·	·	·
	·	·	·	·	·	·	·	·	·
	n	b_{n1}	b_{n2}	·	·	·	b_{nn}	b_n^f	1
Import IS (*sector_i*)	*1*	b_{11}^m	b_{12}^m	·	·	·	b_{1n}^m		
	2	b_{21}^m	b_{22}^m	·	·	·	b_{2n}^m		
	·	·	·	·	·	·	·		
	·	·	·	·	·	·	·		
	·	·	·	·	·	·	·		
	n	b_{n1}^m	b_{n2}^m	·	·	·	b_{nn}^m		

Source: Based on Miller & Blair (2009)

2.2 Forward Impact Analysis Technique

When we define $b_{ij}=\frac{z_{ij}}{X_i}$ and $b_{ij}^m=\frac{z_{ij}^m}{x_i}$, the output coefficients in Figure 5 using the matrix Z and Z^m from 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}. We also define $b_i^f=\frac{f_i}{X_i}$ for final demand coefficients.

The denominators and the numerators are taken from Figure 3. 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 $\acute{x}\mathrm{B}^d+\acute{v}=\acute{x}$ under output coefficient framework, which can be solved as below:

$$\acute{x}=\acute{v}(I-B^d)^{-1} \tag{8}$$

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 (9). The elements of G^d is referred to as g_{ij}^d. So,

$$\mathrm{G}^d=(I-B^d)^{-1} \tag{9}$$

We define the imported output coefficient matrix as B^m, as B^d in case of domestic output coefficient matrix. When we calculate the total output coefficient, i. e., domestic effect and import effect, we combine the domestic effect and import effect into one matrix as $B=B^d+B^m$. As a result of this combination, we get the total effect (G) of final demand changes by taking the inverse of $(I-B)$. So, the total effect is defined as in the following equation (11).

$$G=(I-B)^{-1} \tag{10}$$

The model specifications for total forward impact (FI), domestic forward impact (DFI) and economic leakage of forward impact (EL_FI) are given below:

$$FI_i=\sum_{j=1}^{n} g_{ij} \tag{11}$$

$$DFI_i=\sum_{j=1}^{n} g_{ij}^{d} \tag{12}$$

$$EL\_FI=\sum_{j=1}^{n} g_{ij}-\sum_{j=1}^{n} g_{ij}^{d} \tag{13}$$

Here g_{ij} indicates elements of Ghosh inverse matrix (G), g_{ij}^{d} indicates the domestic elements of the Ghosh inverse matrix (G^d) of non-competitive type IOT.[8)]

3. Results and Discussion

3.1 The Backward Impact

The term backward linkage or backward impact (BI) is used to indicate the interconnection of a particular sector with the upstream sectors from which it purchases inputs (Miller & Blair, 2009). Industrial sectors depend on each-other for inputs. This dependence can be called backward linkage (Hara, 2008). BI is also known as the output multiplier effect, which is also known as the sector's pull power (Ilhan & Yaman, 2011). The larger the BI multiplier, the more inputs that sector receives from other sectors. If the output multiplier is high, it means that an increase in final demand increases the total production, i. e., it activates the other sectors by receiving inputs.

3.1.1 Inter-industry BI of the TCI.

This section discusses the relationship of the TCI with all other industries. The backward impact analysis shows that TCI is the 11th input accepting industry in the economic structure of Bangladesh. Food, beverages and tobacco is ranked the top industry in the economic structure followed by hotels and restaurants, chemicals and chemical products, air transport, etc. as summarized in Table 1 below and in the Table A2 in the Appendix. The top sectors, ahead of TCI, have strong contributions for the other industries.

But export earnings, value addition, and employment generation effects of other indus-

Table 1. The backward impact (BI) coefficients of the major industries in 2016

Sector name	Total BI coefficient [Equation (5)]	Domestic BI [Equation (6)]	Backward Leakage [Equation (7)]	Intra-sector coefficient*
Food, beverages and tobacco	3.56	2.49	1.07	2.07
Hotels and restaurants	3.51	2.49	1.02	2.00
Chemicals and chemical products	3.50	2.41	1.08	2.22
Air transport	3.47	2.38	1.06	2.01
Basic metals and fabricated metal	3.44	2.38	1.02	2.47
Leather, leather and footwear	3.40	2.27	1.20	2.38
Rubber and plastics	3.36	2.23	1.03	2.11
Wood and products of wood and cork	3.26	2.18	1.05	2.13
Pulp, paper, printing & publishing	3.23	2.14	1.09	2.08
Construction	3.23	2.12	1.11	2.01
TCI	3.16	2.05	1.11	2.47

Source: Authors' calculation
*This indicates the inputs TCI accepts from TCI's subsectors (TCI itself). These coefficients include the import leakage.

tries (excluding TCI) are not as large as TCI.[9] Moreover, TCI has the second largest value-adding sector after agriculture. Average VA share of all other sectors is 2.25% as shown in the Table A1 in the Appendix also.

Although TCI is the 11th important industry to accept inputs from the other industries, the difference with the other top ten industries is not so large, i. e., it is only 14% on average. The magnitude of difference with the 1st industry is only 0.13.[10]

The inter linkage of TCI with the other sectors is very weak. TCI is accepting major inputs from TCI's subsectors (2.47 units). TCI is taking only 0.69 unit from the other industrial sectors (details are given in Table A3 in the Appendix). On the other hand, the inter linkage of food, hotel, and other economic sectors are higher than TCI, e. g., food sector accepting 1.49 units from other sectors (out of which 0.84 unit from agriculture), hotels accept 1.51 units from other sectors, chemicals use 1.28 units from other sectors.

The analysis finds that the pattern of domestic effect of the top industries is almost same as the total effect. However, when we look at the economic leakage, we find that economic leakage of the air transport is the highest followed by TCI, paper, chemicals, food, metal, etc. as shown in the Table 1. Although TCI has import leakage, the industry is also exporting the highest amount of outputs.

3.1.2 Intra-industry BI of the TCI.

This section discusses the relationship among the sub-sectors of the TCI. Bangladesh's IOT 2012 is used for the sub-sectoral backward impact analysis.[11] As mentioned early, IOT is an inter-industry transactions table. The rows of such a table describe the distribution of

Table 2. Backward impact (BI) coefficients of the TCI's subsectors in 2012

Subsectors	Total[12] BI coefficient	Domestic[13] BI coefficient	Backward leakage
Yarn industry	1.40	1.14	0.26
Cloth milling	1.26	1.15	0.11
Handloom cloth	1.98	1.76	0.22
Dyeing and bleaching	1.88	1.43	0.45
Woven	1.97	1.38	0.59
Knitting	1.86	1.44	0.42

Source: Authors' calculation from input-output table 2012 of Bangladesh

a producer's output throughout the economy. The columns describe the composition of inputs required by a particular industry to produce its outputs. The production process of the TCI is subdivided into fiber, yarn, fabric, wet processing, and clothing in the IOT 2012. Fabric is described as cloth milling and handloom cloth. In the IOT 2012, clothing is further subdivided into knit clothing and woven clothing.

Handloom cloth, among the production process components, has the highest degree of total production repercussions. The backward coefficient of this subsector is 1.98. Out of these 1.98 units, 1.76 units is supplied domestically, and 0.22 units is leakage. If the total production repercussion in the economy is considered, the ranking of the components of the production process is as follows: handloom cloth, woven clothing, wet processing, knit clothing, yarn making, and cloth milling with 1.98, 1.97, 1.88, 1.86, 1.40, and 1.26 coefficients respectively.

Table 2 summarizes the total backward linkage, domestic backward linkage, and backward leakage. Domestically, the handloom cloth subsector is also the strongest for backward linkage with 1.76 coefficient. The other important subsectors for domestic production repercussion are woven, knit, yarn, and cloth milling (another part of the fabric sector) with 1.38, 1.44, 1.14, and 1.15 coefficients respectively. The woven subsector has the highest degree of leakage (0.59 units).

The direct impact of the TCI is discussed here. Yarn subsector is the beginning process of the textile-clothing processing industry. The raw materials of this subsector are mainly cotton and fiber. This sub-sector accepts inputs mainly from cotton, yarn itself, wholesale trade, retail trade, transport sectors. The second stage of the TCI processing is fabric subsector (cloth milling and handloom cloth). The handloom subsector has the highest input accepting subsector, which accepts inputs from yarn, dyeing, chemicals, trading, and transport sectors. Dyeing and bleaching subsector accepts direct inputs from cloth milling, trading and transport sectors. Woven subsector accepts inputs from clothing milling mainly among the domestic sources. Knitting subsector mainly depends on yarn and transport

Table 3. Direct input coefficients of the TCI's subsectors in 2012

	Yarn	Cloth milling	Handloom	Dyeing	Woven	Knit
Jute cultivation	0.00	0.00	0.02	0.00	0.00	0.00
Cotton cultivation	0.11	0.00	0.00	0.00	0.00	0.00
Yarn industry	0.09	0.08	0.07	0.00	0.00	0.28
Dyeing and bleaching	0.00	0.00	0.10	0.16	0.00	0.00
Basic chemical	0.00	0.00	0.02	0.00	0.00	0.00
Cloth milling	0.00	0.00	0.00	0.23	0.33	0.00
Wholesale trade	0.02	0.03	0.10	0.04	0.02	0.00
Retail trade	0.04	0.05	0.17	0.07	0.04	0.04
Land transport	0.02	0.02	0.09	0.04	0.10	0.11
Other services	0.00	0.00	0.09	0.00	0.00	0.02
Bank	0.00	0.00	0.00	0.00	0.02	0.00
Metal	0.00	0.00	0.00	0.00	0.02	0.00
Electricity generation	0.00	0.00	0.00	0.00	0.02	0.00
Petroleum	0.00	0.00	0.00	0.00	0.00	0.02
Gas	0.00	0.00	0.00	0.00	0.00	0.02

Source: Authors' calculation from input-output table 2012 of Bangladesh
Note: The coefficients in the above table are taken from A matrix $[A=A^d+A^m]$ as in equation (4).

industries. The direct input coefficient is summarized in the Table 3.

According to IOT 2012, the woven subsector[14] has the highest economic leakage. This subsector is very much import dependent. Domestic backward linkage of woven subsector is weak (Haider, 2007). The knit subsector is also import dependent. Many buyers impose condition to import backward linking items from the nominated suppliers[15] (Masum, 2016). Wet processing subsector purchases dyes and chemicals from abroad. Yarn subsector is dependent on imported cotton and fiber. Relatively, the fabric subsector (cloth) is less dependent on imported supply.

The sub-sectoral analysis, as shown in Table 3, exposes that the economic impact among the subsectors are good, e.g., yarn subsector is taking 0.11 unit intermediate inputs[16] from cotton subsector, cloth milling (fabric) subsector is taking 0.8 unit intermediate inputs from yarn industry, handloom subsector is accepting 0.07 unit intermediate inputs from yarn subsector and 0.10 unit from dyes-chemical subsector, dyes and bleaching subsector receiving 0.23 unit intermediate inputs from cloth milling, woven subsector accepting 0.33 unit inputs from cloth milling, and knitting subsector is receiving 0.28 unit inputs from yarn subsector. So, sub-sectoral interrelations are good. But the relationship with the other industries are not satisfactory. The interconnection between trading and transport services with the TCI is mentionable.

The Table 3 shows that cotton and fiber sector is the surviving sector for the yarn industry because it is the prime raw materials for the yarn production. Similarly, yarn is the prime subsector for cloth milling, trading is the prime raw materials source for handloom subsector, fabric subsector is the input provider of dyeing-bleaching subsector, woven subsector is mostly supported by cloth milling, and knit subsector is also mostly dependent on yarn industry. Among the clothing subsectors (woven and knit), knitting industry converts yarn into clothing as a processing industry, but the woven subsector cannot do similar processing due to high cost involvement. As a result, woven subsector depends on cloth milling subsectors mostly.

When we discuss with the input leakage, we find that woven subsector is accepting much imported inputs, specially woven fabric. The woven fabric production capacity is very poor in Bangladesh. Dyeing and bleaching subsector is also dependent on imported dyes chemical. Similarly, the yarn subsector is importing much cotton and fiber.

3.2 The Forward Impact

The term forward linkage or forward impact (FI) indicates the interconnection of a particular sector with the downstream sectors (Miller & Blair, 2009), so-called input multiplier. The input multiplier measures the effect of a monetary unit change in the primary input available to a sector on the input of all industries (Bon, 2000).

3.2.1 Inter-industry FI of the TCI.

The analysis shows that agriculture is providing the highest amount of inputs to other industries. The forward impact analysis shows that TCI is the 10^{th} input providing industry in the economic structure of Bangladesh. It means that TCI supports the other industries by providing inputs for further production of goods and services in the economy. The forward impact is shown in the following Table 4 below and Table A2 in the Appendix.

Although forward impact of the TCI is ranked higher than backward impact but the magnitude of difference with the high forward impact industries is much higher. TCI's forward impact is almost 50% less than agriculture industry, with a standard deviation of 1.08. So, forward impact of the TCI is weaker than backward impact. Usually, the forward impact of service sectors is higher than manufacturing sectors in balanced economy.

3.2.2 Intra-industry FI of the TCI.

Input-output analysis using IOT 2012 shows that the total forward impact of knitting and weaving subsectors is the strongest among the textile-clothing subsectors; the yarn subsector has strong forward-impact followed by handloom cloth, cloth milling, and wet processing. Table 5 shows that the domestic forward-impact coefficients for yarn, cloth milling, handloom, wet process, woven, and knit are 2.15, 1.65, 1.00, 2.29, 1.01, and 1.02, respectively. The yarn and cloth milling subsectors have some import leakage.

Table 4. The forward impact (FI) coefficients of top ten sectors in 2016

Sector name	FI coefficient [Equation (12)]
Agriculture, hunting, forestry and fishing	6.64
Retail trade	5.13
Basic metals and fabricated metal	4.78
Inland transport	4.13
Other community, social and personal services	4.10
Wholesale trade	4.01
Chemicals and chemical products	3.40
Electrical and optical equipment	3.37
Real estate activities	3.23
TCI	3.19

Source: Authors' calculation

Table 5. The forward impact (FI) coefficients of the TCI's subsectors in 2012

	Total FI coefficients [Equation (12)]	Domestic FI coefficients [Equation (13)]	Forward leakage [Equation (14)]
Yarn industry	2.15	1.25	0.90
Cloth milling	1.65	0.93	0.72
Handloom cloth	1.00	1.00	0.00
Dyeing and bleaching	2.29	2.29	0.00
Woven	1.01	1.01	0.00
Knitting	1.02	1.02	0.00

Source: Calculated from input-output table 2012 of Bangladesh

Forward impacts of yarn, cloth milling, dyeing and bleaching are higher than clothing subsectors (woven and knitting) because clothing subsectors accept inputs from the other subsectors.

4. Conclusions

This research has focused on the backward and forward impact analysis of the TCI because there is no previous empirical study on this topic.

The paper finds that the total backward multiplier/backward impact (domestic and import) of the TCI on other industries is 3.16, which is 11th among the industries in Bangladesh in 2016. Whereas, food industry has the strongest backward multiplier impact.

The backward impact of TCI is not so strong among the manufacturing sectors. On the other hand, the total forward impact of agriculture sector is much higher than other industries. The forward impact coefficient of the TCI is 3.19, which is a half of agriculture. Among the manufacturing industries, the forward economic impact coefficient of TCI is 4^{th}. But the primary valued-added of TCI is much higher than other industries, which is 3.7 times higher than food industry and 3.33 times higher than metal industry (this industry has the strongest forward impact in the manufacturing basket). So, we can conclude that the economic impact of the TCI on other sectors is not so effective as those of the other industries like food and agriculture. But the importance of the industry for the overall economic development is significant in terms of value-added, employment generation, export earnings, etc.

The sub-sectoral impact analysis finds that the input sharing among the sub-sectors is satisfactory. Yarn subsector is taking 36% intermediate inputs from cotton subsector, cloth milling (fabric) subsector is taking 36% intermediate inputs from yarn industry, handloom subsector is accepting 10% intermediate inputs from yarn subsector and 15% from dyes-chemical subsector, dyes and bleaching subsector receiving 38% intermediate inputs from cloth milling, woven subsector accepting 55% inputs from cloth milling, and knitting subsector is receiving 46% inputs from yarn subsector. So, sub-sectoral interrelations are good. But, the relationship with the other sectors is not satisfactory. Among the industrial sectors, the interconnection between trading and transport services with the TCI is mentionable.

When we discuss with the sub-sectoral input leakage, we find that woven subsector is accepting much imported inputs, specially woven fabric. The woven fabric production capacity is very poor in Bangladesh. Dyeing and bleaching subsector is also dependent on imported dyes chemical. Similarly, the yarn subsector is importing much cotton and fiber. According to IOT 2016, it also reveals that TCI is accepting inputs from agriculture (cotton and jute), wholesale trade, retail trade, and inland transport service sectors.

As a processing industry, the production process of TCI begins from cotton and fiber stage. Cotton and fiber belongs to agriculture and chemical sectors. If we can develop backward linkage with agriculture and chemical industries, the inter-industry connectivity will be sustainable. At present TCI accepts 0.09 unit from agricultural sector and 0.01 unit from chemical sector. This relationship can be improved by developing and diversifying the backward sectors, e.g., if Bangladesh can diversify the usage of jute, as jute is available and low-cost substitute of TCI's raw materials, the impact of TCI would be widened in the economic structure. An initiative in this regard has taken by the Government of Bangladesh. Three companies of Finland and Sweden are going to finish the work of scientific investigation, quality assessment, marketing process, and the feasibility of designing the factory to produce viscose[17] from jute (Akhter, 2018). In addition to agricul-

ture and chemical sectors, the government should try to build nexus among other industries for sustainable development of the overall economy reducing dependency on imports and diversifying export basket.

The backward economic impact of the TCI on the other industries is not so strong. Although BI coefficient is 3.16, the impact on other industries is only 0.69, the rest amount (2.47 units) of input is taken from itself (TCI's subsectors). Moreover, the import backward impact is also very high, thus TCI is also importing much of its inputs. So, based on this result, we recommend widening the base of inputs from the local industries, e.g., if local firms can be encouraged to produce chemicals-based inputs (synthetic fiber) and natural inputs (cotton), the TCI will be more dependable for the economy of Bangladesh.

As our analysis finds that the TCI is accepting inputs mostly from its subsectors (yarn, fabric, dyeing, clothing, etc.), it is important to improve the sub-sectoral input taking relationship. The sub-sectoral analysis suggests that it is important to reduce the import impact on woven and knit clothing, which are the finished output of the TCI and main export items. If we can improve the domestic input consumption, the unit production cost will be favorable for international competition. At present, the order-based manufacturers rely on the foreign importers. The foreign importers impose conditions to buy backward items from the nominated suppliers. This is one of the factors leading to use imported inputs by woven and knit clothing subsectors. Moreover, dyeing and bleaching subsector is also dependent on imported chemicals, as a result, our policy makers should concentrate on the local chemical production and development for TCI.

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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.

2) Here we define primary inputs as value-added. The sum of primary inputs and intermediate inputs is defined as total supply.

3) The earlier export item was jute-textile like sacks, carpets, etc. which were produced from

jute-processing. Nowadays the production and export of jute-textile have declined significantly. UNCTAD statistics in 2015 shows that Bangladesh exported Yarn for US$573 million against the import of US$1906 million, fabric for US$229 million against the import of US$5899 million but export and import of jute-textile is almost nil. So, today's textile industry means processing of yarn, fabric, etc. Whereas clothing industry means the production of apparel linked with textile-processing.

4) In this paper, we use industry and sector synonymously. The sector classification is available at Table A1 in the Appendix

5) See Temurshoev, Miller, & Bouwmeester (2013) for detailed mathematical derivation.

6) This IOT is constructed by Professor Bazlul Khondker of Dhaka University, Bangladesh.

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

8) When the IOT does not have separate import matrix (Z^m) and import is integrated with Z, the IOT is known as competitive IOT. The IOT framework shown in Figure 3 is a non-competitive IOT.

9) TCI is the top export earning sector and employs 5 million people, which is the largest industrial employer in Bangladesh (Masum, 2016).

10) We define magnitude as $\frac{BI_i}{BI_{TCI}}$, where BI_i indicates BI coefficients of every sector, and BI_{TCI} indicates the BI coefficient of TCI.

11) IOT 2012 is the only IOT which has subsector-classifications of the TCI. In this IOT, the TCI is further classified into handloom cloth, woven clothing, wet processing, knit clothing, yarn making, and cloth milling subsectors. All other tables used TCI as one sector. So backward impact of TCI means impact of TCI on other industries. But when I analyze backward impact using IOT 2012, this linkage reflects linkage with the subsectors also.

12) Calculated using $(I-A)^{-1}$ model, as in equation (4), which includes import repercussion and known as Leontief input-output model. This coefficient includes both domestic and import impact.

13) As IOT 2012 is a competitive import-type IOT, domestic BI is calculated using the $[I-(I-\widehat{M})A]^{-1}$ model, which excludes import repercussion, and is known as the competitive import type input-output model. To calculate domestic effect in non-competitive import-type IOT, we use equation (3).

14) Ready-made garments (clothing) manufactured in Bangladesh are divided mainly into two broad categories: woven and knit products. Shirts and trousers are the main woven products and undergarments, socks, stockings, T-shirts, sweaters and other casual and soft garments are the main knit products (Haider, 2007).

15) When the suppliers are selected and nominated by the buyer to supply intermediate goods related to the buying order (finished goods), these intermediate goods suppliers are termed as nominated supplier.

16) The primary inputs for the yarn, cloth milling, handloom, dyeing, woven, and knitting subsectors are 0.68 unit, 0.81 unit, 0.32 unit, 0.40 unit, 0.28 unit, and 0.40 unit respectively. the rest are intermediate inputs. The sum of primary input coefficient and intermediate input coefficient is one.

17) Viscose is a semi-synthetic fiber for yarn production

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Appendix

Table A1. Value-added (VA) share of the 35 sectors in 2016

Sector name	VA share
Agriculture, hunting, forestry and fishing	15.00%
Mining and quarrying	1.20%
Food, beverages and tobacco	3.10%
Textiles and textile products	11.20%
Leather, leather and footwear	0.70%
Wood and products of wood and cork	0.40%
Pulp, paper, printing and publishing	0.60%
Coke, refined petroleum and nuclear fuel	0.10%
Chemicals and chemical products	1.10%
Rubber and plastics	0.40%
Other non-metallic mineral	0.90%
Basic metals and fabricated metal	2.10%
Machinery, nec	0.60%
Electrical and optical equipment	1.00%
Transport equipment	0.30%
Manufacturing, nec; recycling	0.30%
Electricity, gas and water supply	1.00%
Construction	8.20%
Sale, maintenance and repair	0.10%
Wholesale trade	5.50%
Retail trade	9.40%
Hotels and restaurants	0.70%
Inland transport	8.20%
Water transport	0.60%
Air transport	0.10%
Auxiliary transport activities	0.30%
Post and telecommunications	1.50%
Financial intermediation	1.80%
Real estate activities	5.90%
Other business activities	0.50%
Public admin and defence; compulsory social security	2.80%
Education	2.70%
Health and social work	2.20%
Other community, social and personal services	6.50%
Private households with employed persons	3.30%

Source: Authors' calculation from input-output table

Table A2. Backward impact (BI) and forward impact (FI) coefficients of the 35 sectors in 2016

Sector Name	Total FI	Total BI
Agriculture, hunting, forestry and fishing	6.64	3.15
Mining and quarrying	2.56	2.86
Food, beverages and tobacco	3.16	3.56
Textiles and textile products	3.19	3.16
Leather, leather and footwear	2.46	3.40
Wood and products of wood and cork	2.26	3.26
Pulp, paper, printing and publishing	2.55	3.23
Coke, refined petroleum and nuclear fuel	2.39	2.55
Chemicals and chemical products	3.40	3.50
Rubber and plastics	2.21	2.91
Other non-metallic mineral	2.58	3.36
Basic metals and fabricated metal	4.78	3.44
Machinery, nec	2.18	2.66
Electrical and optical equipment	3.37	2.96
Transport equipment	2.80	2.98
Manufacturing, nec; recycling	2.74	3.12
Electricity, gas and water supply	2.25	2.72
Construction	2.74	3.23
Sale, maintenance and repair	2.04	3.00
Wholesale trade	4.01	2.46
Retail trade	5.13	2.42
Hotels and restaurants	2.22	3.51
Inland transport	4.13	2.62
Water transport	2.21	3.13
Air transport	2.13	3.47
Auxiliary transport activities	2.05	2.72
Post and telecommunications	2.80	2.63
Financial intermediation	2.99	2.69
Real estate activities	3.23	2.43
Other business activities	2.16	2.96
Public admin and defence; compulsory social security	2.34	2.80
Education	2.00	2.62
Health and social work	2.61	2.76
Other community, social and personal services	4.10	2.60
Private households with employed persons	3.05	2.57

Source: Authors' calculation from input-output table

Table A3. Sector specific backward impact (BI) and forward impact (FI) of the TCI in 2016

Sector name	Sectoral BI coefficients	Sectoral FI coefficients
Agriculture, hunting, forestry and fishing	0.09	0.00
Mining and quarrying	0.01	0.00
Food, beverages and tobacco	0.01	0.01
Textiles and textile products	2.47	2.47
Leather, leather and footwear	0.00	0.00
Wood and products of wood and cork	0.00	0.01
Pulp, paper, printing and publishing	0.01	0.07
Coke, refined petroleum and nuclear fuel	0.00	0.00
Chemicals and chemical products	0.01	0.02
Rubber and plastics	0.00	0.01
Other non-metallic mineral	0.00	0.06
Basic metals and fabricated metal	0.02	0.01
Machinery, nec	0.00	0.07
Electrical and optical equipment	0.01	0.04
Transport equipment	0.00	0.01
Manufacturing, nec; recycling	0.00	0.05
Electricity, gas and water supply	0.01	0.00
Construction	0.01	0.01
Sale, maintenance and repair	0.00	0.00
Wholesale trade	0.07	0.00
Retail trade	0.11	0.00
Hotels and restaurants	0.00	0.00
Inland transport	0.16	0.01
Water transport	0.01	0.05
Air transport	0.00	0.01
Auxiliary transport activities	0.00	0.01
Post and telecommunications	0.01	0.01
Financial intermediation	0.02	0.01
Real estate activities	0.02	0.02
Other business activities	0.00	0.05
Public admin and defence; compulsory social security	0.01	0.06
Education	0.00	0.04
Health and social work	0.01	0.05
Other community, social and personal services	0.04	0.01
Private households with employed persons	0.02	0.00

Source: Authors' calculation from input-output table