The role evolution of textile industry in China's economy during 2002–2020: an input-output analysis

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ABSTRACT – REZUMAT

The role evolution of textile industry in China's economy during 2002–2020: an input-output analysis

This paper uses the input-output (I-O) model to evaluate industry linkages and industry spread of China's textile industry (CTI) to investigate the role evolution of CTI in China's economy during 2002–2020. The research results show that: (1) the role of CTI in China's economy is on a declining trend and its share in the industrial sectors is shrinking; (2) CTI has long and high backward linkages with the upstream agriculture, chemistry and wholesale & retail and high forward linkages with the downstream garment, papermaking and culture, chemistry and health; these connections are becoming closer and closer; (3) the power of dispersion and the power of dispersion index of CTI has been greater than the sensitivity of dispersion and sensitivity of dispersion index for a long time; it indicates that CTI is still the sector that drives China's economic growth; (4) the final demand effect shows CTI has always been the most dependent on net exports, followed by consumption and investment and it's still an export-oriented industry. Finally, some relevant policy suggestions are put forward.

Keywords: *China's textile industry, role evolution, input-output model, industry linkage, industry spread*

Evoluția rolului industriei textile în economia Chinei în perioada 2002–2020: o analiză input-output

Această lucrare utilizează modelul input-output (I-O) pentru a evalua legăturile și răspândirea industriei textile din China (CTI), pentru a investiga evoluția rolului CTI în economia Chinei în perioada 2002–2020. Rezultatele studiului arată că: (1) rolul CTI în economia Chinei are o tendință de scădere și ponderea sa în sectoarele industriale este în scădere; (2) CTI a avut de multă vreme legături strânse cu agricultura, industria chimică și comerțul cu ridicata și cu amănuntul pe pieţele din amonte și legături strânse cu industria de îmbrăcăminte, fabricarea hârtiei și cultura, industria chimică și sănătatea pe pieţele din aval; aceste legături devin din ce în ce mai strânse; (3) puterea de dispersie și puterea indicelui de dispersie al CTI au fost mai mari decât sensibilitatea de dispersie și sensibilitatea indicelui de dispersie pentru o lungă perioadă de timp; aceasta indică faptul că CTI este în continuare sectorul care stimulează creșterea economiei Chinei; (4) influența cererii finale arată că CTI a fost întotdeauna cea mai dependentă de exporturile nete, urmată de consum și investiții și este încă o industrie orientată spre export. În cele din urmă, sunt prezentate câteva sugestii relevante privind politicile de dezvoltare.

Cuvinte-cheie*: industria textilă din China, evoluția rolului, model input-output, legătura dintre industrii, răspândirea industriei*

INTRODUCTION

The textile industry has been traditionally positioned as the pillar industry of China's national economy. It plays an important role in promoting economic growth, absorbing labour and expanding exports. In 2020, the prime operating revenue above the designated size of China's textile industry (CTI for short, hereafter) is approximately 2.35 trillion CNY. Textile enterprises directly employed about 2.86 million people and the exports amounted to approximately 280 billion USD. All the figures above show that CTI is the largest in the world. However, it should also be noted that although the gross output of CTI in 2020 increased nearly 4.35 times compared to 2001, its share in the industrial sectors fell from 5.76% in 2001 to 2.17% in 2020 and its ranking also dropped sharply from 5th to 16th. As a typical labour-intensive industry, the absorption of labour by CTI is also declining significantly. Until 2008, CTI has been the sector absorbing the largest labour in the industrial sectors, but its ranking has gradually dropped to the 9th by 2020. These evidences show that CTI is being overtaken by other industrial sectors and its position in the national economy is declining. So, what are the characteristics of the evolution of CTI's role in China's economy since the beginning of the 21st century? What's the impact of its role evolution on the national economic sectors? Answering these questions is essential to re-examine the role of CTI in China's economy and further promote the coordinated development of CTI and other sectors of the national economy.

In the early days of research on the role of an industry in the national economy, academics usually used indicators such as gross output, the number of employees etc. to conduct qualitative and descriptive analyses. With its continuous improvement, the input-output (I-O) method has been gradually applied

to study the role played by industry in the national economy. The I-O method was established by economist Leontief in the 1930s [1] to quantitatively analyse the inter-industrial relationship of a specific country or region. Now it's widely used to solve a variety of practical economic problems, such as economic planning and forecasting. When analysing the role of an industry in the national economy, industry linkages and industry spread are commonly used as measures. Industry linkages refer to the technological correlation between an industry and its upstream and downstream industries with various inputs and outputs as the connecting link. Industry spread is when a change in an industry causes a change in the industries associated with it. By evaluating industry linkages and industry spread of a specific industry, it is beneficial to analyse its operation status and role in the national economy and further formulate related industrial policies to promote the coordinated development of national economic sectors.

Considerable research has analysed the roles of different industries in the economy at national and regional levels. At the national level, Kwak [2], Morrissey [3] and Wan [4] investigated the role changes of the marine industry in the economies of South Korea, Ireland and China respectively. Khanal [5] studies the impact of the tourism industry on Laos' economy. At the regional level, San [6], Rong [7] and Kelly [8] assessed the industry linkages and industry spread of the mining industry of Region II in Chile, the maritime industry in Taiwan, China and the aerospace industry in Florida, USA respectively. In addition, there were also studies using I-O tables from multiple countries to perform international comparisons for specific industries. Huang [9] analysed and compared the industry linkages and industry spread of China's steel industry with Germany, Britain, Japan and the United States to study the change of their positions in national economies. Gaygysyz [10] conducted comparative research on different roles played by the marine industry in the national economies of Estonia and Finland. However, in the research of the textile industry, the I-O method has not been fully used. Existing research in this area was scarce and had many shortcomings. You [11] used input coefficients to analyse the industry linkages of China's textile and garment industry over the period 2002–2012. But You's study was not only flawed by incomplete selection of indicators and insufficient data timeliness, but also failed to conduct a separate study on the textile industry. Chang [12], Wang [13] and Zhang [14] studied industry linkages of CTI in 2005, 2010 and 2002–2012 respectively. However, these researches also suffered from a low number of indicators and poor data timeliness.

To bridge the gap, this paper uses 2002, 2007, 2012 and 2017 China Input-output (I-O) tables and the 2020 China I-O prolong table as the data source. The 2020 China I-O prolong table was published in 2022 and is the latest data available. This paper evaluates industry linkages and industry spread of CTI using the input-output (I-O) model to investigate CTI's role-play in China's economy and its evolution. The research is outlined as follows. First, this paper calculates the input and output coefficients of CTI to examine: (1) how much CTI is influenced by other sectors; and (2) how much impact CTI has on other sectors. Then it calculates the power of dispersion, sensitivity of dispersion and final demand effect of CTI to evaluate the industry spread of CTI. Finally, based on the first two parts of the study, this paper discusses the potential for implications from the results and some policy recommendations for the optimization and upgrading of CTI to promote the coordinated development of CTI with other national economic sectors.

METHODOLOGY AND DATA SOURCES

Methodology

Industry linkages

Industry linkages can be divided into backward linkage and forward linkage according to the production process. Backward linkage is to analyse the impact of a specific industry on those industries that supply it with products or services as their intermediate consumption from an input perspective. It's usually measured by direct input coefficient (a_{ij}) and its economic meaning is the value of product i consumed in the production of per unit product j. Based on the I-O table, it is calculated by dividing the transaction flows between sectors i and j (x_{ij}) by the total output of sector j (x_j). The direct input coefficient reflects the technological correlation between sectors i and j, measured by intermediate input. The larger the coefficient is, the tighter the correlation between these two sectors is. The calculation formula is as follows:

$$a_{ij} = \frac{x_{ij}}{x_j} \quad (i, j = 1, 2, ..., n) \tag{1}$$

Forward linkage is to analyse the impact of a specific industry on those industries that use the industry's products or services as intermediate inputs from an output perspective. It's commonly measured by the direct output coefficient (c_{ij}) and is calculated by dividing the transaction flows between sectors i and j (x_{ij}) by the gross output in sector i (x_i). The larger the coefficient is, the more intermediate products in sector i supplied to sector j are. The calculation formula is as follows:

$$c_{ij} = \frac{x_{ij}}{x_i} \quad (i, j = 1, 2, ..., n) \tag{2}$$

Industry spread

Industry spread is commonly analysed by the power of dispersion (PD) and power of dispersion index (PDI), the sensitivity of dispersion (SD), the sensitivity of dispersion index (SDI) and the final demand effect. PD refers to the impact on all the industries' gross output of the national economy when the final demand of a specific industry changes. It is calculated by the sum of every column of the Leontief inverse matrix, which reflects the demand for the gross

output of the national economy as the final demand of sector j increases per unit. The greater the PD of sector j, the more intermediate input to sector j is supplied from other sectors. PDI (r_j) is the ratio of PD of sector i to the average of all the sectors. The calculation formula is as follows:

$$r_j = \frac{\sum_{i=1}^{n} \bar{b}_{ij}}{\frac{1}{n}\sum_{j=1}^{n}\sum_{i=1}^{n} \bar{b}_{ij}} \quad (i, j = 1, 2, \ldots, n) \qquad (3)$$

SD refers to the impact on the gross output of sector i when each sector's final demand in the national economy changes. It is calculated by the sum of every row of the Leontief inverse matrix, which means the increase in the production of sector j as the final demand of each sector in the national economy increases per unit. The greater the SD, the more intermediate input to other sectors supplied from sector j. SDI (s_j) is the ratio of SD of sector j to the average of all the sectors. The calculation formula is as follows:

$$s_j = \frac{\sum_{j=1}^{n} \bar{b}_{ij}}{\frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{n} \bar{b}_{ij}} \quad (i, j = 1, 2, \ldots, n) \qquad (4)$$

Final demand consists of consumption, investment and net exports (the difference between exports and imports) according to I-O theory. Final demand effect refers to the impact of final demand on the gross output of sector i. It is generally measured by production induction and dependence coefficient. Production induction represents the production of sector i induced by consumption, investment and net exports. It can be obtained by multiplying each row of the Leontief inverse matrix with the final demand column:

$$X_i^M = \sum_{j=1}^{n} \bar{b}_{ij} Y_j^M \quad (i, j = 1, 2, \ldots, n; M = 1, 2, 3) \qquad (5)$$

X_i^M refers to the output of sector i induced by final demand M. Y_j^M refers to the value of final demand M of sector j. $M = 1, 2, 3$ represents consumption, investment and net exports respectively.

The dependence coefficient (DC_i^M) is the ratio of the output of sector i induced by final demand M to that of all the sectors and is calculated as follows:

$$C_i^M = \frac{X_i^M}{\sum_{j=1}^{n} X_i^M} \quad (i = 1, 2, \ldots, n; M = 1, 2, 3) \qquad (6)$$

Data sources

All the data used in this paper are obtained from 2002, 2007, 2012 and 2017 China (I-O) tables and the 2020 China I-O prolong table released by China's National Bureau of Statistics. The textile industry discussed in this paper refers to the textile industry defined by the national economy classification standard (GB/T 4754-2011), excluding the garment industry.

THE EVOLUTION OF CTI'S ROLE IN CHINA'S ECONOMY

Overall, CTI's role in China's economy shows a declining trend in the period of 2001–2020. In terms of industrial scale (figure 1), the gross output of CTI first grew from 540.1 billion CNY in 2001 to 4084.4 billion CNY in 2016, then began to decrease as the foreign demand for China's textile products weakened. It dropped to 2347.4 billion CNY in 2020 and is still nearly 4.35 times that of 2001. However, its share and ranking in the industrial sectors have been declining. Its share falls from 5.76% to 2.17% and its ranking drops significantly from 5th to 16th. In terms of employment (figure 2), the total number of employees of CTI grew from 3.01 million in 2001 to a maximum of 6.52 million in 2008 after China entered into WTO. Then it begins to decrease after the outbreak of the 2008 international financial crisis and CTI gradually optimizes industrial structure by eliminating outdated production capacity and industrial transfer. Its total number of employees dropped to 2.86 million in 2020 with a decrease of about 56.12%. Its share in the industrial sectors decreased from 7.84% to 3.69% and its ranking dropped from 1st in 2001 to 9th in 2020. In sum, until 2008, the gross output of CTI has been ranked around 7th in the industrial sectors and the number of employees has always been the

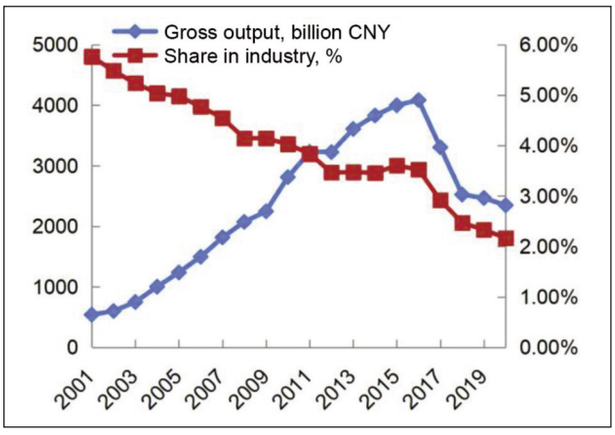

Fig. 1. CTI's gross output and its share in the industry

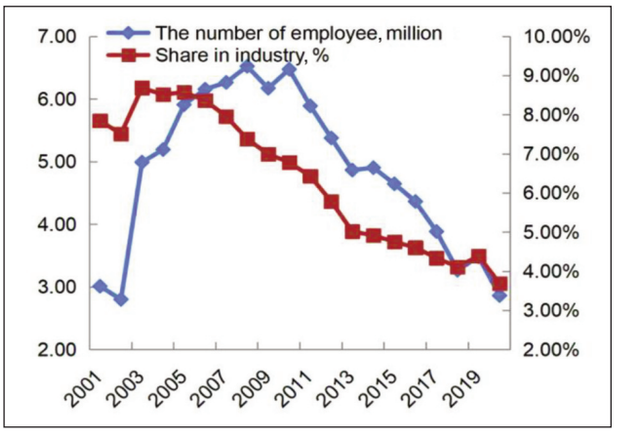

Fig. 2. CTI's employees and its share in the industry

largest. After that, both begin to decline gradually to 16th and 9th. It means that 2008 was the year when the role of CTI in the national economy changed significantly, which was largely related to the international financial crisis in 2008. Since then CTI has started industrial restructuring on a large scale, with the result that it has been continuously overtaken by other industrial sectors, both in terms of industrial scale and employment. As a result, the importance of CTI in the national economy is decreasing. And it is currently neither the sector that absorbs the most labour nor the main driver of national economic growth.

INDUSTRY LINKAGES OF CHINA'S TEXTILE INDUSTRY

Backward linkage

The top 5 sectors in the national economy that provide direct intermediate inputs for CTI are identified as shown in table 1. The sum of their direct input coefficients increased from 0.641 in 2002 to 0.746 in 2017, then decreased to 0.642 in 2020, indicating a fluctuant dependence of CTI on the top 5 sectors. In 2017 the top 5 were textile, agriculture, chemistry, post, information & software, which provided nearly 3/4 of the direct intermediate inputs for CTI's production. What's more, CTI has long maintained a higher backward linkage with itself, agriculture and chemistry during 2002–2020 and their direct input coefficients have always been in the top 3. The coefficient of CTI itself is always the largest, showing that the textile industry is the most dependent on its intermediate products. The reason is that the rapid development of manufactured textiles has increased the demand for intermediate products of CTI. For example, manufactured textiles consumed 33% of total fibre output in 2020, which exceeded household textiles (27%). The coefficients of agriculture and chemistry have always ranked 2nd and 3rd. This is because they provide the main raw materials such as natural fibre, chemical fibre and printing and dyeing agents for the production of CTI. It is worth noting that the coefficient of power, on the other hand, decreased from 0.022 (the 5th) in 2002 to 0.0001 (the 35th, not listed in table 1) in 2020. It implies that CTI has made significant improvements in energy saving and the restriction of power on CTI has been greatly weakened.

Forward linkage

The sum of the direct output coefficients of the top 5 sectors gradually increased from 0.650 in 2002 to 0.690 in 2020 (table 2). It shows that the intermediate products of CTI are increasingly supplied to these sectors and the technological links between CTI and the top 5 are becoming stronger. Textile, garment, papermaking & culture and health are always among the top 5 sectors between 2012 and 2020. It means that textile products mainly flow into these downstream sectors and they have an increasing restriction on CTI's development. The coefficient of the garment had been rising from 0.210 in 2002 to 0.291 in 2020, which revealed that CTI was increasingly dependent on garments. The coefficient of papermaking & culture continuously increased from 0.013 (the 7th) in 2002 to 0.027 (the 3rd) in 2017, which showed that papermaking and culture were consuming more and more textile products. The increasing coefficient of health also indicates a growing demand for textiles. These are all beneficial to the development of CTI.

INDUSTRY SPREAD OF CHINA'S TEXTILE INDUSTRY

Power of dispersion and sensitivity of dispersion

The PD, PDI, SD and SDI of CTI all rose first and then fell throughout 2002–2020 (table 3). This means that both the pulling effect of CTI on China's economy and that of China's economy on CTI show an inverted U-shaped trend of growth followed by decline. In 2020, the PD and SD of CTI ranked 9th and 12th in the industrial sectors respectively, slightly higher than their share rankings. In contrast, except for 2012, the PD and PDI of CTI have been greater than the SD and SDI for a long time. It suggests that the pulling effect of CTI on China's economy is always stronger than that of China's economy on CTI. So it can be concluded that although the share and ranking of CTI in China's economy are gradually declining, it's still an important supporting industry that drives the growth of China's economy.

Table 1

DIRECT INPUT COEFFICIENT OF CTI DURING 2002–2020 (TOP 5 SECTORS)

Sectors	2002	Sectors	2007	Sectors	2012	Sectors	2017	Sectors	2020
Textile	0.339	Textile	0.383	Textile	0.410	Textile	0.374	Textile	0.354
Agriculture	0.133	Agriculture	0.144	Agriculture	0.176	Agriculture	0.185	Agriculture	0.121
Chemistry	0.105	Chemistry	0.120	Chemistry	0.099	Chemistry	0.111	Chemistry	0.088
Wholesale & retail	0.042	Power	0.023	Information & Software	0.037	Post	0.039	Agricultural service	0.045
Power	0.022	Garment	0.017	Water	0.019	Information & Software	0.036	Wholesale & retail	0.035
Total	0.641	Total	0.686	Total	0.742	Total	0.746	Total	0.642

Table 2

DIRECT OUTPUT COEFFICIENT OF CTI DURING 2002–2020 (TOP 5 SECTORS)

Sectors	2002	Sectors	2007	Sectors	2012	Sectors	2017	Sectors	2020
Textile	0.339	Textile	0.383	Textile	0.410	Textile	0.374	Textile	0.354
Garment	0.210	Agriculture	0.074	Garment	0.286	Garment	0.350	Garment	0.291
Other social services	0.042	Chemistry	0.049	Chemistry	0.040	Papermaking & culture	0.027	Shoe	0.017
Public administration	0.039	Water	0.024	Papermaking & culture	0.031	Chemistry	0.017	Health	0.015
Other manufacturing	0.019	Garment	0.023	Health	0.009	Health	0.015	Culture	0.013
Total	0.650	Total	0.554	Total	0.776	Total	0.784	Total	0.690

Table 3

THE PD, PDI, SD AND SDI OF CTI DURING 2002–2020

Indicator	2002		2007		2012		2017		2020	
	Value	Ranking	Value	Ranking	Value	Ranking	Value	Ranking	Value	Ranking
PD	3.024	10	3.563	10	3.491	14	3.363	9	3.320	9
PDI	1.198	10	1.214	10	1.182	14	1.235	9	1.187	9
SD	2.938	14	3.355	13	3.562	13	3.019	12	2.965	12
SDI	1.164	14	1.143	13	1.206	13	1.109	12	1.081	12

Final demand effect

The production induction of consumption, investment and net exports all showed a growing trend from 2002 to 2020 (table 4), suggesting that the pulling effect of final demand on CTI is increasing. The production induction and dependence coefficient of net exports have always been the largest, followed by consumption and investment. This is also in line with the current situation that CTI is still an export-oriented industry. Meanwhile, it should also be noted that the dependence coefficient of net exports shows a slight decline, implying that CTI is gradually becoming less dependent on exports. The dependence coefficient of consumption fluctuates around 0.38, which means that only 38% of CTI's output flows into consumption. So under the background of the global spread of COVID-19 and US-China trade friction, with exports showing a certain degree of contraction, actively expanding domestic consumption is of great significance for optimizing CTI's demand structure and developing the domestic market is also vital for the future development of textile enterprises. The dependence coefficient of investment has always been minimal, indicating that the textile industry is the least dependent on investment and investment plays a minor role in driving the development of CTI.

Table 4

THE FINAL DEMAND EFFECT OF CTI DURING 2002–2020

Year	Final demand	Production induction	Dependence coefficient
2002	Consumption	429	0.383
	Investment	78	0.069
	Net exports	614	0.548
2007	Consumption	445	0.360
	Investment	91	0.074
	Net exports	700	0.566
2012	Consumption	475	0.373
	Investment	65	0.051
	Net exports	732	0.576
2017	Consumption	494	0.375
	Investment	80	0.061
	Net exports	743	0.564
2020	Consumption	537	0.377
	Investment	94	0.066
	Net exports	794	0.557

Note: The unit of production induction is billion CNY.

CONCLUSIONS & POLICY SUGGESTIONS

This paper uses the I-O model to evaluate industry linkages and industry spread of the textile industry to investigate its role evolution in China's economy from 2002–2020. The research results are as follows:

The role of CTI in China's economy is in a downward trend and its share in the industrial sectors is also shrinking. In terms of industry linkages, CTI has long maintained high backward linkages with the upstream agriculture, chemistry and wholesale & retail and high forward linkages with the downstream garment, papermaking and culture, chemistry and health. And these connections are becoming closer and closer. It reveals the proper operation of these sectors is increasingly important for the development

of CTI. In terms of industry spread, the power of dispersion and power of dispersion index of CTI has been greater than the sensitivity of dispersion and sensitivity of dispersion index for a long time, which indicates that the pulling effect of CTI on China's economy is always stronger than that of China's economy on CTI. CTI still drives the growth of China's economy. The estimate of the final demand effect shows CTI has always been most dependent on net exports, followed by consumption and investment and it's still an export-oriented industry.

Therefore, it should be fully recognized that although the importance of CTI in China's economy is declining, it still drives China's economic growth. The findings also suggest we should always put more emphasis on the close cooperation between CTI and its upstream and downstream key sectors, such as agriculture, chemistry, garment, papermaking and culture and health. Further, it is also important to actively expand domestic consumption, reduce the dependence on exports and optimize the demand structure so that CTI will play a better role in promoting the coordinated development of China's economy.

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