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Analysis of Technical Complexity and Trade Structure of China's Export Trade Products

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Abstract

Based on the latest trade statistics, this paper analyzes the technical complexity, comparative advantage and trade structure of China's exports from 2000 to 2019. Using the technology complexity index and revealed comparative advantage index, this paper measured the technology complexity of China's export trade products, analyzed the structure of China's export trade, and compared the comparative advantage in the world market. It is found that the height of China's overall export structure has increased, the proportion of products with medium technological complexity in China's export products has increased and the competitive advantage has been enhanced, but the export trade of products with high technological complexity is still at a low level.

Keywords

Export Trade; Technical Complexity; Comparative Advantage; Trade Structure.

1. Introduction

According to the traditional statistics of total trade value, the proportion of products with high technical complexity in China's export is increasing, the technology upgrade of export products is obvious, the export structure is constantly optimized, the technical complexity of export products is significantly increased, and the technical complexity of export products exceeds its income level (Rodrik, 2006; Schott, 2008). The technical complexity and upgrading of China's trade export has always been a hot and controversial issue. Therefore, scientifically and reasonably measuring the technical complexity of trade export becomes the key to answer this question. For China, by actively participating in the global value chain and international product division and vigorously developing export industries, will the technical complexity of China's export products be increased? Has China's overall export structure been improved and upgraded? What are the similarities and differences between the technological changes in China's exports and those in other countries? What is the comparative advantage of China's export products in the international market? On this basis, this paper tries to use the technology complexity index and the revealed comparative advantage index to measure the technical content of China's export trade, and analyzes the overall structure height of China's export trade.

2. Organization of the Text

2.1. Literature Review

Fruitful researches have been done by scholars on the technical content measurement of export trade products. Ricardo Hausmann (2003) first proposed the use of complexity index to measure the technical content of exported trade goods. Lall, Weiss and Zhang (2006) believe that the higher the average income level of exporting countries, the higher the complexity and high-tech degree of exported products. Hausmann, Hwang and Rodrik (2007) revised the export complexity index and proposed that the explicit comparative advantage of each country's export products should be taken as the weight, so as to avoid overestimating the role of "big trading country" and ignoring the problem of "small trading country". Scholars have

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calculated the technological content of China's exports, and there are obvious differences in the research conclusions. One view holds that the technological content of China's exports has significantly improved in the past 10 years, even reaching the level of developed countries (Rodrik 2006, Yang and Yao 2008, Zhang 2015) is not obvious (Xu 2011). Ni (2017) believes that the technological content, domestic technological content and domestic technological content index of China as a whole and in various industries all show an upward trend, showing a weak convergence trend to the average level of developed countries.

There are many researches on export comparative advantage in international trade theory, most of which focus on a certain aspect that reflects export comparative advantage. It can be divided into two categories: one is to measure a country's export comparative advantage based on the content of trade elements and HOV theorem. Such literature, on the one hand, explains the comparative advantage of a country's export through the contribution value of domestic factors to trade (Vanek 1968, Trefler et al 2010). On the other hand, a country's export comparative advantage is examined through the change of technological content of exported products. The higher the technical level of general export products, the higher the added value of export products, and vice versa. Studies in this aspect mainly reflect a country's export comparative advantage by measuring the export technology structure or related indicators (Lall 2006, Fan et al 2006, Du et al 2007, Hausmann et al 2007, Yao et al 2008, Wei et al 2011, Wang 2017). Relevant research results show that compared with countries with similar income, China's export technology structure is rapidly upgrading, and the complexity of export technology is also rising rapidly, and the level is even close to that of developed countries, which may form wage competition for the employment of middle and high skilled workers in European and American countries (Rodrik 2006, Schott 2008). However, such studies ignore the import intermediate input contained in export products, which may overestimate the complexity of China's export (Koopman et al 2012).

The second type of literature mainly analyzes the comparative advantage of export based on the background that product production participates in the international division of labor. This kind of literature either analyzes the export comparative advantage of a certain production link and different products in a country from the perspective of intra-product division of labor (Feenstra et al 2012), or studies the export comparative advantage of a country from the perspective of added value of export products. The literature used corporate and microdata to analyze a country's comparative advantage in exports (Upward et al 2013, Zhang et al 2013, Kee et al 2016), measurement results of such studies are prone to errors due to inconsistent decision-making of enterprises for various production activities. Another research idea of this kind of literature is to use the input-output table to calculate the industrial correlation degree between departments, so as to calculate the proportion of the export sector using foreign input, so as to measure the comparative advantage of the export sector. This kind of literature mostly inherits the vertical specialization method proposed by Hummels et al. (2001). Representative studies include Johnson and Noguera (2012), Li et al. (2013), Koopman et al. (2014) and Wang et al. (2015).

In general, there are many literatures on the measurement of technical content and export comparative advantage of China's export trade products, but the existing literatures still have some deficiencies in the following three aspects. First of all, most of the literature on product classification has strong subjectivity and capriciousness, this will cause the incomparability of export structure in time, and the existing literature is mostly according to the classification standard of a fixed commodity can be divided into several categories, often ignore the product technical complexity over time, thus ignoring the products divided into types according to the technical complexity of dynamic change. Secondly, most of the existing literature only studies export trade from the perspective of measuring technological complexity or comparative advantage, but does not combine the two. In view of the shortcomings of the existing literature,

ISSN: 2688-9323

the research on China's export trade structure and comparative advantage mainly focuses on the following three points. First of all, this paper adopts the classification criteria used by Fan et al. (2006) and Du et al. (2007) in the analysis of China's export technology structure, so as to overcome to some extent the subjectivity and randomness in the process of product classification and ensure the realization of dynamic product classification. Secondly, this paper combines technological complexity index and comparative advantage index to analyze China's export trade situation more comprehensively. Finally, using the latest trade data, this paper studies the technological complexity and its change of China's exports from 2000 to 2019.

3. Classification Methods of Indicators, Data and Products

3.1. Index System

3.1.1. Complexity Index of Export Technology

In this paper, the export Technology complexity Index (EXPY) modified by Hausmann, Hwang and Rodrik (2007) is adopted to measure the technology content of China's exports. The specific calculation formula is as follows:

$$prody_{jk} = \sum_j \frac{(x_{jk}/x_j)}{\sum_j (x_{jk}/x_j)} y_j \tag{1}$$

$$expy_i = \sum_k (x_{jk}/x_j) prody_{jk} \tag{2}$$

Formula (2) suggests that a country's manufacturing technology complexity index is the country's export all technical complexity index of the weighted average of the export products, the weight is the proportion of the export scale of various export products of the country in the total export scale of the country, in which a country's exports the product with high technical complexity, the more the greater the $expy_i$ value, out of the country, the higher the technical complexity of exported products.

3.1.2. Comparative Advantage Index

This paper selects the revealed comparative advantage index to measure the comparative advantage of China's export products. Display comparative advantage index is a classic index used to measure comparative advantage of products, and its expression can be written as:

$$RCA_{ij} = \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}} \Big/ \frac{\sum_{i=1}^{n} x_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{m} x_{ij}} \tag{3}$$

In Formula (3), i represents country(region), j represents product, and RCA represents the displayed comparative advantage of export products. x represents the export value of the corresponding product, x_{ij} is Export data under the added value statistical caliber, and the calculation of this data needs to be obtained after processing the export data under the current related environmental statistical aperture, where $i = 1,2,\ldots n, j = 1,2,\ldots,m$; $\sum_{j=1}^{m} x_{ij}$ represents the total export value of country i; $\sum_{j=1}^{m} x_{ij}$ represents the world's total exports. RCA usually takes 1 as the critical value. When the index is greater than 1, it indicates that the corresponding export products have comparative advantages. When it is less than 1, it indicates that the export products have comparative disadvantages.

ISSN: 2688-9323

3.2. Data

According to the calculation formula of technical added value of various products mentioned above, the original data used in this paper include: The export trade volume of 260 products priced in US dollars under the standard three digit (rev.3 SITC, digit-3) level revised by the United Nations Standard Classification of international trade for the third time in 2000-2019, the volume of exports of 260 products in US dollars from 2000 to 2019,the per capita GDP in US dollars of 130 countries in the same period, and China‘s exports of various products at the SITC triple-digit level. These data are respectively from the WDI database of the World Bank and the United Nations Commodity Trade Statistics Database. The GDP data of China used in analyzing the impact of structural changes of export trade on China‘s economic growth comes from the website of The National Bureau of Statistics of China (http://www.stats.gov.cn).

3.3. Method of Product Classification

In this paper, the export technology complexity index modified by Hausmann, Hwang and Rodrik (2007) is selected as the index reflecting the technical content of products. The product classification method proposed by Du et al. (2007) is used to divide the above products into 5 categories according to the technical complexity. They are high technical complexity products, medium high technical complexity products, medium technical complexity products, medium low technical complexity products and low technical complexity products. Because the technical complexity of the final product varies from year to year, products can be dynamically classified by technology category. It can be seen that the products involved in the classification themselves contain many segmented products, and the technical complexity of the segmented products contained in these categories also varies. At the same time, the classification method does not distinguish between the level of technology needed to produce different products in different regions. To overcome these problems, it is necessary to classify the original data in more detail or study with microscopic data, but it is still difficult to obtain relevant data. Nevertheless, the classification method in this paper can still play a certain reference role in understanding China's export comparative advantage and export structure.

4. Measure of Technical Complexity of China's Export Trade Products

By using formula (1) and (2) and the classified data of export trade products and per capita GDP data of 130 sample countries worldwide, the technical complexity and growth rate of China's export trade products from 2000 to 2019 are obtained, as shown in Figure 1. As can be seen from Figure 1, from 2000 to 2016, except for a slight decline in 2009 and 2013, the technical complexity of China's export products continued to increase. The technical complexity of China's exports declined from 2017 to 2018 due to trade frictions between China and the US, but recovered in 2019. Meanwhile, from 2010 to 2017, the growth rate of technological complexity of China's export products had a certain downward trend, but increased sharply after 2018. This was largely influenced by the 2008 financial crisis. Measure results show that the change trend of China's export trade product technology content and its growth rate of the evolution of the trend is not the same, in order to further explore the internal structure of China's export trade product technology content, this paper will use display technology comparative advantage index to measure the comparative advantage of China's export products in the international market.

ISSN: 2688-9323

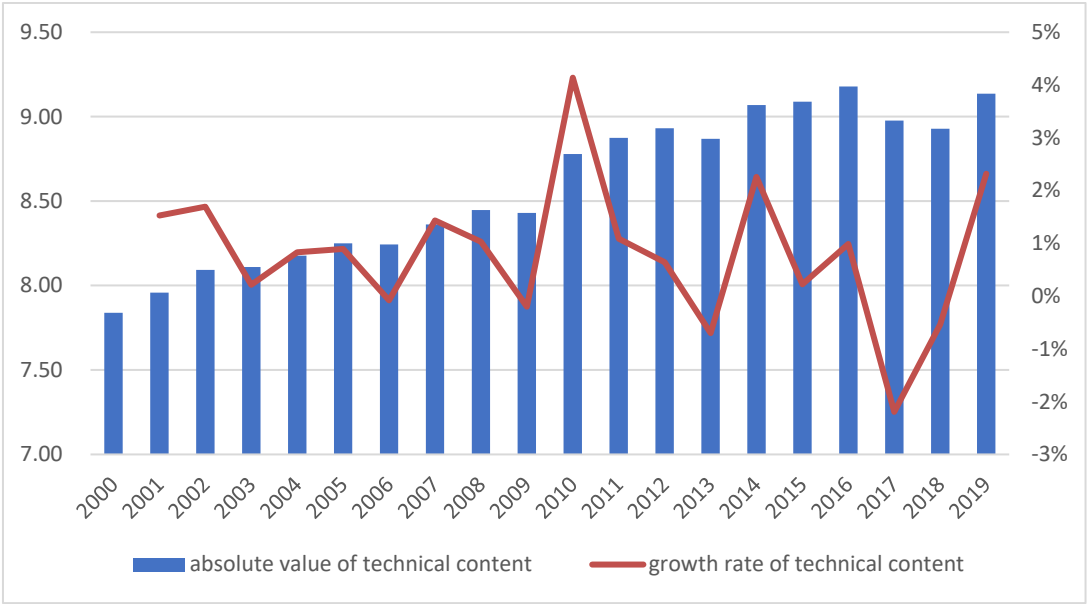

Figure 1. Absolute value and growth rate of technological complexity change of China's manufacturing export

5. Comparative Advantage Analysis of China's Export Products

5.1. Comparative Advantages of China's Export Products in the World Market

Table 1. The distribution of comparative advantage of China's export products in the world market in 2019

Product category	RCA≤1	1<RCA≤2	2<RCA≤3	RCA>3	World ranking
high technology	transport aviation	paper industry machinery			84
medium high technology	measurement / control applications	wire	television receiver		25
medim technology	steam / steam turbine	circuit equipment	sanitary / down / thermal holder	stroller / toys / games / sports	12
medium low technology	iron / reinforcement / bar / etc.	office / stationery supply	tableware / women's wear	ceramics	32
low technology	fuel wood / charcoal	waste materials and accommodation	box	silk/knitting/ crochet fabric	8

The 258 products exported from China in 2019 were arranged according to the calculated technological complexity from low to high, and divided into 5 groups on average, which were respectively defined as high technology complexity group, medium high technology complexity group, medium technology complexity group, medium low technology complexity group and low technology complexity group. Table 1 shows the distribution of comparative advantage of China's export products in the world market in 2019. In 2019, 103 of the 258 products that China exported had a comparative advantage (RCA>1), accounting for nearly 40 percent of its total exports. 25 products had strong comparative advantage (2<RCA≤3); Thirteen products had significant comparative advantages (RCA>3).

ISSN: 2688-9323

In 2019, China's export comparative advantage products are mainly concentrated in low, medium low and low technological complexity products. Among them, the most representative export products are those with traditional advantages, such as textile and garment manufacturing products with low technical complexity, tableware, pottery with medium low technical complexity, toys with medium technological complexity, etc. Since the reform and opening up, this kind of products are mostly centered on the processing trade led by foreign investment. A large amount of labor is used in the production process, and they are in the low-tech processing and assembly link in the production and processing process, and at the middle and low end of the "smile curve". Export products mainly rely on low price competition, so as to gain a comparative advantage in export volume. At present, our country's export product advantage has to move from low end to high end trend.

5.2. The Distribution and Changes of China's Comparative Advantage in the World Market

Table 2 lists the distribution of China's export products showing comparative advantage in the world market in 2000 and 2019.

Table 2. Distribution and change of Comparative advantage of China's export products in the world market

Year	Product category	RCA≤1	1<RCA≤2	2<RCA≤3	RCA>3	Total products
2000	high technology	34	5	5	5	49
	medium high technology	35	9	4	6	54
	medium technology	27	8	4	4	43
	medium low technology	25	6	3	8	42
	low technology	41	7	8	14	70
2019	high technology	39	3	0	0	42
	medium high technology	35	7	7	0	49
	medium technology	31	18	6	2	57
	medium low technology	16	16	8	8	48
	low technology	34	21	4	3	62
	total	155	65	25	13	258

Compared with 2000, 103 of the 258 products exported by China in 2019 had a comparative advantage (RCA>1), an increase of 7 products compared with 2000. The number of products with strong comparative advantage (2<RCA≤3) was 25, 1 type more than 2000. The number of products with significant comparative advantage (RCA>3) was 13, 24 less than that in 2000. This is mainly due to the aging of China's population structure and the gradual disappearance of demographic dividend. Products that used to have strong advantages are gradually losing their advantages, which should be taken seriously. Compared with 2000, the proportion of products with RCA value less than 2 in export comparative advantage products has decreased. In addition, in terms of the types of technological content of products with comparative advantage, the proportion of products with low technological complexity is the first and the proportion of products with medium technological complexity is the second among 103 export products with comparative advantage, breaking away from the pattern of products with comparative advantage dominated by products with low technological complexity in 2000. But the proportion of products with high technology complexity has declined since 2000. The proportion of products with medium technical complexity increased compared with 2000, while the proportion of products with high technical complexity decreased compared with

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2000. This shows that while the original demographic dividend advantage is lost, China has not been able to quickly find its own new advantage products.

6. Analysis of the Trade Structure of China's Export Products

6.1. Changes in the Height of the Export Trade Structure

This paper uses the height index of product technology structure proposed by Du et al. (2007). The change of the height index over time reflects the upgrading and changing trend of the technology structure of export trade of an economy compared with other economies. This index excludes the technological structure upgrading caused by the common technological progress of the world, so as to more accurately measure the changing trend of the technological structure of an economy's export trade.

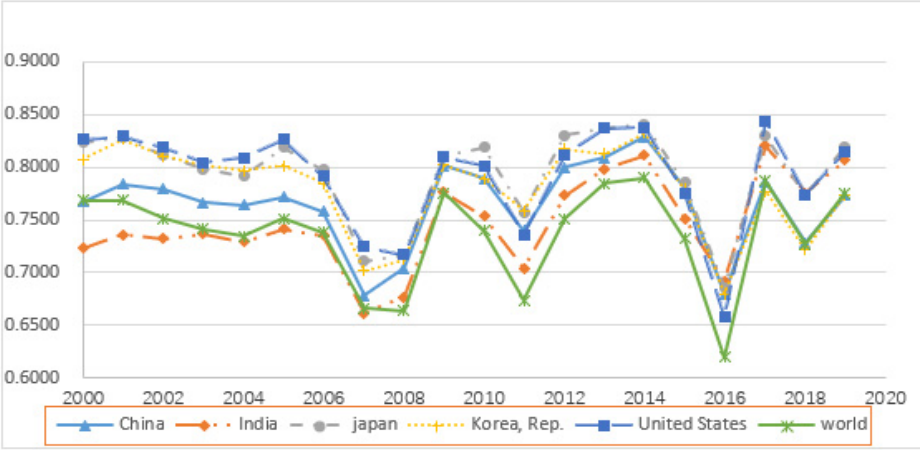

Figure 2. Changes in structural sophistication index of countries, 2000-2019

According to Figure 2, on the whole, the height of China's export trade products to the world has changed significantly, which is mainly reflected in gradually exceeding the world average level and narrowing the gap with developed countries. In comparison with the height of export trade structure of other countries in the world, it is found that the change of China's export trade structure is slightly behind the average level of the world, and the range of change is greater than that of developed countries. This reflects that China is still in the stage of catch-up, but it is trying to adjust its product trade structure, and has achieved a certain practical effect.

6.1.1. Comparison with Other Countries' Export Product Structure to the World

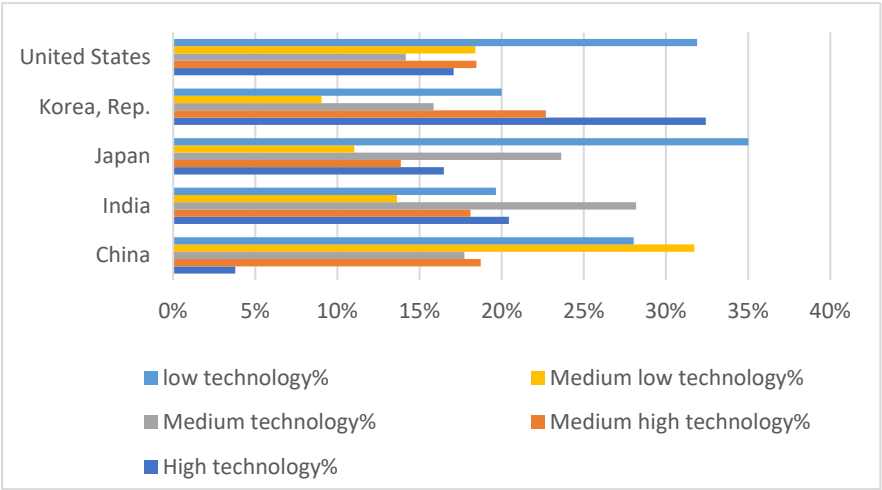

Figure 3. Comparison of export structure in the world market by country in 2019

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Focus on China's export trade product technology content change trend can not accurately reflect the status of China's export trade in the international market competition, therefore, this paper compares the technical complexity of China's exports with developed countries, such as United States and Japan, the BRICs countries, such as India, typical countries and east Asia, southeast Asia, such as South Korea. It is found that the proportion of high-tech products exported by China in domestic products is still at a low level, not only falling behind the major developed countries, but also behind India. The export proportion of high-tech products is too low, and even there is a fault. At the same time, the proportion of China's export of high and medium technology products is equal to that of medium technology products, and the proportion of China's export of low and medium technology products ranks first among the above countries. There are two main reasons for this situation: first, major developed countries gradually shift the processing and assembly links of manufacturing industry to China and other developing countries with relatively low prices of factors of production, which is not conducive to the optimization of industrial structure of developing countries; Second, the technological blockade of high-tech products from major developed countries to developing countries further restricts the research and development of high-tech products in China.

7. Conclusion

Through the analysis of the export comparative advantage and export structure of 258 types of products exported in China, the following basic conclusions are drawn in this paper:

From 2000 to 2016, except for a slight decline in 2009 and 2013, the technical complexity of China's export products continued to increase. The technical complexity of China's exports declined from 2017 to 2018, but resumed rising in 2019. Meanwhile, from 2010 to 2017, the growth rate of technological complexity of China's export products had a certain downward trend, but increased sharply after 2018.

In the world market, compared with 2000, the types of products with comparative advantages in China will increase in 2019, but the types of products with significant comparative advantages decreased from 37 in 2000 to 13 in 2019. The products with comparative advantages are mainly products with low technical complexity, products with medium low technical complexity and products with medium technical complexity. The distribution of products with comparative advantages in China among products with different technical complexity is more reasonable. From 2000 to 2019, the comparative advantage of products with medium technical complexity is increasing, and the proportion of products with comparative advantage is increasing, but the comparative advantage of products with high technical complexity is still at a low level, or even decreased. The proportion of products with comparative advantages, especially those with high technical complexity, needs to be improved.

From 2000 to 2019, the height of the product structure of China's export trade to the world has changed significantly, mainly by gradually exceeding the world average level and narrowing the gap with developed countries. In comparison with other countries in the world in the height of export trade structure, it is found that the proportion of high-tech products exported by China in domestic products is still at a low level, not only behind the major developed countries, but also behind India. At the same time, China's exports of high - and medium-technology products account for the same proportion.

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ISSN: 2688-9323

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