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Study the impact of major industries' export on carbon emissions in China

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ABSTRACT

Studying the impact of foreign trade on carbon emissions and solving the contradiction between trade and environment in the process of economic development in China, both have the important strategic significance for China to speed up the construction of resource saving and friendly environmental society. The factor decomposition method was used in this paper, which chose three time point data of year 2003, 2007 and 2011. The method was applied to quantitative analysis and the impact of major industries' export on carbon emissions from three levels of scale effect, structural effect and technological effect. It proved that the scale effect and the structural effect on the export trade in carbon emissions are positive, but the technological effect is negative in the first calculation period. However, the three effects are all negative in the second calculation period.

KEYWORDS

Industries; Export; Carbon emission.

INTRODUCTION

Since the reform and opening policy began in China, the amount of foreign trade had a rapid development, especially after joined the World Trade Organization, amount of exports rises at an annual rate from 20% to 30%, which has made an important contribution to the economical development in China. However, with the rapid development of exports, the energy consumption in China is also growing, which causes the sharply rising carbon emissions, the environmental pollution is becoming more and more serious and even deteriorate the global ecological environment. Energy saving, environmental protection and the rational use of natural resources have become the focus in international society. According to the international energy agency estimation, the carbon dioxide emissions in China could exceed the United States to become the largest mission country in the world in 2025. So in recent years, the relationship between China's foreign trade and carbon emissions problem is becoming a focus of research scholars at domestic and abroad. China, as a trading power and carbon emissions country, is facing the enormous international pressure in energy saving and emission reduction. From the existing research on the impact of export trade on carbon emissions, the conclusion is that export trade is the assignable factor to make the increase of carbon emissions. High carbon economy for China's economic and social sustainable development brings severe challenges, while low-carbon economy has become the inevitable choice in the process of economic development. It has positive practical significance to analyze the relationship between foreign trade and carbon emissions and to explore a new ways for China to reduce emission.

Foreign scholars studied the export trade's impact on environment. Grossman & Krueger[1](1991) earliest used a general equilibrium model of trade and environment, and did the research of effects of trade on the environment of the North American Free Trade Area. They decomposed the trade's impact on the environment into three aspects which were scale effect, structure effect and technology effect. The trade liberalization reduced environmental pollution in developed countries, but increased environmental pollution in developing countries, and the total pollution may be increased. Tolmasquim & Machado[2](2003)studied the Brazil implicit carbon emissions of import and export trade, pointed out that it would cause tremendous effect to its environment if a country changes its economic structure to energy-intensive structure. In Brazil, there is a close relationship between the changes of energy-intensive trade with the increase of carbon emission in 1990s. Export of energy-intensive products lead to Brazil's carbon emissions increased by 7.1%. Shui & Harriss[3](2006)estimated that in China, 7% ~ 14% of the carbon emissions is due to the exports to the United States. China's export trade made benefit for United States to reduce energy consumption, but it greatly increases the global carbon emissions. Ferda Halicioglu[4](2009)showed that the development of bilateral trade between the two countries made a significant impact on the increase of carbon dioxide emissions.

Domestic scholars' research is mostly on the basis of foreign research results, and the study can be summed up in two kinds. First kinds use the econometric method from the macroscopic level to test the relationship between China's export trade and the carbon emissions. Second kinds use the Factor decomposition method from the microscopic industry level to compare and analyze, in order to investigate the effect of foreign trade on carbon emissions.

In view of the existing domestic and abroad literature, most of the research on export trade impact on environment is limited to the macro perspective. It is rare to base on the different angles of industry with the econometric analysis. And it is still uncertain about how does the export trade affect the carbon emission. There for this paper uses the factor decomposition method with the export trade data of the main industries in three time points in 2003, 2007 and 2011 and builds a variable coefficient fixed effects model to quantitatively measure Chinese main industry export trade's influence on carbon emissions through three levels of scale effect, structural effect and technological effect. Hereby put

forward countermeasure and suggestion to achieve the coordinated development goals between "twelfth five-year" carbon reduction and the development of foreign trade in China.

MODEL AND DATA PROCESSING

Model

Factor decomposition analysis is a very effective tool to research the side effects of economic activity to the environment, whose theoretical background is comparative static analysis. It can clearly investigate the root of research object changes and calculate the influence degree of the basic factors to the changes of the object because of the change of a factor to cause the change of the object in the condition of other conditions unchanged. Refer to the research achievement of Joseph[5](2002),carbon emissions caused by export trade can be specified as follow:

$$C = \sum_{i=1}^{n} S_i X E_i \quad (1)$$

Where C indicates the total carbon emissions caused by export trade of Beijing. S_i indicates K sector exports accounted for the proportion of total exports in Beijing, reflecting the export structure. E_i indicates the carbon intensity of k sector, reflecting the technology progress. X indicates total exports, reflecting the scale of export trade

$$C' = \sum_{i=1}^{n} S_i' X E_i + \sum_{i=1}^{n} S_i X E_i' + \sum_{i=1}^{n} S_i X' E_i \quad (2)$$

Equation (2) on the left shows the changes of carbon emissions caused by the export, and on the right, the first shows the structure effect of export trade in Beijing, which means that the changes in carbon emissions caused by the change of export structure under the condition of the immutability of total exports and carbon intensity of departments. The second is the technical effect; it shows the change of carbon emissions caused by the changes of carbon emissions intensity of departments in the case of the immutability of total exports and export structure. The third is the scale effect, which presents the changes of carbon emissions caused by total exports under the condition of the invariable of the export structure and carbon intensity of departments.

Data sources and processing

The added value of industrial divisions, divisions of energy consumption and the total export trade data are obtained from the China Statistical Yearbook in 2004, 2008 and 2012. Divisions export trade data comes from China industrial economic statistical yearbook. It should explain that in this paper the export trade of large and medium-sized industrial enterprises was chosen as the divisions export trade. In order to eliminate the influence of price factors, this paper uses the consumer price index and producer price index minus the value of export trade and the data of industrial added value. In the light of the statistical caliber inconsistent and availability of data, the paper uses the classification method of Zhang Xiaoping for reference, which adjusts and merges Chinese major industrial classification into 14 kinds of industry.

Measurement of industry carbon emissions

In order to calculate the carbon intensity of the main industry, and then calculate the technical effect of carbon emissions influenced by the export trade, it is necessary to get the data of each industry carbon emissions. As shown in equation (3), the calculation formula is adopted in this paper to estimate

the carbon dioxide emissions of major industry in primary energy consumption activities through the primary energy consumption and the coefficient of carbon emissions:

$$C = E_{Coal} \times F_{Coal} + E_{petroleum} \times F_{petroleum} + E_{gas} \times F_{gas} \quad (3)$$

where c indicates Industry carbon emissions, E indicates primary energy consumption (coal, oil, natural gas) in industry and F indicates coefficient of carbon emissions of primary energy. It can be determined that the coefficient of carbon emissions of coal, oil and gas energy F is 0.728, 0.728 and 0.549.

FACTOR DECOMPOSITION ANALYSIS OF THE INFLUENCE OF THE EXPORT TRADE TO THE CARBON EMISSIONS

Structure effect

According to the calculation method of model (2), the main industry of export quotas varied in 2007 relative to 2003 and in 2011 relative to 2007, then multiplied the industry's carbon emissions in 2003 and 2007. Summing up it can get the changes of carbon emissions due to changes in export structure of the main industries in the two calculation period of 2003-2007 and 2007-2012. The calculation results are shown in TABLE 1.

TABLE 1 : Share of exports and structural effect in 2003-2007

Industry classification	Export market share (%)		The structure effect	
	03	07	Share changes (%)	Changes in emissions of carbon (10000 tons)
Coal, oil and natural gas industry (1)	0.54	0.29	-0.25	-2699.28
Metal, non-metallic mining industry (2)	0.12	0.03	-0.09	-59.9013
Metal products industry (3)	1.61	1.85	0.24	36.108
Metal smelting and rolling processing industry (4)	1.54	3.32	1.78	21006.23
Non metallic mineral products industry (5)	0.67	0.81	0.14	1146.11
Shoes and clothing manufacturing, feather and leather products industry (6)	4.03	2.99	-1.04	-142.002
Chemical raw materials and products and pharmaceutical manufacturing industry (7)	2.04	2.19	0.15	1403.31
Paper printing and stationery manufacturing industry (8)	1.46	1.33	-0.13	-181.494
The textile industry (9)	3.95	2.47	-1.48	-1536.27
The transportation equipment manufacturing industry (10)	2.09	3.51	1.42	721.5588
Food, beverage and tobacco products (11)	0.48	0.43	-0.05	-47.375
Rubber and plastic products industry (12)	1.78	1.76	-0.02	-5.957
Electrical machinery and equipment manufacturing industry (13)	4.03	5.00	0.97	115.3233
Communication and other electronic equipment manufacturing (14)	21.23	26.84	5.61	383.6679
total				20140.03

It can be seen in TABLE 2, that the great changes of the export commodities structure have been taken place in China in the first calculation period. Through the above analysis, it can be seen that the industry structure of export trade in our country is in the transitory stage that from the textile industry to mechanical and electrical products and high-tech products industry.

TABLE 2 : Export share change and the structure effect from 2007 to 2011

Industry classification	Export market share (%)		The structure effect	
	2007	2011	Share changes (%)	Changes in emissions of carbon (10000 tons)
1	0.29	0.10	-0.19	-2509.39
2	0.03	0.01	-0.02	-11.6138
3	1.85	1.58	-0.27	-52.9173
4	3.32	2.35	-0.97	-17810.1
5	0.81	0.86	0.05	627.7015
6	2.99	3.13	0.14	30.5606
7	2.19	2.71	0.52	6194.328
8	1.33	1.36	0.03	75.0567
9	2.47	2.57	0.1	174.429
10	3.51	4.97	1.46	819.425
11	0.43	0.50	0.07	85.3839
12	1.76	1.97	0.21	92.0976
13	5.00	6.45	1.45	154.5555
14	26.84	29.30	2.46	274.29
total				-11856.19

It can be seen from the data in TABLE 3, industry export share is growing rapidly in the industry of transportation, equipment manufacturing, electric equipment and machinery manufacturing, also the communications equipment and other electronic equipment manufacturing industry. This is mainly due to gradual development of the export of the mechanical and electrical products and high-tech products over the years, which results in the carbon increment, respectively for 8.19425 million tons, 1.545555 million tons and 8.19425 million tons. The structure effect is negative. It shows that this calculation period, China always insists on putting capital and technology intensive industries as the mainly export structure, and takes the reducing the exports of the resource-intensive products as the main direction of optimizing the structure of export industries.

Combined with the two phase calculation, China initially established the consciousness of industrial carbon emissions, but the effect is not obvious in the first calculation period. While in the second calculation period, the major industry has basically realized the changes to the new high-tech product export structure, and achieved significant results in carbon emission reduction.

Technological effects

Carbon emission intensity is also called the carbon intensity, refers to the carbon dioxide emissions to the unit of gross domestic product (GDP). The index is mainly used to measure the relationship between a country's economy and the carbon emissions. It means that the country achieves a low carbon development if a country’s carbon dioxide emissions brought about by per unit of gross domestic product (GDP) is in the fall with the development of the economic at the same time. In view of the research object

of the paper is the main industry, carbon intensity here refers to carbon dioxide emissions contained in the unit industrial added value. According to the computing method of model (2), combined the industry exports with the change quantity of carbon intensity of the major industries in the two periods, multiplied the both and added totally. Then the technology effect of the influence that the export of the major industry made on carbon emissions was achieved. The result is shown in TABLE 4.

TABLE 3 : Carbon intensity and technology effect from 2003 to 2007

Industry classification	Carbon intensity (10000 tons / billion yuan)		The effects of Technology	
	2003	2007	Carbon intensity variation (10000 tons / billion yuan)	Changes in emissions of carbon (10000 tons)
1	2.087	1.112	-0.975	-191.1
2	1.043	0.289	-0.754	-34.01
3	0.097	0.051	-0.046	-26.93
4	1.090	0.563	-0.527	-295.23
5	3.246	2.364	-0.882	-215.83
6	0.053	0.043	-0.01	-14.62
7	1.092	0.651	-0.441	-327.04
8	0.626	0.569	-0.057	-30.28
9	0.234	0.221	-0.013	-18.64
10	0.054	0.031	-0.023	-17.47
11	0.185	0.137	-0.048	-8.38
12	0.139	0.102	-0.037	-23.90
13	0.023	0.008	-0.015	-21.96
14	0.005	0.004	-0.001	-7.70
Total				-1233.08

From carbon intensity data in TABLE 4, in year 2003-2007 and 2007-2011, the two calculation period, the larger carbon emissions intensity industries are coal, oil and natural gas mining industry, metal smelting and rolling processing industry, non-metallic mineral products industry, chemical materials and products and paper printing and stationery manufacturing industry, these high carbon emission industries are resource intensive processing and manufacturing industries. By the end of the second period, the 14 major industries in carbon intensity level 13 industries has been reduced to 10000 tons / billion Yuan, shows that China's energy-saving technological progress, the industry won a good reduction effect, some of the industry such as carbon emissions intensity of all types of machinery, equipment and equipment manufacturing the industry has been close to 0 tons / billion Yuan.

CONCLUSIONS AND SUGGESTIONS

Export trade has promoted rapid economic growth, on the other hand also led to large increases in carbon emissions, causing damage to the environment. Factor decomposition was used to analyze the effects of carbon emissions on the export of industry from three aspects. Several important conclusions have been concluded. In 2003-2007 and 2007-2011 two calculation periods, the export scale is the main factor affecting the variation of carbon emissions. In the first calculation period, the scale effect of export trade on carbon emissions is positive, structure effect, technical effect is negative, in second during the period, the scale effect of export trade on carbon emissions is negative, negative structure

effect, and technical effect is negative. Energy saving emission reduction technology is the key factor affecting the carbon emissions increase or decrease, adjust the export structure make it turn to clean is the inevitable choice for promoting carbon reduction. Therefore, our country in the precondition of the development of foreign trade, want to make the industry export and carbon emission reduction targets are compatible, which makes the foreign trade and the coordinated development of environmental protection, the key to make efforts in the structure effect and technology effect.

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