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LETTERS TO THE EDITOR

The Effect of the Implied Carbon Emissions of International Trade under the Division of Value Chain

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In the context of the value chain division of labor, taking the international import and export trade volume and carbon emission data from 2005 to 2010 as a sample, estimating the carbon emissions of international trade by estimating the carbon intensity of the sector, and conducting LMDI on the net transfer of implied carbon in international trade. break down. The study found that between 2005 and 2010, the carbon emission intensity of various departments in China was significantly higher than that of foreign counterparts. The implied carbon emissions of international trade mainly came from the chemical industry, metal industry and machinery and equipment manufacturing sectors. International trade has reduced global carbon emissions by 209.38-306.03 million tons. This paper not only provides a theoretical basis for the implied carbon emissions of international trade from the perspective of the sector, but also provides environmental support for the further development of international trade from the perspective of global carbon emissions.

Value chain division; international trade; implied carbon emissions

1 INTRODUCTION

With the rapid development of economic globalization, international trade has grown rapidly. Due to differences in international division of labor, industrial structure, energy efficiency and trade structure, the transfer of implied carbon emissions from international trade has aroused widespread concern in the international community. In the form of trade, a country or region not only meets its own needs, but also carbon emissions for the needs of other countries or regions. As a "world processing factory", China has surpassed the United States to become the world's largest carbon emitter. Study the problem of implied carbon emissions in international trade, measure the implied carbon emissions of trade, analyze the carbon emission direction of international trade and its impact on global carbon emissions, optimize the structure of import and export products, reduce energy consumption, and promote global carbon emission reduction. Has important practical significance.

Na Bian, Hongwei Yu published an article in Ekoloji (Issue 107, 2009). The title is: "How does Energy Endowment and Technological Progress Affect Carbon Emission Intensity? —An Empirical Analysis Based on China's Yangtze River Economic Zones" (Bian and Yu 2019). Based on the provincial panel data of 11 provinces (cities) in the Yangtze River Economic Zone from 1997 to 2015, this paper analyzes the effects of energy endowments, technological advances and their interactions on carbon intensity using a fixed-effects model. The following results are obtained: technological advancement has an inhibitory effect on carbon emission intensity, and energy endowment contributes to carbon emission intensity. And the inhibition of the former is stronger than

the promotion of the latter.

Lei (2017) provides useful inspiration for international trade adjustment and CO2 reduction by quantitative analysis of implied carbon emissions from international trade. This paper mainly includes the following aspects: Firstly, the research ideas, research contents and research methods of this paper are proposed. Secondly, in the basic part of the implied carbon theory of international trade, it mainly introduces the origin of the study of trade implied carbon, defines the concept of implicit carbon, and elaborates on the use of new methods in the current calculation of implicit carbon in international trade. Introduction. Then, the article analyzes the high implied carbon emissions of the development characteristics of international trade and the intensity of carbon dioxide emissions. This article is of great significance for seeking a balance between international trade and reducing carbon dioxide emissions, but the data lacks scientific calculations and needs further verification; Kang (2016) combs the concept of implicit carbon and its origins, and summarizes the commonly used implicit carbon accounting methods: the emerging non-competitive model and the new additional trade statistics perspective input-output model. It summarizes three basic carbon emission responsibility sharing mechanisms: producer responsibility system, consumer responsibility system and shared responsibility system, which reveals the irrationality and future efforts of the current internationally recognized producer responsibility system. The feasibility of the scheme is verified in principle, but no follow-up research is carried out, and there are drawbacks of small application scope.

2 IDEA DESCRIPTION

2.1 Research review

The problem of implied carbon emissions in international trade has become a hot topic in academic research. The focus of research is mainly on the calculation methods of implied carbon emissions: one is to use the input-output method, and the other is the life cycle assessment method. The method of measuring the implied carbon emissions of trade used the input-output model to calculate the carbon emissions of Brazil in import and export trade (Hannum et al. 2017). It was concluded that the implicit carbon in Brazil's non-energy products exports was 13.5 million tons in 1995, while the implied carbon in imports was 9.9 million tons. Therefore, Brazil is a net exporter of implied carbon. Peters and Hertwich used the input-output model to measure the proportion of Norwegian import and export products' implicit carbon in their domestic emissions. They believe that carbon calculation methods based on consumption principles rather than production principles can better solve the carbon emissions brought by international trade. Yan and Yang used the input-output method to measure the implied carbon emissions of China's trade. The results show that the implied carbon of China's export products accounted for 10.03% – 26.54% of China's annual carbon emissions in 1997-2007, while the imported implied carbon was in 1997, it only accounted for 4.4%, accounting for 9.05% in 2007. China's export trade increased world carbon emissions by 48.94 million tons between 1997 and 2007. Muñoz and Steininger used a multi-regional input-output model to measure Austria's global carbon emissions responsibilities. The results show that Austria's carbon emissions based on consumption principles are much larger than those based on production principles, and need to rethink existing the impact of the principle of measurement on the allocation of carbon emissions. On the basis of using the input-output method to measure the implied carbon emissions of trade, more and more scholars pay attention to the implicit carbon emissions of bilateral trade. Rhee and Chung used the 1990 and 1995 international input-output data to calculate the carbon emission shift between Korea and Japan by expanding the input-output model. The study found that Korea has more energy-intensive industrial structures than Japan. South Korea has a comparative advantage in emissions-intensive products. Pretis (2016) found that US-Japan trade reduced US carbon emissions by 14.6 million tons, Japan's carbon emissions increased by 6.7 million tons, and global carbon

emissions decreased by 7.9 million tons, resulting in the need for tax or other policies. To regulate carbon emissions. (Azadbakht et al. 2017) used traditional input-output methods to estimate the impact of Sino-Japanese trade on carbon emissions, and also believed that Sino-Japanese trade is conducive to reducing global carbon emissions. Li and Hewitt's research suggests that Sino-British trade has reduced UK carbon emissions by 11%, while global carbon emissions have increased by 117 million tons, leading to the conclusion that international trade may increase global carbon emissions. Similar studies, such as Guo et al., based on the input-output model, measured the impact of Sino-US trade on domestic and global carbon emissions in 2005, and found that Sino-US trade reduced US carbon emissions by 190.13 million tons, while global carbon emissions It has increased by 515.25 million tons.

In summary, it can be found that the current research on the implicit carbon emissions of international trade mainly adopts the input-output method. The research on the implicit carbon emissions of bilateral trade is mainly based on the total amount research, and less detailed research by sub-sector. Based on the relevant literature, this paper estimates the implicit carbon emissions in international trade from a sectoral perspective, analyses the direction of the transfer of implicit carbon emissions in international trade and its impact on global carbon emissions, and analyses the reasons for the net transfer of implicit carbon emissions in international trade.

2.2 Research methods and data sources

Based on the input-output model and the data of international import and export trade and carbon emissions from 2005 to 2010, this paper calculates the implicit carbon emissions in international trade by estimating the intensity of sector carbon emissions, and decomposes the implicit carbon net transfer in international trade by LMDI.

①Estimation of Sectoral Carbon Emission Intensity

In order to measure the intensity of sector carbon emissions, this paper introduces an effective tool to evaluate the hidden energy or pollution in goods and services from a macro perspective: input-output model. This model was proposed by Walsi Lyontiv in the 1930s. It has been widely used to estimate the emissions of energy, carbon dioxide and other pollutants in international trade. Its advantage is that it can calculate the direct or indirect carbon emissions of any product or sector in its production process.

②Measurement of Implicit Carbon Emissions in International Trade

Carbon emissions come not only from the final manufacturing process of export (import) products, but also from every process related to the production and transportation of these products. The implied carbon emissions of export (import) products in each sector are equal to the output of the sector multiplied by the total carbon emission intensity of the sector.

2.3 LMDI Decomposition of Implicit Net Carbon Transfer in International Trade

A country or a region imports and exports products with different implied carbon content, will form a net carbon transfer. When the implied carbon of a country or region's export products is greater than that of its import products, the country or region will have a net carbon inflow; otherwise, a net carbon outflow. According to the method of net transfer of carbon emissions, the net transfer of implicit carbon emissions in international trade is decomposed into scale effect, structure effect and technology effect, in order to further analyze the reasons for the transfer of implicit carbon emissions in international trade.

The international input and output data used in this paper are from the OECD, and the international trade data comes from the China Trade Foreign Economics Statistical Yearbook. China's sectoral and total energy consumption data comes from the China Energy Statistics Yearbook, and foreign sector and total energy consumption data comes from the "Foreign Energy Authorities" website (Falahatkar et al . 2016). China's energy carbon emission coefficient is taken from the National Greenhouse Gas Inventories Guidelines published by the

IPCC in 2006. The coefficients are calculated according to IPCC2006. China's energy calorific value comes from the IPCC, and the energy value of foreign countries comes from the "Foreign Areas" 1999 Energy Statistics Manual. Since the sectoral classification of the input-output table is inconsistent with the classification of the energy consumption sector and the customs HS department, this paper integrates all the data of the international trade involved into 13 departments.

3 RESULTS

Based on the international input-output table and the international import and export trade volume and carbon emission data from 2005 to 2010, this paper uses the above-mentioned research method to measure the implied carbon emissions of international trade and further develop according to the LMDI decomposition method. 3. Analyze the reasons for the implied carbon emissions transfer in international trade (Busari et al. 2016).

①International sector carbon emission intensity carbon

Emission intensity refers to the carbon emissions per unit of GDP, which is mainly used to measure the relationship between economic growth and carbon emissions. In general, carbon intensity declines as technology advances and economic growth. Comparing the carbon intensity of various international departments, it is known that China's average total carbon emission intensity is 356,300 tons of carbon per 10,000 US dollars of exports, while foreign countries only have 19,100 tons of carbon. China's average carbon emission intensity is 19 times that of foreign countries. This reflects that China still has a large gap with foreign countries in terms of energy efficiency and production technology.

②Implied carbon emissions from international trade

From the perspective of sectoral implied carbon emissions, the international trade sector and total implied carbon emissions: from 2005 to 2010, China's exports to foreign regions accounted for 43.79% - 51.98%, 13.15% - 29.74%, 10.97% - 19.01% and 82.61% - 85.6% of the total carbon emissions from sectoral 9, 10.15% - 29.74% and 6 respectively; from the imports of foreign regions, China's carbon emissions from sectoral 9 accounted for about 82.61% - 85.6%. 39.96% - 43.75% of the emissions, 27.62% - 33.29% in sector 6, 10.64% - 17.69% in sector 8, and 86.27% - 88.53% in three sectors. Among these three sectors, the high carbon emission intensity is the main reason for China's higher hidden carbon export to foreign regions, while the larger trade volume is the main reason for China's higher hidden carbon import from foreign regions. 2. In 2005-2010, international trade reduced global carbon emissions by 20938.3-306033,000 tons. It can be seen that international trade plays a positive role in reducing global carbon emissions. Therefore, from the perspective of reducing global carbon emissions, international trade in general helps to reduce global carbon emissions.

③Reasons for Net Transfer of Implicit Carbon Emissions in International Trade

In order to analyze the reasons for the net transfer of implicit carbon emissions in international trade, this paper decomposes the net transfer of implicit carbon in international trade (Table 1).From Table 1, we can see that in 2005-2010, in addition to the impact of the financial crisis in 2009, the decrease of international trade volume led to the decrease of net carbon transfer, and the net carbon transfer in China's trade showed an upward trend. In terms of scale effect, China is in a trade deficit position in international trade, with negative net exports and net carbon transfer. In terms of structural effect, the structural effect of implied net carbon transfer in China is positive in 2005-2010, which indicates that carbon content in export products is higher than that in import products, and net carbon transfer is not significant in international product structure. From the perspective of technology effect, the technology effect of implicit net carbon transfer in China is significantly positive, which indicates that the unit carbon intensity of export products is higher than that of imported products of the same kind, and net carbon transfer. In a word, the net carbon transfer in international trade is greatly affected by scale effect and technology

effect, while the structural effect is relatively small.

Table 1 Net Carbon Transfer Decomposition Implicit in International Trade (10,000 tons)

Particular year	Net carbon transfer	scale effect	structure effect	Technical effect
2005	5201	-4284	156	9425
2006	6874	-5000	328	11692
2007	7685	-5915	364	13526
2008	8736	-5862	351	14523
2009	6125	-4722	30	10698
2010	9521	-6458	188	15472

4 DISCUSSION

Under the background of value chain division of labor, the direct and total carbon emission intensity of major international sectors is calculated by constructing input-output model, and the net carbon transfer implied in international trade is decomposed. The following important conclusions and enlightenments are obtained: First, the carbon emission intensity of China's sector is significantly higher than that of corresponding foreign sectors. This shows that foreign regions have higher production technology and energy efficiency, and China has great potential in reducing carbon emission intensity. Secondly, the hidden carbon emissions in international trade mainly come from chemical industry, metal industry and machinery and equipment manufacturing industry. The main reason for the high implicit carbon emissions from imports from foreign countries is the huge trade volume, and the high carbon emission intensity is the main factor for the high implicit carbon emissions from exports to foreign countries. From the sectoral point of view, the control of carbon content in international trade should start from these three sectors, improve their production technology, reduce their carbon emission intensity, adjust and optimize product structure, and promote low-carbon import and export products. Third, international trade has reduced global carbon emissions. In 2005-2010, international trade reduced global carbon emissions by 209383-306033,000 tons, and international trade played an important role in reducing global carbon emissions. Fourthly, scale effect and technology effect have greater impact on net carbon transfer implied in international trade, while structural effect has less impact. The decomposition of implicit net carbon transfer in international trade shows that net exports and technology level are the main factors of implicit net carbon transfer in international trade. This study shows that it is unreasonable for producers or consumers to undertake emission reduction obligations. To reduce global carbon emissions, it is necessary to establish a carbon emission responsibility system based on the joint responsibility of producers and consumers.

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