Does Chinese Industries' Status in GVC Affect Its Carbon Emission Intensity?

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Abstract. Recently the division of labor, caused by economic globalization, makes big difference to the whole world economy. The traditional inter-industry division gradually transfers to intra-industry division during one certain production process. Developing countries have to face serious environmental problems and pressure of huge carbon emissions. Based on literatures about GVC and carbon emission intensity, this paper chooses 38 industries as research sample and uses data from 2004 to 2014 to measure the annual carbon emission intensity and index of GVC status of different Chinese industries. Finally, we found that the higher the index of GVC status, the lower the carbon intensity. TIFA is negatively correlated with carbon emission intensity, while adjusting energy consumption structure and increasing FDI in high-carbon industries are beneficial to reduce the carbon emission intensity.

Introduction

With the deepening of economic globalization and international division of labor, the participation of developing countries in global industrial competition and cooperation has brought about not only the rapid economic development but also the rising level of domestic carbon emissions and environmental pollution. Under the background of advocating green economy and sustainable development worldwide, it is urgent to alleviate domestic carbon emissions and realize the transformation and upgrading of industries and the whole economy. As the second largest economy in the world, China's participation in the global value chain has undergone a typical process of initial participation in a passive mode, gradual involvement in an active mode, coexistence of two modes of participation and their changing proportions and fluctuations in the status of international division of labor.

Based on relevant literatures and empirical studies about global value chain and carbon emission intensity at home and abroad, this paper calculates the annual carbon emission intensity and its global value chain status of 38 subdivision industries. Further, we empirically studied the influence of the position of industries in global value chain on the carbon emission intensity and puts forward carbon emission reduction strategies of our country from the perspective of global value chain and industrial upgrading. This research can help decision-makers to examine the characteristics of carbon emission intensity of various industries from macro perspective, which is helpful to promote green development and solve outstanding environmental problems.

The Model

According to existing researches, carbon emission intensity of different industries can also be affected by many factors, such as energy structure, technological level, industrial scale and industrial openness. According to the theory of global value chain, the higher the position of the industry in the value chain, the more dependence on technology and capital elements, thus the carbon emission level is relatively low. Therefore, we comprehensively consider a series of control factors and construct the following measurement model:

$$Y_{it} = \alpha + \beta * GVC_{it} + \gamma * X_{it} + \varepsilon_{it} \quad (1)$$

Y_{it} is the carbon emission intensity of industry i at the t period, GVC_{it} is the global value chain

status index. In addition, X_{it} refers to six other control variables: the proportion of coal in the energy consumption of various industries (ES), representing the energy structure; Industrial cost and expense margin (RPCE), indicating the economic benefits of the industry; The social fixed assets investment (TIFA) in different industries represents the construction scale and usage direction of the fixed assets in the industry; Foreign direct investment (FDI) reflects the openness of the industry; Industry R&D investment (R&D), reflecting the industry's technical level; And the producer price index (PPI) of industrial commodities, reflecting the price level.

(i) Measurement of carbon emission level of different industries

Carbon dioxide emissions mainly comes from natural emissions and artificial emissions. According to statistics, more than 95% of carbon dioxide emissions are from human activities, namely artificial emissions, while industrial activities account for an absolute proportion of man-made emissions. Therefore, this paper focuses on the measurement of carbon emission in coal, oil, natural gas combustion and industrial production processes in China.

The general formula for calculating carbon emissions is as follows: $C_i = \alpha M + \beta S + \gamma T$. C_i refers to the total amount of carbon emissions, α, β, γ represent the carbon emission conversion coefficient of coal, oil and natural gas consumption, M,S,T respectively represent the total consumption of coal, oil and natural gas. According to the carbon emission decomposition model and the optimized calculation formula of carbon emission in different industries:

$$C_n = \sum C_i = \sum \frac{E_i}{E} \times \frac{C_i}{E_i} \times E = A_i \times S_i \times E \tag{2}$$

Where C denotes carbon emissions, n denotes industry, E denotes the total energy consumption of a certain industry, i denotes the type of energy, A_i denotes the proportion of total energy i consumption of a certain industry in total energy consumption, S_i denotes the carbon emission intensity of class i energy.

(ii) Measurement of Global Value Chain Index

According to the status of global value chain put forward by Koopman (2010), comparing a country's exports and imports of intermediates in a certain industry can measure the industry 's position in global value chain. The specific formula is as follows:

$$GVC\_position_{xn} = ln\left(1 + \frac{IV_{xn}}{E_{xn}}\right) - ln\ \left(1 + \frac{FV_{xn}}{E_{xn}}\right) \tag{3}$$

$$GVC\_participation_{xn} = \frac{IV_{xn}}{E_{xn}} + \frac{FV_{xn}}{E_{xn}} \tag{4}$$

Where, IV_{xn} refers to the indirect domestic added value of n industry in x country. This indicator measures how much added value is included in the intermediate product export of n industry in x country, which is processed by one country and exported to a third country. FV_{xn} means the added value of foreign products contained in the final products exported by n industry in country x, namely, the value of foreign intermediate products included in the final products exported by n industry of country x; E_{xn} refers to export added value of n industry in country x.

Empirical Analysis

According to the estimation results in table 1, we can find that the parameter of the global value chain status index (GVC) and energy consumption structure (ES) don't change the sign or significance due to the different control variables, showing strong robustness. Based on this, the following two conclusions can be drawn.

Table 1. Full Sample Regression Results

Variable	Model 1	Model 2	Model 3	Model 4
GVC	-0.0823** (0.0357)	-0.0780** (0.0346)	-0.0772** (0.0354)	-0.0749** (0.0350)
ES	0.1361*** (0.0332)	0.1745*** (0.0330)	0.1777*** (0.0341)	0.1711*** (0.0338)
TIFA	-0.1433*** (0.0438)	-0.1327*** (0.0425)	-0.1341*** (0.0427)	-0.1310*** (0.0423)
R&D	0.0075 (0.0291)	-0.0256 (0.0289)	-0.0261 (0.0290)	-0.0194 (0.0288)
FDI		1.1620*** (0.2252)	1.2022*** (0.2476)	1.2504*** (0.2457)
RPCE			0.0014 (0.0035)	-0.0001 (0.0035)
PPI				2.0099*** (0.6714)
_cons	1.1617*** (0.3034)	1.1812*** (0.2942)	1.1681*** (0.2964)	-8.2304*** (3.1530)
N	418	418	418	418
R2	0.0847	0.1329	0.1327	0.1418

Notes: *** p<0.01, ** p<0.05, * p<0.1

Firstly, the global value chain status index of various industries is negatively correlated with carbon emission intensity. The industry's higher status in global value chain means its production stage can create more added value and the corresponding carbon emission intensity is relatively low. The proportion of coal consumption, reflecting the energy structure, has a significant positive impact on carbon emission intensity. Compared with clean energy such as solar energy and wind energy, the carbon emissions brought by fossil energy have a greater influence on environmental pollution. In addition, the higher the PPI and TIFA, the higher the carbon emission level, which indirectly indicates that China's pre-project participation in the global value chain is still in the basic processing link.

Secondly, there is a significant positive correlation between industry’s openness and carbon emission intensity. In other words, the more open the industry, the higher carbon intensity. According to the trend of "world factory" transforming from China to southeast Asia, production cost is an important factor of location choice of foreign direct investment. Used to be "workshop of the world", China’s low environmental standards and cheap labor attracted the pollution-intensive industries of developed economies, which made China a "pollution paradise". Recently, many scholars proved the "pollution haven" effect in China using provincial panel data, empirically analyzed that "pollution haven" effect exists and has a certain lag. With the strengthening of China's environmental regulation and industrial structure transfer, "pollution haven" effect will be enhanced. Besides, the relationship between industrial R&D investment (or RPCE) and the carbon emission level is not significant.

Table 2. Fixed Effect Model Regression Results

variable	high emission industry (N=110)		low emission industry (N=308)	
	Coef.	S.E	Coef.	S.E
GVC	0.1007*	0.0565	-0.1288***	0.0410
ES	0.1453***	0.0370	-0.0505	0.0659
RPCE	0.0028	0.0154	0.0033	0.0039
TIFA	-0.1266**	0.0531	-0.1393**	0.0612
FDI	0.0436	0.3896	2.0270***	0.3205
R&D	-0.0110	0.0538	-0.0552	0.0348
PPI	0.0831	1.0102	2.5243***	0.7991

Notes: *** p<0.01, ** p<0.05, * p<0.1

Considering that carbon emission intensity of various industries has great differences, in order to further reflect the industrial differences of the impact of global value chain status on carbon emission intensity, this paper divides the sample into high-emission industries and low-emission industries according to the carbon emission intensity index. Regression results separately are shown in table 2.

It revealed that for high carbon emission industries, the global value chain position of the industry has a significant positive relationship with the carbon emission intensity at significance level of 10%. As developed economies continue to shift their development model towards high-tech, low-emission industries, developing countries are gradually becoming the main force in labor-intensive and resource-intensive industries with high energy consumption and pollution. Besides, the energy structure is positively correlated with carbon intensity, while TIFA is negatively correlated with the carbon emission intensity. The regression results for low-carbon industry show that, at the significance level of 1%, GVC and TIFA are inversely correlated with the carbon emission intensity, while FDI and PPI are positively correlated with the carbon emission intensity.

Summary and Implications

Based on the related research of global value chain and carbon emission intensity, this paper empirically studies the influencing mechanism of global value chain status index of 38 subdivided industries on carbon emission intensity. Through static fixed effects regression model estimation, following conclusions can be proved: (1) the industry status of global value chain index are significant inverse with carbon emissions intensity, but there is no direct relationship between the industrial cost profit margins and the carbon intensity; (2) for the low-carbon industry, the improvement of global value chain status index and the increase of TIFA are conducive to the reduction of carbon emission level. In addition, the increase of foreign direct investment and PPI will lead to the increase of carbon emission. (3) in terms of China's high carbon emission industry, energy structure is the most important influencing factor. The increase of the proportion of coal consumption and the index of GVC will lead to the increase of the industry's carbon emission level.

Based on the above conclusions, this paper draws several policy implications of carbon emission reduction. Firstly, the global value chain position of each industry should be promoted to occupy a new competitive advantage in global production network. Secondly, for low-carbon emission industry, increasing the industry's index of GVC and TIFA are important ways to reduce carbon intensity. Besides, it is positive and effective to reduce carbon emissions through the technological and economic spillover effects of foreign direct investment. For the high carbon emission industry, the government needs to make rational use of administrative and economic methods to formulate corresponding energy conservation and emission reduction policies, increase financial input to promote technological innovation of enterprises. Improving the energy consumption structure of the industry, improving the utilization level of clean energy and improving the energy production

efficiency are the sources of environmental pollution control in high carbon industry.

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