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Environmental Performances of Foreign Trade-Taking China's Manufacturing Industry as an Example

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Abstract

This paper analyzes the trend of pollution degree of China's manufacturing industry using the data from 2006 to 2015 and analyzes the influence of the three factors of foreign trade of China's manufacturing industry on environmental pollution. The results show that the technical effect in the foreign trade of China's manufacturing industry plays a decisive role in the impact of environmental pollution, and the improvement of the structural effect is also promoting the improvement of the environment. Combining with the above conclusions, this paper puts forward some countermeasures and suggestions on how to improve the impact of China's manufacturing industry on the environment.

Keywords: China's manufacturing industry, foreign trade, environmental pollution, technical effect

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INTRODUCTION

To some extent, the manufacturing industry directly represents the international competitiveness of a country. Although the manufacturing industry undoubtedly brings huge economic benefits, some countries usually neglect the severe environmental problems brought by developing the manufacturing industry in the preliminary phase (Skellern et al. 2016). Up till now, the worldwide manufacturing industry has experienced three transfers to the U.K., America and Japan respectively (Barefoot et al. 2011). In these three transfers, there occurred the problem of inadequate attention to the environment. It wasn't until the early 21st century did China start to pay attention to the negative impact from environmental problems. As of the present, however, China is still one of the countries implementing relaxed environmental control. Moreover, the commodity structures of most China's manufacturing enterprises are unbalanced, consume much energy and yield few profits. Conversely, the manufacturing enterprises that adopt high technology and make high profits only account for a tiny proportion (Hummels et al. 2001). Needless to say, China fails to formulate an effective plan of improvement and control to improve environmental governing. Environmental performance is an effective means of controlling enterprises' pollution discharge. At present, the in-depth research on environmental performance orients on the enterprises of developed countries. Conversely, the research on the environmental performances of enterprises in developing countries is much less. For this reason, the environmental issues of developed countries tend to be less severe than those of developing countries (Shi et al. 2016). Apart from retaining economic performances, it is crucial to ensure the quality of environmental performances. In addition, China's manufacturing enterprises also need to pay attention to environment strategies to obtain better environmental performances and higher profits. In such an industrial context, the following questions are worthy of research. What are the impacts of China's manufacturing industry on environmental factors? How to improve the industrial structure of manufacturing industry and exert positive impact on the environment? The research on these questions is of strategic significance for China to improve its manufacturing industrial structure, use foreign capital and improve the industrial output models of other countries (Dogan and Seker 2016).

By analyzing and summarizing extant literature, the paper firstly concludes the status quo of China's manufacturing foreign trade and the impact of the manufacturing industry on the environment. In addition, the paper analyzes the investment directly attracted by the manufacturing industry, the amount of used foreign capital and the discharge of pollutants in

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waste gases and sewage. Based on the data including total energy consumption, the paper classifies the sectors in the manufacturing industry into the food manufacturing sector, paper-making & paper product manufacturing sector, metal metallurgy processing sector, chemical raw material and chemical product manufacturing sector (Sakamoto and Managi 2017). Based on setting up a model, the paper clarifies the impact of China's manufacturing foreign trade on the environment, its range and trend. Next, the paper determines the impact of different factors in the manufacturing industry on the environment by setting up the measurement model. Based on the results of empirical analysis, the paper proposes the countermeasures and suggestions for reducing the impact of China's manufacturing foreign trade on the environment (Hayashi et al. 2016).

THEORETICAL FOUNDATION OF ESTIMATING THE IMPACT OF CHINA'S MANUFACTURING FOREIGN TRADE ON ENVIRONMENT

By setting up the pollution intensity indicator of China's manufacturing foreign trade, the thesis researches the impact of changes in China's manufacturing foreign trade on the environment. In addition, the thesis refers to the international trade & environment effect benchmark model of Grossman and Krueger (1991) (Solaymani and Shokrinia 2016). In the analysis of the effects of NAFTA on environmental quality, Grossman and Krueger (1991) put forward three effects, namely the technique effect, the composition effect and the scale effect. The scale effect refers to the impact of general national economic scale on the environment. The composition effect refers to the impact of an industrial structure of a national economy on the environment. The technique effect refers to the impact of product manufacturing technology and pollution discharge treatment technology in a national economy on the environment.

The pollution intensity index refers to the pollution discharge contained by a unit of value in the manufacturing industry (Kai and Siyan 2011). The average weighted value of the pollution intensity in the manufacturing industry should be expressed in the following formula:

$$p_t = \frac{O_t}{W_t} = \frac{\sum_{i=1}^{n} O_{it}}{W_{it}} \times \frac{W_{it}}{w_t} = \sum_{i=1}^{n} f_{it} \times \frac{W_{it}}{W_t} = \sum_{i=1}^{n} f_{it} \times \theta_i^{\omega}$$

In the above-mentioned formula, p_t represents the pollution intensity of the whole manufacturing industry; O_t represents the pollution discharge of the whole manufacturing industry; W_t represents the output value of the whole manufacturing industry; f_{it} represents the pollution intensity of every sector in the manufacturing industry; θ_i^{ω} represents the proportion of the output value of one sector to the output value of the whole manufacturing industry; t represents time; i represents the department of the manufacturing industry; n represents the number of sectors in the manufacturing industry.

As is shown by the above-mentioned formula, the pollution intensity of the whole manufacturing industry is the weighted average of the pollution intensity of all sectors. Similarly, the pollution intensity of total manufacturing export & import trade is the weighted average value of the pollutant intensity of sector export & import (Rauscher 2005). The weighted values are the proportions of import & export of every sector to the total manufacturing export & import.

The measurement model is set up according to measurement methods: The theories of Grossman and Krueger are applied to analyze the specific impact of scale effect, composition effect and technique effect of the manufacturing foreign trade on the environment (Running 2015).

STATUS QUO OF CHINA'S MANUFACTURING FOREIGN TRADE AND CHINA'S ENVIRONMENT

Current Status of China's Manufacturing Foreign Trade

The research object of the thesis, namely the China's manufacturing industry, is consisted of 28 sectors in China, including agricultural products and by-products, beverages, cigarettes, furniture, paper-making and paper products, petroleum processing, chemical raw material, rubber, metal metallurgy and other manufacturing or processing sectors. The foreign trade of these sectors is the primary research object, while their domestic manufacturing states are secondary research objects. The data related to China's manufacturing foreign trade between 2006 and 2015 is selected from *China Statistical Yearbook* and arranged into **Table 1**.

As is seen from **Table 1**, China's manufacturing foreign trade only accounted for 545.6 billion dollars in 1997. As of 2015, the scale had risen to 6.6747 trillion dollars, increasing by 1,223.36%.

Table 1. Foreign trade data of China's manufacturing industry from 2006 to 2015

Year	Total foreign trade of China's manufacturing industry /10 thousand USD	Total export trade of China's manufacturing industry /Million USD	Annual growth rate of China's manufacturing exports /%	Total import trade of manufacturing/ Million USD	Annual growth rate of foreign import of China's manufacturing industry /%	Balance of trade surplus
1997	545634	318723		226911		91812
1998	561411	327410	2.73	234001	3.12	93409
1999	627304	350742	7.13	276562	18.19	74180
2000	803431	448010	27.73	355421	28.51	92589
2001	874164	479809	7.10	394355	10.95	85454
2002	1085071	594449	23.89	490622	24.41	103827
2003	1486095	806895	35.74	679200	38.44	127695
2004	1992597	1105655	37.03	886942	30.59	218713
2005	2448662	1425409	28.92	1023253	15.37	402156
2006	3038587.82	1830913	28.45	1207674.82	18.02	623238.18
2007	3736419.5	2311753.37	26.26	1424666.13	17.97	887087.24
2008	4243137.9	2705291.67	17.02	1537846.23	7.94	1167445.44
2009	3707863.45	2276978.76	-15.83	1430884.69	-6.96	846094.07
2010	4901356.47	2992575.16	31.43	1908781.31	33.40	1083793.85
2011	5828205.36	3595603.59	20.15	2232601.77	16.96	1363001.82
2012	6200058.37	3897485.88	8.40	2302572.49	3.13	1594913.39
2013	6687942.9	4204352.57	7.87	2483590.33	7.86	1720762.24
2014	7006864.54	4459816.99	6.08	2547047.55	2.56	1912769.44
2015	6674679.72	4340010.56	-2.69	2334669.16	-8.34	2005341.4

Data source: The research data is abstracted and arranged from *China Statistical Yearbook* (2006-2015)

As is seen from Table 1, China's manufacturing foreign trade only accounted for 545.6 billion dollars in 1997. As of 2015, the scale had risen to 6.6747 trillion dollars, increasing by 1,223.36%.

Status Quo of Environment in China

Regarding the impact of manufacturing of all walks of life on the environment, the industry exerts a negative impact to the environment; among all sectors in the industry, the pollution from the manufacturing industry exerts the biggest impact on the environment. An important reason why the production in the manufacturing industry causes such severe pollution to the environment is that the pricing mechanism of products in Chinese domestic manufacturing industry is imperfect. That is to say, environment is not incorporated into costs, namely the environment performance in the thesis is neglected. The internalization of environmental costs can represent the values of a product in a faithful manner. In addition, resources will be used more efficiently and the resource allocation will be optimized. In the past years, Chinese manufacturing industry has been adopting the development pattern of "first pollution and then treatment". As is proven by fact, such a developmental path is infeasible. The most effective measures of solving environment problems include internalizing environment costs and incorporating environmental performance as a manufacturing indicator. The measures of restricting trade forms and scale are only sub-optimal choices. It is necessary to think from the thinking of using resources and the environment with pays and collect the taxation on using relevant resources and occupying the environmental capacity to prevent foreign traders from making excessive consumption or wasting resources. On the one hand, governmental efforts of lowering the standards for regulating environmental pollution increase the manufacturing capacities of Chinese manufacturing industry. On the other hand, they also cause enterprises to destroy the environment.

The previous research mostly represents environmental pollution through SO^2 or carbon emission. The environmental pollution generated by the industry not only includes SO_2, but also liquid pollutants and solid pollutants (Aller et al. 2015, Arce et al. 2016, Busse and Silberberger 2012, Ferrara et al. 2009, Gallagher 2005, Johnson 2015, Kellenberg 2009, Monkelbaan 2014, Wilhelm 1992, Zomorrodi 2017, Zhang and Liu 2010). The thesis abstracts the pollution discharge data generated by the manufacturing industry in ten years between 2006 and 2015 from *China Environmental Statistical Yearbook*. The specific pollutants include FS (industrial sewage), YC (industrial smoke or dust), COD (chemical oxygen demand) and SO_2 (industrial sulfur dioxide). The total pollutant discharge of 28 sectors in the manufacturing industry is listed in **Table 2**.

As is seen from **Tables 1-2**, the industrial sewage, COD and industrial SO_2 discharge of all sectors between 2006 and 2015 basically represented the trend of constant decreases. Conversely, the discharge of

Table 2. Classification of China's manufacturing industry by sub-sectors

Industry Code	Industry Code	Industry Code	Sector Name
8	Food manufacturing sector	22	Chemical fiber manufacturing sector
9	Alcohol, beverage and fine tea manufacturing sector	23	Rubber and plastic product sector
10	Tobacco product sector	24	Non-metal mineral product sector
11	Textile sector	25	Black metal metallurgy and rolling processing sector
12	Textile & clothing sector	26	Color metal metallurgic and rolling sector
13	Leather, furs, feathers and shoes sector	27	Metal product sector
14	Timber processing, wood, bamboo, vine, palm and grass product sector	28	General equipment manufacturing sector
15	Furniture manufacturing sector	29	Special equipment manufacturing sector
16	Paper and paper product sector	30	Automobile manufacturing sector
17	Printing and recording media replication sector	31	Railway, shipping, aerospace and other transportation equipment manufacturing sector
18	Culture and education, working, sports and entertainment product manufacturing sector	32	Electrical, mechanical and device manufacturing sector
19	Petroleum processing, coking and nuclear processing sector	33	Computer, telecommunications and other digital equipment manufacturing sector
20	Chemical component and chemical product manufacturing sector	34	Instrument and apparatus manufacturing sector
21	Medical manufacturing sector	35	Other sectors

industrial smoke (dust) was fluctuating substantially and had the rising trend compared with other pollutants. Based on the data of 2006, the discharge of industrial sewage had decreased by 13.69% as of 2015; the COD decreased by 46.65%; industrial SO_2 decreased by 4.42%; conversely, the discharge of industrial smoke (dust) rose by 123.3%.

EMPIRICAL ANALYSIS OF THE ENVIRONMENTAL EFFECT OF CHINA'S MANUFACTURING FOREIGN TRADE

Estimate the Pollution Intensity of China's Manufacturing Foreign Trade

Data source and processing

The pollutant discharge data of all sectors in China's manufacturing industry is abstracted from *China Environmental Statistical Yearbook*. The output data of all sectors in China's manufacturing industry is abstracted from *China Statistical Yearbook*. The foreign trade data of sectors in the manufacturing industry is abstracted from *China Customs Statistical Yearbook* and concluded by sector according to the standards of *International Standard Industrial Classification*.

Estimation results and analysis

Figs. 1-3 respectively show the total output of China's manufacturing industry and the pollutant discharge intensity of China's import & export in industrial sewage discharge, COD, SO_2 and smoke (dust). The above-mentioned data shows the pollutant intensity data in industrial sewage, COD and industrial SO_2 in China's manufacturing foreign trade is constantly decreased. However, the pollutant intensity of industrial smoke (dust) is constantly fluctuating. Because of these two distinctive change trends, industrial sewage, COD and industrial SO_2 are classified into one category. Smoke (dust) is classified into another category. The specific analysis is listed as follows:

Firstly, the export and import trade of China's manufacturing industry represents basically a stable clean trend regarding three pollutant discharges. Compared with the pollutant discharge level of 2006, the industrial sewage intensity of China's manufacturing export and import trade had decreased by about 63.59% and 55.35% respectively as of 2015. Correspondingly, the COD pollutant intensity decreased by 77.49% and 72.40% respectively. In terms of air pollution, the SO_2 pollution intensity of China's manufacturing export and import trade decreased by 50.51% and 39.23% respectively. In addition, the smoke (dust) intensity of China's manufacturing import and export represented unstable fluctuations. Compared with that of 2006, the smoke (dust) pollutant intensity increased, which is consistent with the phenomenon of constantly severe haze pollution in cities throughout China. The specific reason for such a phenomenon will be analyzed as follows.

Secondly, China's manufacturing export trade represents cleaner characteristics than China's manufacturing import trade. Regarding water pollution, the COD pollution intensity of China's manufacturing export trade is 11% lower than that of China's manufacturing import trade on average. However, such differences constantly decrease as time passes; in terms of air pollution, China's manufacturing export trade

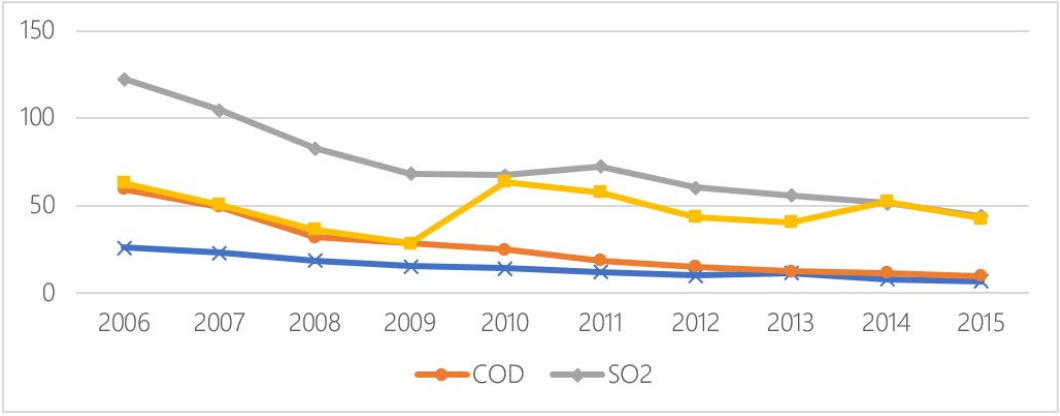

Fig. 1. Pollution intensity of China's manufacturing output from 2006 to 2015

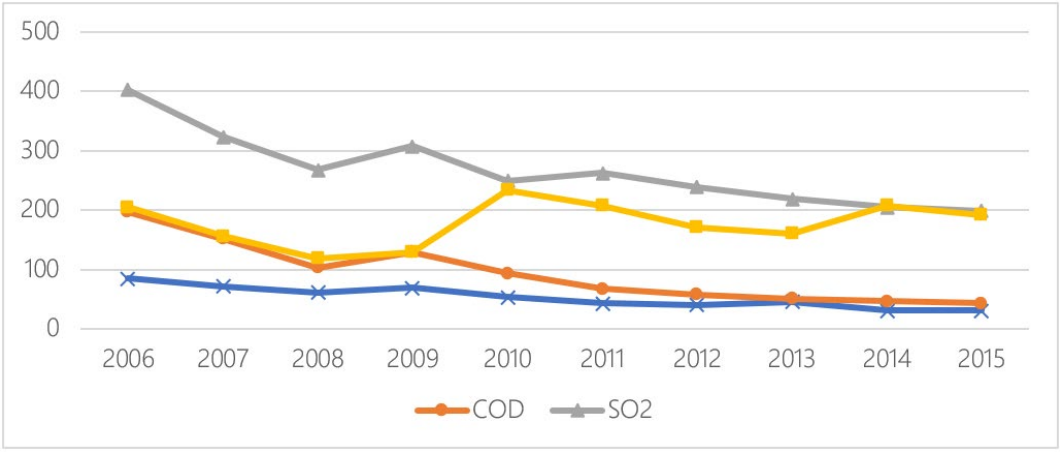

Fig. 2. Pollution intensity of foreign trade in China's manufacturing industry from 2006 to 2015

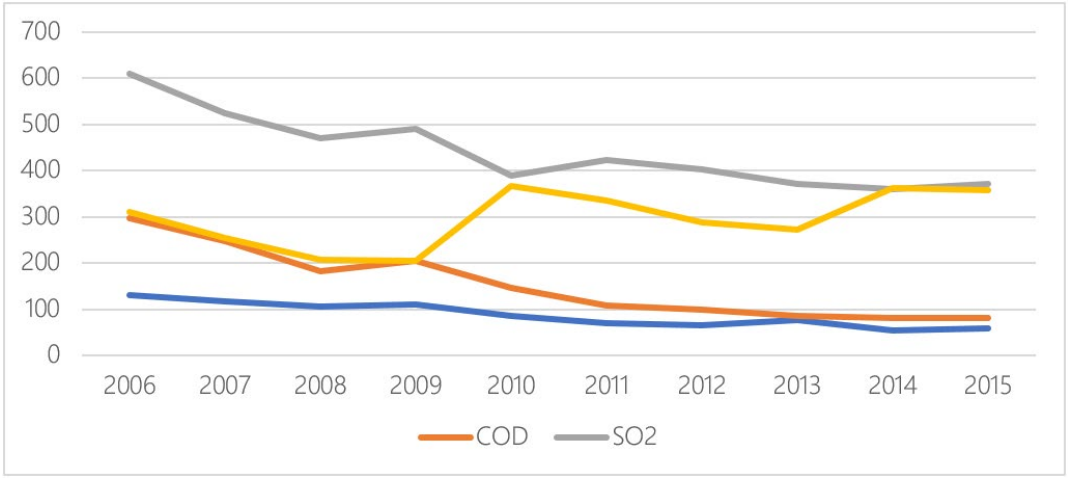

Fig. 3. The pollution intensity of China's manufacturing export trade from 2006 to 2015

also represents a lower intensity of SO_2, smoke and dust pollution. However, the differences are not as huge as those in water pollution.

Thirdly, the product structure changes of China's manufacturing foreign trade bring a cleaner trend for the export and import trade of China's manufacturing industry. Combining with relevant proof, it is found out the product structure of China's manufacturing industry is transferring towards industrial sectors of highly international manufacturing sectors. In addition, these sectors represent a lower water and air pollution intensity. Moreover, the composition effect of foreign trade and subsequent technique effect are two important reasons that promote China's manufacturing foreign trade to be cleaner. Among these two effects,

technique effect may play a bigger role of explanations than composition effect.

Analysis of the environmental effect of China's manufacturing foreign trade

The effects of China's manufacturing foreign trade on the environment can be represented in the above-mentioned three effects, namely the technique effect, composition effect and scale effect. Relevant measurement tools are adopted to measure the specific influences of three influential factors on environmental pollution.

a. Introduction to the Setting and Relevant Data of Measurement Models and Variables

The analysis of comprehensive effects from China's foreign trade on the environment is represented through the empirical equation of economic factors and environmental pollution factors. This equation is determined by introducing the producer function and consumer function of environment factor and the governmental taxation function of environmental factor.

$$\ln Z = \pi_1 lnS + \pi_2 lnK + \pi_3 ln\beta + \pi_4 lnI + \pi_5 lnQ$$

Based on this equation and given considerations to the possibility of obtaining data, the regression model is eventually determined as follows:

$$\ln Z_t = C + \pi_1 lnY_t + \pi_3 lnFDI_t + \pi_5 lnTR_t + \pi_6 lnST_t + \varepsilon_t$$

In the model:

The explained variable: The pollution discharge of China's manufacturing industry is represented as Z_t, meaning the discharge of pollution in Year t.

Explanatory variable: Y_t represents the GDP of China's manufacturing industry in Year t, meaning the scale effect of China's manufacturing industry in the current year; FDI_t refers to foreign investor's investment in China's manufacturing industry in Year t, meaning the technique effect of China's manufacturing industry; TR_t is used to represent the foreign trade of China's manufacturing industry in Year t, meaning the scale effect; ST_t refers to the industrial structure of China's manufacturing industry in Year t (the proportion of highly-polluted industry to China's general manufacturing industry; As is analyzed by the pollutant intensity of sectors in manufacturing industry, highly-polluted industries include paper-making industry, chemical product industry, basic metal products, coke and oil refining industry and textile industry), meaning the composition effect of China's manufacturing industry.

b. Data Source

Analyzed from the data of *China Statistical Yearbook* and *China Environment Statistical Yearbook* between 2006 and 2015, the thesis concludes the environmental pollution conditions of China's manufacturing industry, foreign trade conditions and total output.

c. Regression Results of Measurement Model

With the Eviews 8.0 software, the thesis conducts an empirical analysis of the correlations between China's manufacturing foreign trade and environment impact factors. In addition, the thesis conducts a regression estimation of the equation with the least square method. The regression results show the fitting is good, namely R^2=0.862042. The specific regression results are listed in the following table.

d. Measurement Analysis

As is analyzed from the regression results in the table, the following conclusions are drawn in the selected regression model:

(1) R^2 is 0.910897 and the DW statistical value is 2.057292, which proves the model is reasonable and does not reach good fitting. On the one hand, it is because the amount of sample data is limited. On the other hand, the above-mentioned analysis means China's manufacturing industry has undergone the process of transferring from foreign countries to China and from China to foreign countries. As a result, the data changes exert some impact on regression results.

(2) There are negative correlations between the GDP of China's manufacturing industry and the discharge of industrial pollution. It means the technique level and composition designing of China's manufacturing industry are constantly optimized. Based on ensuring the GDP increase of the manufacturing industry, China has effectively controlled the pollution discharge.

(3) There are significant negative correlations between the FDI of China's manufacturing industry and the industrial pollutant discharge. Conversely, there are some positive correlations between the scale of manufacturing foreign trade and industrial pollutant discharge, which are not obvious. The reason for such correlations is two-fold: On the one hand, the constant input of foreign capital has brought a corresponding technologic revolution to the domestic manufacturing

industry. In addition, enterprises are also learning such technology constantly to develop and update relevant technology, thereby gradually reducing the reliance on foreign capital and foreign technology. On the other hand, China plays a constantly changing role in international production fragmentation. Correspondingly, the domestic manufacturing field and the product structure of foreign trade are constantly transferring to cleaner industries.

(4) There are certain positive correlations between the industrial structure of China's manufacturing foreign trade and industrial pollution discharge. As the proportion of highly-polluted industries in China gradually decreases, China's pollutant discharge also decreases correspondingly. However, such changes are not obvious. It means the composition effect of China's manufacturing foreign trade plays a small role of promoting the pollution intensity of manufacturing foreign trade.

CONCLUSION

In conclusion, the composition effect, scale effect and technique effect all exert an impact on the pollution discharge intensity of China's manufacturing foreign trade. In general, technique effect plays the most crucial role. The technological revolution and the role played by China's manufacturing industry in the global manufacturing chain jointly lower the discharge of pollution effectively and represent huge positive correlations. Similarly, the product structure of China's manufacturing foreign trade exerts certain positive impact on the discharge of industrial pollution, improves environmental conditions and reduces the pollutant discharge. More importantly, it improves manufacturing technology and pollution discharge technology.

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