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# Wastewater Emission Reduction by China's Industrial Imports of and Its Influencing Factors

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**Abstract.** By using the input-output model and the data of China's industrial segment industries, this paper measure the wastewater emission reduction intensity and the wastewater emission reduction of China's industrial imports in 2012 and 2015. At the same time, it also uses the LMDI to analyze the impact of the imports changes in scale, the structural and the intensity of the wastewater emission reduction by the imports on China's industrial wastewater emission. The results are as follows:(1) In 2012 and 2015, China's industrial product import caused its industrial wastewater discharge to decrease by 15% and 14% respectively; (2) The decreases in the scale of the imports and the intensity of wastewater emission reduction lowered the reduction of the emission but the change in the structure of the imports improved the capacity of the reduction.

## 1. Introduction

The 2017 China Ecological Environment Bulletin showed that the water quality of Class IV, Class V and inferior Class V accounted for total of 32% in one thousand nine hundred and forty China’s evaluation and assessment sections of surface water in 2017 and among six thousand one hundred and twenty-four monitoring points for groundwater quality in China, sixty percent of them are at low levels [1]. This means that the problem of water pollution in China is serious. The main cause of the water environmental pollution is that the wastewater discharged by China’s industrial production contains a large amount of harmful substances such as nitrogen oxides, ammonia nitrogen, cyanide and heavy metals. These harmful substances flowing into China’s rivers and underground polluted the surface water, groundwater and soil, which endanger the safety of China’s drinking water and food safety. Therefore, it is imperative to reduce the discharge of industrial wastewater in China.

Usually, there are three ways to reduce industrial wastewater pollution. Firstly, environmental protection technology is used to reduce the wastewater discharge of enterprises; secondly, the industrial structure is adjusted, namely, the productions of pollution-intensive industries are cut down. Finally, environmental tax is levied on polluting industries to internalize the cost of pollution enterprises. These three ways of reducing pollution are all from the domestic perspective. In addition, China can use imports to reduce its pollutant emissions. For example, in March 2012, the conference of ‘Appropriate Expansion of Import Scale to Alleviate Resource Pressures’ held by China’s State Council pointed out that with the constraints on resources and environment being strengthened and the improvement of the living standards of the people, China needed to appropriately increasing its imports while keeping the growth of exports [2]. In recent years, what has been the environmental effects brought by the industrial products imports on China? Which factors affect the effects of the imports? This paper will study these issues.

The International Federation of Advanced Research Institutions (IFIAS, 1974) proposed the concept so called implicit contaminants to measure total pollutants discharge from production of upstream intermediate inputs to the processing, manufacturing and transportation of final products. After that, the concept has been widely used to analyze the environmental impact of trade by academic circles. Wyckoff and Roop (1994) found that French industrial imports had reduced its carbon emissions by 40% in 1985[3].Dietzenbacher etal (2007) found that the pollutants implied in India's imports of are twice as high as that implied its exports. They thought that India's import trade helps protect the country's ecological environment [4]. Peters (2007) studies the influencing factors of China's $CO^2$ emissions and found that the implied carbon emissions in China's imports had offset the growth of $CO^2$ emissions implied in the country's exports, and import had reduced China's $CO^2$ emissions [5]. Li (2013) measured the $CO^2$ emissions implied in Macao's imports from 2005 to 2009, and found that the $CO^2$ emissions implied in the imports were 3to4 times that implied exports in the Area at the same period [6] .Wang (2006) analyzed the $CO_2$ emissions implied in trade between China and Japan. They found that the $CO_2$ emissions implied in China's imports from Japan are one-sixth of that implied in China's exports to Japan which was not good for China's environment [7]. Zhang (2009) analyzed the impact of foreign trade on China's $SO_2$ emissions during the period 1987-2006 and found that the sulfur implied in China's imports had been increasing for many years but the growth of imports was much lower than that of its exports. He thought that the growth of China's foreign trade had led to a huge surplus of sulfur emissions. He suggested that China should further pay the role of China's import in environmental protection [8]. Xu (2010) measured the pollutants emissions implied in the imports of 42 sectors in China in 2002. His study showed that China's imports had reduced its environmental pollution [9]. Yan and Xie (2011) analyzed the impacts of China's agricultural foreign trade on the environment in the country from 1995 to 2009, and found that the agricultural imports had reduced China's environmental pollution [10]. Ni etal. (2012) measured the pollutant emissions implied in the trade between China and OECD countries in 2002 and 2007 and found that the $CO_2$ emissions implied in China's imports were $1.49 \times 10^8 m^3$ and$1.1 \times 10^5$ $m^3$ in the these two years respectively [11]. Liu etal (2015) measured the $CO_2$ emissions implied in China's imports and exports from 2001 to 2012 and found that the CO2 emissions implied in China's imports in 2012 were 7.5 times that in 2001[12]. Zhu etal(2018) found that the emission reductions of industrial wastes by China's imports in 2002 and 2012 were equivalent to 20% and 22% of its industrial waste emissions in the same period. They thought that expansion of China's import trade were conducive to its environment [13].

The data used in the literatures are out of date, and it is difficult to show the environmental benefits brought by China's imports recently. In addition, there are few researches on the influencing factors of China's import environmental effects. This paper use China's latest input-output data to analyze the effects of industrial imports on the reduction of industrial wastewater discharge in the country and to reveal the factors affecting the effects of the imports on the wastewater reduction, and to look for method to improve the environmental benefits of China's imports.

## 2. Methodology and Model

### *2.1. Calculating Wastewater Emission Reduction Intensity of Industrial Imports*

The reduction of the wastewater emission reduction by China's industrial imports is calculated based on substitution effects. Namely, the reduction is measured according to the wastewater discharge emitted from the production of similar products in China. Because China's imports of industrial products not only reduce the production of similar domestic products that directly reduce the discharge of industrial wastewater in China, but also reduce the consumption and production of domestic inputs in the production process of the product which indirectly reducing China’s discharge of industrial wastewater. Therefore, the reduction of wastewater discharge by China's industrial imports can be measured by input-output model (Machado etal., 2001; Chen Ying etal., 2008; Zhu etal., 2016) [14] [15] .

When input-output model is used to calculate the wastewater emissions reduction of China's industrial imports, it is necessary to use formula (1) to calculate the direct discharge of industrial wastewater from the production sector(No.i) and then the wastewater reduction intensity of the same sectoris obtained by using input-output model,.

$$d_i = Q_i / X_i \quad (i = 1,\ 2,\ \ldots,\ n) \tag{1}$$

$$p_i = d_i\,(I - A)^{-1}\,(i = 1,\ 2,\ \ldots,\ n) \tag{2}$$

Where, $d_i$ is the direct wastewater emissions intensity from (No.i) sector. $Q_i$ are the reduction of wastewater emissions from (No.i) sector in China, $X_i$ is China's output. $n$ is the number of (No.i) import sector. $(I - A)^{-1}$ is the Leontief inverse matrix, $p_i$ indicates the intensity of wastewater reduction by (No.i) import.

### *2.2. Calculating Reduction of Wastewater Emissions by Industrial Imports*

Using formula (3), reductions of the wastewater emissions by China's industrial imports sectors are calculate, and then by adding the reductions, total whole of industrial wastewater emissions reductions by China's import sectors is gotten.

$$Q = \sum_{i=1}^{n} Q_i = \sum_{i=1}^{n} IM_i \times \beta_i = \sum_{i=1}^{n} IM \times \theta_i \times p_i\,(i = 1,\ 2,\ \ldots,\ n) \tag{3}$$

Where, $Q$ is total of wastewater emission reductionby the import, $\beta_i$ is the reduction intensity of importing ($N_O$.i) sector, $IM_i$ is ($N_O$.i)sector import, $\theta_i$ is the proportion of ($N_O$.i) sector imports to China's total imports of industrial products, $IM$ is total industrial products imports of China.

### *2.3. Model of Factors Affecting Wastewater Emission Reduction in China's Industrial Imports*

From the base year to the reporting year, the change in the wastewater discharge reduction by China's industrial products imports can be expressed as the effects of changes in the scale of the import, the imports structure and the intensity of wastewater reduction of the imports shown in equation (6).

$$\Delta Q_{IM} = Q_{IM}^{t} - Q_{IM}^{0} = \Delta Q_{IM}^{G} + \Delta Q_{IM}^{S} + \Delta Q_{IM}^{T} \tag{4}$$

Where, $\Delta Q_{IM}$ represents the total changes in the reduction of wastewater discharge by China's industrial imports from the base year to the reporting year. $Q_{IM}^{0}$ and $Q_{IM}^{t}$ are the reduction by the imports in base year and reporting year respectively. $\Delta Q_{IM}^{G}$ , $\Delta Q_{IM}^{S}$ and $\Delta Q_{IM}^{T}$ are changes in the scale of China's industrial products, structure of the imports and the intensity of wastewater emissions reduction by the imports respectively

Using the method of log-average weight decomposition, the formula of the effects factors is obtained.

$$\Delta Q_{IM}^{G} = \sum_{i=1}^{n} \frac{Q_{IMi}^{t} - Q_{IMi}^{0}}{\ln Q_{IMi}^{t} - \ln Q_{IMi}^{0}} \times \ln \frac{IM_t}{IM_0} \tag{5}$$

$$\Delta Q_{IM}^{S} = \sum_{i=1}^{n} \frac{Q_{IMi}^{t} - Q_{IMi}^{0}}{\ln Q_{IMi}^{t} - \ln Q_{IMi}^{0}} \times \ln \frac{\omega_i^{t}}{\omega_i^{0}} \tag{6}$$

$$\Delta Q_{IM}^{T} = \sum_{i=1}^{n} \frac{Q_{IMi}^{t} - Q_{IMi}^{0}}{\ln Q_{IMi}^{t} - \ln Q_{IMi}^{0}} \times \ln \frac{\beta_i^{t}}{\beta_i^{0}} \tag{7}$$

Where, $IM_0$ and $IM_t$ are China's industrial product imports in base year and reporting year respectively, $\omega_i$ is the proportion of ($N_O$.i) importing sector to the total industrial imports in China, $\beta_i$ is the wastewater reduction intensity of the importing sector. $Q_{IMi}^{0}$ and $Q_{IMi}^{t}$ are the reductions wastewater discharge by the importing sector in the bass year and that in the reporting year respectively.

## 3. Data

At present, the latest China's Input-Output Table is the '2015 National Input-Output Table', which is an extension of the '2012 National Input-Output Table'. In order to compare China's wastewater emissions reductions by the industrial imports in these two years, this paper uses 2015 National Input-Output Table and 2012 National Input-Output Table. The data of China's output and imports of industrial sectors used in this paper also come from the database of the input-output table in these two years. The wastewater discharge of the industrial sectors comes from the China Environmental Statistics Yearbook. In order to match the industrial sectors in the input-output table with the industrial sectors in the yearbook, the industrial sectors were merged into 24 sectors shown in table1.

## 4. Empirical Analysis

### *4.1. Intensity of Wastewater Reduction by China's Industrial Imports*

Using formula (1) and formula (2), the wastewater emissions reduction intensity of China's industrial importing sectors in 2012 and 2015 was calculated. Tables 1 that the reduction intensity of the importing sectors such as paper and stationery, manufacturing, electrical and mechanical and equipment manufacturing, clothing and leather and down and its products, textile materials, transportation equipment, other manufactures, chemicals and metal products is higher than the average reduction intensity of the wastewater emission by China's industrial importing sectors. These import sectors had higher capability of reducing wastewater emission in China. By comparison, the reduction intensity of import sectors such as oil and gas extraction, water production and supply, coal mining and washing, petroleum processing and coking and nuclear fuel processing, non-metallic mining and mining, wood and furniture manufacturing, metal mining, food and tobacco is significantly lower than the average reduction intensity of China's industrial imports. The reduction intensity of these importing sectors is lower.

From 2012 to 2015, the wastewater emission reduction intensity of China's importing sectors changed greatly. In 2012, the average wastewater emission reduction intensity was 6.84 $m^3$ /ten thousand Yuan, but in 2015, the intensity dropped to 5.26 $m^3$ /ten thousand Yuan. Namely, the intensity decrease 23% during the three years. In the light of changes in China's importing sectors, the reduction intensity of sectors such as coal extraction and washing, waste utilizing, gas production and supply was increased, but the reduction intensity of the rest of the importing sectors was decreased among which paper and stationery, food and tobacco, clothing and leather and down and its products, other manufacture, electricity and heat production and supply industries, the textile raw materials and the chemicals reduced significantly, all of which declined more than 30%.

Table1 shows that the simple average and the weighted average of the wastewater emission reduction intensity of China's industrial importing sectors were 6.84 $m^2$/ ten thousand Yuan and 6.38 $m^2$/ ten thousand Yuan respectively in 2012. Obviously, the former is larger than the latter. That means that the imports with high reduction intensity of wastewater emission in China is relatively small in the year (according to the relationship between the simple average and the weighted average, when the weight of the large number is small, the simple average is greater than its weighted average), which is not conducive to reducing industrial wastewater discharged in China.

In 2015, the simple average and weighted average of the reduction intensity of China's importing sectors were 5.26 $m^2$/ ten thousand Yuan and 5.97 $m^2$/ ten thousand Yuan respectively. Obviously, the former is smaller than the latter, which is conducive to reducing China's wastewater emissions in this year. By comparing the structural differences in China's industrial products import between 2012 and 2015, the result showed China's industrial products imports structure had been changing towards a good condition that is conducive to reducing China's wastewater discharge.

**Table 1.** Intensity of wastewater emission reduction in China's importing sectors in 2012 and 2015

| Sector | Intensity of wastewater emissions reduction [cubic meter/ten thousand Yuan (RMB)] 2012 | 2015 | Changes in the intensity during 2012 and2015 (%) |
|---|---|---|---|
| Coal mining and washing industry | 4.38 | 4.45 | 1.60 |
| Oil and gas extraction industry | 3.20 | 2.76 | -13.75 |
| Metal mining industry | 5.45 | 4.55 | -16.51 |
| Non-metallic mining industry | 4.65 | 3.94 | -15.27 |
| Food and tobacco industry | 5.07 | 3.18 | -37.28 |
| Textile raw material industry | 12.84 | 8.48 | -33.96 |
| Clothing and leather and down and their products industry | 12.87 | 8.29 | -35.59 |
| Wood and furniture manufacturing industry | 5.76 | 4.05 | -29.69 |
| Paper and stationery manufacturing industry | 15.16 | 7.96 | -47.49 |
| Petroleum and coke and nuclear fuel processing industry | 4.43 | 3.92 | -11.51 |
| chemical industry | 10.21 | 6.65 | -34.87 |
| Non-metallic mineral industry | 6.76 | 4.98 | -26.33 |
| Metal smelting and processing industries | 7.26 | 6.42 | -11.57 |
| metal products industry | 7.05 | 5.59 | -20.71 |
| General and special equipment industry | 6.24 | 5.22 | -16.35 |
| Transportation equipment industry | 7.22 | 6.21 | -13.99 |
| Electrical and mechanical and equipment industry | 7.54 | 5.66 | -24.93 |
| Communications equipment, computer and other electronic equipment industry | 5.93 | 5.28 | -10.96 |
| Instrument and office machinery | 6.00 | 4.27 | -28.83 |
| Other manufacturing industries | 9.28 | 5.91 | -36.31 |
| Waste utilizing industries | 1.86 | 5.32 | 186.02 |
| Electricity and heat. | 6.28 | 4.02 | -35.99 |
| Gas production and supply industry | 4.47 | 6.26 | 40.04 |
| Water production and supply | 4.15 | 2.98 | -28.19 |
| Simple average | 6.84 | 5.26 | -23.10 |
| weighted average | 6.38 | 5.97 | -6.43 |

### *4.2. Analysis of Emission Reduction of Wastewater by China's Industrial Imports*

Using formula (3), wastewater emission reductions by China's industrial imports sectors were calculated in 2012 and 2015. Table 2 shows that the reductions in 2012 were 711.177 million cubic meters, which reduced the total discharge of industrial wastewater in China by 15% in this year. Among China's importing sectors, communication equipment, computer and other electronic equipment, chemicals, metal products, metal mining and processing, oil and natural gas, and transportation equipment all reduced the wastewater emission by more than 43 million cubic meters.

In 2015, the wastewater emission reduction decreased to 534.147 million cubic meters, which reduced the total amount of industrial wastewater discharged in China by 14%. Among China's importing sectors, communication equipment and computers and other electronic equipment, chemicals, metal smelting and rolling processing, transportation equipment manufacturing, general and special equipment manufacturing, metal mining and mining, electrical and mechanical and equipment manufacturing imports cut down more wastewater discharged than other importing sectors, each of which reduced wastewater emissions by more than 230 million cubic meters.

It can be found that the emission reduction of the wastewater caused by the import in 2015 decreased by 25% compared with that in 2012. The main reason is due to the decrease of emission reduction of the wastewater by some importing sectors such as fabricated metal products, chemicals, oil and gas, metal smelting and rolling processing, electrical and machinery and equipment, paper and stationery, communications equipment and computer and other electronic equipment, oil and coke and nuclear fuel processing, coal mining and washing, instruments and meters, and office machinery manufacturing and other 20 manufactures.

**Table 2**. The wastewater discharge reduction by China's importing sectors in 2012 and 2015

| Sector | Wastewater reduction (Ten thousand cubic meter) 2012 | 2015 | Changes in wastewater reductions during 2012-2015 (%) |
|---|---|---|---|
| Coal mining and washing industry | 7941.16 | 3426.29 | -56.9% |
| Oil and gas extraction industry | 45717.85 | 23838.40 | -47.9% |
| Metal mining industry | 45796.22 | 27060.75 | -40.9% |
| Non-metallic mining industry | 1832.72 | 1305.12 | -28.8% |
| Food and tobacco industry | 17141.58 | 14200.72 | -17.2% |
| Textile raw material industry | 12066.20 | 9510.86 | -21.2% |
| Clothing and leather and down and their products industry | 14344.70 | 14808.00 | 3.2% |
| Wood and furniture manufacturing industry | 2920.02 | 3508.96 | 20.2% |
| Paper and stationery manufacturing industry | 22311.46 | 16137.94 | -27.7% |
| Petroleum and coke and nuclear fuel processing industry | 12765.83 | 8002.26 | -37.3% |
| chemical industry | 125651.47 | 80447.00 | -36.0% |
| Non-metallic mineral industry | 4749.77 | 4387.33 | -7.6% |
| Metal smelting and processing industries | 64997.59 | 55924.84 | -14.0% |
| metal products industry | 62962.53 | 4713.57 | -92.5% |
| General and special equipment industry | 31899.57 | 42083.04 | 31.9% |
| Transportation equipment industry | 43466.92 | 42910.45 | -1.3% |
| Electrical and mechanical and equipment industry | 30070.64 | 23855.36 | -20.7% |
| Communications equipment, computer and other electronic equipment industry | 142379.37 | 136950.91 | -3.8% |
| Instrument and office machinery | 17423.86 | 13293.34 | -23.7% |
| Other manufacturing industries | 320.02 | 220.09 | -31.2% |
| Waste utilizing industry | 4278.18 | 7475.36 | 74.7% |
| Electricity and heat. | 139.34 | 86.27 | -38.1% |
| Gas production and supply industry | 0.00 | 0.00 | - |
| Water production and supply | 0.00 | 0.00 | - |
| Total | 711177.00 | 534146.86 | -24.9% |

### *4.3. Factors Affecting the Reduction of Wastewater Emission by China's Industrial Imports*

Using formula (4), formula (5) and formula (6), the effects of China's industrially importing scale change, the importing structure changes, and the effects of changes in wastewater emission reduction of the imports were calculated during 2012 and 2015 shown in Table 3.

Table 3 shows that during the times, wastewater emissions increased 590 million cubic meters and 1.38 billion cubic meters in China due to the decline of its industrial products import and the fall of the reduction intensity respectively, and the wastewater emissions decreased 202 million cubic meters because of structural changes in this period. Offsetting the positive and the negative effects mentioned, the reduction of the wastewater emission by the imports decreased by 1770.3million cubic meters during these three years.

From the effects of the change in imports scale of sectors, the import scale effects of wastewater reduction by China's importing sectors were negative, Among which, imports of metal products, oil and natural gas exploitation, metal mining, oil and coke and nuclear fuel processing, metal smelting and processing decreased so significantly that the reduction of wastewater emissions decreased obviously.

From the effects of changes in the intensity of wastewater emission reduction by the importing sectors, except that the effects of the changes in the intensity of waste utilizing, coal mining and washing industries, gas production and supply, water production and supply were positive, the effects of the changes in intensity of other importing sector were all negative due to the decline of the wastewater emission reduction intensity of these importing sectors in past three years. Specially, the effects of changes in chemicals, communication equipment and computers and other electronic equipments, metal, paper and cultural and stationery, food and tobacco, general and special equipments, transportation equipments, metal decreased significantly.

In terms of the effects of structural change in China’s importing sectors, the effects of wastewater discharge reduction in 17 importing sectors such as communication equipment and computers and other electronic equipments, general and special equipments, transportation equipment, clothing and leather and down and its products, chemical, paper and stationery, food and tobacco, metals, electrical and mechanical and equipment were positive were positive but the structural change effects of wastewater discharge reduction in other importing sectors were negative.

**Table 3.** Decomposition of wastewater emission reductions in China's importing sectors from 2012 to 2015 (Unit: Ten thousand cubic meter)

| Sector | Scale effects | Structural effects | Intensity effects | Net effects |
|---|---|---|---|---|
| Coal mining and washing industry | -522.93 | -4077.11 | 85.16 | -4514.87 |
| Oil and gas extraction industry | -3271.18 | -13638.3 | -4969.99 | -21879.5 |
| Metal mining industry | -3467.04 | -8841.09 | -6427.34 | -18735.5 |
| Non-metallic mining industry | -151.3 | -118.82 | -257.48 | -527.6 |
| Food and tobacco industry | -1521.24 | 5868.83 | -7288.45 | -2940.86 |
| Textile raw material industry | -1045.43 | 2944.77 | -4454.67 | -2555.34 |
| Clothing and leather and down industry | -1419.02 | 8293.17 | -6410.85 | 463.3 |
| Wood and furniture manufacturing industry | -312.08 | 2030.06 | -1129.03 | 588.94 |
| Paper and stationery industry | -1855.5 | 7959.96 | -12278 | -6173.52 |
| Petroleum and coke and nuclear fuel processing industry | -993 | -2523.12 | -1247.46 | -4763.57 |
| chemical industry | -9869.78 | 8129.93 | -43464.6 | -45204.5 |
| Non-metallic mineral industry | -444.56 | 1477.5 | -1395.38 | -362.44 |
| Metal smelting and processing industries | -5875.39 | 4223.08 | -7420.44 | -9072.75 |
| metal products industry | -2187.83 | -50846.6 | -5214.54 | -58249 |
| General and special equipment industry | -3578.58 | 20322.44 | -6560.4 | 10183.46 |
| Transportation equipment industry | -4204.75 | 10156.47 | -6508.19 | -556.47 |
| Electrical and mechanical equipment industry | -2613.43 | 4096.72 | -7698.58 | -6215.29 |
| Communications equipment, computer and other electronic equipment industry | -13596 | 24380.32 | -16212.8 | -5428.46 |
| Instrument and office machinery | -1486.24 | 2548.25 | -5192.52 | -4130.52 |
| Other manufacturing industries | -25.99 | 46.51 | -120.45 | -99.93 |
| Waste utilizing industries | -557.75 | -2265.48 | 6020.42 | 3197.19 |
| Electricity and heat. | -10.78 | 7.09 | -49.38 | -53.06 |
| Gas production and supply industry | 0 | 0 | 0 | 0 |
| Water production and supply | 0 | 0 | 0 | 0 |
| Industrial sector change effect | -59009.76 | 20174.61 | -138194.99 | -177030.14 |

## 5. Conclusions and Policy Suggestions

Industrial imports made great contributions to protecting China's environment. In 2012, the imports reduced wastewater discharge by 711million cubic meters in China, which reduced its industrial wastewater discharge by 15% in that year. In 2015, the imports cut down China's wastewater discharge by 535 million cubic meters which reduced China's industrial wastewater discharge by 14%.

Obviously, the imports played an important role in reducing the discharge of industrial wastewater in China. Currently, water pollution is a serious problem in China. As a big importer of industrial products, the positive role of industrial import in reducing China's wastewater discharge should be paid more attention to.

The research results in this paper show that during 2012 and 2015, the decrease of China’s import industrial products increased the wastewater discharge by 590.1 million cubic meters in China, which is not conducive to improving China's environment so the industrial imports should be increased in order to alleviate China’s environmental protection pressures.

China's import structure should be optimized to increase the environmental benefits of industrial imports by cutting down China's tariffs of some industrial products. The research results in this paper shows that compared with the proportion of the imports with the higher wastewater emission reduction intensity in 2012, the proportion were significantly increased, which brought huge environmental benefits to China in 2015. The research results also shows that wastewater emission reduction intensity of import in paper, cultural and educational products, garment and leather, textile raw materials, chemicals electrical and machinery and equipments, transportation equipment manufacturing, metal products were higher. Therefore increase these imports reducing by cutting down their tariffs can further enhance the environmental protection benefits of China's industrial import.

## 6. References

[1] Ministry of the Environment of the People's Republic of China: 2017 China's Ecological Environment,Bulletin[EB/OL] http://www.mee.gov.cn/gkml/sthjbgw/qt/201805/W020180531606576563901.pdf, 2018-05-31.

[2] Office of the State Council. 2012. Appropriate expansion of imports to alleviate resource and environmental pressures [EB/OL]. Http://money. 163. Com/12/0331/03/7TT58LTC00253B0H. html.

[3] Wyckoff, A.W,J.M.Roop.1994.The implementation of Imports of Manufactured Products: Implications for International A agreements on Greenhouse Gas Emissions [J]. Energy Policy (22): 187-194.

[4] Dietzenbacher, E., Mukhopadhyay, K. An Empirical Examination of the Pollution Haven Hypothesis for India: towards a Green Leontief Paradox?[J].Environmental and Resource Economics,2007,36(4):427-449.

[5] Peters,G.P. China’s Growing $CO_2$ Emissions:A Race between Increasing Consumption and Efficiency Gains [J]. Environmental Science and Technology, 2007,41(17): 5939-5944.

[6] Li J S, Chen G Q, Lai T M, etal. Embodied Greenhouse Gas Emission by Macao [J]. Energy Policy, 2013, (59): 819-833.

[7] Wang Wenzhong, Cheng Yongming. Global Warming and Greenhouse Gas Emissions—The Problem of $CO_2$ Emissions in Sino-Japanese Trade[J].Ecological Economy,2006(7):22-25.

[8] Zhang Youguo. Energy and Environmental Costs of China's Trade Growth[J].Quantitative Economics & Technology Economics Research, 2009(1): 16-30.

[9] Xu Hui. Environmental Cost Transfer of China's Import and Export Trade——Based on Input-Output Model Analysis [J]. World Economy Study, 2010(1): 51-55.

[10] Kuang Yuanpei,Xie Jie. An Empirical Analysis of the Resource Effect and Environmental Effects of China's Agricultural Products Trade[J].International Trade Issues,2011(11):138-147.

[11] Ni Hongfu,Li Shantong,He Jianwu.Study on the Measurement of Trade Implicit Pollutants and the Green Transformation of Structure[J].China Population, Resources and Environment,2012,22(5): 164-169.

[12] Liu Xiangxia, Wang Rui, Chen Xuezhong. Analysis of China's Foreign Trade Eco-environment and Green Trade Transformation—An Empirical Study Based on Implicit Carbon[J].Resource Science, 2015(2): 280-290.

[13] Zhu Qirong, Wang Yuping, Liu Xuan. Environmental Benefits and Improvement Ways of Import Trade of Industrial Products—Based on the Analysis of Reducing Industrial Waste Gas and Wastewater Emissions [J]. International Economics and Trade Research, 2018(8): 34-48.

[14] Machado, G., R. Schaeffer, E. Worrell. Energy and Carbon Embodied in the International Trade

IOP Conf. Series: Materials Science and Engineering **730** (2020) 012060 doi:10.1088/1757-899X/730/1/012060

of Brazil: An Input Output Approach [J]. Ecological Economics, 2001, (39): 409-424.
[15] Chen Ying, Pan Jiahua, Xie Laihui. The Connotation Energy and Its Policy Implications inChina's Import and Export Commodities [J]. Economic Research, 2008(7): 11-25.