





Table 1. CO<sub>2</sub> emission coefficients of Chinese industrial divisions. Unit: wan tons CO<sub>2</sub>/hundred million yuan.

Industry	C <sup>d</sup>			E (1)			E (2)		
	2002	2005	2008	E <sup>d</sup>	E <sup>t</sup>	E <sup>d</sup> /E <sup>t</sup>	E <sup>d</sup>	E <sup>t</sup>	E <sup>d</sup> /E <sup>t</sup>
Agriculture	0.507	0.515	0.361	1.788	2.102	0.850	1.778	2.252	0.789
Mining industry(energy)	3.939	3.147	2.688	4.375	4.810	0.910	5.916	6.994	0.846
Mining industry (non-energy)	2.653	2.787	1.803	4.919	5.636	0.873	6.399	8.080	0.792
Food processing manufacturing	0.687	0.500	0.373	1.954	2.351	0.831	2.122	2.679	0.792
Textile industry and clothing industry	0.682	0.616	0.476	2.598	3.402	0.764	2.736	3.703	0.739
Wood-processing industry	0.834	0.830	0.495	3.236	4.129	0.784	3.342	4.281	0.781
Papermaking industry, printing industry	1.462	1.133	0.795	3.040	4.251	0.715	3.633	4.759	0.763
Petroleum processing industry	3.774	3.215	2.940	5.804	7.038	0.825	6.985	8.619	0.810
Chemical industry	4.200	3.288	2.404	6.646	7.948	0.836	7.055	8.755	0.806
Rubber and plastic product industry	0.807	0.815	0.572	3.699	5.131	0.721	4.082	5.305	0.769
Non-metallic production industry	4.966	4.521	2.974	7.670	8.552	0.897	6.960	7.873	0.884
Smelting processing industry of black metal	6.341	4.891	4.196	9.145	10.382	0.881	9.427	11.840	0.796
Metal product industry	0.958	0.809	0.531	5.206	6.505	0.800	4.942	6.673	0.741
Equipment manufacture industry	0.635	0.428	0.264	3.751	4.940	0.759	3.632	5.228	0.695
Instrument manufacture industry	0.331	0.141	0.113	1.620	3.449	0.470	1.808	4.036	0.448
Electrical machinery manufacturing industry	0.252	0.191	0.148	3.146	4.720	0.667	2.841	4.724	0.601
Communication equipment manufacturing industry	0.151	0.099	0.084	1.807	3.772	0.479	1.393	3.227	0.432
Transportation equipment manufacturing industry	0.396	0.251	0.168	3.178	4.233	0.751	2.896	4.267	0.679
Other manufacturing industries	1.459	0.905	0.518	3.242	4.375	0.741	3.067	4.251	0.721
Production and supply industry of electric power	4.033	2.037	1.524	4.038	4.945	0.817	4.319	5.186	0.833
Industry for production and supply of water	3.068	2.898	2.547	3.759	5.246	0.717	5.054	5.732	0.882
Construction industry	2.178	0.227	0.163	3.886	4.928	0.789	3.399	4.550	0.747
Wholesale, retail and catering industries	0.617	0.791	0.529	2.202	2.724	0.808	2.092	2.604	0.803
Transportation and postal service industries	2.514	3.218	2.753	4.882	5.591	0.873	4.945	5.728	0.863
Other service industries	0.468	0.383	0.310	1.823	2.322	0.785	1.827	2.463	0.742

E (1) denotes the complete discharge coefficient calculated according to input-output table (hereby, the direct consumption coefficient can be calculated) in 2000 and CO<sub>2</sub> direct emission coefficients in 2005. E (2) denotes the complete discharge coefficient calculated according to input-output table (hereby, the direct consumption coefficient can be calculated) in 2005 and CO<sub>2</sub> direct emission coefficients in 2005.

divided into the two parts of domestic input and import input, and  $A^d = \{x_{ij}^d/x_j\}$  represents the direct consumption matrix of domestic input among the intermediate use, in which,  $x_{ij}^d$  refers to the domestic input of department  $i$  consumed for the production of  $x_j$  output, and  $x_j$  refers to the total output of department  $j$ ;  $A^m = \{x_{ij}^m/x_j\}$  represents the direct consumption matrix of import input among the intermediate use, where  $x_{ij}^m$  refers to the import input of department  $i$  consumed for the production of  $x_j$  output.  $A = A^d + A^m$ . Then, the input-output model can be written as:

$$X^d = (I - A^d)^{-1}(Y^x + Y^d) \tag{1}$$

$$X^m = A^m X^d + Y^m = A^m (I - A^d)^{-1}(Y^d + Y^x) + Y^m \tag{2}$$

where  $Y^d$  and  $Y^x$  represent the domestic demand and export demand in the final demand respectively;  $Y^m$  refers to the part of import products directly used for domestic consumption.

$C^d = \{C_j^d/x_j\}$  represents the direct emission coefficient of CO<sub>2</sub> in unit output of various industries, where  $C_j^d$  refers to direct emission amount of CO<sub>2</sub> in department  $j$ . Then, the complete emission of domestic part in domestic unit output (i.e., the complete emission coefficient) is

$E^d = C^d(I - A^d)^{-1}$  in accordance with the input-output theory.

From the perspective of import substitution, the implicit CO<sub>2</sub> emission in the import products of China can be equivalent to saving the CO<sub>2</sub> emission in domestic production [8]. Therefore, it is assumed that the CO<sub>2</sub> complete emission coefficients of unit product manufactured in foreign countries are the same as that in China, then, the CO<sub>2</sub> emission saved for China through import is  $E^m = X^m E^d$ , and the domestic CO<sub>2</sub> emission generated by export is  $E^x = Y^x E^d$ .

### 3.2. Simulation Results and Analysis of Discharge Coefficient

OECD input-output table includes 48 departments, which is different from the division of Chinese economic department. Hence, with reference to the international standard industrial classification (ISIC) method, the classification and docking are conducted on the input-output table and the economy sectors, and finally they are merged to 25 departments (industry). Table 1 is the CO<sub>2</sub> emission coefficients of Chinese industrial divisions calculated according to the input-output model.

It is concluded from Table 1 that first CO<sub>2</sub> emission coefficient displays an obviously decreased trend. In the 25 industries in China, except "wholesale, retail and catering industries" and "transportation and postal service industries", CO<sub>2</sub> emission coefficient has an obviously decreased trend in other industries. Moreover, the reduction range of discharge coefficients are especially obvious for three industries such as "smelting processing industry of black metal", "metal product industry" and "chemical industry" with the highest direct discharge coefficients. It shows that energy conservation and emission reduction measures in various industries, especially, in the high discharge industries make obvious progress after Chinese accession to WTO. Secondly, complete discharge coefficient is significantly higher than that of direct discharge coefficient, and complete discharge coefficients in some industries increase. This suggests that degree of correlation among various Chinese domestic industries is higher, and unit output in each industry implies higher CO<sub>2</sub> emission of other industries. Because the complete discharge coefficients are calculated by the input-output table in 2000, input-output table in 2005, and direct emissions coefficients in 2005. Hence, the rise of complete discharge coefficient show that the correlation in some industries has a tendency to improve. Furthermore, this means that it may be one of the reasons for the reduction of direct emission coefficient in each industry that the CO<sub>2</sub> is

shifted to other industries. Thirdly, except a few industries, the proportion of CO<sub>2</sub> emission abroad implied in unit output of each industry obviously increases. Except the four industries of "papermaking and printing industries", "non-metallic products industry", "electric power production and supply industry" and "industry for production and supply of water", the proportion of CO<sub>2</sub> emission abroad implied in unit output of other industries to the all CO<sub>2</sub> emission is significantly increases. This shows that the degree that Chinese industries participate in the international vertical specialization obviously increases.

### CONCLUSION

This paper divides Chinese industrial CO<sub>2</sub> emission into two parts which are domestic emission and implicit carbon of import trade, and calculated carbon emission of export industry in China according to OECD input-output table. It shows that in China complete discharge coefficient is significantly higher than that of direct discharge coefficient, Chinese industries participate in the international vertical specialization obviously increases.

### CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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