The research on the import and export trade based on the low carbon economy

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Abstract – Low carbon economy has become a fashion in the world, China will inevitably join the club. But China's economy relies most on the trade, what influences will the task of carbon emission reduction and the implementation of the low carbon economy imposed on China's trade, in returns, what kind of influences will the import and export have on the carbon emissions? This paper will use some math ways to calculate the relation between carbon emissions and trade, try to find out the influences they put on each other. The results of this paper show that the carbon emissions reduction do have a negative impact on the export, and in return, the export and import will also infect the low carbon economy in long term, which is export will push up the low carbon economy to develop in a long view, and import will not be beneficial to the low carbon economy development.

Keywords: carbon emissions, trade, low carbon economy

So far, there are many authors conducted the correlation analysis between the import and export trade and the carbon dioxide emissions, Bai hongjv, Li Xiaozheng(2010)[3] analyze the regressive relation between China's carbon dioxide emissions and exports, it shows that the carbon emissions and export have a coinregration relationship, namely a long term stable relationship; the research results shows that the export trade volume has negative effect that cannot be neglected; Every 1% increase of export trade will bring carbon emissions increased by 0.33%; confirmed the proportional relationship between export trade and the carbon dioxide emission. Currently, domestic scholars have done research much often on the calculation of implicit carbon emissions, this paper analyze the relationship between import –export trade and indexes of trade competitiveness and intra-industry trade, and the long term effect that import and export have imposed on low carbon reduction.

1. Competiveness of export product and carbon emission

1.1 Competiveness of export product

Export product Competitiveness index is also called trade competiveness (TC), which is one of the commonly used indexes to analyze the international competiveness. TC says the proportion that one country's import and export trade balance accounts for the total import and export trade, namely

$$TC_t = (EX_t - IM_t)/(EX_t + IM_t) \qquad (1)$$

TC_t represents the Export product Competitiveness index of the 't' industry, EX_t is the export volume of the 't' industry, IM_t represents the import volume of the 't' industry.

TC index is a relative value of total trade, it eliminates the macroscopic factors which will bring the fluctuation, such as the economic expansion, inflation. No matter how much the absolute magnitude of the export and import is, TC index is between -1 and 1. The value of TC is much more close to the average level if it is more close to 0; If the index is -1, which will mean this is a industry only has import. The more close to -1, the competiveness of this industry is much weaker. While the index is 1, this is a industry only has export. The more close to 1, the competiveness of this industry is much stronger.

This paper analyzes the relationship between the export product competiveness and the carbon emissions of industries, trying to find out the relations between product competiveness and the carbon emissions.

1.2 Data sources

Currently, scholars from various countries calculate the carbon emission by using the method input-output assessment, this method's advantage is it can calculate the direct and indirect carbon emissions in the

manufacturing process of each product. This paper quotes the calculated result- 17 industries' carbon emission factor, at the same time, sorts out the corresponding the carbon emission factors and export product competiveness according to the SITC (Standard International Trade Classification) .The import and export data of industries is from the website of the ministry of commerce of China. Table 1 shows the export products competiveness and the carbon emission factors of nine representative industries.

Table1. export products competiveness and the carbon emission factors (ton \ ten thousand yuan)

SITC	2002TC index	2007TC index	2002 carbon emission factor	2007 carbon emission factor
0	0.472	0.456	0.1675	0.1439
1	0.435	0	0.3718	0.1478
2	-0.676	-0.856	1.0549	1.0502
3	-0.391	-0.68	4.4854	2.8813
4	-0.886	-0.921	0.3718	0.1478
5	-0.436	-0.281	1.4284	1.2533
6	0.044	0.363	0.6013	0.2289
7	-0.038	0.166	0.5578	0.8169
8	0.545	0.673	0.3565	0.6255

Carbon emissions of various industries are calculated by the carbon emission factors and the import and export volume of various industries from the website of the ministry of commerce of China.

1.3 Model

Use the export product competiveness index calculated by the SITC classification and import and export volume of industries, and carbon emission calculated by the import and export volume and the carbon emission factors to do the regression analysis, the regression equation is:

$$LnEC_{it} = \alpha_0 + \alpha_1 LnTC_{it} + \mu_i \qquad (2)$$

$LnEC_{it}$ is the logarithm of carbon emissions of t industry in i year.

$LnTC_{it}$ is the logarithm of the export product competiveness of t industry in i year.

If the calculation result α_1 is positive, it means that our export products competiveness and carbon emissions have proportional relations, which shows that China's mode of economic development of relying on export really depends on the carbon emissions, and the export products are of high carbon, high emissions; If it is negative, it is proved that China's export products competiveness and carbon emissions have inverse ratio relation, the more China export products, the more the competiveness of export products, the more the 'reduction' effect of carbon emissions.

1.4 Results and analysis

The regression results are as follows:

$$LnEC_{it} = 0.844 + 0.749 LnTC_{it} + \mu_i$$
$$(3)$$

From equation (3), we can see α_1 is positive, it proves that China's high competitive export products rely a lot on the carbon emissions, which means that China's export are most the high carbon emission, high consumption industries. If the 'carbon tariff' proposed by the developed countries is made true, it will bring a lot of barriers to China. From formula 1, we can see that a more competitive industry is an export surplus industry, α_1 is positive shows that China's export does bring the double pressure of carbon emissions and environment pollution; it is really a double-edged sword to develop a low-carbon economy in view of international business. On one hand, the export product structure of China determines the high carbon emissions of export products, the low carbon and the emission reduction put forward the high request of export products; on the other hand, low carbon economy is a kind of implementation of the sustainable development theory, it is an inevitable choice of China's development.

The result shows the high carbon quality of China's export products, China needs to adapt to the international trend of low carbon economy complete the carbon emission reduction target, speed up the upgrading of industries. Changing the mode of economic development is an inevitable choice of China.

2. Intra-industry trade and carbon emission

2.1 IIT-Index of Intra-industry Trade

Trade competitive index refers the ratio of a product's net export and the total export and import volume. If the ratio is positive, it means the country is a net exporter, the ratio is more close to 1, the stronger the product's international competitiveness is.

The index of industry inner trade: is used to measure a industry's intra-industry trade degree. The index calculation formula is:

$$IIT_i = 1 - |EX_i - IM_i| / (EX_i + IM_i)$$
$$(4)$$

IIT_i is the intra-industry trade index of I industry, EX_i is the export volume of i industry or product, IM_i is the import volume of i industry or product. The value

range of IIT_i is 0 to 1, if IIT_i is 0, it means there is no intra-industry trade; if IIT_i is 1, it means the product's export equals its import; the greater the value is, the higher the degree of intra-industry trade is.

Intra-industry trade index and its added value reflect a country's ability of adjusting its production ability when facing a broad international market. Thus it can be seen,

improve the intra-industry trade level, is an important means of improving trade competitiveness for a country.

Intra-industry trade and carbon emission relationship

The data of intra-industry trade is from the website of the ministry of commerce of China, the carbon emission factors are the same as data in table 2, table 3 shows the intra-industry trade data.

Table 2. Intra-industry trade data according to the classification of SITC

SITC	0	1	2	3	4	5	6	7	8
IIT2002year	0.528	0.547	0.324	0.609	0.114	0.564	0.956	0.962	0.455
IIT2007year	0.544	1	0.144	0.32	0.079	0.719	0.637	0.834	0.327

Calculate the carbon emission of the nine industries by the carbon emission factors in table 2 and the export and import volume, establish the follow regression equation:

$$LnEC_{it} = \beta_0 + \beta_1 LnIIT_{it} + \mu_1 \qquad (5)$$

$LnEC_{it}$ is the logarithm of carbon emission of t industry in i year

$LnIIT_{it}$ is the intra-industry trade index of i industry

The regression result is as follows:

$$LnEC_{it} = 1.016 - 0.165 LnIIT_{it} + \mu_1 \qquad (6)$$

From formula (5) we can see that, China's intra-industry trade index and the carbon coefficient has a negative correlation relationship, which means the higher the intra-industry trade index is, the less the carbon emission is. The result means the relatively balanced industry in China relies less on the carbon emission. The smaller the intra-industry index is, the bigger the carbon emission is. Most China's products are trade surplus products, which mean the products China exports much more are of high-consumption and high-pollution.

3. Analysis of carbon emission effect on import and export trade

3.1 The theoretical analysis of carbon emissions effect on international trade

Each coin has two sides, China's import and export trade development has double effect on the development of low carbon economy. On one hand, the development of international trade increases the foreign currency income of our country, promotes the development of economy, which means a lot to the economic development of China. Besides, the development of domestic economy and the promotion of people's living standard strengthens the domestic environment protection consciousness and low carbon emission reduction consciousness, the government has money and the mass basic to formulate and implement related low carbon policy, optimize the industrial structure , improve citizen's environmental protection awareness, advance the efficiency of the usage of energy, reduce carbon emission, finally establish a resource-friendly and

environment-friendly society . As far as the enterprises, under the modern trend of low carbon economy, enterprises will pay more emphasis on the usage of clean energy and the introduction and development of new technology in order to fulfill the task of low carbon emission reduction. These will definitely promote the development of China's low carbon economy, and accelerate the speed of meeting the goal of carbon reduction.

On the other hand, international trade export inevitably accelerates the energy consumption of China, speed up the environment damage speed, add barrier to low carbon reduction emission. In recent years, the industrial economy of China develops a lot , China exports from original primary raw materials to industrial manufactured goods, export relies on the fossil fuel much more and the environment pressure becomes heavier. Besides, some developed countries transfer the high carbon emission industries to China through the foreign direct investment, which add China's carbon emission.

This section tries to inspect the influence that international trade imposes on the carbon emission from two aspects of import and export. Unlike regression analysis before, this paper consider the hysteresis effect of import and export, not only considers the current import and export volume, but also the lag phase's import and export volume, tries to comprehensively consider the influence that import and export put on the low carbon economy.

3.2 Data resources

Carbon emissions data cannot be obtained directly, scholars calculate them by carbon emission factors. According to the <China statistics yearbook 2010>, we can see that in 2009, China consumes nearly 3.0667 billion tons of standard coal, the ratio of coal consumption is 70.4%, oil,17.9%, natural gas,3.9%, with water, nu clear power, wind power account for 7.8%. These clean energy-water, nuclear, wind are barely no carbon emission energy. So this paper also calculates China's carbon emission based on the three major energy- coal, oil, and natural gas.

$$EC = \sum_{i=1}^{n} C_i = \sum_{i=1}^{n} \delta_i \theta_i T \qquad i=1,2,3$$

$$(7)$$

EC represents the total carbon emission of China, C_i, δ_i, θ_i respectively represent the carbon emission volume, the ratio of total consumption of energy, the carbon emission factor of energy i

In this paper, referring to the method in XuGuangYue, SongDeYong (2010) [5], make the average value as the carbon emission factor of the three major energies (table3).

Table 3. carbon emission factors of coal, oil, natural gas（t-c/tce）

Data resources	coal	oil	Natural gas
DOE/EIA	0.702	0.478	0.389
Japan energy economy research center	0.756	0.586	0.449
China's science and technology commission	0.726	0.583	0.409
China's development and reform commission	0.747	0.588	0.444
AVERAGE	0.733	0.558	0.423

Figure1 and Table 4 show the total carbon emission of China since its reform and opening up.
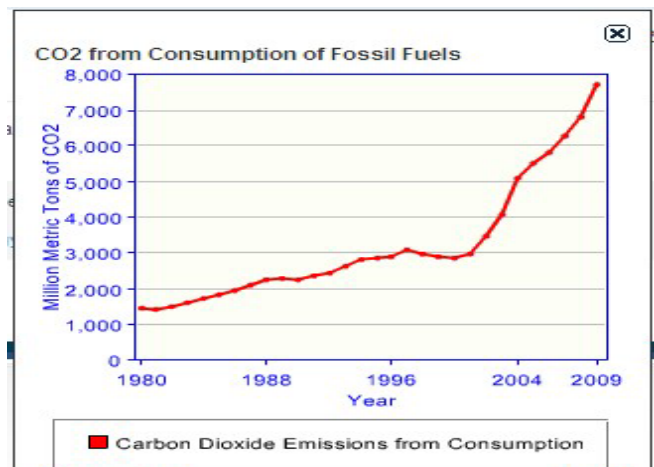
Figure1. Total carbon emissions of China from 1980 to 2009

Table 4. the total carbon dioxide emissions of China(million metric tons)

Year	emissions	Year	emissions
1980	1448.464	1995	2861.685
1981	1439.86	1996	2893.377
1982	1506.942	1997	3081.745
1983	1593.386	1998	2967.256
1984	1724.489	1999	2885.722
1985	1857.808	2000	2849.75
1986	1970.823	2001	2969.576
1987	2102.78	2002	3464.843
1988	2240.368	2003	4069.239
1989	2275.338	2004	5089.78
1990	2269.709	2005	5512.703
1991	2369.252	2006	5817.144
1992	2449.162	2007	6260.033
1993	2626.645	2008	6803.921
1994	2831.547	2009	7710.501

From figure 1 and table 4 we can see that since the reform and opening up in 1980s, China's carbon emissions grows steadily. From 1980s and 1990s, carbon emissions grows because the fast speed of industrialization , in 1999 to 2001, the demand of energy declines which leads to the decrease of the carbon emission. In the century 21, China's economy enters into a new stage of fast growing, the export is expanding, and

the domestic needs are improving. The demand of energy increased sharply. Although a lot of corresponding reduction policy has been conducted, it cannot stop the fast speed of carbon emission.

Table 4 shows the import and export trade volume in 1978-2009, the data is from the website of commerce department of China

Table5. The import and export trade volume of China in 1978-2009 (thousand billion Renminbi)

year	import	export	year	import	export
1978	108.9	97.5	1990	533.5	620.9
1979	156.8	136.5	1991	637.9	719.1
1980	195.5	182.7	1992	805.9	849.4
1981	220.2	220.1	1993	1039.6	917.4
1982	192.9	223.2	1994	1156.2	1210.1
1983	213.9	222.3	1995	1320.8	1487.8
1984	274.1	261.4	1996	1388.3	1510.5
1985	422.5	273.5	1997	1423.7	1827.9
1986	429	309.4	1998	1402.4	1837.1
1987	432.2	394.4	1999	1657	1949.3
1988	552.7	475.2	2000	2250.9	2492
1989	591.4	525.4	2001	2435.5	2661

3.3 Model

This paper establishes a regression model to calculate the relation between import and export trade and carbon emission, the model is as follows:

$$EC_i = \alpha_0 + \alpha_1 EC_{i-1} + \alpha_2 EC_{i-2} + \beta_0 EX_i + \beta_1 EX_{i-1}$$
$$+ \beta_2 EX_{i-2} + \gamma_0 IM_i + \gamma_1 IM_{i-1} + \gamma_2 IM_{i-2} + \mu_i$$
(8)

EC_i means the carbon emission of year i, EC_{i-1} is the carbon emission of year i-1, EC_{i-2} is the carbon emission of year i-2, EX_i is the export volume of year i, EX_{i-1} is the export volume of year I, EX_{i-2} is the export volume of year i-2, IM_i is the import volume of year I, IM_{i-1} is the import volume of year i-1, IM_{i-2} is the import volume of year i-2, μ_i is the error term, i represents the year, i=1980, 1981,1982,,,,2009.

In order to avoid the heteroskedasticity of all the variables, and logarithmic will not change the heteroskedasticity, so formula (7) can be changed into:

$$\ln EC_i = \alpha_0 + \alpha_1 \ln EC_{i-1} + \alpha_2 \ln EC_{i-2} + \beta_0 \ln EX_i$$
$$+ \beta_1 \ln EX_{i-1} + \beta_2 \ln EX_{i-2} + \gamma_0 \ln IM_i + \gamma_1 \ln IM_{i-1}$$ (10)
$$+ \gamma_2 \ln IM_{i-2} + \mu_i$$

3.4 Analysis and result

The regression result is as follows:

Table 6. parameters' value

parameters	α_0	α_1	α_2	β_0	β_1	β_2	γ_0	γ_1	γ_2
value	1.829	1.204	0.541	0.108	0.064	0.002	0.092	0.172	0.028

From the result of regression we can see that, the current period of carbon emission changes little compared with last year, the elastic coefficient is only positive 1.204, this result is consist with the fact. Because of the inertial effect of carbon emissions, current carbon emission will not change a lot in a short time.

β describe the relation between the export and carbon emissions, in the first two phases , β_0 and β_1 are positive, but β_2 is negative. China's export inevitably relies on the consumption of environment resources, which will bring the acceleration of carbon emission. And at the same time, besides the pressure that export brings to the consumption of energy and environment, it also increases the foreign currency income of our country, which will provides more money for the government to develop the low carbon economy, transform and upgrade the industrial structure, promote the low carbon consciousness of citizens. And at the same time, domestic export enterprises will initiatively take measures to meet the low carbon barrier, such as paying attention to the innovation and upgrading of the products and consume less unclean energy, this will reduce the carbon emissions in long term. The only shortage is the benefit of export will only appear in a long time.

The same as export, import also has two aspects on low carbon environment, a long term one and a short term one. γ_0 is positive with γ_1 and γ_2 are negative. Unlike export, import reduce the consumption of energies, lighten the pollution pressure of environment, thus in a short time import will decrease the carbon emission. But, import cost a lot foreign exchange reserves, reduce the national income which leads to the reduction of money that the government can put into the low carbon industry. So in long term, import plays a negative role on the reduction of carbon emissions and the development of low carbon economy.

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