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Correlation analysis on China's carbon emissions and its specific industrial structure- Based on grey correlation analysis model

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ABSTRACT

Industrial structure adjustment and the low carbon economy development are connected with each other and there exists intrinsic unification between the two of them. To discuss the issue of carbon emissions intensity based on the specific industrial structure is conducive to correctly judge and grasp the industry factors that result in the change of carbon emissions and effectively formulate industrial development policies for controlling carbon emissions. This paper based on the analysis of China's carbon emissions change trend, chose 28 major provincial data of carbon emissions, proportion of three industries, per unit of GDP carbon emissions during 2004－2011, studied correlation between China's carbon intensity, primary industry, secondary industry and tertiary industry, using gray correlation analysis method. And the following conclusions are obtained: The second industry is the main factor influencing the regional carbon intensity. There are 16 areas around the country that have the biggest correlation between secondary industry and carbon intensity. However, the second industry is not the only factor that affects regional carbon emissions increase. Tertiary industry does not have obvious effect on the reduce of regional carbon emissions. There are 11 areas around the country whose influence of the third industry on carbon emissions exceeds that of second industry, which needs to be brought to the forefront. The first industry has the minimal impact on carbon emissions intensity. There are only 4 areas around the country whose first industry's impact on carbon emissions intensity is not the minimal. In summary, there is no single, precise evolution law between industrial structure change and carbon emissions in different provinces domains in China. On this basis, this paper discusses carbon reduction strategy of industrial structure adjustment of our country in the future, so as to effectively control influence of the industrial development on carbon intensity.

KEYWORDS

Low carbon economy; Industrial structure; Carbon intensity; Grey correlation analysis.

INTRODUCTION

Currently, the low-carbon economy has become the focus of the world. Its goal is to realize the decoupling development of economic growth and carbon emissions[1]. Due to different national conditions and stage of development, the connotation of low carbon economy development in our country has essential difference with that of the developed countries. Developed countries have entered the post-industrial era with two-thirds of their carbon emissions come from the consumption field. While China is still in the middle stage of industrialization development, and more than 70% of the carbon emissions are from production areas, especially the field of industrial production[2]. Therefore, the low carbon economy of the developed countries mainly lies in the low carbon consumption, especially low carbon way of family life[3,4]. While China's low carbon economy mainly emphasizes the industry's low carbon development[5]. In 2009, the Chinese government announced its goal to the international community of reducing 40% - 45% of per unit of GDP carbon emissions intensity compared with 2005 until 2020. For the next 10 to 20 years, it is right the period which accomplishes the basic industrialized task and enters the industrial stage. This to a certain extent, has formed the biggest external pressure and restriction conditions to China's development of low-carbon economy, which also makes it more urgent for the Chinese industrial low carbon development task.

Although there are many researches on industrial structure adjustment of China currently[6-11], the existing researches are basically based on macro economy perspective and made qualitative analysis on the relationship between industrial structure adjustment and industrial low carbon development which are lack of necessary supporting data, as a result, this paper applied gray correlation analysis method to carry out an empirical analysis on the relationship between the industrial structure and carbon emissions intensity in our country. So as to put forward the future industrial development policies to control carbon emissions in China and provide the necessary scientific basis for low carbon economy development.

The status analysis of China's carbon emissions

According to the IPCC fourth assessment report, carbon dioxide (CO2) is one of the most important anthropogenic greenhouse gases. And global CO2 concentration increase is mainly due to the use of fossil fuels, such as coal, oil and gas[12]. Therefore, according to the actual circumstance of China's energy consumption and data availability, carbon emissions discussed in this paper mainly refers to the amount of CO2 emissions by burning fossil fuels in primary energy (coal, oil and natural gas).

Since there is no direct carbon emissions monitoring data in our country at present, most of current studies on the carbon emissions are based on the energy consumption, energy coefficient of carbon emissions[13-17]. Through comprehensive comparison and consider algorithm recognized degree and the variable data sources, calculation of carbon emissions in the paper uses the following formula:

$$C = \sum_i E_i \times S_i \times F_i \tag{1}$$

Among them, C is total carbon emission; E_i is the type i fossil energy consumption; S_i is the convert coefficient, F_i is the carbon emissions coefficient.

The fossil energy consumption data come from China Energy Statistical Yearbook. Fossil energy conversion coefficient of standard coal applies the numerical value stipulated in the book. That is, 1kg raw coal for 0.7143kg standard coal, 1kg crude oil for 1.4286kg standard coal, 1m^3 natural gas for 1.3330kg standard coal. The carbon emissions coeffeicents each country adopt are not exactly the same, see TABLE 1[18,19]. Based on China's national conditions, this paper selects the data from the Energy Research Institute of NDRC (National Development and Reform Commission).

TABLE 1 : Coefficient of carbon emissions of all kinds of energy(kg coal/kg standard coal)

Data sources	coal	Oil	gas
United States Department of Energy/Energy Information Administration	0.702	0.478	0.389
Institute of Energy Economics Japan	0.756	0.586	0.449
The national development and reform commission energy research institute	0.7476	0.5825	0.4435

Data source: Energy Research Institute, National Development and Reform Commission[18]; Wang Gang, Feng Xiao[19].

According to the current research results about China's carbon emissions, since 2004, fast growth was registered in China's carbon emissions[20]. And since the early 20th century, it has been a key period of our country's industrial structure adjustment. Therefore, this paper selects 2004-2004 as the sample time series and made an empirical analysis to explore the industial reasons for rapid growth of carbon emissions in our country. In this study, the required tertiary industry proportional data come from China statistical yearbook (2005-2012), fossil energy data come from Chinese calendar year energy statistical yearbook (2004-2011). Using the formula (1), the national and provincial carbon emissions in 2004-2011 can be calculated, as shown in TABLE 2.

TABLE 2 : The national and provincial carbon emissions during 2004－2011 (a hundred million t)

Region	2004	2005	2006	2007	2008	2009	2010	2011
nationwide	8.74	9.40	11.07	12.95	14.53	15.99	17.06	18.44
Beijing	0.18	0.18	0.19	0.21	0.22	0.23	0.25	0.26
Tianjin	0.19	0.19	0.20	0.23	0.25	0.25	0.27	0.26
Hebei	0.73	0.79	0.89	0.99	1.12	1.14	1.30	1.35
Shanxi	0.92	1.08	1.25	1.36	1.49	1.67	1.76	1.74
Inner Mongolia	0.34	0.37	0.45	0.64	0.76	0.89	1.02	1.26
Liaoning	0.79	0.83	0.89	1.06	1.11	1.16	1.21	1.22
Jilin	0.29	0.30	0.34	0.36	0.45	0.48	0.51	0.53
Amur River	0.48	0.50	0.56	0.62	0.70	0.74	0.78	0.85
Shanghai	0.30	0.31	0.35	0.37	0.40	0.38	0.38	0.41
Jiangsu	0.59	0.63	0.71	0.85	1.04	1.13	1.21	1.24
Zhejiang	0.38	0.42	0.47	0.60	0.69	0.78	0.89	0.89
Anhui	0.34	0.38	0.42	0.45	0.49	0.53	0.57	0.65
Fujian	0.14	0.17	0.20	0.23	0.28	0.31	0.35	0.37
Jiangxi	0.15	0.14	0.17	0.22	0.23	0.26	0.29	0.30
Shandong	0.70	0.94	1.14	1.39	1.79	2.02	2.18	2.28
Henan	0.60	0.67	0.70	0.95	1.15	1.34	1.50	1.53
Hubei	0.34	0.35	0.41	0.46	0.49	0.54	0.58	0.56
Hunan	0.25	0.26	0.30	0.35	0.49	0.52	0.57	0.54
Guangdong	0.48	0.51	0.59	0.66	0.72	0.82	0.92	0.96
Guangxi	0.12	0.11	0.14	0.17	0.19	0.21	0.25	0.24
Chongqing	0.15	0.15	0.14	0.17	0.19	0.22	0.25	0.32
Szechwan	0.28	0.33	0.43	0.49	0.47	0.53	0.60	0.67
Guizhou	0.28	0.29	0.38	0.44	0.49	0.58	0.60	0.58
Yunnan	0.16	0.18	0.23	0.16	0.35	0.40	0.40	0.42
Shaanxi	0.22	0.24	0.28	0.35	0.41	0.52	0.57	0.78
Gansu	0.20	0.22	0.25	0.28	0.29	0.31	0.35	0.35
Qinghai	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.09
Sinkiang	0.25	0.26	0.29	0.34	0.37	0.42	0.46	0.50

Note : hainan, ningxia and Tibet due to the lack of data sequence is unable to estimate.

Grey correlation analysis between carbon intensity and the industrial structure

Research method

There are a lot of econometric models of correlation analysis, such as the regression analysis, variance analysis, principal component analysis in mathematical statistics, etc. But these methods often require a large number of sample data, and have nothing to do with each other between various factors[21,22]. Carbon emissions is an uncertain system of incomplete information which is closely related with many factors in the process of industrial development, such as industrial structure, energy structure, technology level, etc. The result of joint action of many factors decides the development trend of the system. And, as mentioned above, China's carbon emissions data are either estimated or predicted currently and therefore is lack of accuracy. As a result, the econometric model is not applicable to the research of carbon intensity and its related influencing factors. In addition, the value of correlation between the carbon intensity and industry structure itself is not the key in this paper, what is more important is the rank of correlation between different industries and carbon emissions, so as to find out the future direction and focus of industrial structure adjustment to control carbon emissions. Through a comprehensive comparative analysis, this paper selects the gray correlation analysis method to reflect the relationship between carbon emissions intensity and the industrial structure. On the basis of uncertain information, the correlation degree between uncertainties can be well described as well as main factors and secondary factors causing changes in the system, to grasp the main characteristics of things, promote and guide the rapid and effective development of the system. As a result, it is widely used in the economy, transportation, education and other fields.

Model building

The basic idea of grey correlation degree is to judge whether the connection between different sequences is close according to the sequence curve geometric shapes. Based on the grey system theory put forward by professor Deng Julong, many scholars put forward different grey correlation models, such as gray comprehensive relational grade, gray slope-correlation , grey point correlation degree, etc[23]. Refer to the existing empirical model of the grey correlation; this paper set the carbon intensity as the system characteristics mother sequence, denoted by X0. National and provincial share of first, second, third industry production value accounted for gross domestic product is taken as industrial structure for the relevant factor sequence, denoted respectively by X1, X2 and X3, then:

$$X_i = \{x_i(1), x_i(2), \ldots x_i(n)\}$$

In the equation, i represents the mother sequence and compare sequence, i =0, 1, 2, 3; n is the time series length, n=8; Time series data of carbon emissions proportion and the proportion of primary industry, secondary industry, tertiary industry during 2004-2011 is taken as the original data sequence to calculate the gray relational grade and get the grey comprehensive correlation order, to determine the relationship between carbon intensity and industrial structure. The specific calculation steps are as follows:

(1) Request of absolute correlation degree. Gray absolute correlation degree is the characterization of similarity degree between X0 and Xi. The more similar between the two, the bigger the grey absolute correlation degree. Then:

$$X_0^0 = \left(x_0(1) - x_0(1), x_0(2) - x_0(1), \ldots, x_0(n) - x_0(1)\right) = \left(x_0^0(1), x_0^0(2), \ldots, x_0^0(n)\right)$$

$$X_i^0 = \left(x_i(1) - x_i(1), x_i(2) - x_i(1), \ldots, x_i(n) - x_i(1)\right) = \left(x_i^0(1), x_i^0(2), \ldots, x_i^0(n)\right)$$

Then, X_8, X_i^0 can be obtained as follows:

$$|s_0| = \left|\sum_{t=2}^{n-1} x_0^0(t) + \frac{1}{2} x_0^0(n)\right|$$

$$|s_i| = \left|\sum_{t=2}^{n-1} x_i^0(t) + \frac{1}{2} x_i^0(n)\right|$$

$$|s_i - s_0| = \left|\sum_{t=2}^{n-1} (x_i^0(t) - x_0^0(t)) + \frac{1}{2}(x_i^0(n) - x_0^0(n))\right|$$

Gray absolute correlation degree is as follows:

$$\varepsilon_{oi} = \frac{1 + |s_0| + |s_i|}{1 + |s_0| + |s_i| + |s_i - s_0|}$$

(2) Request of relative correlation degree. The grey relative correlation is the characterization of rate of change between X_0 and X_1. The closer the rate of change, the bigger the grey relative relational grade, then:

$$X_0^{'} = \left(\frac{x_0(1)}{x_0(1)}, \frac{x_0(2)}{x_0(1)}, \ldots, \frac{x_0(n)}{x_0(1)}\right) = \left(x_0^{'}(1), x_0^{'}(2), \ldots, x_0^{'}(n)\right)$$

$$X_i^{'} = \left(\frac{x_i(1)}{x_i(1)}, \frac{x_i(2)}{x_i(1)}, \ldots, \frac{x_i(n)}{x_i(1)}\right) = \left(x_i^{'}(1), x_i^{'}(2), \ldots, x_i^{'}(n)\right)$$

The initial value $X_o^{'}$, $X_i^{'}$ of the sequence can be obtained and initial point zero out value is:

$$X_0^{0'} = (x_0^{'}(1) - x_0^{'}(1), x_0^{'}(2) - x_0^{'}(1), \ldots, x_0^{'}(n) - x_0^{'}(1)) = \left(X_0^{0'}(1), X_0^{0'}(2), \ldots, X_0^{0'}(n)\right)$$

$$X_i^{0'} = (x_i^{'}(1) - x_i^{'}(1), x_i^{'}(2) - x_i^{'}(1), \ldots, x_i^{'}(n) - x_i^{'}(1)) = \left(X_i^{0'}(1), X_i^{0'}(2), \ldots, X_i^{0'}(n)\right)$$

$$|s_0^{'}| = \left|\sum_{t=2}^{n-1} x_0^{0'}(t) + \frac{1}{2} x_0^{0'}(n)\right|$$

$$|s_i^{'}| = \left|\sum_{t=2}^{n-1} x_i^{0'}(t) + \frac{1}{2} x_i^{0'}(n)\right|$$

By

$$|s_i^{'} - s_0^{'}| = \left|\sum_{t=2}^{n-1} (x_i^{0'}(t) - x_0^{0'}(t)) + \frac{1}{2}(x_i^{0'}(n) - x_0^{0'}(n))\right|$$

The grey relative correlation can be obtained:

$$r_{0i} = \frac{1+|s_0^{'}|+|s_i^{'}|}{1+|s_0^{'}|+|s_i^{'}|+|s_i^{'}-s_0^{'}|} \quad (3)$$

(3) Request of comprehensive correlative degree. Gray comprehensive relational grade both reflects the degree of sequence similarity and the proximity relative to the starting point of the change rate. It is a quantity index with more comprehensive characterization of whether there is close ties between sequences. Generally, we may take $\theta = 0.5$ to show equal attention of absolute value and change rate. By:

$$\rho_{0i} = \theta\varepsilon_{0i} + (1-\theta)r_{0i} \quad (4)$$

We can get grey comprehensive relational grade ρ_{0i} between carbon emissions and three industries. And based on the value of ρ_{0i}, comprehensive correlation order of tertiary industry impact on carbon emission can be obtained, to determine its influence on carbon emissions.

Empirical Calculation

In order to accurately reflect the relationship between carbon intensity and industrial structure, we take national data for example to make a detailed description of the grey correlation calculation process. Numerical values of X_0 and X_i are respectively as follows:

$$X_0 = (8.74, 9.40, 11.07, 12.95, 14.53, 15.99, 17.06, 18.44)$$
$$X_1 = (14.4, 13.7, 12.8, 13.4, 12.2, 11.3, 11.1, 11.3)$$
$$X_2 = (45.1, 44.8, 46.0, 46.2, 47.7, 48.7, 48.5, 48.6)$$
$$X_3 = (40.5, 41.5, 41.2, 40.4, 40.1, 40.0, 40.4, 40.1)$$

By formula (2), absolute correlation degree between primary, secondary and tertiary industry and carbon emission is:

$$\varepsilon_{01} = 0.51, \varepsilon_{02} = 0.70, \varepsilon_{03} = 0.51$$

By formula (3), we can get the relative correlation degree:

$$r_{01} = 0.55, r_{02} = 0.59, r_{03} = 0.56$$

By formula (4), we can get the comprehensive correlative degree:

$$\rho_{01} = 0.53, \rho_{02} = 0.65, \rho_{03} = 0.54$$

According to the above steps, we can get the correlation degree between main provincial carbon intensity and primary, secondary and tertiary industry, as shown in TABLE 3:

TABLE 3 : Grey correlation degree between national and provincial carbon intensity and industrial structure

District	primary industry			secondary industry			tertiary industry			results
	ε_{01}	r_{01}	ρ_{01}	ε_{02}	r_{02}	ρ_{02}	ε_{03}	r_{03}	ρ_{03}	
nationwide	0.505	0.548	0.526	0.700	0.591	0.646	0.513	0.559	0.536	X2>X3>X1
Beijing	0.525	0.554	0.540	0.508	0.594	0.551	0.509	0.813	0.661	X3>X2>X1
Tianjin	0.529	0.565	0.547	0.512	0.793	0.652	0.509	0.598	0.554	X2>X3>X1
Hebei	0.517	0.559	0.538	0.581	0.619	0.600	0.539	0.570	0.553	X2>X3>X1
Shanxi	0.512	0.542	0.527	0.550	0.646	0.598	0.509	0.551	0.530	X2>X3>X1
Inner Mongolia	0.505	0.525	0.515	0.532	0.603	0.568	0.516	0.530	0.523	X2>X3>X1
Liaoning	0.574	0.589	0.582	0.606	0.631	0.619	0.522	0.586	0.554	X2>X3>X1
Jilin	0.513	0.560	0.536	0.549	0.620	0.585	0.619	0.596	0.607	X3>X2>X1
Amur River	0.735	0.629	0.682	0.535	0.581	0.558	0.791	0.596	0.694	X3>X1>X2
Shanghai	0.554	0.561	0.557	0.581	0.654	0.618	0.595	0.624	0.609	X2>X3>X1
Jiangsu	0.511	0.540	0.525	0.558	0.608	0.583	0.539	0.554	0.547	X2>X3>X1
Zhejiang	0.510	0.533	0.522	0.590	0.570	0.580	0.607	0.573	0.590	X3>X2>X1
Anhui	0.508	0.554	0.531	0.607	0.598	0.602	0.530	0.679	0.605	X3>X2>X1
Fujian	0.513	0.533	0.523	0.528	0.581	0.554	0.540	0.539	0.540	X2>X3>X1
Jiangxi	0.508	0.550	0.529	0.507	0.817	0.662	0.506	0.554	0.530	X2>X3>X1
Shandong	0.509	0.523	0.516	0.581	0.572	0.576	0.510	0.526	0.518	X2>X3>X1
Henan	0.508	0.535	0.521	0.555	0.603	0.579	0.533	0.542	0.538	X2>X3>X1
Hubei	0.682	0.615	0.649	0.509	0.568	0.539	0.530	0.682	0.606	X1>X3>X2
Hunan	0.519	0.545	0.532	0.600	0.569	0.586	0.686	0.559	0.623	X3>X2>X1
Guangdong	0.514	0.546	0.530	0.582	0.598	0.590	0.745	0.578	0.661	X3>X2>X1
Guangxi	0.514	0.555	0.534	0.525	0.629	0.577	0.602	0.563	0.582	X3>X2>X1
Chongqing	0.514	0.571	0.543	0.530	0.661	0.595	0.597	0.616	0.606	X3>X2>X1
Szechwan	0.516	0.542	0.529	0.551	0.588	0.570	0.544	0.546	0.545	X2>X3>X1
Guizhou	0.506	0.539	0.523	0.536	0.613	0.574	0.563	0.588	0.575	X3>X2>X1
Yunnan	0.506	0.530	0.521	0.520	0.611	0.570	0.511	0.542	0.523	X2>X3>X1
Shaanxi	0.511	0.532	0.522	0.522	0.608	0.565	0.511	0.535	0.523	X2>X3>X1
Gansu	0.513	0.558	0.535	0.558	0.603	0.581	0.551	0.615	0.583	X3>X2>X1
Qinghai	0.515	0.559	0.537	0.508	0.714	0.611	0.512	0.569	0.540	X2>X3>X1
Sinkiang	0.579	0.568	0.574	0.532	0.633	0.583	0.514	0.562	0.538	X2>X1>X3

Note: the result is on the basis of comprehensive correlation degree.

RESULT AND ANALYSIS

TABLE 4 shows the average value of the proportion of tertiary industry accounting for gross domestic product, average value of per unit of GDP carbon emissions as well as the decreasing amplitude.

TABLE 4 : Each mean value of the tertiary industry and carbon emission

District	primary industry(%)	secondary industry (%)	tertiary industry (%)	Per unit of GDP carbon emissions (t/Million)	decreasing amplitude of per unit of GDP carbon emissions(%)
	12.5	47.0	40.5	0.75	-4.12
nationwide	2.0	31.8	66.2	0.35	-12.21
Beijing	3.2	54.0	42.8	0.70	-11.43
Tianjin	14.6	51.9	33.5	1.12	-6.43
Hebei	7.2	57.1	35.7	3.76	-8.70
Shanxi	17.0	47.2	34.5	1.87	-3.86
Inner Mongolia	10.6	50.2	39.2	1.35	-7.44
Liaoning	17.6	45.2	37.2	1.15	-6.52
Jilin	12.0	55.2	32.8	1.26	-5.12
Amur River	1.2	48.1	50.7	0.44	-8.77
Shanghai	8.6	54.8	36.6	0.54	-6.01
Jiangsu	7.1	53.0	39.9	0.50	-4.25
Zhejiang	18.7	44.0	37.3	0.93	-5.87
Anhui	12.7	48.0	39.3	0.39	-0.49
Fujian	19.1	45.7	35.2	0.58	-5.50
Jiangxi	11.3	54.8	33.9	0.88	-2.65
Shandong	17.8	51.8	30.4	1.04	-3.13
Henan	15.3	46.1	38.7	0.74	-5.63
Hubei	19.1	40.8	40.2	0.63	-1.51
Hunan	7.2	51.8	41.0	0.34	-7.06
Guangdong	22.8	38.2	39.0	0.45	-6.48
Guangxi	14.3	43.6	42.1	0.67	-5.54
Chongqing	20.3	42.3	37.4	0.66	-2.86
Szechwan	20.1	41.9	38.0	2.39	-5.66
Guizhou	17.2	42.9	37.5	0.82	4.56
Yunnan	12.8	50.1	37.2	1.10	-0.19
Shaanxi	16.7	46.0	37.3	1.54	-6.86
Gansu	12.0	49.2	38.8	1.12	-3.77
Qinghai	19.0	45.2	35.8	1.46	-5.01

Based on TABLE 4 and TABLE 2, we can draw the following conclusions:

(1) the secondary industry has the greatest impact on carbon intensity but it is not the only factor. From the national level, the influence of three industries on carbon emissions intensity based on the correlation can be ranked as second industry> third industry> first industry. From regional level, there are 16 areas among the 28 provinces and autonomous regions in China which have the biggest correlation between secondary industry and carbon intensity. They are, respectively, in tianjin, hebei, shanxi, Inner Mongolia, liaoning, Shanghai, jiangsu, fujian, jiangxi, shandong, henan, sichuan, yunnan, shaanxi, qinghai and xinjiang. Among which 10 regions' secundiparity rate exceeds more than 50%, as shown in

TABLE 4, which is far greater than the proportion of first and tertiary industry, suggesting that the rapid development of the secondary industry is the main factor prompting regional carbon intensity increases. However, this does not mean that a regional secondary industry which occupies a large share in the national economy can inevitably produce higher carbon emissions. Take the three municipalities directly under the central government Beijing, Tianjin and Shanghai as examples, Tianjin is a typical "two, three, one" industrial city while Beijing and Shanghai are two cities which truly achieve the "three, two, one" industrial structure in China. It can be seen from TABLE 4 that the mean value of Tianjin per unit of GDP carbon emissions in 2004-2011 is 7000 t/one hundred million yuan which is less than the national average value of 7400 t/ one hundred million yuan. Though seen from the absolute value, Tianjin per unit of GDP carbon emissions still ranked 12 in the 28 provinces and cities in the country, its rate of descent ranked second in the country which is only slower than Beijing while faster than Shanghai. This shows that development of secondary industries is not directly linked with high carbon emissions.

(2) the reduce effect of third industry regional carbon emissions intensity is not obvious and thus needs attention to be paid. On the whole, there are 11 regions which have the biggest correlation between third industry and carbon intensity, including Beijing, heilongjiang, jilin, zhejiang, anhui, hunan, guangdong, guangxi, chongqing, guizhou, gansu. Beijing is one of the cities which truly achieved the "321" industrial structure in our country. The third industry has become its leading industry with the national economy's share of 66.20%. The industrial structure to a certain extent makes the third industry the main source of carbon emissions in Beijing. However, its per unit of GDP carbon emissions intensity is significantly lower than other regions which ranked second in the country. This to a certain extent suggests that third industry belongs to the low carbon industry and rapid development of the tertiary industry helps to reduce the strength of regional carbon emissions. However, seen from Guangdong province that's per unit of GDP carbon emissions intensity is the lowest in China, despite its economic structure is given priority to the second industry, the main factors affecting carbon emissions in the province is the third industry. This requires us to think seriously about low carbon effect problem of the tertiary industry. Guangdong belongs to the forefront of reform and opening to the outside areas in China, the national preferential policies and its advantageous geographical location lead to an overall relatively developed economy. Ecological level is relatively high with the minimum per unit of GDP carbon emissions intensity. But during the past 30 years of reform and opening up process, Guangdong province has the "Heavy production, light service" policy, its government set up and policy subject are almost entirely focused on the industrial manufacturing services. Industrial development level is much higher than the service industry development level and low carbon effect of third industry didn't get to play. At the same time, there also exist the policy bias of “Heavy secondary industry, Light tertiary industry” in other provinces to varying degrees. The relevant government departments should attach great importance to this phenomenon.

(3) The development of primary industry has the minimal impact on carbon intensity. No matter from the national level, or local level, the research results show that development of primary industry has the minimal impact on carbon intensity. In the 28 provinces domain, only in liaoning, heilongjiang, hubei and xinjiang 4 regions are the primary industry impact on carbon emissions not the minimum. Historically, the four provinces are big agricultural provinces of our country. In order to keep the advantage of the first industry, all of the four provinces are taking active measures to promote the development of agriculture. Besides, the government also provides vigorously support to their development of the first industry and leads to a higher proportion of the first industry in the gross national product (GNP). This is the primary cause which results in the great impact of the first industry on carbon intensity.

CONCLUSION

To sum up, second industry is the main factor influencing the regional carbon intensity. There are 16 areas around the country that have the biggest correlation between secondary industry and carbon intensity. However, the second industry is not the only factor that affects regional carbon emissions increase. Tertiary industry does not have obvious effect on reduce of regional carbon emissions. There are 11 areas around the country whose influence of the third industry on carbon emissions exceeds that of second industry, which needs to be brought to the forefront. The first industry has the minimal impact on carbon emissions intensity. There are only 4 areas around the country whose first industry's impact on carbon emissions intensity is not the minimal.

Therefore, the central government should accelerate the low carbon development of the second industry, pay attention to the difference between direct and indirect carbon emissions in the process of industrial development and formulate appropriate policies and measures. Reduce direct carbon emissions of energy intensive industrial sectors through eliminating backward production capacity, optimizing energy consumption structure and developing environmental conservation industries. Also, the materialization reduction development of the intermediate input production process of production should be strengthened; second, attach great importance to the low carbon development of the tertiary industry. At the same time of increasing the proportion of the tertiary industry, the government should pay attention to optimization of the third industry internal structure. Raise the level of the development of service industry to prepare for promoting regional industrial structure and reducing industrial carbon emissions intensity; again, pay attention to low carbon effect of agricultural development. Realize the innovation of agricultural development system, transformation of the mode of agricultural development. Promote circulation agriculture model and low carbon agricultural technology; realize zero discharge of carbon in the agricultural system. Meanwhile, play the carbon sink function of agricultural system, select conditional areas for the construction of various forms of agricultural carbon sinks test areas, including the woodland, grassland, fishery, etc. Strengthen the carbon sequestration ability of agricultural system, reduce the actual carbon emissions in the process of economic development; finally, establish and implement different spatial scales of low carbon development policy. Respect the heterogeneity of local economic development. Comprehensively consider the provinces domain between industrial structure and carbon emissions associated characteristics of the different. Formulate suitable low carbon development measures, including the direction of industrial structure adjustment, quantitative differentiation of carbon emission reduction. This is not only beneficial to plan as a whole the region economy development, but can also improve the local development of low carbon economy, the enthusiasm of controlling carbon emissions. Each region also should combine their characteristics of the industrial structure to find their own low-carbon development path. To develop targeted policies and measures with emphasis and promote low-carbon development in the region.

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