Study on the Harmonious Development of Carbon Emission and Eco-environment in Logistics Industry -- Taking Beijing-Tianjin a- Hebei as an example

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Abstract. As the capital economic circle of China, Beijing-Tianjin-Hebei has always been a model for national development, but with the development of its economy, environmental issues have increasingly attracted the attention of the state. I Combined with the current background of the times, it is necessary to study the carbon emissions of the logistics industry in Beijing-Tianjin-Hebei. Through the research on the carbon emission situation of the logistics industry in Beijing-Tianjin-Hebei in the past ten years, the sample data was selected to construct the coupling index system of carbon emission and ecological environment in the logistics industry. The coupling model and the system coupling coordination degree model were analyzed to obtain the Beijing-Tianjin The coupling coordination degree of the vast ecosystem is in a relatively coordinated development stage, showing a trend of rising volatility. In response to this summary, the opinions on optimizing the industrial structure of the logistics industry and jointly controlling carbon emissions with the state and enterprises are given, in order to finally realize the low-carbon transformation and sustainable development of the logistics industry.

Keywords: ecological environment; carbon emission; system coupling model; coordination degree.

1. Introduction and literature review

Since the industrial revolution, the endothermic greenhouse gases such as carbon dioxide emitted by humans into the atmosphere have increased year by year, and the greenhouse effect of the atmosphere has also increased, causing a series of extremely serious problems such as global warming. After years of economic development and extensive economic growth in China, carbon emissions have suddenly increased. In this context, China has proposed the concept of a low-carbon economy, not maintaining economic development at the expense of the environment, and maintaining economics while saving energy and reducing emissions. development of.

Chinese scholars' research on economic development and ecological environment is relatively late compared to foreign countries, but it is gradually improving. At present, the models used in economic development and ecological environment research mainly involve coupling coordination degree model, fuzzy comprehensive evaluation, principal component analysis and analytic hierarchy process. For
example, Baoli Song (2015) used principal component analysis and fuzzy membership model to study the coordination of economic development and ecological environment in the western region. The research shows that the economic development and ecological environment in most parts of western China are in an uncoordinated state [1]. Rongtian Zhang et al. (2015) used the improved entropy method to calculate the comprehensive scores of ecological environment and economic development, and used the coupling coordination degree model to analyze the coupling degree and its evolution between the two. Kong Wei et al. (2016) adopted the evaluation index system for constructing the coordination degree between ecological environment and economic development, and introduced the coupling degree model [2]. Zhichuan Zhu (2018) measured the coordination between China's ecological environment and economic development by establishing a coupled coordination model of ecological environment and economic development [3]. Guofeng Gu et al. (2018) constructed the coupling degree model based on the grey correlation model and analyzed the main factors affecting the coupling system [4].

In summary, by combing the literature at home and abroad, we can find that domestic and foreign scholars have made certain achievements in the exploration of the coordinated development of the ecological environment and economy. However, in empirical research, the research model is too singular.

2. Method and theoretical basis
The development of the Beijing-Tianjin-Hebei logistics industry relies mainly on coal-based fuels such as raw coal and coke. Due to the small proportion of clean energy, the energy structure of the logistics industry is still unreasonable. The coupling between the energy consumption of the logistics industry and the ecological environment is the relationship between the two. The whole system is divided into three parameters of carbon emission, energy consumption and ecological environment, and the index system of ecological environment system is constructed. Then the coupling coordination degree of the whole ecological environment system is measured by the coupling system coordination degree model. With certain innovation, and finally based on the results of the assessment, put forward targeted recommendations.

Beijing’s carbon emissions data, energy consumption sub-data from the "Beijing Statistical Yearbook", Tianjin carbon and carbon emissions data, energy consumption sub-data from the "Tianjin Statistical Yearbook", Hebei Province carbon emissions, energy consumption data from "Hebei statistics Yearbook, Eco-environment system indicator data from the China Environmental Statistics Yearbook.

Calculation of carbon emissions. Considering that the logistics industry mainly involves four kinds of energy inputs such as raw coal, coke, crude oil and natural gas. In the calculation of carbon dioxide emissions, this paper mainly focuses on these four kinds of energy sources. The calculation uses the primary carbon emission coefficient, standard coal conversion coefficient and related measurement methods published in the IPCC National Greenhouse Gas Inventory 2006 to measure the carbon emissions of the manufacturing industry. The carbon emission coefficient and standard coal conversion coefficient for various energy sources are shown in Table 1.

| Energy type       | Raw coal | coke  | crude oil | natural gas |
|-------------------|----------|-------|-----------|-------------|
| Carbon emission coefficient | 0.755    | 0.855 | 0.585     | 0.448       |
| Standard coal coefficient | 0.714    | 0.971 | 1.428     | 0.330       |

Note: unit of coal emission coefficient, tons of carbon / ton of standard coal, natural gas equivalent standard coal coefficient kg / cubic meter
The formula for calculating the total amount of CO\(_2\) emissions is as follows

\[
CE = \sum C_i = \sum_{i=1}^{4} M_i \times N_i \times EC_i \times P
\]  

(1)

Among them, CE indicates the total amount of carbon dioxide emissions in the year; C\(_i\) generation indicates the carbon emissions of the i-th energy; M\(_i\) indicates the energy consumption (ten thousand...
tons); N_i indicates the converted standard coal coefficient; EC_i indicates the carbon emission coefficient, P Indicates the number of people engaged in the logistics industry in the current period. The energy consumption data of Beijing-Tianjin-Hebei 2009-2018 was selected as a research sample, and the carbon emissions of energy consumption in the logistics industry were calculated using Equation (1). As shown in Figure 1.

![Figure 1. Energy consumption statistics of the Beijing-Tianjin-Hebei logistics industry (unit: 10,000 tons of standard coal)](image)

3. Model construction and analysis

3.1. Carbon Economy - Energy Consumption - Coupling Mechanism of Ecological Environment System

The coupling mechanism between the carbon emissions, energy consumption and ecological environment systems in the logistics industry is as follows: The optimization and improvement of the carbon emission system can promote the improvement of the energy consumption structure and the improvement of the ecological environment, which is bound by energy and environmental factors. Changes in energy consumption structure and changes in utilization rates will promote social and economic transformation and accelerate environmental change; the ecological environment is a feedback on carbon emissions and energy consumption, while giving both pressure.

3.2. Determination of indicator weights

In this paper, the entropy method is used to determine the weight. The entropy method is an objective weighting method that determines the weight of an indicator according to the degree of dispersion of each indicator. The specific steps are as follows:

Step 1: Standardize each indicator, assuming x objects, y indicators.

Positive indicator:

\[ P_{ij} = \frac{a_{ij} - \min \{a_{ij}\}}{\max \{a_{ij}\} - \min \{a_{ij}\}} \quad (i = 1,2, \ldots, x; j = 1,2, \ldots, y) \]  

(2)

Negative indicators:

\[ P_{ij} = \frac{\max \{a_{ij}\} - a_{ij}}{\max \{a_{ij}\} - \min \{a_{ij}\}} \quad (i = 1,2, \ldots, x; j = 1,2, \ldots, y) \]  

(3)

Calculate the entropy of the j-th indicator:

\[ E_j = -\frac{1}{\ln x} \sum_{i=1}^{x} \left( P_{ij} \ln P_{ij} \right), E_j \in [0,1] \]  

(4)

Calculate the difference coefficient:
Calculating indicator weights:

\[ W_j = \frac{g_j}{\sum_{j=1}^{x} g_j} \]  \tag{6}

The interaction and overall development level in the process can better evaluate the overall harmony of economic development and ecological environment interaction \[5\]. The specific coupling and coordination standards are shown in Table 2.

| Coupling coordination interval | Coordination level       | Coupling coordination interval | Coordination level       |
|-------------------------------|-------------------------|-------------------------------|-------------------------|
| [0,0.09]                      | Extreme imbalance       | [0.5,0.59]                   | Reluctant coordination  |
| [0.1,0.19]                    | Serious disorder        | [0.6,0.69]                   | Primary Coordination    |
| [0.2,0.29]                    | Moderate imbalance      | [0.7,0.79]                   | Intermediate coordination|
| [0.3,0.39]                    | Mild imbalance          | [0.8,0.89]                   | Good coordination       |
| [0.4,0.49]                    | On the verge of imbalance | [0.9,1]                    | Quality coordination    |

Assume that the original index values of subsystems such as carbon emissions, energy consumption, and ecological environment for respectively \( A_y, B_y, C_y, X_y, Y_y, Z_y \) correspond to their standard values, then the three-system evaluation function is as follows:

Carbon emission system:

\[ \alpha_i(x) = \sum_{j=1}^{n} W_i x_j \quad j = 1, 2, \ldots, n \]  \tag{7}

Energy consumption system:

\[ \beta_i(y) = \sum_{j=1}^{n} W_j y_j \quad \beta_i(y) = \sum_{j=1}^{n} W_j y_j \]  \tag{8}

Ecological environment system:

\[ \gamma_i(z) = \sum_{j=1}^{n} W_j z_j \quad j = 1, 2, \ldots, n \]  \tag{9}

Then the coupling formula of the energy carbon emission system of the Beijing-Tianjin-Hebei logistics industry is as follows:

\[ M = \left\{ \frac{\alpha_i(x)\beta_i(y)\gamma_i(x)}{\alpha_i(x)+\beta_i(y)+\gamma_i(x)} \right\}^{\frac{1}{3}} \]  \tag{10}

This paper selects the total carbon emissions, per capital carbon emissions, carbon emission intensity, carbon productivity as secondary indicators, and their numerical increase will increase environmental pollution, so they are negative indicators. The consumption of coal, oil, natural gas and other resources in the energy consumption index will lead to environmental pollution. Therefore, the secondary
indicators of the energy consumption system subsystem are positive indicators except for the new energy and fossil fuel, and the rest are negative indicators. The total amount of exhaust emissions in the Eco-environment system is a negative indicator, and the coverage of green land and the proportion of investment in pollutant treatment are positive indicators.

**Table 3.** Composite system coordination degree measurement index system

| System                   | Primary indicator                  | Secondary indicators                                                                 |
|--------------------------|------------------------------------|---------------------------------------------------------------------------------------|
| Carbon emission system   | Carbon emission level              | Total carbon emissions                                                               |
|                          |                                    | Per capita carbon emissions                                                          |
|                          |                                    | Carbon intensity                                                                      |
|                          |                                    | Carbon productivity                                                                  |
| Energy consumption system| Energy consumption structure       | Coal consumption                                                                     |
|                          |                                    | Oil consumption                                                                       |
|                          | Energy efficiency level            | Natural gas consumption                                                               |
|                          |                                    | New energy and fossil energy consumption ratio                                        |
| Ecological environment system | Environmental stress level    | Energy consumption                                                                   |
|                          |                                    | Unit GDP energy consumption                                                          |
|                          | Environmental protection level     | Total exhaust emissions                                                              |
|                          |                                    | Green space coverage                                                                 |
|                          |                                    | Pollution treatment investment proportion                                             |

According to the entropy method and the formula (2) and (3), the data is normalized by Python software, then use Python software to calculate the entropy, use Formulas (4) to (10), weight and score of each indicator separately. Finally, the degree of coordination is calculated by the coupling degree and the coupling coordination degree formula. The results are shown in Table 4.

**Table 4.** Coupling calculation of carbon emissions in the logistics industry of Beijing-Tianjin-Hebei

| Year | Beijing | Compound coordination | Tianjin | Compound coordination | Hebei | Compound coordination |
|------|---------|------------------------|---------|-----------------------|-------|-----------------------|
| 2009 | 0.725   | 0.564                  | 0.881   | 0.658                 | 0.703 | 0.713                 |
| 2010 | 0.796   | 0.641                  | 0.863   | 0.764                 | 0.862 | 0.699                 |
| 2011 | 0.841   | 0.435                  | 0.796   | 0.651                 | 0.697 | 0.658                 |
| 2012 | 0.937   | 0.364                  | 0.835   | 0.638                 | 0.725 | 0.541                 |
| 2013 | 0.954   | 0.456                  | 0.910   | 0.712                 | 0.699 | 0.608                 |
| 2014 | 0.886   | 0.549                  | 0.932   | 0.647                 | 0.874 | 0.713                 |
| 2015 | 0.801   | 0.401                  | 0.798   | 0.636                 | 0.756 | 0.686                 |
| 2016 | 0.769   | 0.399                  | 0.856   | 0.601                 | 0.804 | 0.647                 |
| 2017 | 0.620   | 0.610                  | 0.912   | 0.687                 | 0.647 | 0.498                 |
| 2018 | 0.601   | 0.553                  | 0.941   | 0.740                 | 0.629 | 0.526                 |

3.3. Model conclusion

Overall, the coordination degree of carbon emission, energy consumption and Eco-environmental composite system in Beijing-Tianjin-Hebei is spiraling upward. The coordination degree of Beijing composite system fluctuates within the interval [0.4, 0.49], [0.5, 0.59]. The disordered state is also constantly optimized and gradually developed, showing a coordinated development trend. The coordination degree of Tianjin's composite system is significantly higher than that of Beijing, and it fluctuates within the interval [0.6, 0.69] and [0.7, 0.79]. The coordination degree has been coordinated.
for the primary, mainly because there are many carbon emission and energy consumption systems in Tianjin. The growth is slow, while the order of the ecological environment subsystem is rising. The coordination degree of the compound system in Hebei Province is \([0.5, 0.59], [0.6, 0.69]\), mainly because the Hebei Provincial Government pays attention to carbon emissions, and has adopted certain policy measures. In recent years, it has achieved initial results.

4. Conclusions and recommendations
This paper believes that the research on the coordinated development of the entire complex system for the orderly development of the ecological environment should take measures to reduce pollution emissions and improve resource utilization efficiency, build a mechanism of ecological civilization, ease environmental pressure, and improve the order of the ecological environment. To promote the steady development of the three systems of industrial, economic, social development and ecological environment of Beijing-Tianjin-Hebei. The specific countermeasures suggest the following three points:

(1) Strictly observe the ecological red line and improve the efficiency of resource utilization. The government departments of Beijing, Tianjin and Hebei should standardize the ecological red line and resolutely prevent the high-pollution and high-energy consumption of the logistics industry from appearing in the ecological red line area.

(2) Deepening the reform of industrial structure, encouraging the development of environmentally-friendly and innovative enterprises, facilitating the adjustment of the economic growth structure, achieving optimal allocation of factors, reducing energy consumption, and reducing pollution emissions are the key to improving the orderliness of the ecological environment.

(3) In the task of carbon emission reduction in the industry, the implementation of new and old kinetic energy conversion work will greatly reduce the proportion of coal consumption and increase the promotion and use of clean fuels such as natural gas in the logistics industry.

References
[1] Baoli Song. Research on the coordination between economic development and ecological environment in the western region [J]. Western Economic Management Forum, 2015, 26 (02): 1-4.
[2] Wei Kong, Ren Liang, Shujia Wang, Yufeng Liu. Spatial and temporal evolution of coordinated development of ecological environment and economy in Hebei Province [J]. Chinese Journal of Applied Ecology, 2016, 27(09): 2941-2949.
[3] Zhichuan Zhu, Junxi Zhang. A Coupling and Coordination Analysis of Ecological Environment and Economic Development in China [J]. Journal of Jilin Normal University (Natural Science Edition), 2018, 39(03): 48-55.
[4] Guofeng Gu, Xuehui Wang. Time and space analysis of the coupling relationship between economic development and ecological environment in Northeast China [J]. Journal of Northeast Normal University (Philosophy and Social Sciences Edition), 2018(04): 154-160.
[5] Li Hong, Xie Yao. Research on the Coordinated Development of Regional Service Trade and Ecological Environment [J]. Guangxi Social Sciences, 2019(01): 65-69.