Research on coal supply and demand matching process based on carbon emission

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Abstract. The use of coal is an important part of China's energy use and an important source of economic development. Due to the need for sustainable development and environmental protection, the problem of uncoordinated transactions between the two parties in the transaction process has been closely watched by all sectors of society. Based on the current shortage of coal market transactions, this paper designs a coal supply and demand matching process considering carbon emissions from an intermediary perspective, aiming at reducing carbon emissions and improving matching efficiency.

1. Introduction
We have a huge population and huge energy consumption. Although the growth rate of coal production and consumption has slowed down in the context of increased national support for new energy, but coal still accounts for a large portion of energy consumption. The experience of e-commerce, lack of full consideration of the characteristics of coal, such as multi-attribute, multi-level, multi-purpose direction, it is difficult to achieve the best match between the two sides of the transaction, the impact of coal on the e-commerce platform is not satisfactory[1], comprehensive consideration It is of great practical significance to achieve optimal matching of supply and demand for various attribute indicators of coal. At the same time, in order to respond to the government's environmental protection requirements, this paper incorporates the carbon emission problem in the coal transportation process into the coal supply and demand matching decision, thereby promoting the development of coal market transactions to low carbon, high efficiency.

2. Literature review
Liu Yong[2] is equivalent to foreground theory and grey relational analysis, and proposes a new prospect-based bilateral matching decision model for matching the technical knowledge supply and demand assisted by brokers. In terms of dynamic matching, Zaefarian [3] pointed out that suppliers and customers should constantly adjust themselves in a dynamic environment to achieve maximum value. Research on coal supply and demand operations is focused on the coal supply chain. Through the research on the current coal situation, Dou Yuanyuan [4] summed up the relevant theories of the coal supply chain and analyzed the definition and structure of the coal supply chain. Yang Yang[5] established a regional energy supply chain elastic measurement model from the perspective of regional resource constraints. With the improvement of people's awareness of environmental protection, more and more scholars have strengthened research on low-carbon coal supply chain. Sun Xuejun [6] used the
ISM model to analyze the factors affecting the carbon supply of the coal supply chain and determined its relevance. In summary, this paper considers the characteristics of coal supply and demand matching, considers the carbon emissions during coal transportation, and establishes the coal supply and demand matching model with the highest matching degree and the lowest carbon emission.

3. Low carbon coal supply and demand matching problem description
Carbon supply and demand matching refers to the mapping relationship between supply and demand of coal products and services. It finds the best match based on the specific requirements of the coal supplier and the needs of third-party intermediaries to maximize the overall benefits. The process of planning. Coal supply and demand matching considering carbon emissions is based on information from both the supply and demand sides of third-party intermediaries. Pairing is based on the carbon emissions of the transport vehicle, achieving the highest satisfaction of coal suppliers and demanders as well as the transportation process. The carbon emissions during the matching process are the lowest, as shown in Figure 1.

![Diagram of coal supply and demand matching process](image)

**Figure 1.** Low coal supply and demand matching process

4. Low carbon coal supply and demand matching method

4.1. Matching degree calculation method based on axiom design
The company's design was originally proposed by Suh[7] et al. The basic meaning is that the least amount
Of information in all scenarios is the best solution. The level of expectation of the decision maker is
Considered to be the scope of the design, and the actual level of the indicator is considered to be system
Wide[8]. The intersection is a common area, as shown in Figure 2. The public scope reflects the degree of match between expected and actual levels.

![Diagram](image)

**Figure 2.** System axiom related concept design

4.2. *Calculation of carbon emissions during coal transportation*

In order to eliminate its influencing factors and improve accuracy, this paper adopts the carbon emission formula as follows

\[
P (\text{carbon emissions}) = e (\text{unit carbon emissions}) \times q (\text{mechanism}) \times s (\text{distance})[9]
\]

4.3. *Coal supply and demand matching process considering carbon emissions*

Coal supply and demand matching considering carbon emissions requires the highest matching between supply and demand sides, and requires matching schemes to have the lowest carbon emissions during transportation. Therefore, the entire matching process is shown in Figure 3.

![Diagram](image)

**Figure 3.** Coal supply and demand matching process considering carbon emissions

4.4. *Building a model*

According to the research in this paper, the following construction is done when building the model.

1. All suppliers have sufficient supply to meet the coal ordering needs of any demand side.
2. Each coal supplier generates a transaction with only one demand side.
3. The carbon emission factors are the same under the same mode of transport.
4. The effects of force majeure such as weather conditions on transportation vehicles are negligible.
The matching model includes a total of three objective functions: minimum supplier information, minimum demand side information, and lowest carbon emissions. And constructing the objective function model as

\[ \begin{align*}
\min Z_1 &= \sum_{i=1}^{n} \sum_{j=1}^{m} l_i x_{ij} \\
\min Z_2 &= \sum_{j=1}^{m} \sum_{i=1}^{n} l_j x_{ij} \\
\min Z_3 &= e \sum_{i=1}^{n} \sum_{j=1}^{m} q_{ij} s_{ij}
\end{align*} \]

The constraint function model is

\[ \begin{align*}
\sum_{j=1}^{m} x_{ij} &\leq 1 \quad i = 1, 2, \ldots, m \\
\sum_{i=1}^{n} x_{ij} &\leq 1 \quad j = 1, 2, \ldots, m \\
x_{ij} &\leq 1 \quad i = 1, 2, \ldots, m; \quad j = 1, 2, \ldots, n
\end{align*} \]

4.5. Empirical Research

A coal trading platform provides support for coal trading of coal enterprises and power generation companies. Eight coal companies and six power generation companies have released supply and demand information on the platform, and relevant information on corresponding indicators has been proposed according to their own needs. According to the expectation information of coal-fired enterprises on coal, the expectation information of coal enterprises on power generation enterprises, the actual transaction level of coal enterprises, the actual transaction level of power generation enterprises, the distance, and the demand for coal, we can obtain the matching between available coal enterprises and power generation enterprises. The degree is shown in Table 1 and Table 2.

### Table 1. Information on the degree of matching of power generation enterprises to coal enterprises

|       | P1   | P2   | P3   | P4   | P5   | P6   | P7   | P8   |
|-------|------|------|------|------|------|------|------|------|
| d1    | 8.006| 6.287| 2.180| 5.706| 2.171| 2.512| 6.841| 3.903|
| d2    | 10.656| 4.149| 5.195| 3.525| 1.619| 3.313| 9.452| 2.195|
| d3    | 2.859| 3.006| 5.211| ∞    | 5.600| 6.539| 3.362| 5.211|
| d4    | 2.880| 2.808| 5.347| ∞    | 4.895| ∞    | 3.606| 4.762|
| d5    | 6.400| 2.448| 5.626| 6.428| 4.573| 4.302| 3.828| 4.626|
| d6    | ∞    | 3.825| 5.064| 4.763| 2.818| 3.628| ∞    | 4.064|

### Table 2. Information volume of coal enterprises matching power generation enterprises

|       | d1   | d2   | d3   | d4   | d5   | d6   |
|-------|------|------|------|------|------|------|
| P1    | ∞    | 0.246| 0.246| 1.576| 1.035| 1.035|
| P2    | 2.899| ∞    | 0.000| 5.375| 6.375|      |
| P3    | 1.450| 2.318| 2.318| 0.340| 0.035| 1.035|
| P4    | 6.568| ∞    | ∞    | 0.974| ∞    | ∞    |
| P5    | 1.031| 3.296| 3.296| 0.974| 0.398| 1.398|
| P6    | ∞    | 1.318| 1.318| 1.567| 1.983| 0.983|
| P7    | 1.629| 0.000| 0.000| 0.629| 0.629|      |
| P8    | ∞    | 2.669| 2.669| 2.517| 1.136| 1.136|
According to the data, the unit carbon emissions of railway transportation are about 0.013kg / t* km, and the calculation results of carbon emissions between coal enterprises and power generation enterprises are shown in Table 3.

|       | d1     | d2     | d3     | d4     | d5     | d6     |
|-------|--------|--------|--------|--------|--------|--------|
| P1    | 690990 | 849807 | 983710 | 770649.6 | 947520 | 829080 |
| P2    | 723800 | 716562 | 1108730 | 688531.2 | 690900 | 1033060 |
| P3    | 713900 | 906066 | 1197560 | 1108598.4 | 1033060 | 891590 |
| P4    | 904750 | 657342 | 917910 | 758016 | 1112020 | 835660 |
| P5    | 789600 | 796509 | 825790 | 852768 | 825790 | 694190 |
| P6    | 967260 | 654498 | 1075830 | 843292.8 | 921200 | 681030 |
| P7    | 1000160 | 980091 | 1171240 | 1067539.2 | 1204140 | 1151500 |
| P8    | 868560 | 1033389 | 694190 | 1137024 | 677740 | 1108730 |

In this paper, the weight ratio of the target Z1, Z2, and Z is 4:4:2, and the final scheme can be calculated as (1-8, 2-7, 3-3, 4-5, 5-1, 6-6). That is, the best matching result is that the electric enterprise 1 and the coal enterprise 8 trade, the power generation enterprise 2 and the coal enterprise 7 transaction, the power generation enterprise 3 and the coal enterprise 3 transaction, the power generation enterprise 4 and the coal enterprise 5 transaction, the power generation enterprise 5 and the coal enterprise 1 transaction. The power generation company 6 and the coal enterprise 6 trade, the matching scheme has the smallest amount of information, the minimum value is 75.541, and the matching degree is the highest.

5. Conclusion

This paper starts from the perspective of mediation, based on the theory of information axiom design. The degree of matching between coal supply and demand and the reduction of carbon emissions have been studied. Since both the supply and demand sides have different quality index requirements for coal, after setting weights for different indicators and determining the carbon emission measurement method in the transportation process, based on the information axioms, the matching between supply and demand sides is maximized and the carbon supply minimum supply and demand during transportation is matched. It can provide some guidance for the low carbon and efficient development of the coal trading market. This paper considers carbon emissions under a single coal transportation model. Subsequent research will further consider the carbon emissions of combined transportation methods and the intelligent coal supply and demand matching in more complex scenarios.

References

[1] Li Guanghui, Guo Xianrong. China's coal trading market development status and countermeasures [J]. China Coal, 2012, 38 (5): 5~8.
[2] Yong Liu, Kevin W Li.. A Two-sided Matching Decision Method for Supply and Demand of Technological Knowledge [J]. Journal of Knowledge Management, 2017, 21(3) : 1 ~5.
[3] Zaefarian G. Understanding the Interplay Between Business Relationships and Business Strategy Using Configuration Theory [D]. University of Manchester, 2011.
[4] Dou Yuanyuan, Fan Zhongqi. Coal service supply chain concept definition and structure analysis [J]. China Mining, 2017, 26 (12): 64~69, 110.
[5] Yang Yang, Liu Xu, Fu Hao. Research on energy supply chain elasticity based on Bayesian posterior probability [J]. Soft Science, 2018, 32 (6): 103-107.
[6] Sun Xuejun. Analysis of factors affecting low carbonization of coal supply chain based on ISM [J]. Journal of Safety and Environment, 2014, 14 (5): 270-274.
[7] Haylett R. The Principles of Design [J]. Manufacturing Engineer, 2009, 70 (2) : 10.
[8] Yan Xiuli, Dong Xueqi. Optimization of product function requirements based on cloud model and information axiom [J]. Computer Integrated Manufacturing System, 2018, 24 (1): 154~163

[9] Cai Bofeng, Cao Dong, Liu Lancui, et al. China's traffic carbon dioxide emissions research [J]. Progress in Climate Change Research, 2011, 7 (3): 197-203.