Comprehensive evaluation of the principal components of the key industrial chain development

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Abstract. In order to systematically plan, scientifically study and judge and prudently determine the key direction, goal and path of Inner Mongolia industrial transformation and development, lay a good foundation and pave the way for the future transformation. Based on the registration data and regulatory data of market entities, supplemented by the tax payment data, revenue data and profit data of the tax authorities, the evaluation index system of 10 key industrial chains is established to calculate the comprehensive evaluation value of the principal components from 2016 to 2021. From 2016 to 2021, except for the modern coal chemical industry chain, the ten industrial chains are basically increasing year by year, and the increase rate is not much different, indicating that the key development of these industrial chains has achieved initial results. We will continue to give priority to ecology and promote green development in promoting industrial transformation and upgrading, and adjust and upgrade the industrial structure.

Keywords: comprehensive evaluation; principal components; industrial chain.

1 Introduction

Inner Mongolia is located in the northern border area of China, with rich resources and reserves, grassland, forest and per capita arable land area rank first in China, and rare earth metal reserves rank first in the world. In recent years, the national market share of bulk industrial products such as coal, PVC, methanol, olefin, electrolytic aluminum and ferroalloy has been increasing, and the market share of rare earth compounds has exceeded 70%. Inner Mongolia is the province with the largest scale of raw coal and electricity transmission, which accounts for 13.5% of the total scale of inter-provincial electricity transmission, making an important contribution to the national energy security [1-5]. As one of the 13 major grain producing areas and five provinces, Inner Mongolia is currently able to provide more than 20 billion jin (10 million tons) of commodity grain to the state every year. The output of milk, mutton, wool and grass industry all rank first in China, and the output of beef is the second in China. It has the capacity of steadily transferring 5 million tons of milk and 1.5 million tons of meat from outside

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the region every year. About 1 / 4 of the mutton and 1 / 5 of the milk come from Inner Mongolia.

Since the 18th National Congress of the Communist Party of China, General Secretary Xi Jinping has visited Inner Mongolia twice and attended the deliberation of the Inner Mongolia delegation of the National People's Congress for five consecutive years, pointing out the direction for the development of Inner Mongolia. The general secretary pointed out that Inner Mongolia should be built into an important national energy and strategic resource base and a production base for agricultural and livestock products. The industrial development of Inner Mongolia should not only focus on sheep, coal, soil and gas, but also vigorously cultivate new industries, new driving forces and new growth poles.”

At present, under the background of "double-carbon", Inner Mongolia is in an extremely difficult and important transition period. Inner Mongolia's total carbon emission is large and is still in the stage of rigid growth. The problem of "one coal is the dominant" in the energy structure is prominent, and the development path of high energy consumption and high carbonization is obviously dependent. Currently, Inner Mongolia's total carbon emissions rank fourth in China, accounting for about 6.3% of the country. Its carbon emissions per unit of GDP and carbon emissions per capita are nearly four times the national average level. Coal consumption accounted for 25.2 percentage points higher than the national consumption. At the same time, Inner Mongolia's economy and society are still in the stage of rapid development of industrialization and urbanization, and the level of economic development is low. In the future, with the economic development, population growth and urbanization, carbon emissions will still show an increasing trend [6-7]. This means that Inner Mongolia faces more difficulties and greater challenges in achieving the "two-carbon" target than most provinces (autonomous regions and municipalities directly under the Central Government). Despite this, Inner Mongolia is still in an important period of strategic opportunities for development. In the context of "double carbon", it is necessary to find the road of Inner Mongolia's transformation and development more accurately and forward-looking. Among them, the most critical is to systematically plan, scientifically study and prudently determine the key direction, goal and path of Inner Mongolia's industrial transformation and development, so as to lay a good foundation and lay a good foundation for the future transformation.

2 Results

The analysis is based on the registration data and regulatory data of market entities, supplemented by tax payment data, revenue data and profit data of the tax department. With the help of Inner Mongolia Statistical Yearbook, China Statistical Yearbook and other peripheral data, the data of China Energy Statistical Yearbook 2021, extracted the relevant data ranging from 2016-2021.

Based on the development positioning of the two bases, Inner Mongolia is now developing 16 industrial chains in eight industrial clusters. We choose ten of them to evaluate their development rationality and potential by mathematical modeling method.

Taking the modern coal chemical industry chain as an example, using the correlation between tax data and GDP as an analysis, it is concluded that it is highly related with GDP growth. How to break the "resource curse" while maintaining economic growth lies in industrial transformation and upgrading.

Based on the above analysis, we will be the traditional energy industry and traditional agriculture transformation and upgrading development direction respectively for the five key industrial chain, namely the green energy industry: modern coal chemical industry chain, rare earth industry chain, non-ferrous metals, wind power equipment, photovoltaic equipment, green modern agriculture industry: dairy, beef cattle, mutton sheep, potato, cashmere.

The industrial development evaluation index system is as follows (Fig 1):

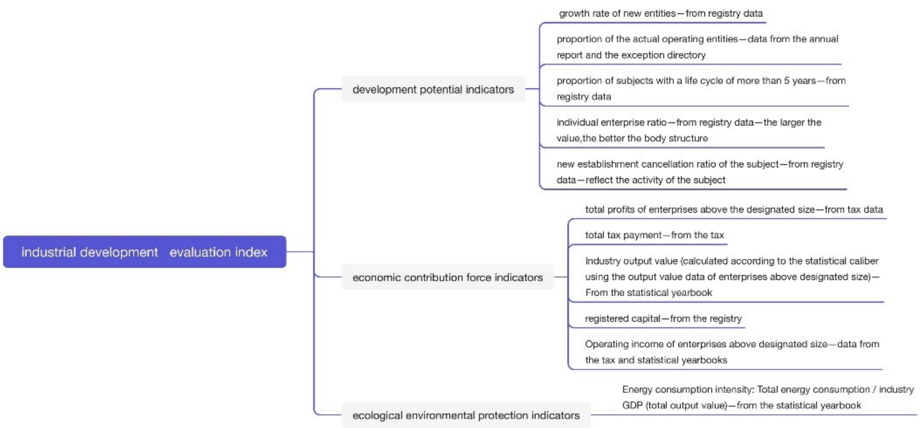

Fig. 1. The industrial development evaluation index system

Based on the above evaluation index system, we conclude

1. Actively foster green energy industrial clusters

The purpose of the principal component is to use a few components to describe the connection between many indicators or factors, the related closely several variables in the same category, each kind of variables become a component (called components, because it is not observable, namely not specific variables), on the premise of the least information loss, with less components reflect the most of the information of the original data.

Before the main components, each index in the selected index system has its own dimension and variation difference, which brings inconvenience to the comprehensive analysis and modeling. Therefore, we need to preprocess the collected data to eliminate the influence of dimension and variation difference. The data was normalized (Z-score method), minus the mean divided by the standard deviation. The smaller the individual ratio is, the better. It is a negative indicator, and multiplying by the negative one becomes a positive indicator.

Principal component analysis is to transform a given set of variables into another set of unrelated variables through linear transformation, and arrange in decreasing order of variance, find the first, second, k the principal components, and then calculate the factor load matrix to establish the principal component model. Finally, the weight is determined according to the factor score and the contribution rate size, and the comprehensive evaluation score is calculated and ranked.

Therefore, the contribution rate of the first four principal components variance is 0.38+0.21+0.15+0.11= 85%(Fig.2), so the load coefficient of the four principal components is selected to calculate the weight of each index.

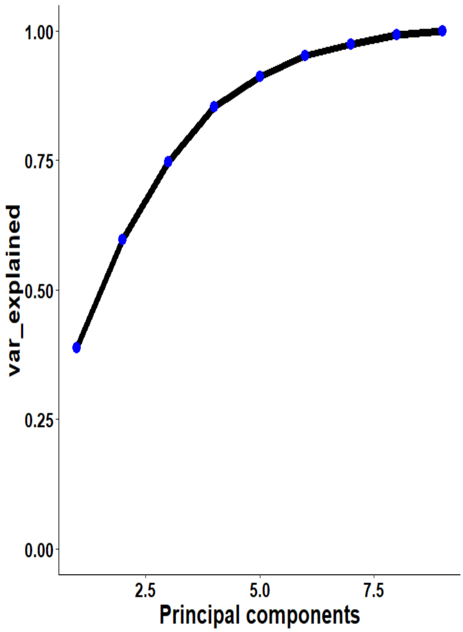

Fig. 2. variance contribution of principal components

According to the load matrix, the positions of the first and second principal components are drawn. It can be seen from the figure that the registered capital, operating income, total tax payment and total profit are very close, which can be summarized as the profit-generating ability of the industrial chain (Fig. 3). The ratio of enterprise individuals, the cancellation ratio of new subjects, the proportion of actual operating entities and the growth rate of new entities are very similar, which can be summarized as the internal structure characteristics of the industrial chain. The proportion of subjects operating for more than five years can be ignored in the evaluation and development of the industrial chain.

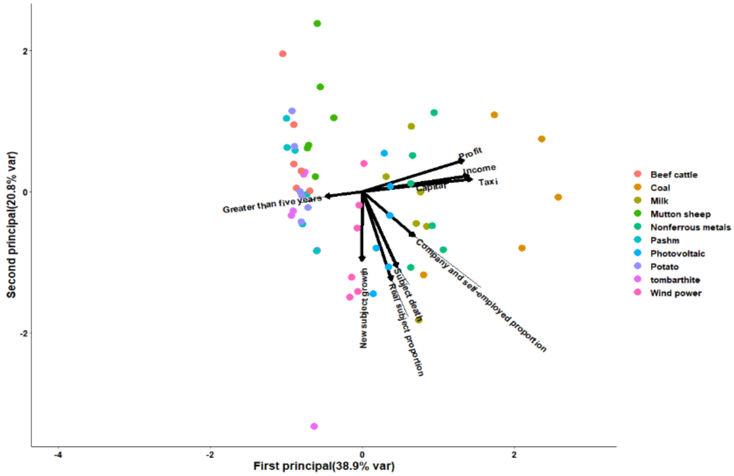

Fig. 3. the scores of each industrial chain and the evaluation index in the first and second principal components.

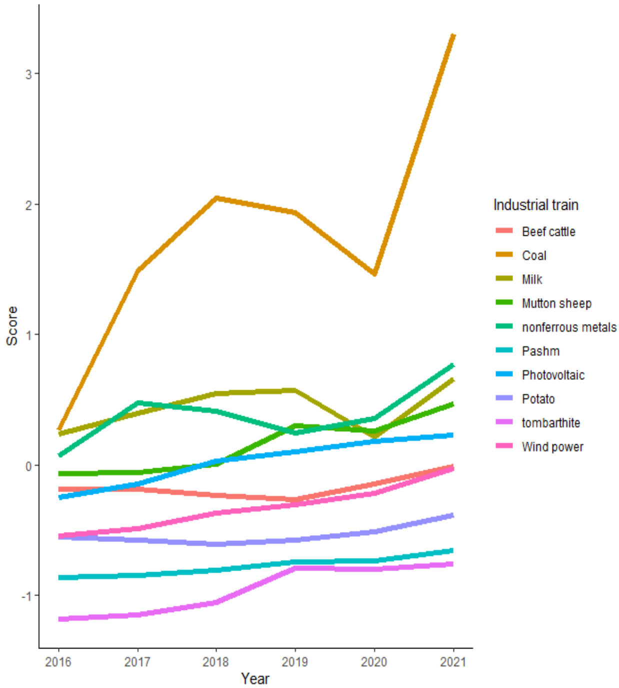

Fig. 4. Comprehensive evaluation score of principal components in 2016-2021

Through the ten industrial chains from 2016 to 2021 shown in the Figure 4, it can be found that the overall development trend of the ten industrial chains is concentrated and positive, and the increasing rate is not much different, indicating that the key development of these industrial chains in Inner Mongolia Autonomous Region has achieved initial results. Under the national policy of developing green energy economy, the original modern coal chemical industry chain has declined. However, due to the changes in the international environment, the import of Australian raw coal has been stopped, resulting in local coal power supply tension. In order to ensure the living needs of the people, the coal mining and the corresponding processing and smelting in Inner Mongolia have been increased. Through mathematical modeling, it can be seen that the ten industrial chains are generally in the development trend and have broad prospects.

3 Methods

The comprehensive evaluation of the ten industrial chains by using the comprehensive evaluation model of principal components follows the following steps [8-11]:

1. Let $X_1, X_2, \cdots, X_p$ be p evaluation indicators. In order to eliminate the influence of different dimensions of indexes, Z-score standardization method is adopted for each index, namely $X_i' = \frac{X_i - \mu_i}{\sigma_i}$, where μ_i is the mean of index X_i in all samples, σ_i is the standard deviation of index X_i.

2. Establish the covariance matrix R according to the standardized data matrix, which is a statistical indicator reflecting the close relationship of the standardized data. The larger the value, it is necessary to conduct principal component analysis on the data. $R_{ij}(i, j = 1,2, \cdots, p)$ are the correlation coefficients of the original variables X_i and X_j. R is a real symmetric matrix, which only needs to calculate the upper triangle element or the lower triangle element. The calculation formula is:

$$R_{ij} = \frac{\sum_{k=1}^{n}(X_{kj} - X_i)(X_{kj} - X_j)}{\sqrt{\sum_{k=1}^{n}(X_{kj} - X_i)^2 (X_{kj} - X_j)^2}} \quad (1)$$

where X_{kj} is the value of the article k th industrial chain on the index X_j.

3. A linear model of the principal component Z_i is established as

$$\begin{cases} Z_1 = \mu_{11}X_1 + \mu_{12}X_2 + \cdots + \mu_{1p}X_p \\ Z_2 = \mu_{21}X_1 + \mu_{22}X_2 + \cdots + \mu_{2p}X_p \\ \cdots \\ Z_p = \mu_{p1}X_1 + \mu_{p2}X_2 + \cdots + \mu_{pp}X_p \end{cases} \quad (2)$$

Where $\{\mu_{ij}\}$ are the load matrix.

4. The number of principal components was determined based on the covariance matrix R field eigenvalues, principal component contribution and cumulative variance contribution. Solve the eigenequation, find the feature root $\lambda_i, i = 1,2, \cdots, p$. Since R is a positive definite matrix, its eigenvalues λ_i are all positive numbers, and they are arranged in size order, namely $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p \geq 0$。 The eigenvalue is the

variance of each principal component, and its magnitude reflects the influence of each principal component.

5. According to the principle of selecting the number of principal components, the eigenvalue whose eigenvalue is greater than 1 and the cumulative variance contribution rate of the variance is 80% -95% is $\lambda_1, \lambda_2, \cdots, \lambda_m (m \leq p)$, where the integer m is the number of principal components. The contribution of principal component Z_i , $W_i = \frac{\lambda_i}{(\sum_{j=1}^{p} \lambda_j)}$, the cumulative contribution is $\frac{\sum_{j=1}^{m} \lambda_j}{\sum_{j=1}^{p} \lambda_j}$.

6. Establish the initial factor load matrix, explain the principal components, and calculate the score of each principal component, $\widehat{Z_i}, i = 1,2, \cdots, m$.

7. The final comprehensive evaluation score was $\sum_{i=1}^{m} \widehat{Z_i} W_i$.

4 Discussion & conclusions

By the end of the difference, the basic industrial development by more dependent on resources development to diversified transformation, modern industrial system to speed up the construction," two bases " to the high-end, intelligent, green accelerated transformation, industrial chain supply chain complete chain innovation chain and value chain key root generation, to better safeguard national ecological security and energy security, food security, industry security provide solid support.

Inner Mongolia falls under the backward economic development region of China. The dual characteristics of high economic growth and large renewable energy bases gave rise to a contradictory situation where both high carbon emission and high carbon reduction occurred at the same time. The rapid wind power growth and the renewable energy weight increase helped reduce the growth of CO2 emission. First, in 2009, two areas in Inner Mongolia were selected as ten-million-KW wind power bases in China (including 1. Ulanqab City and Bayannur Cityin Western Mongolia; 2. Xilingol League, Chifeng city, and Tongliao city in Eastern Mongolia), effectively enhancing the region’s renewable energy power generation weight. Due to the serious wind (power) abandonment problem, Inner Mongolia has in recent years promoted the “multi-measure promotion of new energy accommodation” policy, including wind power heating supply, new energy hydrogen production, energy storage technology, and the direct supply of new energy to major users. These policies have effectively reduced fossil energy use and inhibited the growth of CO2 emissions in recent years. Secondly, government promotion of the “Western Development” strategy in 2000 has resulted in the development of an equipment manufacturing industry, including the production of heavy-duty automobiles, construction machinery, railway vehicles, mining equipment, new-energy automobiles, wind power equipment, and so on. Although the rise of these manufacturing industries has effectively supported the growth of the industrial and transportation sectors in Inner Mongolia, the problem of energy consumption has caused increased CO2 emission. Since the respective industrial sectors differ in production characteristics and CO2 emission, a systematic monitoring and management system is needed to regulate them. In other words, by use of the Best Available

Techniques (BATs), equipment upgrades in the industrial sectors (especially in heavy industry) and transportation can reduce production costs as well as CO2 emissions.

First, the industrial scale has reached a new level. We will promote industrial transformation and upgrading by giving priority to ecology and green upgrading, adjusting and upgrading the industrial structure, upgrade the industrial base and modernize the industrial chain, and foster 100 leading enterprises with over 100 billion yuan and global competitive influence. By 2025, the added value of industry will exceed 750 billion yuan, and the added value of the service sector will reach 1 trillion yuan.

Second, the industrial innovation capacity has been newly improved. The strategy of promoting Mongolia through science and technology has been thoroughly implemented, the dominant role of enterprises in technological innovation has been further consolidated, the environment for industrial innovation has been more optimized, the industrial innovation system has become more coordinated and efficient, the elements of industrial innovation have become more complete, and the vitality of entrepreneurship and innovation has been continuously enhanced. By 2025, the average annual growth rate of r & D investment will exceed 12%, the number of high-value invention patents per 10,000 population will be about 1. 8, and the number of high-tech enterprises per 10,000 enterprises is 50.

Third, the digital transformation of industries has achieved new results. The construction of digital infrastructure has been gradually improved, the digital transformation of traditional industries such as agriculture, animal husbandry and strategic resources has achieved initial results, and the digital, intelligent and networked strategic emerging industries such as equipment manufacturing and new materials have been improved and improved. By 2025, the added value of core industries in the digital economy will account for 2.5% of GDP, and industrial enterprises above designated size in the region will achieve 5G coverage, and 10 key industrial clusters will be piloted for digital transformation at the autonomous region level, covering no less than 100 micro, small and medium-sized enterprises.

Fourth, the development of green industries took on a new look. Construction of more than 10 to take the lead in achieving carbon peak carbon neutral, promote industry low carbon green transformation development " as the theme of the autonomous region green development innovation demonstration area, new green low carbon technology high and new technology enterprise 1000, green low carbon technology innovation and industrial development made positive progress, renewable energy, energy storage, hydrogen and in key areas such as technology breakthrough, support the carbon neutral.

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