Evaluation of the Transformation and Development of Mining Industry in China from 2010 to 2017

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Abstract. The transformation and development of mining industry is the inevitable choice based on the economic society of China of China under the new development concept. This paper builds an evaluation index system for the transformation and development, and uses a comprehensive evaluation method to calculate and analyze the transformation and development the mining industry in China from 2010 to 2017. The results show that: Over the past eight years, the transformation and development of the mining industry has increased steadily, and the transformation development index has increased from 1 to 1.677, an increase of 67.7%. The four sub-indexes, namely the average output value of mine, proportion of mining industry, proportion of large and medium-sized mines, and proportion of clean energy production, are all in good agreement with the trend of the transformation and development index. In different historical periods, the significance of the promoting effect is different. In the future, it is necessary to implement comprehensive strategies for the improvement of the transformation and development of mining industry in China.

1. Introduction
Mining is an important basic industry for China's economic and social development. About 90% of primary energy, 80% of industrial raw materials, and 70% of agricultural production materials come from mineral products or their processed products. Different economic and social development stages and scientific and technological levels determine the difference in the content and utilization of mineral resources. The 19th National Congress of the Communist Party of China historically judged that China has entered a new era and proposed a new journey towards building a modern socialist country in two stages by the middle of this century closely following changes in social contradictions. Facing the new situation, the development of the mining industry should be based on basic national conditions, grasp new requirements, identify new directions, and assume the historical mission of the great rejuvenation of the Chinese nation in the new era. Mining is the industry that is most closely associated with nature. Decades of development of mining industry have exerted an impact on the ecological environment. Therefore, the overall situation of tight resource and environmental constraint has not changed, so it is necessary to grasp and practice the green development of mining industry from a strategic perspective and take the green development path of resource intensive, environment friendly, efficient utilization...
and harmonious mining area. Under the guidance of the new development concept of innovation, coordination, green, coordination and sharing, the direction and concept of mining development in China have changed, transforming from pursuing quantity and speed to improving quality and efficiency. The transformation and development of mining industry is imperative. This paper evaluates the development transformation of mining industry in China 2010 to 2017 with the purpose of providing exploration and direction for mining transformation and development.

2. Research Methods and Data Sources

2.1. Research Methods

2.1.1. Construction of evaluation index system. The transformation and development includes two implications: economic development and structural transformation. Therefore, the index system is built around these two dimensions: one is the economic development, which mainly considers the economic development of the mining industry, and is expressed by the average output value of mine; the second is structural transformation, which is expressed by proportion of clean energy production, mining industry, and large and medium-sized mines from the supply structure, industrial structure and mine scale.

| Index | Connotation | Computational formula | Weight |
|-------|-------------|-----------------------|--------|
| average output value of mine (10k yuan/ per) | Average industrial output value of mine enterprises | KJCZ = CJY/∑i=1nKSSLi, in which KJCZ is the average output value of mines; CJY refers to the sales value of mine industry; KSSLi refers to the the number of mine enterprises, including oil-gas and non-oil-gas. | 0.25 |
| Proportion of mining industry in the overall mining industry (%) | The industrial structure of mining industry is represented by the proportion of industrial output value of the mining industry in the sales value of the entire chain (mining, smelting, processing, manufacturing, etc.), which reflects the proportion of primary industries in the entire mining chain and is an effective measure of industrial structure and overall development level. | CJYB = CJY/(CJY + ∑i=1nJGi + ∑i=1nZi), CJYB is the proportion of mining industry; CJY is the sales value of mining industry; JGi is the sales value of processing industry, including petroleum processing, coking and nuclear fuel processing industry, ferrous metal smelting and rolling processing industry, non-ferrous metal smelting and rolling processing industry; Zi is the sales value of manufacturing industry, including metal products industry and non-metal mineral products. | 0.25 |
| Proportion of large and medium-sized mines (%) | The proportion of large and medium-sized mines to the total number of mines reflects the rationality of the scale structure of mines. | DZB = (∑i=1nDi + ∑i=1nZi)/∑i=1nTi, In which DZB is the proportion of large and medium-sized mines; Di, Zi is the number of large oil-gas and non-oil-gas mines, respectively; Z2 is the number of medium-sized oil-gas and non-oil-gas mines, respectively; T1, T2 is the total number oil-gas and non-oil-gas mines in the administrative region, respectively. | 0.25 |

Table 1. Evaluation index system of the transformation and development of mining industry.
2.1.2. Data standardization. The transformation and development index of mining industry is a relative number that reflects the overall situation of the country. In order to ensure the vertical comparability of the index, this paper refers to the GDP deflator (fixed basis) of the China Statistical Yearbook and the algorithm of the China Innovation Index and uses the fixed basis to measure the growth rate of indexes. Taking the year 2010 as the base year and the index score in 2010 as 1, the score and index of basic index in the following years are calculated. Then, the growth of green development index of mining industry can observed compared with the base year and the specific calculation formula is as follows.

Calculation formula of positive index:

\[ C_k^t = \frac{V_k^t}{V_k^{2010}} \]  

Calculation formula of reverse index:

\[ C_k^t = \frac{V_k^{2010}}{V_k^t} \]

\( C_k^t \) represents the score of the kth basic index in year t; \( V_k^t \) represents the original measurement value of the kth basic index in year t.

2.1.3. Determination of weight. The weight determination method can be divided into three categories: subjective assignment method, objective assignment method and combination of subjective and objective assignment method, including expert consultation method, frequency statistics method, analytic hierarchy process and so on. The transformation and development of mining industry is a multi-objective decision issue and the weight of each index should reflect its significance to the transformation and development of mining industry. In order to ensure the fairness of index measurement, this paper uses the combination of expert consultation and analytic hierarchy process to determine the weight of each level. These two methods are relatively common, which will not be elaborated here.

2.1.4. Comprehensive evaluation method

\[ A_t = \sum w_j B_j^t \]

\( A_t \) represents the measurement value of the first-level index in year t, which is the transformation and development index; \( B_j^t \) represents the measurement value of the jth second-level index in year t, namely the index \( w_j \) being the weight of the jth second-level index. The measurement value \( A_t \) of the total index in year t is the sum of the measurement value of each first-level index (that is, the index) in year t multiplied by the weight.

2.2. Data Sources
The data for the number of large oil-gas and non-oil-gas mines, the number of medium-sized mines, the total number of oil-gas and non-oil-gas mines, and the number of mining enterprises (including oil-gas and non-oil-gas enterprises) are derived from the "China Land and Resources Statistics Yearbook (2011-2018)". The data for the sales value of mining industry, petroleum processing, coking and nuclear fuel processing, ferrous metal smelting and rolling processing, non-ferrous metal smelting and rolling processing, manufacturing industry (including metal products and non-metal mineral products) are derived from "China Industrial Statistics Yearbook (2011-2018)". The data for the proportion of primary energy production, such as natural gas, hydropower, and nuclear power in the total energy production are derived from the "China Energy Statistics Yearbook (2010-2017)".
3. Results and Analysis

3.1. Analysis of Time Variation in the Transformation and Development of Mining Industry

From 2010 to 2017, the transformation and development of mining industry has increased steadily, and the transformation and development index has increased from 1 to 1.677, an increase of 67.7%. There are three reasons: firstly, with the development of the economy and society, mineral resources have become an important raw material, whose consumption has increased significantly. Some cities have insufficient reserve resources, and the trend of transformation and development of resource-exhausted cities is significant; secondly, the continuous improvement of the main content and preparation mechanism of mineral resource planning plays an important role in government management, whose planning objectives include indexes such as output value of mining industry, proportion of large and medium-sized mines, leading the transformation and development of mining industry; thirdly, in the development and utilization process of mineral resources, problems such as disordered management, environmental pollution, and conflict between enterprises and land are becoming increasingly prominent. The previous extensive development model that simply pursues economic benefits is no longer sustainable and transformation and development have become the internal demand for the survival of enterprises. In the future, green development, as one of the five development concepts put forward by General Secretary Xi, will continue to play an important guiding role in the mining field. As its internal characteristics and important content, it is necessary to further improve the transformation and development.

Table 2. Transformation and development of mining industry from 2010 to 2017.

| Year | Transformation and development index | Growth rate (%) |
|------|---------------------------------------|-----------------|
| 2010 | 1                                     |                 |
| 2011 | 1.055                                 | 5.50            |
| 2012 | 1.135                                 | 7.58            |
| 2013 | 1.208                                 | 6.43            |
| 2014 | 1.324                                 | 9.60            |
| 2015 | 1.376                                 | 3.93            |
| 2016 | 1.458                                 | 5.96            |
| 2017 | 1.677                                 | 15.02           |

Figure 1. Transformation and development and its variation from 2010 to 2017.
3.2. Time Variation Analysis of Various Indexes

From 2010 to 2017, the average output value of mines in China increased in an incontinuous way, growing from 39.527 million yuan/per to 73.437 million yuan/per and reaching the maximum in 2017, an increase of 85.58% compared with 2010. In this period, the average output value of mines has all increased except for 2015, of which the growth rate in 2010 was the most significant at 43.19%.

![Figure 2. Average output value and growth rate of mines in China from 2010 to 2017.](image)

From 2010 to 2017, the proportion of mining industry in China increased in the beginning and then decreased, showing an overall downward trend, namely about 34.08%. It increased from 21.77% in 2010 to 22.62% in 2011, reaching its maximum, an increase of 3.90%. After that, it dropped rapidly and reached its minimum in 2017, a decrease about 36.56%. From the perspective of growth rate: the proportion of mining industry was in the growth stage in 2010 and 2011, and the maximum growth rate was in 2010 at 5.06%; the proportion of mining industry was in the decline stage from 2012 to 2017 and the maximum decreasing rate was in 2015 at 11.47%.

![Figure 3. Proportion and growth rate of mining industry in China from 2010 to 2017.](image)

From 2010 to 2017, the proportion of large and medium-sized mines in China decreased in the beginning and then increased. From 2010 to 2011, the proportion showed a decreasing trend and from 2011 to 2015, it presented an increasing trend. In general, there was a significant growing trend in this period and the increasing rate over eight years was about 6.99%. Specially, the proportion of large mines decreased in the beginning and then increased, reaching the minimum in 2011 and then continuing the
growing trend till the end of this period. The proportion of medium-sized mines has been continuously increasing. Overall, the proportion of large and medium-sized mines in China has increased significantly over the past eight years while the increase in the proportion of medium-sized mines has a stronger promotion effect on the overall proportion.

Figure 4. Changes in the proportion of large and medium-sized mines from 2010 to 2017.

From 2010 to 2017, the proportion of clean energy production decreased in the beginning and then increased, showing an overall increasing trend at about 4.41% in this period. It experienced a slight decline in 2011 and then maintained a steady growth till the end of this period. During these eight years, the average annual growth rate was 6.52% and in 2016, the growth rate was the most significant at 10.89%, followed by 10.59% in 2014. The growth rate was the lowest in 2011 with a reverse growth of -3.95%.

Figure 5. Proportion and growth rate of clean energy in China from 2010 to 2017.

4. Conclusion and Discussion
It can be seen from the changing curve of the transformation and development index and its four secondary indicators: the average output value of mines, proportion of mining industry, proportion of large and medium-sized mines, and proportion of clean energy production, are all in good agreement with the trend of the transformation and development index. In different historical periods, the significance of the promoting effect is different.
Figure 6. Changes in the transformation and development index and secondary indexes from 2010 to 2017.

The average output value of mines is a reflection of the average output value of a single mine, which is the only index that reflects the development of the mining economy. In recent years, this value has fluctuated and the main reason is that although the number of mining enterprises has decreased year by year, the industrial sales value of mining industry in China has fluctuated and shown a downward trend in 2014. On the whole, it has a significant positive effect on the transformation and development index. The proportion of mining industry is the index that reflects the proportion of output value of the front-end mining industry in the total output value of the production chain of mining resources, which can reflect the proportion of heavy industry in the total industry to a certain extent. In recent years, the value of the mining industry has continued to decrease, but as a reverse index that reflects the transformation and development index, it shows that the transformation and development level is constantly improving, whose change of index value is corresponding to the transformation and development index. The proportion of large and medium-sized mines, as an index of the structure of mines, has been increasing in recent years. Under the circumstance that the number of mines is decreasing in the in China, the increase in the number of large and medium-sized mines shows the effectiveness of integration measures implemented in China. This index is in line with the variation trend of the transformation and development index, namely a gradual increasing trend, but it is significantly higher than the transformation and development index after 2014, indicating that its promoting effect on transformation and development has enhanced significantly. The proportion of clean energy production is an index that characterizes the ratio of clean energy such as hydropower, nuclear power, and natural gas to the primary energy. In recent years, the proportion of clean energy use has increased steadily, which is in line with the trend of the transformation and development index.

According to the variation trend between the transformation and development index and the four indexes, namely the proportion of large and medium-sized mines, the proportion of clean energy production, the proportion of mining industry and the average output value of mines, it is necessary to implement comprehensive strategies for the improvement of the transformation and development of mining industry in China in the future. In terms indexes with positive promoting effect such as the average output value of mines, it is necessary to further play their proper role. Also, measures should be taken from two aspects, increasing the output value and reducing the number of mines. It is necessary to continue to strengthen the macro guidance role of government, limit the number of new mines, integrate and close existing mines in a proper manner, and encourage the development of mine enterprises to improve the economic benefits. In terms of indexes with growing promoting effect such as the proportion of large and medium-sized mines, it is necessary to emphasize steady increase and maintain the advantage. For indexes with negative prompting effect but good development trend such as the proportion of the mining industry and the proportion of clean energy production, it is necessary to include the proportion of clean energy production in the planning index of mineral resources to
improve the binding force. At the same time, the mining industry chain should be extended to improve the follow-up industry output value.

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