

Evaluation of ecological efficiency of resource exhausted cities — a case study of Jilin old industrial base

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Abstract: Based on DEA theory and window analysis method, this paper empirically measures the ecological efficiency of six resource exhausted cities in Jilin old industrial base from 2012 to 2017, and investigates their regional differences and dynamic evolution characteristics. The results show that: in the sample period, the overall ecological efficiency of Jilin old industrial base is low, but fluctuates slightly; the difference between different urban areas is obvious, while the industrial structure and low level of science and technology inhibit the improvement of ecological efficiency.

1 Introduction

At the beginning of the 13th five year plan in 2016, China launched a new round of strategic plan of "comprehensively revitalizing the old industrial base in Northeast China". In view of the ecological environment problems of the old industrial base, it emphasizes "firmly establish the concept of green development, resolutely abandon the development mode and Practice of damaging or even destroying the ecological environment, and build the old industrial base into an ecological barrier in the north and livable with green mountains and rivers Home ". In this context, in order to alleviate the severe ecological environment pressure of the northeast old industrial base and promote the green and sustainable development of regional economy, this study will introduce the environmental impact factors of industrial pollution based on window DEA method, and evaluate the eco-environmental efficiency of 11 resource exhausted cities in Jilin old industrial bases, which is of great importance to better realize the strategic goal of revitalizing the northeast old industrial base The practical significance of.

The concept of eco efficiency was first proposed by German scholars s. schaltegger and A. Sturm in the early 1990s^[1]. Then, under the definition and promotion of the World Council for sustainable business and industry (WBCSD), the concept of eco efficiency was widely recognized and accepted by relevant research institutions and scholars in the world^[2-3]. Since then, ecological efficiency has become a hot indicator of domestic and foreign scholars, widely used in various fields of ecological efficiency measurement^[4-5].

2 Research methods

Because the frontier of DMUs constructed by traditional DEA method is not the same in different periods, it only reflects the horizontal static efficiency of DMUs in a certain period, so it is not comparable in intertemporal longitudinal analysis. In this regard, a. Charnes et al. (1984) used and expanded the research on DEA efficiency of window analysis method ^[6]. Based on the principle of moving average method, the same decision-making unit in different periods is considered as different decision-making units, so as to expand the number of small sample data and improve the identification and reliability of evaluation relative efficiency; at the same time, it can also make use of the principle of moving average The change trend of the efficiency value of decision-making units (DMUs) is investigated from the perspective of state. In the process of application of DEA window analysis method, the value of window width D should be determined first according to the research object and sample inspection period. In the existing research, most scholars set the window width D as 2 or 3.

3 Sample variables and data

Considering the availability of input-output variable data, the study period is 2012-2017, and the research objects are 11 resource exhausted cities in Jilin Province. On the basis of existing studies, the energy consumption and environmental pollutants discharged in the process of urban economic output are taken as input variables to investigate ecological efficiency. The input variables are defined as follows: energy input is the comprehensive energy consumption (E) of each city, and the data can be obtained from the statistical yearbook of each province;

the industrial wastewater discharge (water), industrial SO₂ emission (SO₂) and industrial wastewater discharge (SO₂) are selected Dust emission (dust) is regarded as the input variable of environmental pollutants in each city. The specific definition of output variables is as follows: economic output is the gross domestic product (GRP) of each city in Jilin old industrial base. In order to keep the data caliber consistent, the regional GRP data of each city from 2012 to 2017 is also expressed in 2012 constant price. The above four index data can be directly obtained from China urban statistical yearbook.

4 Empirical measurement and result analysis

4.1 Ecological efficiency and index decomposition of resource exhausted cities in Jilin Province

By DEA window analysis method, the window width is set to 2 according to the research needs, and the overall ecological efficiency (AEE) of six resource exhausted cities in Jilin Province from 2012 to 2017 is calculated. In addition, in order to better explore the key factors of ecological efficiency change of resource exhausted cities in Jilin Province, the overall ecological environmental efficiency (AEE) of appeal is further decomposed into pure technical efficiency (PTE) and scale efficiency (SE), and the relationship between them is expressed as $AEE = Pte \times se$. The specific calculation results of ecological efficiency of resource exhausted cities in Jilin Province are shown in Table 1.

Table 1 Analysis and decomposition results of ecological efficiency window of resource exhausted cities in Jilin Province (2012—2017 average)

city	AEE	PTE	SE
JL	0.511	0.659	0.776
SP	0.622	0.652	0.954
LY	0.670	0.868	0.772
TH	0.407	0.418	0.974
BS	0.657	0.875	0.751
BC	0.957	0.988	0.968
ALL	0.637	0.743	0.866

According to table 1, on the whole, from 2012 to 2017, the overall ecological efficiency AEE of the six resource exhausted cities in Jilin was 0.637, and there was 36.3% improvement space from the efficiency frontier. In terms of cities, Baicheng city ranks first among the six cities in terms of AEE, with an average of more than 0.957, which is the learning object of other resource exhausted cities.

From the decomposition index, it shows that the main reason for the low ecological efficiency of resource exhausted cities in Jilin Province is the low pure technical efficiency (PTE). Therefore, if Jilin old industrial base wants to better implement the initiative of "revitalizing the old industrial base" and take the road of green ecological transformation, it should focus on improving the pure technical efficiency, introducing the frontier green industrial technology, improving the existing energy conservation and emission reduction management measures and industrial equipment.

4.2 Dynamic evolution trend of ecological efficiency of resource exhausted cities in Jilin Province

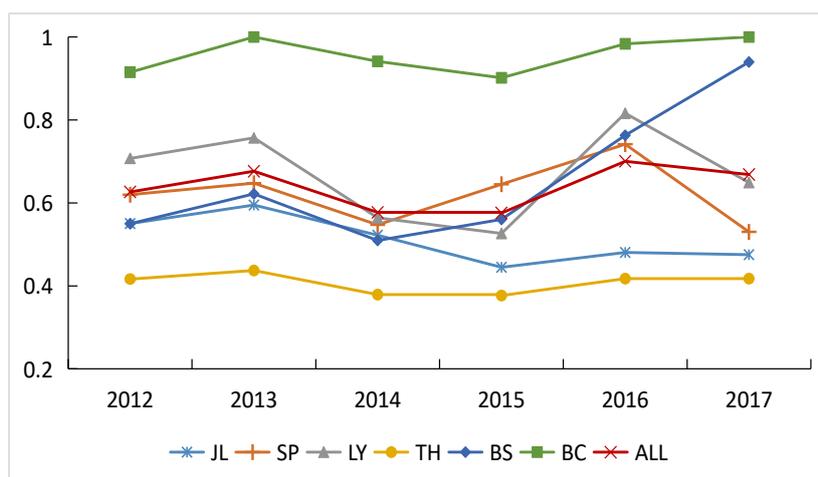


Figure 1 dynamic change trend of ecological efficiency of resource exhausted cities in Jilin Province (2010—2017)

From the analysis of dynamic evolution trend, as shown in Figure 1, from 2012 to 2017, the AEE index of resource exhausted cities in Jilin Province showed the characteristics of moderate fluctuation and increase, from 0.627 in 2012 to 0.669 in 2017. It shows that China's revitalization strategic plan proposed in 2016 has a

certain positive effect on the improvement of the ecological environment of the old industrial base, so we must adhere to the transformation of the old industrial base to the emerging green industrial base, in order to better develop the green ecological economy.

In terms of cities, Baicheng city has the highest AEE

index value and has been increasing steadily year by year. Although the AEE of Tonghua City, Baishan City and Jixi City is still far away from the efficiency frontier, it also shows the phenomenon of fluctuation and increase during the investigation period, while the remaining cities show that the AEE index is low and the value decreases year by year.

5 Conclusions and suggestions

5.1 Conclusion

In this study, DEA window analysis method was used to comprehensively measure the ecological efficiency, dynamic evolution trend and constraints of six resource exhausted cities in Jilin Province from 2012 to 2017.

(1) From 2012 to 2017, the overall ecological efficiency AEE of 6 resource exhausted cities in Jilin Province was 0.637, and the overall ecological efficiency level was low and showed a small fluctuation during the inspection period.

(2) From the decomposition index of ecological efficiency of resource exhausted cities in Jilin Province, the main reason for the overall low level of eco-environmental efficiency of Jilin old industrial base is the low pure technical efficiency.

5.2 Suggestions

(1) Combined with the research results and the strategic plan of revitalizing the old industrial base in recent years, it can be found that the overall ecological efficiency of Jilin old industrial base fluctuates little, and the gap between different resource exhausted cities is still obvious. It is necessary for the regional government to adhere to the implementation of the strategic initiative of "revitalization", and strictly do a good job in environmental regulation and management while ensuring the regional economic growth. At the same time, combined with the industrial characteristics of different urban areas in the old industrial base, we should formulate effective ecological pollution prevention measures according to local conditions, and increase the investment and support of science and technology funds.

(2) The old industrial base of Jilin urgently needs to adjust the single industrial structure mode left over from the past vigorously developing heavy industrial enterprises, and increase the proportion of high-tech industries with green ecological technology as the main force. Secondly, the introduction of new scientific and technological talents, the integration of superior technical resources, and the deepening of scientific and technological exchanges with the provinces, cities and countries in the surrounding developed areas, so as to realize the sharing of advanced scientific and technological resources in a real sense.

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