

Research on the Efficiency Evaluation of the Construction of Ecological Civilization in the County Area of Auditing and Supervision Services

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Abstract:

The classical DEA-BCC model and the DEA-Malmquist index model were used to dynamically and statically calculate the input-output efficiency of ecological civilization construction in 12 districts and counties of Yulin City, respectively. The results show that from 2012 to 2019, the average comprehensive efficiency of ecological civilization construction in 12 districts and counties in Yulin City was 0.734, and the overall input-output efficiency was relatively poor, mainly due to technical efficiency, which led to non-DEA effectiveness. From 2012 to 2019, the average annual decline in total factor productivity of ecological civilization construction in 12 counties and districts in Yulin City was 16.3%, and its technological progress index was the main reason. At the same time, the total factor decomposition productivity found that the decline in scale efficiency also had a certain impact on the growth of technical efficiency. It is proposed that Yulin City should improve the deficiencies at the institutional level, strengthen technological innovation, improve resource utilization, and improve the management level of ecological civilization construction to guide the better development of ecological civilization construction.

Keywords:

Audit Supervision, Construction of Ecological Civilization, Performance Evaluation

1. Raising of the question

Yulin City is located in the northernmost part of Shaanxi Province, rich in coal, oil, natural gas, rock salt and other energy and mineral resources, accounting for 86.2%, 43.4%, 99.9% and 100% of the province's total, respectively. Due to the rapid economic development in recent years, it has led to the long-term overexploitation and utilization of various resources, and it is located in the transitional zone of the Maowusu Desert and the Loess Plateau, with lack of water resources, fragile ecological environment, and increasingly damaged natural ecological environment,

and is facing severe environmental problems such as the reduction of cultivated land area, the destruction of surface vegetation, and air pollution. Shaanxi Province's "14th Five-Year Plan" and long-term goals for 2035 point out that it is necessary to adhere to the new development concept and promote the improvement of the ecological environment, and audit supervision is an important part of the national supervision system and a necessary condition for promoting the construction of ecological civilization.

2. Performance Evaluation Models and Methods

2.1. Performance evaluation model for the construction of ecological civilization

First of all, when constructing the performance evaluation index system for the construction of ecological civilization, each county (district) is regarded as a different decision-making unit in different years, and a panel data is constructed; secondly, based on the BCC model and the Malmquist index model, the performance level of ecological civilization construction in Yulin City is measured from the two aspects of static dynamics, and according to the analysis results, improvement directions and suggestions are proposed to help the county ecological civilization develop better.

2.1.1. BCC model

The data envelopment analysis DEA method is used to evaluate the relative efficiency of the same type decision unit (DMU) with multiple inputs and multiple outputs, and the output-oriented BCC model of "the largest output under the given input" is used to study the efficiency of ecological civilization construction in Yulin City by using the output-oriented BCC model that can be used as a prerequisite for scale remuneration to become a prerequisite.

2.1.2. Malmquist Exponential Model

The Malmquist exponential model measures the dynamic change in the efficiency of multiple decision units over a certain period of time, reflecting the degree of change between production efficiency and technical level. If the final result is $M > 1$, it means that the production efficiency of the decision-making unit has been improved compared with before; If $M < 1$, it means that the productivity of the decision unit is decreasing and needs to be adjusted and upgraded.

2.2. Evaluation index system for the efficiency of ecological civilization construction

Based on the principles of scientificity, systematicness, objectivity and accessibility, as well as the analysis and research of the literature, combined with the evaluation of the efficiency of the construction of ecological civilization, the selected indicators should reflect the economic development, resource utilization, ecological environment, social progress, system construction and other aspects, and the selected indicators are shown in Table 1:

Table 1. Evaluation indicators of the efficiency of ecological civilization construction.

The indicator type	Index	Definition
	Energy consumption (tonnes of standard coal)	The comprehensive energy consumption of industrial enterprises

Input indicators		above designated size in each county (district) every year
	Energy conservation and environmental protection expenditure (10,000 yuan)	Each county (district) invests financial funds in the construction of ecological civilization every year
Output indicators	Added value of culture and related industries (100 million yuan)	The number of cultural and related industries in each county (district) increases every year
	New afforestation area (hectares)	Each year, the forest area of each county (district) is added
	Commonly used arable land area (hectares)	The area of cultivated land commonly used at the end of each county (district) year
	Investment in fixed assets (10,000 yuan)	The new fixed asset investment of each county (district) this year

2.3. Selection of indicators and data sources

Input indicators for the construction of ecological civilization. The input of financial funds and resources is an important guarantee for the implementation of a policy, but also the starting point of national governance, this paper selects “county (district) energy conservation and environmental protection expenditure” and “county (district) scale above the scale of industrial enterprises comprehensive energy consumption” as the input indicators, to evaluate the construction of ecological civilization resource consumption.

Output indicators for the construction of ecological civilization. According to the evaluation content of the efficiency of ecological civilization construction, the output indicators should reflect the construction results of economic development, resource utilization, ecological environment, and social progress. Under the concept of ecological civilization construction, the expected output index “new afforestation area” is selected to evaluate the ecological environment governance, the “new fixed asset investment amount this year” is evaluated to evaluate the economic development, the “commonly used cultivated land area” is evaluated to evaluate the utilization of resources, and the “cultural and related industries added value” is evaluated to evaluate social progress.

Scope of study. The scope of this paper is 12 counties (districts) in Yulin City, Shaanxi Province, followed by the panel data from 2010 to 2019 for performance evaluation and analysis, all of which are derived from the Yulin Statistical Yearbook from 2011 to 2020 and the statistical bulletin of national economic and social development of each county.

3. Performance Evaluation Results

3.1. Analysis of the efficiency results of ecological civilization construction based on BCC model

According to the basic principles of DEA model construction, the efficiency of ecological civilization construction in 12 districts and counties of Yulin City from 2010 to 2019 is calculated, and the specific results are shown in Table 2. Te , Te_0 , and Te_1 represent the comprehensive efficiency, pure technical efficiency, and scale efficiency calculated based on the formula for each year. The comprehensive efficiency reflects the efficiency of ecological civilization construction, which

represents the difference between the actual output and the maximum output that can be achieved under the condition of a certain amount of resource input in each county and district, and measures whether the invested resources are fully functional. Scale efficiency refers to the distance between the actual scale and the optimal production scale. Pure technical efficiency reflects a region's management capacity, the ability to operate the system and the ability to apply technology. Among them, the comprehensive efficiency = pure technical efficiency * scale efficiency. For efficiency values, the closer the size of the value is to 1, the better the efficiency, and an efficiency value equal to 1 indicates that the DEA is valid.

Table 2. Average efficiency of ecological civilization construction from 2010 to 2019.

Region	Te	Te0	Te1	Overall technical efficiency ranking
Yuyang District	0.982	1.000	0.982	2
Dingbian County	1.000	1.000	1.000	1
Jingbian County	0.731	0.814	0.901	7
Hengshan District	0.784	0.926	0.851	6
Kamiki City	0.246	0.494	0.663	12
Fugu County	0.583	0.687	0.861	10
Mizhi County	0.480	0.630	0.809	11
Suide County	0.928	0.984	0.937	3
Zizhou County	0.833	0.890	0.943	5
Wubao County	0.730	0.941	0.784	8
Qingjian County	0.900	0.957	0.943	4
Jia County	0.611	0.843	0.738	9
The population mean	0.734	0.847	0.868	-

The calculation results are as follows:

Comprehensive efficiency analysis, model results show that the average efficiency of ecological civilization construction in 12 districts and counties of Yulin City from 2012 to 2019 is 0.734, except for Dingbian County, the average comprehensive technical efficiency value of the rest of Yulin City is less than 1, all of which are non-DEA effective, the construction of ecological civilization has not been well developed, the structure of input and output is unreasonable, the resource allocation efficiency is not optimal, the resource utilization rate is not optimal or insufficient, indicating that the input scale and technical efficiency of production factors need to be further improved.

The technical efficiency analysis and model results show that the average technical efficiency of ecological civilization construction in 12 districts and counties of Yulin City from 2012 to 2019 is 0.847, of which 2 counties have effective technical efficiency, accounting for 16.67% of the total proportion, indicating that the technical level of ecological civilization construction in Yulin City is poor, the overall input factors have not been reasonably allocated and fully utilized, and the maximum production of ecological civilization construction has not been achieved under the assumption of fixed input. The values of Jingbian, Shenmu, Fugu, Mizhi and Jiaxian are all lower than the average, while 83.33% of the counties and districts are in a state of ineffective technical efficiency, and it is necessary to improve the rationality of the allocation and use efficiency of each input factor.

In the analysis of scale efficiency, the model results show that the average technical efficiency of ecological civilization construction in 12 districts and counties in Yulin

City from 2012 to 2019 is 0.868, and the scale benefits of only 1 county have reached the optimal state. The values of Hengshan, Shenmu, Fugu, Mizhi, Wubao and Jiaxian are all lower than the average, the scale benefit is decreasing, the service scale is too large, and there is a risk of excessive scale expansion. At the same time, the scale efficiency and technical efficiency of these districts and counties are ineffective, and the technical efficiency is relatively low, so it can be seen that in order to maximize the output of the construction of ecological civilization in these districts and counties, the key point is whether technological innovation can promote reasonable allocation of resources and improve application efficiency.

3.2. Dynamic analysis results based on malmquist exponential model

The Malmquist index can dynamically reflect the changing trend of the construction efficiency of ecological civilization in various counties and districts, so the Malmquist index analysis method is introduced, and the panel data of 12 counties and districts in Yulin City from 2010 to 2019 are analyzed by deap2.1 software, and the calculation results are as shown in Table 3 and Table 4. Table 3 shows the changes in the Malmquist index (total factor productivity) and its decomposition in the Yulin region in different years, and the overall view:

Table 3. Malmquist Index and its breakdown by year by county (district) in Yulin City.

Year	Comprehensive technical efficiency (EC)	Rate of technological progress (TC)	Purely technical efficiency (PEC)	Efficiency of scale (SEC)	Malmquist Index (TFP)
2010-2011	0.838	0.909	0.885	0.947	0.761
2011-2012	0.821	0.338	0.900	0.913	0.277
2012-2013	1.278	0.159	1.177	1.085	0.203
2013-2014	1.168	0.708	1.038	1.125	0.827
2014-2015	0.883	4.934	0.923	0.957	4.358
2015-2016	1.191	2.351	1.076	1.107	2.800
2016-2017	1.013	0.247	0.993	1.020	0.250
2017-2018	1.025	2.450	1.035	0.990	2.511
2018-2019	0.818	0.914	0.904	0.905	0.747
average	0.990	0.846	0.988	1.002	0.837

First, from 2010 to 2019, the average total factor productivity of 12 counties (districts) in Yulin City was 0.837, and the average reduction rate was 16.3%, showing negative growth. In addition to the average annual growth rate of scale efficiency of 0.2%, the average of comprehensive technical efficiency, technological progress rate, and pure technical efficiency is less than 1, indicating that the reason for the decrease in total factor productivity in yulin counties (districts) is caused by many aspects, and we need to pay attention to and strengthen all aspects of it.

Second, in terms of time, the values of TFP in 2012-2013 were the lowest in the study period, mainly due to the decline in the rate of technological progress. From 2014 to 2015, 2015 to 2016, and 2017 to 2018, the Malmquist index was greater than 1, and the TFP was positive, indicating that the resource utilization efficiency of ecological civilization construction in these three periods was improved, and the growth rate was the highest in 2014-2015. The decline in the Malmquist index in other years is mainly caused by the decline in the rate of technological progress, indicating that the investment in the construction of ecological civilization resources

has not been rationally utilized, there are problems in the allocation structure, and the ecological civilization construction system is not sound enough. Yuyang District except for 2013, the comprehensive technical efficiency value of 0.821 in other years is 1, and its pure technical efficiency is 1, indicating that the resource investment in Yuyang District in 2013 may be insufficient, and it cannot meet the development needs of ecological civilization construction.

Table 4. Malmquist index and its decomposition means by county in Yulin City.

Region	Comprehensive technical efficiency (EC)	Rate of technological progress (TC)	Purely technical efficiency (PEC)	Efficiency of scale (SEC)	Malmquist Inde (TFP)
Yuyang	1.022	0.835	1.000	1.022	0.854
Dingbian	1.000	0.882	1.000	1.000	0.882
Jingbian	0.958	0.858	0.958	1.000	0.822
Hengshan	1.005	0.852	1.000	1.005	0.856
Kamiki	0.959	0.840	0.943	1.016	0.806
Fugu	1.006	0.693	1.004	1.001	0.697
Mizhi	0.975	0.638	1.000	0.975	0.622
Suide	0.970	0.680	1.000	0.970	0.659
Zizhou	0.996	0.842	0.953	1.045	0.838
Wubao	1.093	0.900	1.000	1.093	0.984
Qingjian	0.972	1.011	1.000	0.972	0.983
Jia	0.937	1.280	1.000	0.937	1.200
Average	0.990	0.846	0.988	1.002	0.837

Table 4 is the result of the Malmquist index of different counties (districts) and their decomposition, taken together:

Analysis of total factor productivity decomposition, from 2012 to 2019, the average change index of total factor productivity in the construction of ecological civilization in 12 districts and counties of Yulin City was 0.837, and the total factor productivity was negative, with an average annual decline of 16.3%, indicating that the overall ecological civilization construction in Yulin City showed a downward trend from 2012 to 2019. Except for Jia County, the remaining 11 counties and districts have had negative growth in total factor productivity in eight years. After decomposing the total factor productivity, it can be seen that the average technological progress rate of the 12 counties and districts is 0.846, and the index is down 15.4%, and the decline in the total factor productivity index is mainly caused by the decline of the technological progress index, so the counties and districts should focus on technological progress and innovation, improve the utilization of resources, and thus promote the construction of ecological civilization.

Technical efficiency decomposition analysis, from 2012 to 2019, the average technical efficiency change of ecological civilization construction in 12 districts and counties of Yulin City was close to negative growth, and the technical efficiency of 7 of the 12 counties showed a downward trend, and the technical efficiency of 1 county changed to 1, and the average annual growth rate remained unchanged. The average pure technical efficiency has not reached 1, and there are 3 counties with a downward trend in pure technical efficiency, and 8 counties have maintained the same average annual growth rate. Although the average scale efficiency has reached 1, there are also 4 counties where the scale efficiency shows a downward trend, accounting for 33.34%, and the decline in scale efficiency also has a great impact on technical efficiency.

Therefore, all counties and districts should pay attention to the input of production factors, and should not invest too many production factors due to excessive pursuit of ecological civilization construction indicators, resulting in a stage of decreasing scale returns and a decline in scale efficiency, while at the same time improving the management level and taking into account the improvement of pure technical efficiency.

4. Conclusions and Recommendations

Through the study of audit supervision service ecological civilization construction performance evaluation, the construction of county-level ecological civilization construction efficiency evaluation index system, so that the audit evaluation results are more accurate, not only can maximize the role of audit recommendations, but also can promote the improvement of national governance capabilities, to help China achieve the goal of high-quality development.

5. Conclusions

From the perspective of static performance, the efficiency of ecological civilization construction in various counties and districts in China is low, and the efficiency of ecological civilization construction in a large part of districts and counties is in an inefficient state and needs to be improved urgently. The allocation of resources for the efficiency of ecological civilization construction in various counties (districts) is very different, among them, the comprehensive technical efficiency of Shenmu, Fugu, Mizhi and Jiaxian is lower than the average, and it can be found that the resource investment in these areas is insufficient or the optimal utilization of resources has not been realized. In terms of scale efficiency, in general, the efficiency of ecological civilization construction in various districts and counties in the past ten years has been at a stable level, and under the stimulation of continuous improvement of national attention and social demand, the scale efficiency of ecological civilization construction will be steadily optimized.

From the perspective of dynamic performance, in the 8 years from 2012 to 2019, the analysis results of the DEA-Malmquist index show that the efficiency of ecological civilization construction in various counties (districts) of Yulin City showed a negative growth trend, mainly due to technological progress hindering the development of ecological civilization construction efficiency in Yulin City from 2012 to 2019. Further decomposition and analysis of technical efficiency shows that too much input factors lead to the construction of ecological civilization entering the stage of decreasing scale returns, and the decline in scale efficiency also has a certain impact on technical efficiency. The technological progress index occupies a major position in the efficiency of ecological civilization construction in Yulin City, followed by pure technical efficiency and scale efficiency.

6. Recommendations

Accelerate the improvement of deficiencies at the institutional level. Judging from the results of the efficiency evaluation, the input resources of each county have not been rationally utilized, and it is necessary to find the links in each region that are wasteful and the utilization rate is not high, and to rectify them, formulate more detailed institutional measures to clarify the purpose and direction of energy conservation and environmental protection expenditures, accurately and efficiently

use energy conservation and environmental protection expenditures, and achieve the improvement of their utilization efficiency. Timely put forward audit suggestions for improvement and reform to relevant units, fill in the deficiencies and loopholes at the level of the system, and then promote the effective operation of national governance, and also lay the foundation for the establishment of a more scientific institutional mechanism.

Strengthen technological innovation. Based on the average efficiency of ecological civilization construction in each year, the efficiency of ecological civilization construction in Yulin City has experienced negative growth, mainly due to the lag of technology, and technological innovation should be strengthened to promote the improvement of ecological civilization construction efficiency.

Improve the utilization rate of energy resources. The analysis results show that the average number of comprehensive efficiency is less than 1, the energy resources invested are not efficiently utilized, not only does not promote the construction of ecological civilization, but also is not conducive to regional economic development, so improving the utilization rate of energy resources is the primary task of forming green development, effectively performing the responsibility of resource and environmental supervision, playing a constructive function of audit supervision, promoting the rational investment and utilization of resources and energy, and tracking and supervising the implementation of relevant policies and measures in the field of resources and environment.

Improve the management level of ecological civilization construction and promote national governance. The management of ecological civilization construction should be combined with the local characteristics of each county (district) in Yulin City and the suggestions on the audit results of energy conservation and environmental protection expenditure, new forest area, sand control, carbon emissions, etc., to improve the management level of ecological civilization construction in a targeted manner, improve sustainable development to green development, and form a pattern of resource conservation and environmental protection.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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