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Evaluation of Shandong Regional Development Quality based on Resource Environment Perspective

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Abstract. by selecting every prefecture-level city of Shandong province as the research object, from the angle of resources and environment, establish the relevant performance evaluation index system, and evaluate the quality of economic development of 17 prefecture-level cities in Shandong province by factor analysis. The results show that the scores of Laiwu, Dongying and Weihai cities are higher and the quality of regional development is better.

Keywords: pollution prevention; factor analysis; green development.

1. Introduction

Great changes have taken place in Chinese national conditions with the rapid economic development [1]. People no longer pursue economic development blindly and begin to take into account the issue of ecological environment construction. Since the reform and opening up, many parts of China have been pursuing the growth of GDP, and GDP is regarded as the only criterion to measure the local government's performance [2]. In recent years, Shandong's economy has developed rapidly, and in 2017 the province's GDP ranked third in the country. At the same time, many scholars only paid attention to the economic development of Shandong, but ignored the status of ecological construction in Shandong. In fact, the development of Shandong Province will inevitably be under the pressure of water environment, air environment, industrial pollution and many other aspects during the development of Shandong Province [3]. In view of this, the innovation of this paper is to establish a reasonable green economy development evaluation index system to judge the quality of regional economic development in Shandong Province from the perspective of resources and environment. There are many methods in performance evaluation, such as fuzzy comprehensive evaluation, analytic hierarchy process, principal component analysis and factor analysis, etc. [4]. Considering that the weight of factor analysis is determined by the index itself, and the potential common factors can be extracted, this paper selects factor analysis to make a comprehensive evaluation.

2. The Construction of Quality Index System of Regional Green Economy Development in Shandong Province

2.1 The Construction of Index System

The purpose of this paper is to evaluate the quality of regional development in Shandong Province from the perspective of resources and environment, so the index system should reflect the strength of economy, environment management, energy utilization and so on. Finally, there is a need to take into account the relevance between the indicators and the fact that the indicators must be positive [5], and thus apply to subsequent statistical analyses. For the above reasons, this paper, in combination with the literature and the requirements of this paper, redefines the following indicators: per capita GDP: expressed in x1; Expressed in terms of SO2 emissions, taking into account that this indicator is the inverse and negative numbers are converted to positive, expressed in terms of x2; Waste-water emissions, expressed in terms of x3; Solid waste treatment: Ratio of the value of comprehensive utilization of industrial solid waste to the amount of solid waste generated, expressed in terms of x4; coverage of green area, Indicated by x5; population density: Considering this index is inverse, take back number and convert back number to positive index, expressed in x6; Water Resources Carrying

Capacity: Ratio of Total Water Supply to Water Consumption Population, expressed in x_7; Each city's electricity consumption, considering this index is the inverse index, so take negative number into positive index, expressed by x_8.

2.2 Sources and Preprocessing of Data

The data in this paper are from the Statistical Yearbook of Shandong Province in 2018. After accurate calculation of the required value of the indicators, the data are normalized to make all data dimension the same, taking into account the differences between the dimensions of the various indicators:

$$x_i^* = \frac{x_i - u_i}{\sigma}$$

3. Evaluation of Shandong Regional Economic Development Quality based on R-Type Factor Analysis

3.1 Research Ideas

The key point of evaluating the quality of development in Shandong is to confirm the weight of index. In this paper, a new common factor is constructed by factor analysis, and the scores of each city are calculated with variance contribution rate as weight.

3.2 Research Method

The object of factor analysis in this paper is the variable, so the R-factor analysis is taken. In the factor analysis, each index contains certain principal factor components, namely:

$$x_i = a_{i1}F_1 + a_{i2}F_2 + \cdots + a_{im}F_m + \varepsilon_i, i = 1,2,3,\cdots,p$$

The α_{ij} in the model represents the load value of the factor, that is, the load of the i-th index on the j-th common factor, representing the importance of the variable for the common factor. The larger the value, the more important the indicator is for the common factor that affects the quality of regional development. Through the matrix calculation, the values of each common factor can be obtained:

$$F = A^{-1}X$$

In fact, the factor scores cannot be calculated precisely because $m < p$ is required by the model, so the factor scores are estimated by Thomson regression method.

3.3 Outcome Analysis

3.3.1 Feasibility Test of Factor Analysis

Results are based on the adoption of the test. Therefore, it is necessary to do the relevant feasibility test on the data. The results of the relevant tests are shown in table 1: the test value of KMO test is 0.669, which is greater than 0.5, so the partial correlation coefficient between variables is considered to be smaller than that of simple correlation coefficient, so it is difficult to interfere with the factor analysis result; Bartlett sphere test corresponds to P values close to 0, so even at the significance level of 0.01, We can still reject the hypothesis that the correlation matrix of the original index is the unit matrix, so we think that there is a strong correlation between the indicators. In summary, the test results indicate that it is suitable for factor analysis.

Table 1. KMO and Bartlett test

KMO sampling shear quantity		0.669
Bartlett sphericality test	Approximate chi-square	67.510
	df	28
	Sig.	0.000

3.3.2 Common Factor Extraction

Table 2 gives the information of the eigenvalue and variance contribution of the extracted principal factor. For the common factor whose eigenvalue is greater than 1, four common factors are obtained. The cumulative variance contribution ratio of the four common factors reaches 79.45%, and most information of the original index is retained.

Table 2. Interpretation of the total variance

Composition	Initial eigenvalue			Extract square sum load			Rotation squared sum load		
	total	% of variance	Cumulative %	total	% of variance	Cumulative %	total	% of variance	Cumulative %
1	2.360	29.497	29.497	2.360	29.497	29.497	1.948	24.344	24.344
2	1.791	22.389	51.886	1.791	22.389	51.886	1.875	23.443	47.788
3	1.594	19.925	71.811	1.594	19.925	71.811	1.781	22.261	70.048
4	1.418	17.720	89.531	1.418	17.720	89.531	1.559	19.483	89.531
5	0.384	4.802	94.333						
6	0.303	3.789	98.123						
7	0.115	1.436	99.559						
8	0.035	0.441	100.000						

3.3.3 Nomenclature of Common Factor

In order to give a more accurate and realistic meaning to the three common factors extracted, the factor component matrix obtained is selected, so that each index has a larger load value only on one common factor as far as possible. Finally, the rotated component matrix is obtained in table 3. For the first common factor, the load on the coverage of green area and volume of waste water discharged is very large. It can be found that these indexes are related to the ecological resources, so they are named ecological resources factors. The second common factor can be named the energy economic efficiency factor because of its large load on volume of sculpture dioxide discharged and electricity consumption by region. For the third common factor, the load on water resources carrying capacity and solid waste disposal is large, so it can be named pollutant treatment factor. The fourth common factor in per capita GDP, population density load value is relatively large, so named population economic factor.

Table 3. Rotating component matrix

		X_1	X_2	X_3	x_4	X_5	X_6	X_7	X_8
Composition	1	-0.388	-0.037	0.694	0.502	-0.958	0.297	-0.193	0.138
	2	0.233	0.901	0.431	-0.100	-0.003	-0.212	0.037	0.876
	3	0.048	-0.277	0.416	0.761	0.102	-0.109	0.933	0.238
	4	0.841	0.119	0.165	0.126	0.093	0.861	-0.153	-0.145

3.3.4 Analysis of Scores in Various Cities

In order to get the score of common factors, the relative variance contribution of four common factors after rotation is obtained by SPSS22.0 software, and the score is taken as the weight of each of the four common factors. Therefore, the final score function is:

$$z_j = 0.411f_1 + 0.312f_2 + 0.277f_3 + 0.198f_4$$

Through this formula and the component score coefficient function, the final ranking of each city is shown in Table 4. It can be concluded that the top five cities in the total are Laiwu, Dongying, Weihai, Zibo and Tai'an. In terms of the total score, the scores of Shandong regions are overall unbalanced. In terms of ecological resource factors, the highest scores are Laiwu, Zibo and Binzhou. Two out of the three cities of Luzhong City are among the top three ecological resources, and Luzhong City has a relatively small population, but its natural resources are very rich, which is very consistent with the fact. Weihai, Zaozhuang and Taian are the top three cities in terms of energy efficiency. Most of these cities are based on the agricultural economy. Therefore, they have a high energy efficiency. Laiwu, Zibo and Jinan are the top three cities in the pollutant's treatment factor, indicating that these cities have good performance in treating the pollutants in the region. Dongying, Weihai and Laiwu ranked higher in population economic factors, indicating that these cities have higher population density and higher economic level.

Table 4. Public factor scores and total score results by city

city	f_1	f_2	f_3	f_4	overall score	Overall ranking
Jinan City	-1.1769	0.6198	0.4727	-0.2414	-0.2072	10
Qingdao City	-2.7373	0.4377	-0.2524	0.4502	-0.9692	17
Zibo City	-1.3404	-0.8261	2.2478	-0.2865	-0.2427	11
Zaozhuang City	0.2293	0.9399	0.1998	-0.9119	0.2623	6
Dongying City	0.2726	0.4645	-0.5561	3.2072	0.7379	2
Yantai City	-0.4053	-0.2152	-0.4261	0.0680	-0.3383	12
Weifang City	-0.1100	-1.2906	-0.8384	0.1697	-0.6465	15
Jining City	-0.1170	-0.0208	-0.9165	-0.6393	-0.4350	13
Tai'an City	0.6436	0.7435	-0.4719	-0.3299	0.3005	5
Weihai City	0.2132	1.3870	-0.4003	0.7756	0.5631	3
Rizhao City	1.0597	0.2698	0.1656	-0.3054	0.5051	4
Laiwu City	1.4025	0.2356	2.6652	0.6053	1.5081	1
Linyi City	-0.2351	-1.3060	-0.2232	-0.7662	-0.7176	16
Dezhou City	0.3817	0.3729	-0.3826	-0.5855	0.0513	8
Liaocheng City	0.5721	0.2566	-0.0240	-0.7761	0.1549	7
Binzhou City	0.7804	-2.6584	-0.4267	0.5893	-0.5102	14
Heze City	0.5669	0.5898	-0.8331	-1.0234	-0.0164	9

4. Conclusion

From the perspective of resources and environment, this paper establishes an evaluation index system and uses factor analysis to evaluate the quality of regional economic development in Shandong Province. The results show that the quality of development and the uneven distribution of resources are the main problems in Shandong. In the future, while developing themselves, cities should pay attention to the problems of resources and environment, phase out industries with high energy consumption and high pollution, and realize the dream of beautiful China.

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