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Evaluation of the Comprehensive Economic Strength of Prefecture-level Cities in Sichuan Province Based on the Factor Clustering Method

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Abstract: *Economic strength has always been an important indicator for assessing a country or a city. In this paper, we select 15 economic indicators to evaluate the comprehensive economic strength of 21 prefecture-level cities in Sichuan Province. Through factor analysis, these indicators were grouped into three aspects: urban production capacity, residents' living standard and urban land area constructing an evaluation system for the comprehensive economic strength of prefecture-level cities in Sichuan Province, and based on the factor scores, we arrived at a ranking of the comprehensive economic strength of prefecture-level cities in Sichuan Province, which showed that Chengdu scored much higher than other cities. What's more, through cluster analysis, we divided the 21 prefecture-level cities in Sichuan Province into four categories, and made suggestions to promote the economic development of the Sichuan region based on the evaluation results.*

Keywords: *Sichuan Province; Factor Analysis; Cluster Analysis; Comprehensive Economic Strength*

1. Introduction

The economic strength of a city not only affects the employment choices of its residents, but also influences the development of relevant national policies. Therefore, this paper uses factor analysis to rank the economic strength of 21 prefecture-level cities in Sichuan Province, and uses cluster analysis to classify the cities, thus providing a detailed perception of the economic development level of each city and offering suggestions for the next step of development.

Currently, the main methods for assessing economic strength are principal component analysis, factor analysis, clustering and TOPSIS. Principal component analysis and factor analysis are variable dimensionality reduction methods that group multiple indicators into several aspects and weight them according to certain weights to derive a comprehensive economic strength score for each city, thus deriving a comprehensive economic strength ranking among cities. Fu Haifeng[1] and Su Lefeng[2] have used this method to research similar problems. The clustering method is a method of grouping city samples according to the degree of similarity or dissimilarity of the characteristics of the patterns to be classified, so that the comprehensive economic strength of cities in the same group is as close as possible and those in different groups are as dissimilar as possible [3]. TOPSIS is a method of ranking a limited number of evaluation objects according to their proximity to an idealised target, and is an evaluation of the relative merits of the existing objects, which was used by Gao Xinwei et al. method to study a similar problem [4].In addition, from the scope of the study, most researchers in recent years have focused on the evaluation of the comprehensive economic strength of economically developed regions such as Guangdong, Jiangsu and Zhejiang [5], and less on the evaluation of the comprehensive economic strength of the more economically backward regions in the central and western regions. Therefore, we selects Sichuan Province as the research object to evaluate the comprehensive economic strength of each prefecture-level city in Sichuan Province.

Sichuan province is located in southwest China and its capital, Chengdu, is one of the top ten cities in the country in terms of GDP. However, the gap between other cities in Sichuan Province and Chengdu is large and the gap between the rich and the poor in the province is relatively serious, which is not conducive to achieving common prosperity. Recently, economic growth in Sichuan has also declined, making it necessary to evaluate the economic strength of each prefecture-level city in Sichuan and to implement economic reforms accordingly. Therefore, we select 15 indicators of the impact of the comprehensive economic strength of cities in the 21 cities and autonomous regions[6] .We also derive a qualitative city classification by cluster analysis to. Through qualitative cluster analysis and quantitative

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factor analysis, the ranking of prefecture-level cities in Sichuan is made more convincing.

2. Research Methodology

2.1. Data Sources

We take 21 cities and autonomous prefectures in Sichuan Province as the research object, by consulting the existing complete and detailed economic evaluation system, referring to its selected economic impact indicators, combined with the actual situation of each city in Sichuan Province to select a comprehensive selection of economic indicators, which resulted in the selection of a total of 15 economic impact indicators. This led to the development of a factor analysis model and a cluster analysis model to rank the economic strength of the 21 cities and autonomous prefectures in Sichuan Province.

The data indicators required in this study are: primary industry (x1), secondary industry (x2), tertiary industry (x3), population (x4), employed persons (x5), total wages of employed persons (x6), urban land area (x7), total retail sales of social goods (x8), public budget revenue (x9), public budget expenditure (x10), urban disposable income per capita of urban residents (x11), disposable income of rural residents (x12), value added of the private economy (x13), consumption expenditure of urban residents (x14) and consumption expenditure of rural residents (x15). The sample data involved in this paper are obtained from Sichuan Statistical Yearbook 2020 [7].

2.2. Research Methods

2.2.1. Factor Analysis Method

Factor analysis can be considered both as an extension of principal component analysis and as a method of dimensionality reduction of the original correlation matrix variables in multivariate statistical analysis, where a number of complex variables are reduced to a few combined factors. It explores the underlying structure of the observed data by examining the intrinsic dependencies between many variables, and uses a number of dummy variables to represent the underlying data structure. These few dummy variables can reflect the main information of many of the original variables. The original variables are observable explicit variables, while the factor is called an unobservable latent variable.

1) Kaiser-Meyer-Olkin test and Bartlett's test

In order to check whether the data are suitable for factor analysis, the Kaiser-Meyer-Olkin (KMO) test and Bartlett test need to be performed on the data first. It was found that the KMO value was 0.728>0.6 and the Bartlett test value was 0.000 below 0.01 over the significance level, so the data are suitable for factor analysis.

2) Standardized data processing

Table 1: Standardisation of data on economic indicators by prefecture-level cities in Sichuan Province, 2019

No.	City	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
1	Chengdu	2.99	4.12	4.33	3.9	3.85	4.29	-0.25	4.27	4.32	4.07	3.27	3.15	4.23	2.9	2.63
2	Zigong	-0.21	-0.24	-0.22	-0.33	-0.35	-0.24	-0.54	-0.24	-0.31	-0.47	0.1	0.36	-0.24	0.2	0.76
3	Panzhihua	-1.07	-0.26	-0.34	-0.86	-0.95	-0.3	-0.45	-0.45	-0.3	-0.72	1.9	0.78	-0.39	0.9	0.26
4	Luzhou	-0.09	0.18	-0.14	0.11	0.11	0.08	-0.31	0.01	0.01	0.06	0.32	0.06	-0.02	0.67	-0.09
5	Deyang	0.04	0.33	-0.11	-0.13	-0.08	-0.03	-0.5	-0.07	-0.1	-0.33	0.31	0.74	0.07	0.73	0.91
6	Mianyang	0.57	0.3	0.1	0.28	0.42	0.03	-0.08	0.24	-0.08	0.09	0.39	0.54	0.3	0.51	0.6
7	Guangyuan	-0.59	-0.41	-0.33	-0.41	-0.37	-0.33	-0.2	-0.35	-0.35	-0.41	-0.97	-1.28	-0.4	-1.07	-1.08
8	Suining	-0.34	-0.2	-0.27	-0.25	-0.38	-0.3	-0.51	-0.31	-0.28	-0.38	-0.5	0	-0.23	0.43	0.49
9	Neijiang	0.09	-0.31	-0.2	-0.09	-0.26	-0.3	-0.51	-0.26	-0.3	-0.37	-0.09	0.03	-0.2	-0.84	0.04
10	Leshan	0.11	-0.02	-0.15	-0.22	-0.25	-0.17	-0.3	-0.15	-0.13	-0.26	0.12	0.14	-0.09	0.46	0.45
11	Nanchong	1.37	0.1	-0.08	0.76	0.5	0.18	-0.31	0.13	-0.11	0.35	-0.88	-0.53	0.09	-1.31	-0.51
12	Meishan	-0.23	-0.28	-0.22	-0.31	-0.23	-0.22	-0.46	-0.27	-0.15	-0.41	0.15	0.71	-0.25	-0.24	1.06
13	Yibin	0.38	0.45	-0.06	0.18	0.44	0	-0.28	0.02	0.06	0.12	0.13	0.25	0.18	0.31	0.28
14	Guang’an	-0.19	-0.39	-0.23	-0.23	-0.07	-0.29	-0.48	-0.26	-0.23	-0.29	-0.11	0.03	-0.29	-0.19	-0.23
15	Dazhou	0.9	-0.11	-0.08	0.54	0.57	-0.12	-0.19	0.05	-0.16	0.01	-0.85	-0.34	0.01	-0.69	-0.79
16	Ya’an	-0.79	-0.56	-0.34	-0.76	-0.72	-0.45	-0.23	-0.44	-0.37	-0.7	-0.44	-0.7	-0.45	-1.48	-0.42
17	Bazhong	-0.82	-0.55	-0.34	-0.21	-0.33	-0.28	-0.31	-0.3	-0.35	-0.27	-0.91	-1.24	-0.45	0.05	-1.04
18	Ziyang	-0.68	-0.55	-0.33	-0.46	-0.3	-0.41	-0.5	-0.37	-0.34	-0.58	-0.03	0.48	-0.45	0.05	0.22
19	Aba	-1.26	-0.68	-0.41	-0.94	-1.01	-0.44	1.72	-0.54	-0.42	-0.29	-0.29	-0.83	-0.6	-0.08	-0.04
20	Ganzi	-1.27	-0.69	-0.4	-0.86	-0.93	-0.45	3.64	-0.52	-0.4	-0.04	-0.51	-1.4	-0.6	0.28	-2.01
21	Liangshan	1.08	-0.25	-0.18	0.29	0.33	-0.23	1.07	-0.18	-0.01	0.82	-1.12	-0.97	-0.22	-1.61	-1.47

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3) Extraction of common factors

In order to allow variables to have higher loadings on fewer factors and to prevent unclear factor meanings, we used SPSS 24.0 to make the factors more explanatory and convincing by performing orthogonal rotations via the maximum variance method, and the results are shown in the table below.

Table 2: Maximum variance orthogonal rotation method rotation factor contribution table

Factor	Eigenvalue	Contribution rate %	Cumulative contribution rate %
F_1	8.424	56.162	56.162
F_2	4.467	29.778	85.940
F_3	1.530	10.199	96.139

As can be seen from Table 2, the eigenvalues of the three public factors are all greater than 1, with a cumulative variance contribution rate of 96.139% and an inflection point at the third factor, so it is appropriate to choose the three factors as the main factors. Among them, F1 contains information on population size, employed persons, public budget expenditure, primary industry, total retail sales of social goods, value added of the private economy, total wages of employed persons, public budget income, tertiary industry and secondary industry, which can be interpreted as urban production capacity. F2 contains information on consumption expenditure of urban residents, disposable income per urban resident, disposable income of rural residents and consumption expenditure of rural residents, which can be interpreted as the living standard of residents; F3 contains information on urban land area, which can be interpreted as urban land area.

4) Comprehensive scores of the 21 prefecture-level cities in Sichuan Province

From the above, the contribution rate of F1 is 56.162, the contribution rate of F2 is 29.778 and the contribution rate of F3 is 10.199. Therefore, the evaluation model of comprehensive economic strength synthesized with the contribution rates of the principal components as weights is

$$F = 56.162F_1 + 29.778F_2 + 10.199F_3 \quad (1)$$

We use the above model to evaluate the 21 cities, and the results are shown below.

Table 3: Overall score of economic strength of 21 prefecture-level cities in Sichuan Province

City	F_1	F_2	F_3	F	Rank	City	F_1	F_2	F_3	F	Rank
Chengdu	3.57	2.27	-0.25	265.72	1	Neijiang	-0.13	-0.41	0.7	-12.13	12
Mianyang	0.09	0.36	0.31	19.18	2	Guang'an	-0.24	-0.15	0.41	-14.08	13
Nanchong	1.03	-1.65	0.66	15.54	3	Suining	-0.47	0.21	0.47	-15.38	14
Yibin	0.14	0.09	0.35	13.92	4	Ziyang	-0.69	0.36	0.5	-22.86	15
Dazhou	0.7	-1.26	0.38	5.69	5	Panzhihua	-1.37	1.72	0.06	-24.91	16
Deyang	-0.42	0.76	0.61	5.55	6	Bazhong	-0.19	-0.6	-0.27	-31.55	17
Luzhou	-0.11	0.34	0.04	4.11	7	Guangyuan	-0.01	-1.1	-0.08	-33.86	18
Liangshan	1.07	-1.93	-0.7	-4.36	8	Ya'an	-0.4	-0.65	0.23	-39.25	19
Leshan	-0.33	0.36	0.33	-4.45	9	Aba	-0.78	0.38	-1.58	-48.43	20
Meishan	-0.52	0.43	0.81	-8.45	10	Ganzi	-0.4	0.04	-3.65	-58.38	21
Zigong	-0.56	0.44	0.66	-11.62	11						

2.2.2. Clustering Analysis Method

We adopt a systematic cluster analysis method, which starts by treating each sample as a class, and then clustering the closest samples (i.e. the group items with the smallest distances) first into smaller classes, and then merging the aggregated smaller classes according to their inter-class distances again, continuing continuously, and finally aggregating all the subclasses into one large class, obtaining the results as shown in Figure 1.

ISSN 2616-5902 Vol. 4, Issue 2: 70-74, DOI: 10.25236/AJBM.2022.040212

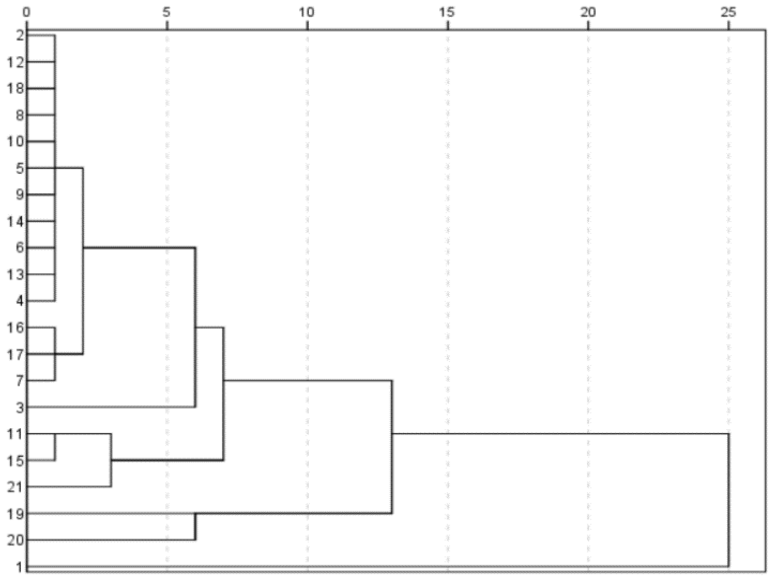

Figure 1: Tree clustering of economic strength scores of 21 prefecture-level cities in Sichuan Province

According to Figure 1, the cities are roughly divided into four categories. Class 1 includes Chengdu, Class 2 includes Nanchong, Dazhou and Liangshan Yi Autonomous Prefecture. Class 3 includes Zigong, Panzhihua, Luzhou, Deyang, Mianyang, Guangyuan, Suining, Neijiang, Leshan, Meishan, Yibin, Guang'an, Ya'an, Bazhong and Ziyang. Class 4 includes Aba and Ganzi .

3. Research Findings and Recommendations

3.1. Research Results

As can be seen from the rankings in Table 3, there is a difference of 246.54 points between the first ranked city of Chengdu and the second ranked city of Mianyang, and a difference of 324.25 points between the last ranked city and Ganzi. At the same time, the cities adjacent to Chengdu are ranked lower, indicating that Chengdu is not driving the synergistic development of its neighbouring cities.

3.2. Development Suggestions

1) Strengthen the construction of the city circle with Chengdu as the centre

Chengdu is the most developed city in Sichuan Province, and its total GDP is even ranked in the top 10 in China, while the economic development of its neighbouring cities is relatively slow and differs greatly from that of Chengdu. Chengdu can play a leading economic role in driving the development of neighbouring cities and achieving common prosperity.

2) Improve talent retention mechanism and talent introduction policy

Competition in the modern economy is ultimately a competition for talent, and Sichuan, as an inland province, has suffered from serious population loss, which has led to a weaker economic competitiveness. Therefore, Sichuan needs to improve its talent retention mechanism to retain its own talent and provide generous treatment for them, while also paying attention to the introduction of external talent to promote the development of Sichuan province.

3) Bringing into play regional advantages and achieving synergistic regional development

The development of a regional economy is conducive to the comprehensive use of regional resources and the integration of the advantages of each city to complement each other's strengths and achieve synergistic economic development. It is important to adhere to the economic development strategy of "one stem, many branches, five regions in synergy", so that those with a high level of economic development can drive those with a low level of development and achieve synergistic regional development.

ISSN 2616-5902 Vol. 4, Issue 2: 70-74, DOI: 10.25236/AJBM.2022.040212

4. Conclusion

We selected 15 economic indicators, extracted three principal components through factor analysis, and constructed an evaluation system of comprehensive economic strength accordingly to derive the ranking of comprehensive economic strength of prefecture-level cities in Sichuan Province in 2019 through a quantitative approach. The rank is: Chengdu, Mianyang, Nanchong, Yibin, Dazhou, Deyang, Luzhou, Liangshan, Leshan, Meishan, Zigong, Neijiang, Guang'an, Suining, Ziyang, Panzhihua, Bazhong, Guangyuan, Ya'an, Aba and Ganzi. Based on cluster analysis, we classified these prefecture-level cities into four categories through a qualitative approach and concluded that the economic strength of the 21 cities in Sichuan Province shows that Chengdu is seriously unipolar and the development of Sichuan Province is seriously unbalanced. The leading role of Chengdu needs to be brought into play, with the first rich leading the second rich and achieving common prosperity.

References

[1] Fu Haifeng, Wei Haiming. Analysis and evaluation of Guangxi regional economic development level based on principal component analysis and cluster analysis [J]. Economic Forum, 2014 (07): 65-70.

[2] Ru Lefeng, Zhang Gaisu, et al. Study on temporal and spatial differences of urban economy in Western China [J]. Regional Research and Development, 2014, 33 (02): 54-59 + 134.

[3] Tang Dongming. Cluster analysis and its application [D]. University of Electronic Science and Technology, 2010.

[4] Gao Xinwei, Wan Shuyuan, et al, Comprehensive economic strength evaluation of Henan Province Based on i-topsis method [J]. Journal of Gansu Science, 2017, 29 (02): 131-137.

[5] Zhu Shiyi, Research on Evaluation of comprehensive economic strength of prefecture level cities in Guangdong Province [D]. Guilin University of technology, 2021.

[6] Bi Peng, Zhang Liting. Research on comprehensive evaluation of low carbon economic development based on Fuzzy Analytic Hierarchy Process -- Taking Heilongjiang Province as an example [J]. Journal of Harbin University of Commerce (Social Science Edition), 2013 (03): 109-114.