Comprehensive Evaluation of Economic Development Level of Zhejiang Province Based on Multivariate Statistical Analysis

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Abstract

In order to comprehensively evaluate the economic development level of Zhejiang Province, his paper selects 10 economic indicators and establishes a comprehensive evaluation system for the economic development level of 11 regions (cities) in Zhejiang Province. Based on the relevant data in 2021, SPSS 25.0 software is used to conduct principal component analysis and cluster analysis. The economic development level of each region (city) is comprehensively ranked and classified, and relevant suggestions are put forward according to the evaluation results.

Keywords: *multivariate statistical analysis, economic development level, comprehensive evaluation*

1. INTRODUCTION

The economic development level of a city is an important indicator to measure the comprehensive strength of a region. With the continuous development of market economy, the difference in economic development level among cities is also increasing. The development level of urban economy is influenced by many factors, such as the development and utilization of natural resources, relevant economic policies and social economic conditions [4]. The economic development level of Zhejiang Province has always been in the forefront of China. In 2021, the total GDP of Zhejiang Province was 7351.6 billion yuan, ranking fourth among the 31 provincial-level administrative regions in China, an increase of 8.5% over the previous year. However, the economic level of various regions in the province is still uneven, which hinders the economic development of Zhejiang Province. Therefore, the analysis and comprehensive evaluation of the economic development level of Zhejiang Province is conducive to reducing the difference of economic development level among cities and promoting the stable and balanced development of regional economy.

This paper selects 10 economic indicators of 11 regions (cities) in Zhejiang Province in 2021, and uses the methods of principal component analysis and cluster analysis in multivariate statistical analysis to comprehensively evaluate the economic development level of each region.

2. ESTABLISHMENT OF EVALUATION INDEX SYSTEM

The level of economic development can be reflected through the overall economy, industrial production, import and export trade, and household consumption. This paper selects the following 10 economic indicators: GDP (billion yuan), general public budget income (billion yuan), retail sales of social consumer goods (billion yuan), per capita disposable income of rural residents (yuan), annual power consumption (billion KWH), per capita disposable income of urban residents (yuan), The added value of the tertiary industry (RMB 100 million), the total industrial output value (RMB 100 million), the total import and export value (USD 100 million) and the added value of the secondary industry (RMB 100 million) are set as variables X_1, X_2, X_3... X_{10} in turn, and a comprehensive evaluation index system is established. The data are shown in Table 1.

Table 1: Original Data of Economic Indicators

City	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
Hanghzou	18109	2386.6	6743.5	42692	910.3	74700	12287	19346.5	1142.21	5489
Ningbo	14594.9	1723.1	4649.1	42946	938.4	73869	7241.6	22554.2	1848.58	6997.2
Wenzhou	7585.02	657.55	3807.7	35844	513.8	69678	4229.4	6141.2	373.74	3191.3
Jiaxing	6355.28	674.8	2275	43598	626.3	69839	2769.56	13904.9	586.5	3453.75
Huzhou	3644.9	413.52	1556.2	41303	345	67983	1631.3	6397.3	231.09	1865
Shaoxing	6795	603.8	2477.1	42636	515.8	73101	3340	7739.3	463.92	3228
Jinhua	5355.44	492.32	2881.9	33709	475.6	67374	2996.41	6067	911.43	2208.71
Quzhou	1875.61	163.93	839.2	29266	210.6	54577	977.45	2660.6	76.17	811.05
Zhoushan	1703.62	180.7	552.4	42945	134.8	69103	790.48	2192.8	365.02	754.7
Taizhou	5786.19	455.43	2605.6	35419	397.3	68053	2939.41	6412	371.91	2543.01
Lishui	1710.03	163.97	822.9	26386	135.5	53259	964.92	1922.3	51.04	637.27

3. MULTIVARIATE STATISTICAL ANALYSIS

3.1. Principal component analysis

In 1933, Hotelling first proposed the principal component analysis method, which uses the idea of dimension reduction to transform multiple indicators into several comprehensive indicators [1]. In order to eliminate the influence of each variable dimension on the analysis, we first standardized the logarithm, and the results are expressed as Z_{X1}, Z_{X2}, Z_{X3}... Z_{X10} in turn. KMO and Bartlett's test is performed on the processed data. As shown in Table 2, KMO value is 0.611, greater than 0.6, and Sig value is less than 0.05. According to the measurement standard, the data are from multivariate normal population, so principal component analysis can be carried out. As shown in Table 3, according to the principle that the eigenvalue is greater than 1, two common factors with eigenvalues of 8.193 and 1.060 are extracted. Their interpretation of the index variability is 81.927% and 10.603% respectively, and the cumulative variance contribution rate reaches 92.531%, which can reflect the variance of the original variable of 92.531%.The Scree Plot is shown in Figure 1.
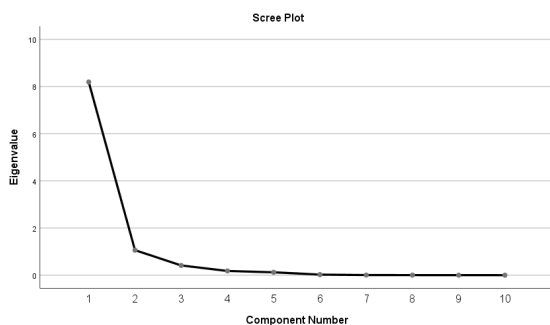
Table 2: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.611
Bartlett's Test of Sphericity	Approx. Chi-Square	213.534
	df	45
	Sig.	.000

Table 3: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.193	81.927	81.927	8.193	81.927	81.927
2	1.060	10.603	92.531	1.060	10.603	92.531
3	.413	4.130	96.661			
4	.178	1.783	98.444			
5	.122	1.223	99.668			
6	.024	.242	99.909			
7	.006	.057	99.966			
8	.003	.028	99.994			
9	.001	.006	100.000			
10	7.563E-6	7.563E-5	100.000			

According to the component matrix in Table 4, the load of the first principal component F1 and the second principal component F_2 on the ten variables, that is, the

Figure 1: Scree Plot

correlation with the ten indicators. It can be seen from the Table 4 that the first principal component is highly correlated with most indicators, up to 0.90, which is a highly positive correlation; The second principal component is positively correlated with rural per capita disposable income and urban per capita disposable income, and negatively correlated with other indicators.

Table 4: Component Matrix

	Componen 1	Componen 2
Zscore(X_1)	.979	-.172
Zscore(X_2)	.957	-.196
Zscore(X_3)	.931	-.237
Zscore(X_4)	.635	.748
Zscore(X_5)	.976	-.043
Zscore(X_6)	.786	.555
Zscore(X_7)	.927	-.256
Zscore(X_8)	.952	-.017
Zscore(X_9)	.881	-.026
Zscore(X_{10})	.968	-.017

Then, the scores of each principal component are calculated according to the component matrix and principal component eigenvalues, namely:

$$F_i = w_{i1}Z_{X1} + w_{i2}Z_{X2} + \ldots\ldots + w_{i10}Z_{X10} \quad (i=1,2) \quad (1)$$

$$w_{ij} = \frac{\theta_{ij}}{\sqrt{\lambda_i}} \quad (i=1,2, j=1,2\ldots\ldots10) \quad (2)$$

θ_{ij} represents the component matrix corresponding to the jth principal component of the ith index, $\sqrt{\lambda_i}$ represents the open root value of the eigenvector corresponding to the ith principal component, and the principal component score expression obtained by bringing in the value is:

$$F_1 = 0.342Z_{X1} + 0.334Z_{X2} + 0.325Z_{X3} + 0.222Z_{X4} + 0.341Z_{X5} + 0.275Z_{X6} + 0.324Z_{X7} + 0.333Z_{X8} + 0.308Z_{X9} + 0.338Z_{X10} \quad (3)$$

$$F_2 = -0.167Z_{X1} - 0.190Z_{X2} - 0.230Z_{X3} - 0.727Z_{X4} - 0.042Z_{X5} + 0.539Z_{X6} - 0.249Z_{X7} - 0.017Z_{X8} - 0.025Z_{X9} - 0.017Z_{X10} \quad (4)$$

By calculating weighting factor, we get:

$$F = 0.885F_1 + 0.115F_2 \quad (5)$$

The ranking of various regions (cities) in Zhejiang Province is shown in Table 5.

Table 5: Comprehensive score

Ranking	City	Comprehensive score
1	Hangzhou	4.63
2	Ningbo	4.23
3	Jiaxing	0.69
4	shaoxing'	0.38
5	Wenzhou	0.12
6	Jinhua	-0.4
7	Taizhou	-0.63
8	Huzhou	-0.97
9	Zhoushan	-1.75
10	Quzhou	-2.97
11	Lishui	-3.33

3.2. Cluster analysis

Cluster analysis is a process of classifying data into different classes or clusters, so objects in the same cluster have great similarity, while objects in different clusters have great differences. At present, cluster analysis has been widely used in many fields, such as economy, management, medicine, psychology, weather forecast, geological exploration, biological classification and so on. First, the SPSS software is used to cluster 11 cities in Zhejiang Province with the class average method, and the dendrogram is obtained as shown in the figure. According to the dendrogram, cities can be divided into three categories: the first category: Hangzhou and Ningbo, the second category: Quzhou and Lishui, and the third category: Huzhou, Zhoushan, Jinhua, Shaoxing, Wenzhou, Taizhou and Jiaxing.
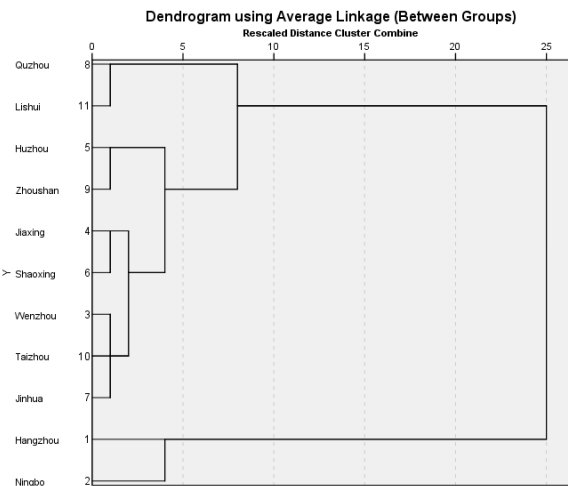

Figure 2: Dendrogram

Then K-means clustering was carried out for 11 regions (cities), and cities were still divided into three categories. The results are shown in the Table 6. The first category is Hangzhou and Ningbo, the second category is Quzhou and Lishui, and the third category is Huzhou, Zhoushan, Jinhua, Shaoxing, Wenzhou, Taizhou and Jiaxing, which are consistent with K-means clustering and systematic clustering.

Table 6: Cluster Membership

Cluster Membership			
Case Number	city	Cluster	Distance
1	Hangzhou	1	1.357
2	Ningbo	1	1.357
3	Wenzhou	3	1.305
4	Jiaxing	3	1.546
5	Huzhou	3	.951
6	Shaoxing	3	.989
7	Jinhua	3	1.330
8	Quzhou	2	.297
9	Zhoushan	3	2.149
10	Taizhou	3	.737
11	Lishui	2	.297

4.CONCLUSIONS AND SUGGESTIONS

According to the principal component analysis and cluster analysis of 10 economic indicators of 11 regions (cities) in Zhejiang Province in 2021, it can be seen that Hangzhou and Ningbo have the strongest comprehensive strength, and their economic development level is significantly better than that of other regions, while Quzhou and Lishui are lagging behind, and the results of the two analysis methods are consistent.

As the capital of Zhejiang Province, Hangzhou has obvious advantages in terms of policy influence, geographical conditions and natural resources. Hangzhou has ranked first in the national entrepreneurship and innovation matrix. Private enterprises have developed rapidly. Traditional manufacturing, Internet high-tech industries and foreign trade competitiveness have strong strengths. The net inflow rate of talents ranks first in the country. Hangzhou is the national economic development center city in Zhejiang Province. Therefore, it should continue to support high-tech industries, Promote the high-quality development of the private economy. As one of the first batch of open cities in China, Ningbo is located in the Yangtze River Delta, with unique port advantages. It is a typical export-oriented economic city. Its foreign trade has always accounted for a high proportion of the regional GDP, and its total import and export volume ranks first in the province.In 2021, Ningbo withstood the pressure to achieve an economic growth rate of 8.2%, and foreign trade played an irreplaceable role [5]. To promote Ningbo's economic development, we need to strengthen foreign trade support, encourage the development of cross-border e-commerce, accelerate the construction of new foreign trade infrastructure, support

the development of new offshore international trade, and enhance the hard core strength of the port.

Among the second tier cities, Shaoxing has great advantages in cultural tourism. The total output value and total import and export volume of the secondary industry rank among the top in the province. At present, there are about 200 cultural and tourism scenic spots in Shaoxing [2]. With the development of digital economy, Shaoxing has begun to develop smart tourism and promote the digital transformation of cultural tourism development. Jiaxing and Huzhou are located in the northeast of Zhejiang Province and the hinterland of the Yangtze River delta plain. Jiaxing is an important city in the Yangtze River Delta. Jiaxing is at the intersection of water areas, close to Shanghai, Hangzhou, Suzhou and other cities, and has obvious regional advantages. Wenzhou is a coastal city with obvious port advantages in Zhejiang Province. Since the reform and opening up, Wenzhou has created its unique warm business model. It is the representative of the unique development model of China's private economy and private entrepreneurs, forming a new pattern of small commodities and large markets.In 2021, the added value of Wenzhou's secondary and tertiary industries will be high. However, in the new era of digital transformation, Wenzhou lacks the ability of digital economic innovation, and the accumulation, convergence and application level of data are long. There is still a certain distance for key cities in the triangle. It is necessary to accelerate the transformation on the basis of traditional manufacturing industry [3]. Taizhou is also a coastal city with obvious port advantages. It should speed up the digital transformation and give full play to its port advantages. Jinhua is located in the middle of Zhejiang Province. The economic development of Jinhua is mainly based on the tertiary industry. The voluntary small commodity city is also famous in the world, which has promoted the economic development of Jinhua. Jinhua should highlight its own industrial advantages, vigorously develop the tertiary industry while developing in a balanced way, cooperate with the talent introduction policy, and promote the better and faster development of the city. Zhoushan is the only island city in Zhejiang Province. It has rich maritime traffic resources, but the lack of land resources will reduce its economic development speed. Therefore, Zhoushan should strengthen exchanges and cooperation with inland cities to jointly improve the level of economic development [6].

The economic development level of Quzhou and Lishui is in the lower reaches of Zhejiang Province, and their residents' consumption capacity, industrial production capacity and import and export trade competitiveness lag behind other cities. Therefore, we should speed up economic transformation, issue supporting talent introduction policies, solve the problem of talent shortage, and realize innovation driven

and high-quality development of economic development.

Based on the above analysis, cities in Zhejiang Province should, according to their own conditions, enhance their own advantages, improve their deficiencies, speed up the cultivation of new industries, strengthen the guarantee of talent elements, promote the coordinated development of regional economy and achieve common prosperity.

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