Overall Evaluation on the Level of Rural Economic Development in 31 Regions of China

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Abstract Taking *China Rural Statistical Yearbook* in 2008 as the data source, we select 10 indices scientifically and rationally. By using SPSS statistical software, factor analysis method and cluster analysis method in multivariate statistical analysis, we conduct analysis on the level of rural economic development in 31 provinces, municipalities directly under the Central Government, autonomous regions in China. Finally we extract 4 composite factors and offer the overall ranking of them. We divide the 31 regions of China into four types, namely the regions with developed agricultural economy, the regions with relatively developed agricultural economy, the regions with less-developed agricultural economy, and the regions with underdeveloped agricultural economy.

Key words Agricultural economy, Multivariate statistical analysis, Factor Analysis, Cluster Analysis, China

In ancient China, there was a saying that people regard food as their prime want; food regards grain as basis; grain depends on land. Agriculture means the guarantee for basic materials. Agricultural economy, the basis of entire national economy, plays a determinant role in promoting the level and pace of national economic development. In different regions, there is a great disparity on resources and environmental conditions. With the prodigious changes of agricultural economic situation of all regions, the status quo of regional difference of agricultural economic development in China also changes. In order to conduct precise and rational analysis on the situation and level of agricultural economic development in all regions of China, this paper adopts scientific multivariate statistical analysis method to conduct overall evaluation and research on the level of agricultural economic development in all regions of China, so as to provide basis for relevant departments to formulate agricultural policies.

1 Index selection, data source and research method

1.1 Index selection Taking 8 indices amid main indices of rural economy from *China Rural Statistical Yearbook* in the year 2008 as reference, after referring to other research data[1-2], we conform to the principles that the indices are mutually independent, the repeated calculation of related indices should be reduced, and the indices have comparability and universality, finally we select 10 indices, which can be seen in Table 1.

1.2 Data source The data in this paper comes from *China Rural Statistical Yearbook* in 2008, and in practice, it reflects the situation of the year 2007. The original data is shown in Table 2[1].

Table 1 Evaluation index of rural economy

Index	Index interpretation
Z_1 Grain yield per unit area of farmland // t/hm^2	Reflect the level of yield per unit area of farmland
Z_2 Added value of agriculture, forestry, animal husbandry and fishery // $\times 10^8$ yuan	Reflect the level of agricultural output
Z_3 Total power of agricultural machinery per unit area of farmland kw/hm^2	Reflect the level of agricultural mechanization
Z_4 Use of agricultural chemical pesticide per unit area of farmland t/hm^2	Reflect agricultural chemical level
Z_5 Effective irrigation rate of farmland // %	Reflect the level of agricultural water conservancy
Z_6 Income per capita of rural households // Yuan	Reflect the level of farmers' economic income
Z_7 The original value of productive fixed assets owned by rural households // Yuan/household	Reflect the level of total input of farmers' production
Z_8 The ratio of added value of the primary industry and total output value of the region // %	Reflect the output rate of agriculture
Z_9 The ratio of employees who are engaged in the primary industry and the employees // %	Reflect rural productivity
Z_{10} The ratio of the labor forces with educational level of junior high school and above // %	Reflect the quality of rural labor forces

1.3 Research method In this paper, we adopt multivariate statistical analysis method to conduct research. First, we select index and data from *China Rural Statistical Yearbook* in 2008, and start SPSS17.0. By virtue of SPSS17.0, we conduct a series of mathematical processing on the original data. After factor analysis, we get comprehensive evaluation index, and then use cluster analysis method to conduct classification on all regions[3].

2 Results and analysis

2.1 Factor analysis In many cases, due to the correlation among the variables, the statistical data information obtained

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may overlap to some extent, thus affecting the scientificity of evaluation and zoning research. By using the thought of dimension reduction, we transform many initial indices into several composite indices unrelated with each other, to conduct analysis and research. These composite indices are not only the linear combination of original many initial indices, but also remain the principal information of original variables, which are more excellent than the original indices. This paper adopts the factor analysis in the method of dimension reduction. By using SPSS software, we calculate the correlation matrix, eigenvalue, eigenvector, contribution rate of variance and the orthogonal factor matrix in succession, so as to get composite indices, and calculate the scores of composite factors[4]. First, we conduct standardization processing on the data, and get the correlation coefficient matrix of index by calculation, which can be seen Table 3.

Table 2 The main agricultural economic indices in 31 regions of China in 2007

	Z_1 Grain yield per unit area of farmland t//hm^2	Z_2 Added value of agriculture, forestry, animal husbandry and fishery $\times 10^8$ Yuan	Z_3 Total power of agricultural machinery per unit area of farmland kw/hm^2	Z_4 Use of agricultural chemical pesticide per unit area of farmland t//hm^2	Z_5 Effective irrigation rate of farmland %	Z_6 Income per capita of rural households Yuan	Z_7 The original value of productive fixed assets owned by rural households Yuan/household	Z_8 The ratio of added value of the primary industry and total output value of the region %	Z_9 The ratio of employees who are engaged in the primary industry and the employees %	Z_{10} The ratio of the labor forces with educational level of junior high school and above %
Beijing	4.397 07	101	12.941 43	0.602 93	0.747 631	9 439.63	7 679.7	1.1	5.9	38.2
Tianjin	3.317 56	110	13.633 09	0.581 47	0.787 244	7 010.06	1 1723.7	2	18	19.98
Hebei	4.499 69	1 805	14.464 54	0.493 9	0.725 087	4 293.43	1 0561.7	14.2	41.7	20.12
Shanxi	2.484 58	270	6.021 61	0.248 68	0.309 789	3 665.66	5 086.9	5.5	41.2	14.88
Inner Mongolia	2.533 76	797	3.091 53	0.196 33	0.394 134	3 953.1	15 359.9	13	52.6	14.85
Liaoning	4.491 82	1133	4.753 01	0.312 1	0.364 854	4 773.43	9 247	10.7	34	13.99
Jilin	4.433 24	784	3.032 16	0.278 95	0.296 405	4 191.34	13 244.3	15.6	46.8	10.94
Heilongjiang	2.925 14	915	2.352 77	0.147 99	0.249 214	4 132.29	1 4017.7	12.6	46.6	9.55
Shanghai	4.206 47	102	3.763 48	0.543 14	0.793 914	10 144.62	1436.1	0.8	6.1	33.3
Jiangsu	6.575	1 816	7.121 21	0.717 91	0.805 072	6 561.01	8225.8	6.8	22.7	19.06
Zhejiang	3.799 74	986	12.159 58	0.483 96	0.746 493	8 265.15	14066.9	5.5	19.2	18.21
Anhui	5.065 12	1 200	7.917 5	0.532 45	0.594 113	3 556.27	8 229.9	16.5	45.9	11.62
Fujian	4.764 08	1 002	7.974 65	0.897 91	0.714 8	5 467.08	7 423	11.3	32.4	17.84
Jiangxi	6.735 77	906	8.866 52	0.469 45	0.650 9	4 044.7	5 020.5	16.6	41.6	13.64
Shandong	5.526 5	2 536	13.211 23	0.666 44	0.644 297	4 985.34	11396.8	9.7	37.2	21.16
Henan	6.617 71	2 218	11.000 13	0.718 77	0.625 259	3 851.6	7 756.5	15.7	50.6	16.06
Hubei	4.686 28	1 378	5.470 47	0.643 09	0.449 329	3997.48	4 996	15.5	38.8	14.51
Hunan	7.105 3	1 627	9.723 94	0.579 57	0.711 692	3 904.2	4 063.3	17.6	50.7	16.84
Guangdong	4.511 36	1 696	6.486 64	0.771 15	0.460 723	5 624.04	4 130.1	5.7	29.2	18.72
Guangxi	3.313 64	1241	5.047 1	0.523 88	0.361 188	3 224.05	5 186.5	21.5	55.1	15.68
Hainan	2.439 86	361	4.515 46	0.573 2	0.233 54	3 791.37	7 512.2	31.1	53.5	18.8
Chongqing	4.859 1	482	3.842 17	0.376 49	0.283 015	3 509.29	3 862.2	12.9	39.3	9.43
Sichuan	5.087 31	2 032	4.240 43	0.400 33	0.420 127	3 546.69	5 820.3	19.9	46.3	10.01
Guizhou	2.453 26	446	3.145 85	0.182 95	0.173 749	2 373.99	4 738.9	16.8	52.9	7.23
Yunnan	2.405 47	837	3.066 17	0.260 69	0.249 835	2 634.09	7 927.7	18.4	64.8	6.72
Tibet	2.600 39	55	9.122 13	0.127 39	0.433 121	2 788.2	3 0261.6	16.2	57.6	0.7
Shaanxi	2.637 44	593	3.892 57	0.392 2	0.317 955	2 644.69	7 240	11.1	48.5	15.72
Gansu	1.768 32	388	3.384 91	0.171 9	0.228 121	2 328.92	7 995.6	14.3	54.4	15.31
Qinghai	1.958 69	83	6.429 36	0.140 17	0.325 71	2 683.78	11 223.9	11.3	44.4	8.41
Ningxia	2.924 16	98	5.692 85	0.312 75	0.385 248	3 180.84	16 917.7	11.7	45.7	9.34
Xinjiang	2.107 34	629	3.098 29	0.319 62	0.842 302	3 182.97	14 676.7	18	52	10.27

Table 3 Correlation coefficient matrix of all indices

Index	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7	Z_8	Z_9	Z_{10}
Z_1	1.000	0.675	0.444	0.660	0.526	0.310	−0.355	−0.088	−0.314	0.289
Z_2	0.675	1.000	0.290	0.518	0.265	−0.032	−0.233	0.162	0.071	0.055
Z_3	0.444	0.290	1.000	0.501	0.657	0.427	0.141	−0.348	−0.431	0.421
Z_4	0.660	0.518	0.501	1.000	0.616	0.503	−0.429	−0.179	−0.493	0.587
Z_5	0.526	0.265	0.657	0.616	1.000	0.654	−0.004	−0.429	−0.609	0.553
Z_6	0.310	−0.032	0.427	0.503	0.654	1.000	−0.164	−0.707	−0.935	0.821
Z_7	−0.355	−0.233	0.141	−0.429	−0.004	−0.164	1.000	0.042	0.234	−0.420
Z_8	−0.088	0.162	−0.348	−0.179	−0.429	−0.707	0.042	1.000	0.811	−0.534
Z_9	−0.314	0.071	−0.431	−0.493	−0.609	−0.935	0.234	0.811	1.000	−0.770
Z_{10}	0.289	0.055	0.421	0.587	0.553	0.821	−0.420	−0.534	−0.770	1.000

It can be seen from the correlation matrix that there is strong correlation among the 10 indices, that is, the information reflected by the 10 indices is overlapped, thus it is necessary to conduct factor analysis, so as to eliminate such overlapping. Then we conduct KMO test and Bartlett's sphericity test on the data, to test whether conducting factor analysis is suitable. If the statistic of KMO is between 0.5 and 1, it indicates that we can conduct factor analysis; if the statistic of KMO is smaller than 0.5, it indicates that it is inappropriate to conduct factor analysis[5]. In this study, the KMO value is 0.721, indicating that it is appropriate to conduct factor analysis. Bartlett's sphericity test is to test whether the correlation matrix is unit matrix (the correlation matrix of null hypothesis is unit matrix) or not. The chi-square statistic of Bartlett's sphericity test is 235.081 ($P<0.000$), which rejects the null hypothesis, indicating that the correlation matrix is not unit matrix, and it is appropriate to conduct factor analysis. According to the factor analysis, we conduct the maximized rotation of the variance, and the matrix after rotation can be seen in Table 4. Table 4 indicates that each factor, corresponding to several index factors, has relatively big load, so we can classify the indices according to the above table.

We classify the 10 indices as 4 types, and offer the naming of all factors on the basis of professional knowledge which can be seen in Table 5.

Table 4 Rotated component matrix

Index	F_1	F_2	F_3	F_4
Z_1	0.152 7	0.284 5	0.844 8	0.200 9
Z_2	−0.174 3	0.143 5	0.894 4	0.090 0
Z_3	0.242 0	0.786 2	0.284 6	−0.218 8
Z_4	0.154 6	0.607 2	0.475 8	0.486 0
Z_5	0.415 9	0.739 0	0.292 7	−0.012 9
Z_7	−0.094 3	0.166 1	−0.253 5	−0.899 6
Z_6	0.799 3	0.452 8	−0.009 3	0.245 5
Z_8	−0.955 6	−0.063 3	0.009 0	0.077 6
Z_9	−0.880 9	−0.344 9	−0.026 4	−0.238 4
Z_{10}	0.561 4	0.518 8	−0.047 4	0.549 2

Table 5 Classification of indices

Factor	Naming	High load index
Factor 1	Factor of labor forces and agricultural economic benefit	The ratio of added value of the primary industry and total output value of the region The ratio of amount of people engaged in the primary industry and the amount of workers Net income per capita of rural households The ratio of the labor forces with education of junior secondary school and above
Factor 2	Factor of human input conditions	Total power of agricultural machinery per unit area of farmland The use of agricultural chemical fertilizer per unit area of farmland Effective irrigation rate of farmland
Factor 3	Factor of traditional agricultural yield	The grain yield per unit area of farmland Added value of farming, forestry, husbandry and fishing
Factor 4	Factor of original value of productive fixed assets	The original value of productive fixed assets owned by rural households

2.2 Factor score and sequencing of all regions By using regression method, we calculate the overall scores of the level of rural economic development in all regions, and the scores of all common factors, that is, we take the ratio of variance contribution rate of the first principal factor, the second principal factor and the third principal factor, and the cumulative contribution rate of the first principal factor, the second principal factor the third principal factor and the fourth principal factor as weight, to conduct weighting aggregation. The calculation formula of overall score F is as follows:

$$F=(F_1\times 48.838+F_2\times 20.877+F_3\times 12.852+F_4\times 5.044)/87.611$$

Table 6 Mark of factors and overall ranking of 31 regions of China

Region	Score of F_1	Score of F_2	Score of F_3	Score of F_4	Overall Score	Overall ranking
Beijing	1.937 9	1.797 0	−1.306 2	0.917 3	1.369 7	1
Tianjin	1.336 1	1.491 8	−0.89 25	−0.623 1	0.933 5	4
Hebei	−0.500 8	1.643 2	0.569 3	−0.529 2	0.165 4	10
Shanxi	0.746 4	−1.162 0	−0.658 5	0.147 1	0.051 0	11
Inner Mongolia	−0.057 9	−0.573 0	−0.603 4	−0.710 1	−0.298 2	21
Liaoning	0.748 5	−1.151 4	0.556 9	−0.231 6	0.211 3	9
Jilin	−0.004 5	−0.978 9	0.150 1	−0.484 3	−0.241 6	19
Heilongjiang	0.353 6	−1.492 4	−0.070 1	−0.860 2	−0.218 3	18
Shanghai	2.467 4	0.019 5	−1.019 1	1.832 3	1.336 1	2
Jiangsu	1.188 2	0.088 9	1.685 2	0.017 2	0.931 7	5
Zhejiang	1.385 6	1.037 9	−0.080 5	−1.012 4	0.949 6	3
Anhui	−0.594 1	0.351 7	0.644 2	−0.038 5	−0.155 1	17
Fujian	−0.045 0	1.148 6	0.210 2	0.744 8	0.322 4	8
Jiangxi	−0.303 8	0.284 6	0.908 3	0.239 0	0.045 5	12
Shandong	0.145 3	0.997 4	1.683 0	−0.588 6	0.531 7	7

Continued (Table 6)

Region	Score of F_1	Score of F_2	Score of F_3	Score of F_4	Overall Score	Overall ranking
Henan	−0.760 3	0.828 0	1.847 6	0.014 6	0.045 3	13
Hubei	−0.322 9	−0.186 8	0.628 4	0.836 8	−0.084 1	15
Hunan	−0.764 9	0.695 5	1.453 5	0.486 7	−0.019 4	14
Guangdong	0.864 6	−0.474 1	0.997 5	0.821 3	0.562 6	6
Guangxi	−1.399 5	0.226 9	−0.260 5	1.140 9	−0.698 6	28
Hainan	−2.425 4	1.364 9	−1.906 8	1.918 5	−1.196 0	31
Chongqing	0.266 0	−1.439 3	0.338 2	0.493 9	−0.116 7	16
Sichuan	−0.564 3	−0.894 5	1.390 3	0.270 2	−0.308 2	22
Guizhou	−0.536 7	−1.444 9	−0.571 2	0.380 8	−0.705 4	29
Yunnan	−1.032 6	−0.951 1	−0.375 2	0.077 3	−0.852 8	30
Tibet	−0.682 8	0.669 9	−0.898 3	−3.441 3	−0.550 9	26
Shaanxi	−0.163 9	−0.729 0	−0.581 9	0.451 8	−0.324 4	24
Gansu	−0.477 3	−0.887 4	−1.154 6	0.325 6	−0.628 2	27
Qinghai	0.081 1	−0.745 5	−0.985 0	−0.793 4	−0.322 6	23
Ningxia	−0.019 3	−0.221 9	−0.779 9	−1.150 3	−0.244 3	20
Xinjiang	−0.864 5	0.686 2	−0.919 1	−0.653 2	−0.490 8	25

2.3 Cluster analysis On the basis of factor analysis, we conduct sample clustering. According to the scores of factors, we divide 31 regions into 4 types which can better reflect the actual situation of China. The classification of 31 regions can be seen in Table 7. The cluster results directly reflect the similarity and difference of level of the agricultural economic development in 31 cities of China.

Table 7 Cluster result of regions

Layer of rural economic level	Overall mark	Evaluation of rural economic level	Region
The first layer	More than 0.9	The regions with developed agricultural economy	Beijing, Shanghai, Zhejiang, Tianjin, Jiangsu
The second layer	0 – 0.9	The regions with relatively developed agricultural economy	Guangdong, Shandong, Fujian, Liaoning, Hebei, Shanxi, Jiangxi, Henan
The third layer	−0.4 – 0	The regions with less-developed agricultural economy	Hunan, Hubei, Chongqing, Anhui, Heilongjiang, Jilin, Ningxia, Inner Mongolia, Sichuan, Qinghai, Shaanxi
The fourth layer	Below −0.4	The regions with underdeveloped agricultural economy	Xinjiang, Tibet, Gansu, Guangxi, Guizhou, Yunnan, Hainan

3 Conclusion and suggestions

Through multivariate statistical analysis, the 4 types of economic development we have classified, to much extent, are consistent with the actual situation of development of all provinces and regions of China in reality we have known. We can clearly find that the level of agricultural economic development in all regions of China is uneven; the level of rural economic development in all provinces are consistent with the overall level of economic development, which verifies that the rural economy plays the role of supporting the national economy; the level of rural economic development has obvious geographical differences, and the rural economic development of the central and eastern China has obvious advantages in comparison with the rural economic development of the western China.

There are multifarious factors responsible for the differences of agricultural economy in provinces and regions of China. China should pay attention to these regional characteristics, formulate the relevant policies, focus on solving the imbalance of rural economic development, adjust the agricultural economic level by steps with purposefulness, spare no efforts to bridge the regional gap, and support the rural economic development of the northwestern regions of China, so that we achieve the overall goal of joint development and common prosperity.

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