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Research on the Evaluation of Urban Development Levels in Shaanxi Province Based on Factor Analysis Method

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Abstract: Through statistical analysis of economic, social, environmental, and other aspects of data in various cities in Shaanxi Province, this paper constructs a comprehensive evaluation index system, conducts evaluation research on the development level of cities in Shaanxi Province, and uses factor analysis in mathematical statistics methods to evaluate 2021. The results of the study show that: Xi'an City is a city with a relatively high level of development in Shaanxi Province, Yulin City and Yan'an City have an intermediate level of development, Xianyang City, Weinan City, and Baoji City, Hanzhong City, Shangluo City, Ankang City, and Tongchuan City have roughly the same development level and a lower level of development.

Keywords: Urban development level, Factor analysis, Evaluation study, Factor score.

1. Introduction

The development of a country is inseparable from the development of cities, and each district is an essential composing of a metropolis. Therefore, the overall level of urban regional development determines the impartiality of a metropolis's development. Only by grasping the development level of each region and identifying the differences between regions, can supply strong support for the future regional development direction. Urban development promotes the large-scale concentration of factors of diverse economic activities in the district. The city becomes the spatial interweaving of various factor markets within the district. At the same time, it is also the most necessary core part of the regional economy, politics, and culture, especially in central cities. Development plays the role of command and service center in the advance of regional economic development. Regional domestic planning is essentially the rational allocation of production factors within a region to achieve common interests among regions.

As a province with a large economy, tourism, and culture, Shaanxi Province has achieved rapid economic development in recent years and has maintained a growth trend. However, economic growth is no longer the only goal of social progress. Improving the quality of residents' lives is increasingly important. valued by society as a whole. Accelerating infrastructure construction, giving full play to the advantages of human resources, and focusing on talent introduction and training will have a long-term impact on the future urban development of Shaanxi Province. Based on this, this paper uses the factor analysis method to conduct an in-depth study of the urban development level of Shaanxi Province.

The contemplation of regional differences has always been a focus topic in academic circles. Guo Jia studied the development differences of 33 cities in China from the perspective of multivariate function data analysis [1]; Bin Yang used linear dimensionless analysis methods to study the sustainable development of cities. A quantitative analysis of the main influencing factors concluded that China's urban development level is constantly improving, and proposed regulatory policy recommendations for sustainable urban development [2]; Pereverzieva A proposed an industrial city (Zaporoz) under the influence of a knowledge and innovation economy The development level evaluation method uses quantitative evaluation methods and qualitative analysis based on the matrix method to confirm the importance of knowledge and innovation on the urban development level [3]; Han Liu used factor analysis method to evaluate the logistics of 18 cities along the New Western Land-Sea Corridor. A comprehensive evaluation of competitiveness and prompt pertinent suggestions [4]; Jiang Haijun used the factor analysis method to analyze the development level of e-commerce based on the extensive score and relevant policies of each district and pointed out the policies that should be well-informed for reference. Provide a reference for poor areas [5].

Li Meixia used the cluster analysis method to study the urban regional development of Tianjin [6]; Huang Huangfen et al. used the factor analysis method and cluster analysis method to construct an evaluation index system for the comprehensive agricultural development level, and evaluated 14 cities in Guangxi. The extensive rural development level of Tianjin was measured[7]; Du Qingxia used factor analysis and cluster analysis to analyze the development levels and differences of 15 districts and counties in Tianjin, and put forward conclusions and suggestions based on the development characteristics and structure[8] ; Wu Chengxin used principal component analysis and cluster analysis methods to study the income levels of urban residents in 31 provinces and cities, and concluded the current income gap between urban residents in various provinces and cities, and put forward relevant conclusions and suggestions accordingly[9]; Huang Hanrong put forward policy suggestions for the development of small and medium-sized district in Ganzhou, Jiangxi Province, using rare earth expertise and characteristics as a development strategy [10]; Sun Shangmin used factor analysis to conduct a hierarchical assessment of the competitiveness of real estate companies,

and at the same time provided effective and reasonable measures for corporate competitiveness. Theoretical basis [11]; Ni Jiayue calculated the core competitiveness scores of each bank and classified them based on factor analysis and cluster analysis methods to objectively measure the differences in the core competitiveness of various commercial banks in China, aiming to improve the three types of banks. Put forward targeted suggestions for existing problems in inherent business development [12]; Zhang Jing and others started from the aspects of economy, society, resources, and environment. They used the analytic hierarchy process to construct an evaluation index system for urban sustainable development in Shaanxi Province. They evaluated the sustainable development level and capabilities of 10 prefecture-level cities in Shaanxi Province. Their study concluded that the level of urban sustainable development showed the highest regional differences in Guanzhong, followed by northern Shaanxi, and the weakest in southern Shaanxi [13].

The subsequent structural arrangement of the paper is: first, we introduce the basic ideas and theories of the factor analysis method; second, we construct an urban growth even valuation insignitor and explain the data sources; and use the factor analysis method to analyze the urban development level of Shaanxi Province empirically; finally, we summarize the findings of the paper.

2. Methodology

Actor analysis originated in the early 20th century, published by Charles Spearman, and was first widely used in psychology and education. Because of its lack of computing power and fast computing instruments, its promotion and development in practice are hugely circumscribed. With the advent of the computer, the theory and practice of factor analysis have made enormous progress. At present, the factor analysis has made remarkable achievements in various fields. Factor analysis is the promotion and expansion of principal component analysis. Its research object is to combine several variables with complex relations and samples into some unobserved comprehensive factors, to reproduce the information contained in the original data as far as possible, and to classify the primary variables according to different common factors to achieve the effect of dimension reduction.

The main idea of factor analysis is to group original variables according to the magnitude of their correlation. The purpose is to have high correlations between variables in the same group and low correlations between variables in different groups. Each set of variables represents a structure shown by a common factor. Common factors are not measurable. In factor analysis, each variable is the sum of two parts. One part is composed of a linear combination of some unmeasurable common factors. The other part is a peculiar factor that has nothing to do with a common factor.

3. Results and Discussion

3.1. Construction of the evaluation index system

Referring to the evaluation index systems of other scholars on urban development, and based on the principles of the achievability of the index system, the ease of data collection, and objectivity, the paper selected the nine most representative indicators. They are the regional resident population at the end of the year, regional GDP, general public budget revenue, total retail sales of consumer goods, the average annual salary of urban non-private employees, the growth rate of fixed asset investment, total construction output value, total industrial output value, and real estate development invest. We constructed the evaluation system through the above nine evaluation indicators and conducted an empirical study on regional differences among cities in Shaanxi Province based on multivariate statistical analysis.

Table 1. Evaluation index system of urban development level

Index selection	Indicator symbol
The permanent resident population at the end of the year	X_1
Regional GDP	X_2
General public budget revenue	X_3
Total retail sales of social consumer goods	X_4
The average annual salary of urban workers in non-private positions	X_5
Growth rate in fixed-asset investment	X_6
total output of building industry	X_7
gross industrial output value	X_8
Real estate development and investment	X_9

3.2. Data sources

We obtained the data about the evaluation index system of urban development level through the "2022 Shaanxi Province Statistical Yearbook". Based on the statistical data of Shaanxi Province in 2021, we analyzed Xi'an, Tongchuan, Baoji, Xianyang, Yulin, and Hanzhong, Yan'an, Weinan, Ankang, and Shangluo in Shaanxi Province. To minimize the research error, we ensured that the data were obtained from the same statistical yearbook to the greatest extent during the data collection.

3.3. KMO and Bartlett test

Before conducting factor analysis, we first test whether the indicators are suitable. We conducted KMO and Barlett tests on nine variables through SPSS27.0. Table 2 shows the test results.

Table 2. KMO and Bartlett test

Number of KMO sampling suitability quantities		0.662
Bartlett sphericity test	Approximate chi square	166.495
	free degree	36
	conspicuousness	<0.001

A KMO value above 0.8 indicates suitability for factor analysis. A KMO value below 0.6 indicates unsuitability for factor analysis. A KMO value of 0.6 -0.8 shows that factor analysis is barely possible. From Table 2, the value of KMO is 0.662, and the significance obtained by the Bartlett test is less than 0.001. The above analysis shows that the nine evaluation indexes selected in this study have high similarity and correlation, and the study indexes and data meet the requirements of factor analysis.

3.4. Factor extraction

According to the factor analysis model theory and method, we extracted the common factor by principal component analysis. Table 3 shows the results obtained by the factor analysis using SPSS27.0. Results indicate that there are two common factors with eigenvalues greater than one. The cumulative contribution rate of these two common factors exceeds 90%, and the variance percentages of the two common factors are 78.223% and 15.388%. It shows that the common factors of these two studies have solid interpretative power on the nine original variables. Therefore, we used these two common factors as alternative indicators for the initial nine research indicators. This study evaluates the comprehensive development level of ten cities in Shaanxi Province by using these two common factors.

Table 3. Total variance interpretation

component	Initial eigenvalue			Extracting load sum of squares			Rotating load sum of squares		
	total	variance percentage	accumulation%	total	variance percentage	accumulation%	total	variance percentage	accumulation%
1	7.040	78.223	78.223	7.040	78.223	78.223	5.520	61.337	61.337
2	1.385	15.388	93.611	1.385	15.388	93.611	2.905	32.274	93.611
3	0.451	5.006	98.617						
4	0.083	0.921	99.538						
5	0.028	0.309	99.847						
6	0.012	0.132	99.979						
7	0.001	0.013	99.992						
8	0.001	0.006	99.999						
9	0.000	0.001	100.000						

3.5. Interpretation and naming of the factors

According to the theory and method of the factor analysis model, we use the maximum variance rotation method to extract public factors. Table 4 shows the result. The first common factor has significant factor loadings on these variables. These variables are the regional resident population at the end of the year, regional GDP, general public budget revenue, total retail sales of consumer goods, average annual salary of urban non-private employees, total output value of the construction industry, and real estate development investment. We can see that the first common factor can explain these seven indicators, so the first common factor is named the scale factor. The second common factor has significant factor loadings on fixed asset investment and total industrial output value. We can see that the second common factor can explain these two indicators, so the second common factor is named the degree factor.

Table 4. Composition matrix after the rotation

variable	Component 1	Component 2
X_1	0.947	0.254
X_2	0.838	0.536
X_3	0.704	0.682
X_4	0.973	0.220
X_5	0.716	0.665
X_6	-0.099	-0.841
X_7	0.974	0.194
X_8	0.225	0.906
X_9	0.979	0.173

3.6. Calculation of the factor score

The factor score coefficient matrix is shown in Table 5, and the final formed coefficient matrix is rotated according to the maximum variance.

Table 5. Factor score coefficient matrix

variable	Component 1	Component 2
X_1	0.217	-0.099
X_2	.1012	0.088
X_3	0.034	0.205
X_4	0.233	-0.125
X_5	0.042	0.192
X_6	0.187	-0.451
X_7	0.240	-0.140
X_8	-0.166	0.455
X_9	0.247	-0.153

Table 5 shows the factor score coefficient matrix. From Table 5, we can calculate the factor scores of the two common factors. The formula for calculating the two common factors is as follows:

$$F_1 = 0.217X_1^* + 0.112X_2^* + 0.034X_3^* + 0.233X_4^* + 0.042X_5^* + 0.187X_6^* + 0.240X_7^* - 0.166X_8^* + 0.247X_9^*$$

$$F_2 = -0.099X_1^* + 0.088X_2^* + 0.205X_3^* - 0.125X_4^* + 0.192X_5^* - 0.451X_6^* - 0.140X_7^* + 0.455X_8^* - 0.153X_9^*$$

According to the variance contribution rate table, we can calculate the weight of the two common factors. The weight of each common factor is the variance contribution rate of this common factor divided by the sum of the variance contribution rates of the two common factors. The weight calculation formula of the common factor is as follows:

$$\omega_1 = \frac{78.223}{93.611} = 0.8356$$

$$\omega_2 = \frac{15.388}{93.611} = 0.1643$$

Through the factor weights calculated above and combined with the factor scores of the two public factors of each city, we can obtain the comprehensive factor score of the urban development level in Shaanxi Province. The calculation model of the composite factor score is as follows:

$$F = 0.8356 \times F_1 + 0.1643 \times F_2$$

Table 6. Common factor scores of each city development level in Shaanxi Province

area	F_1		F_2		F	
	score	ranking	score	ranking	score	ranking
Xi'an City	2.54707	1	0.91068	2	2.28	1
Tongchuan City	-0.89045	10	-0.0517	8	-0.75	10
Baoji City	-0.15975	4	0.03614	6	-0.13	4
Xianyang City	-0.07252	3	0.69728	3	0.05	3
Weinan city	-0.16839	5	0.02277	7	-0.14	5
Yan'an City	-0.18292	6	-1.42749	9	-0.39	7
Hanzhong city	-0.4496	7	0.91965	1	-0.22	6
Yulin	0.71556	2	-2.07295	10	0.26	2
Ankang City	-0.57922	8	0.35414	5	-0.43	8
Shangluo city	-0.75978	9	0.6115	4	-0.53	9

According to the above formula, using SPSS27.0, we can calculate the two common factor scores and the comprehensive factor score of each city in Shaanxi Province. Table 6 shows the factor scores and rankings. We can see from Table 6 that in the order of the first common factor, Xi'an City ranks first, Yulin City ranks second, and the values are both positive numbers. The development level of Xi'an and Yulin in terms of scale factor is higher than that of other cities and is greater than the average level. In the second common factor ranking, Hanzhong City ranked 1st, Xi'an City ranked 2nd, Xianyang City ranked 3rd, Shangluo City ranked 4th, Ankang City ranked 5th, Baoji City ranked 6th, and Weinan City ranked 7th. , and all are positive numbers, much higher than other cities, indicating that these seven cities have higher development in the degree factor. Residents in these seven cities have good living standards and have advantages over the other three cities. Tongchuan City, Yan'an City, and Yulin City ranked in the bottom three, indicating that the development of these three cities is relatively backward in terms of degree factors. The living qualities of residents in these three cities need to be improved, and there is considerable room for improvement.

4. Conclusion

This paper uses the factor analysis method to evaluate the urban development level of Shaanxi Province. Overall, Xi'an City, Yulin City, and Xianyang City rank among the top three, with relatively high levels of development. Xi'an City, Yulin City, Xianyang City, and Baoji City have developed relatively well on regional permanent population, GDP, real estate development investment, and other indicators. They have well-developed infrastructure. Hanzhong City, Xi'an City, Xianyang City, and Shangluo City have developed relatively well in variables such as total industrial output value and average per capita salary. Their residents have a higher standard of living. While carrying forward its advantages, each city learns from the development experience of other cities and actively improves its cultivated development level to achieve sustainable urban development.

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