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Research on the Level of Urban Economic Development in Sichuan Province

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Abstract. This paper selects 21 cities and prefectures of Sichuan Province as the research object, adopts 12 comprehensive indicators, establishes a linear model through correlation analysis, carries out regression analysis to modify the model, and uses factor analysis and cluster analysis to study the level of urban economic development. The results show that the GDP of all regions in Sichuan Province has a strong correlation with the three indicators of total retail sales of social consumer goods, passenger volume, and urbanization rate, and plays a positive role in promoting the economic development of all cities in Sichuan Province. Chengdu ranks the highest in the comprehensive ranking of urban economic development level in Sichuan Province.

1. Introduction

To promote the advancement of the western region to form a new pattern, the State Council approved the Development planning of Chengdu-Chongqing urban agglomeration in 2016, and the National Development and Reform Commission issued the Master Plan of the New Western Land-Sea Corridor in 2019. As an important province for the development of the western region, Sichuan Province is the core area in the Development planning of Chengdu-Chongqing urban agglomeration, and the main channel of the New Western Land-Sea Corridor. Therefore, the research on the ability of urban economic development in Sichuan Province has important reference value for promoting regional economic development and policy formulation in the west[1-3]. As a gathering point of regional economy, technology, politics, production, population, information, transportation, culture and other aspects, a city has a certain attraction to its surrounding areas. For a comprehensive evaluation of a city, its own economic development capacity is of great importance. Most scholars conducted studies based on urban agglomerations, economic belts, provinces and other areas [4-5], but there were few studies in the western region. At present, factor analysis [6-8] and cluster analysis are widely used [9-10], with good results. Because of this, the research adopts comprehensive indicators to measure the ability of urban economic development in Sichuan Province. Through correlation analysis, indicators with strong correlation were selected to establish a linear model, and variables with insignificant results were eliminated by regression analysis to establish a new model. The main factors are selected by the factor analysis method, and weighted calculation is carried out according to the contribution rate of the main factors. Finally, the comprehensive score and ranking of the urban economic development ability are obtained.

2. Research Methods and Data

2.1. Indicator Selection and Data Source

In order to ensure the scientific nature, representativeness, completeness, and feasibility of the research results, 12 comprehensive indicators were selected to construct the index system. Shown in Table 1, the data were all from Sichuan Statistical Yearbook 2018.

Table 1. Selection of economic indicators.

code	Economic indicators	code	Economic indicators
x1	GDP	x7	Passenger traffic
x2	Number of urban units employed in primary industry	x8	freight
x3	Number of urban units employed in the secondary	x9	Number of employees in transportation,
x4	Total investment in fixed assets	x10	Highway mileage
x5	Total retail sales of consumer goods	x11	Urbanization rate
x6	Number of employees in rental and commercial services	x12	The intensity of the development

2.2. The Research Methods

2.2.1. Build a Linear Model

The indicators with weak correlation were eliminated, GDP was selected as the dependent variable of the model, and the remaining indicators were taken as the independent variable of the model. Multiple linear regression was carried out on the model. Establish a linear model:

$$v_1 = a \times v_2 + b \times v_3 + c \times v_4 + e \times v_5 + f \times v_6 + g \times v_7 + h \times v_8 + \mu \tag{1}$$

Where v_1 represents the gross regional product, v_2-v_8 represents the remaining indicators, and lowercase letters are their corresponding regression coefficients respectively. They represent the influencing factors other than variables, namely random errors.

2.2.2. Factor Analysis

Formula (2) is the factor analysis mechanism and represents the factor analysis model with K factors as variables:

$$E(f) = 0, \text{var}(f) = I \quad E(u) = 0, \text{var}(u) = \psi = diag(\psi_1^2, \psi_2^2, \cdots, \psi_p^2) \quad \text{cov}(f, u) = 0. \tag{2}$$

2.2.3. Clustering Analysis

K-means algorithm is adopted to carry out cluster analysis on the samples, and the analysis mechanism is shown in Formula (3).

$$\begin{aligned} &d(x_i, x_j) = \sqrt{(x_{i1} - x_{j1})^2 + (x_{i2} - x_{j2})^2 + \cdots + (x_{ip} - x_{jp})^2} \\ &Meandist(S) = \frac{2}{n(n-1)} \times \sum_{i \neq j, i, j=1}^{n} d(x_i, x_j), \quad E = \sum_{i=1}^{k} \sum_{j \in N_i} \| x_i - c_i \|^2 \end{aligned} \tag{3}$$

3. Regression Analysis

3.1. Correlation Analysis

To ensure certain scientificity, this paper carries on the correlation analysis to the 12 indicators. The calculation results are shown in Table 2. Except for var10 highway length and var12 development intensity, all other variables are strongly correlated with GDP.

Table 2. Correlation between variables.

	var1	var2	var3	var4	var5	var6	var7	var8	var9	var10	var11	var12
var1	1											
var2	0.9138*	1										
var3	0.9786*	0.9115*	1									
var4	0.9847*	0.8971*	0.9805*	1								
var5	0.9982*	0.9075*	0.9806*	0.9876*	1							
var6	0.9873*	0.9419*	0.9623*	0.9715*	0.9843*	1						
var7	0.9887*	0.9320*	0.9616*	0.9726*	0.9844*	0.9955*	1					
var8	0.8302*	0.7127*	0.8252*	0.8330*	0.8347*	0.7778*	0.7690*	1				
var9	0.9864*	0.9447*	0.9621*	0.9708*	0.9831*	0.9984*	0.9964*	0.7759*	1			
var10	0.2442	0.4318	0.2861	0.2852	0.2646	0.2957	0.2662	0.0994	0.2858	1		
var11	0.6789*	0.4527*	0.6566*	0.6390*	0.6685*	0.6219*	0.6270*	0.7333*	0.6236*	-0.3402	1	
var12	0.327	0.3278	0.3101	0.3661	0.3261	0.3126	0.3207	0.2079	0.3292	0.4781*	0.0224	1

3.2. Model Updating

Based on the original linear regression model, regression analysis was conducted on the variables. According to the output results in Table 3, the final results were obtained after 7 times of variables elimination. The P-values of var2, var3, var4, var6, var8 and var9 were 0.2045, 0.6869, 0.9133, 0.5909, 0.8903 and 0.1271 respectively. Therefore, eight variables were eliminated based on the original model. The P values of var5 total retail sales of social consumer goods, var7 passenger volume and var11 urbanization rate are 0.000, 0.001 and 0.000 respectively, with significant coefficients. Therefore, a new linear model was established:

$$v_1=16.2309*v_5+0.3035*v_7+0.1046*v_{11}+u$$

Table 3. Regression analysis of the modified model.

var1	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
var5	16.2309	1.3109	12.38	0.000	13.4650	18.9967
var7	0.3035	0.0780	3.89	0.001	0.1389	0.4682
var11	0.1046	0.4183	2.50	0.023	0.0164	0.1929
cons	-0.0260	0.0178	-1.46	0.162	-0.0635	0.0115

3.3. Heteroscedasticity Test

According to Table 4, the P-values obtained by the White test and BP test are 0.3971 and 0.6465 respectively, both of which are greater than 0.05, indicating that there is no heteroscedasticity and the assumption of homoscedasticity is very significant. Therefore, the above model is the optimal model.

Table 4. Heteroscedasticity test.

estat imtest,white	estat hettest,iid
chi2(20)=21	chi2(1) = 0.21
Prob > chi2 =0.3971	Prob > chi2 =0.6465

4. Principal Component Factor Analysis

4.1. Factor Analysis

As shown in Figure 1, two common factors can be extracted from the data in this paper according to eigenvalues and slopes. Factor analysis was carried out by the maximal variance orthogonal rotation method. The calculated results in Table 5 were consistent with the expectation of the rubble diagram.

The characteristic values of factor 1 and factor 2 were 9.0842 and 1.6382, both greater than 1, and the cumulative contribution rate of factor 1 and factor 2 reached 89.35% and greater than 85%.

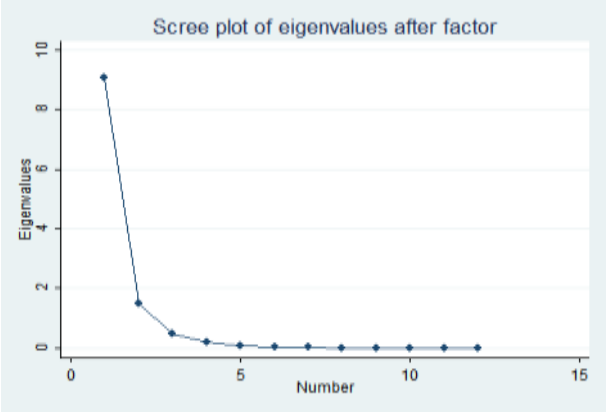

Figure 1. Gravel diagram.

4.2. The Main Factor

According to Table 5, among the 12 factors, the characteristic value of only 2 factors is greater than 1, namely factor 1 and factor 2, of which the characteristic value of factor 1 is 7.4460 and the contribution rate is 0.7570, and the characteristic value of factor 2 is 0.9789 and the contribution rate is 0.1365. The cumulative contribution rate of the two factors is 0.8935, and a total of 89.35% of the data are explained, which has a good interpretation effect.

Table 5. Factor analysis results.

	Eigenvalue	Difference	Proportion	Cumulative		Eigenvalue	Difference	Proportion	Cumulative
F1	9.0842	7.4460	0.7570	0.7570	F7	0.0432	0.0315	0.0036	0.9981
F2	1.6382	0.9789	0.1365	0.8935	F8	0.0117	0.0055	0.0010	0.9991
F3	0.6593	0.3410	0.0549	0.9485	F9	0.0061	0.0025	0.0005	0.9996
F4	0.3183	0.1725	0.0265	0.9750	F10	0.0036	0.0024	0.0003	0.9999
F5	0.1459	0.0578	0.0122	0.9872	F11	0.0012	0.0009	0.0001	1.0000
F6	0.0880	0.0449	0.0073	0.9945	F12	0.0003		0.0000	1.0000

4.3. Analysis of Variables by Principal Factors

According to Table 6, the main factor 1 mainly explains seven variables, namely var1, var3, var4, var5, var6, var7 and var9, among which the explaining proportion of var1 GDP and var5 total retail sales of social consumer goods is larger, which are 0.9966 and 0.9956 respectively. The main factor 2 mainly explained the five variables var2, var8, var10, var11, and var12, among which var10 accounted for the largest proportion of highway mileage, which was 0.8398. All the Uniqueness is less than 0.25, so the factor analysis can explain the variables well.

Table 6. Explanatory components of factor 1 and factor 2.

variable	Factor1	Factor2	Uniqueness	variable	Factor1	Factor2	Uniqueness
var1	0.9966	-0.0398	0.0002	var7	0.9866	0.0042	0.0022
var2	0.9296	0.1889	0.0231	var8	0.8357	-0.2218	0.1197
var3	0.9824	-0.0126	0.0137	var9	0.9892	0.0207	-0.0000
var4	0.9877	0.0124	0.0065	var10	0.2841	0.8398	0.1558
var5	0.9956	-0.0258	0.0004	var11	0.6611	-0.6079	0.1270
var6	0.9889	0.0201	-0.0006	var12	0.3491	0.5561	0.2420

4.4. Comprehensive Evaluation Ranking of Economic Development Ability of Cities in Sichuan Province

Table 7 shows the comprehensive score of economic development of each city. Chengdu ranked

first, with the characteristics of higher scores than other cities in the whole province and much difference from other cities, and it was classified as a first-class city. Six cities, including Dazhou, Yibin, Nanchong, Mianyang, Luzhou, and Deyang, have positive scores and are in the middle and upper level of development in the province with certain development potential and advantages, and are classified as second class cities. The remaining 14 cities and prefectures have a negative overall score, indicating that their economic development level is not ideal and there are certain development conditions. It is classified as a Tier 3 city.

Table 7. Comprehensive scores of cities in Sichuan Province.

city	f_1	f_2	score	city	f_1	f_2	score
Chengdu	4.2957	0.0615	3.2602	Meishan	-0.2476	-0.6414	-0.275
Zigong	-0.2387	-0.9212	-0.3065	Yibin	-0.0196	0.645	0.0732
Panzhihua	-0.1667	-1.2593	-0.2981	Guang 'an	-0.2471	0.5567	-0.1111
Luzhou	0.0306	-0.1371	0.0045	Dazhou	0.0542	0.5962	0.1224
Deyang	0.0429	-0.2082	0.0041	Ya 'an	-0.5069	-0.5793	-0.4628
Mianyang	0.045	-0.2097	0.0054	Bazhong	-0.3016	0.3536	-0.18
Guangyuan	-0.3975	0.3041	-0.2594	Ziyang	-0.3756	-0.2186	-0.3142
Suining	-0.3022	-0.5258	-0.3006	Aba Tibetan and Qiang	-0.5223	0.0041	-0.3948
Neijiang	-0.3324	-0.3642	-0.3013	Garze Tibetan	-0.4241	1.0707	-0.1749
Leshan	-0.1142	-0.6922	-0.1809	Liangshan Yi	-0.575	0.8408	-0.3205
Nanchong	-0.0084	0.2266	0.0245				

5. Clustering Analysis

Figure 2 shows the results of cluster analysis. The value of K is selected as 5, and the cities and prefectures in Sichuan Province are divided into 5 echelons. The first tier is Chengdu. The second tier is Luzhou, Nanchong, and Yibin. The third echelon is Deyang, Guangyuan, Suining, Dazhou, Bazhong, and Mianyang. The fourth echelon consists of six cities and prefectures: Neijiang, Zigong, Guang'an, Meishan, Leshan and Liangshan Yi nationality. The remaining cities are the fifth tier.

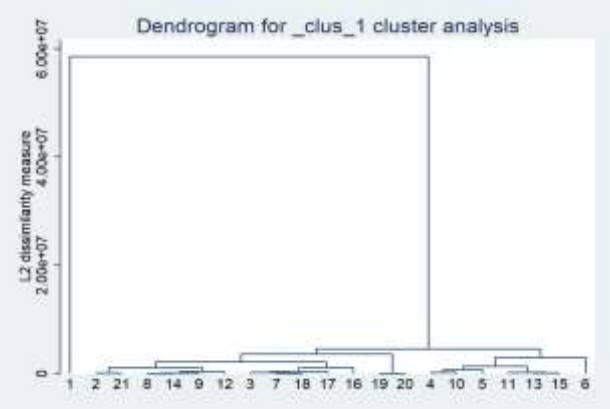

Figure 2. Results of cluster analysis.

6. Conclusion

Through correlation analysis, except for highway length and development intensity, GDP has a strong correlation with the remaining 9 indicators, and the correlation between its variables is also strong. The regression analysis results show that the total retail sales of social consumer goods, passenger volume and urbanization rate play a positive role in promoting the economic development of cities in Sichuan Province, while the regression P value of the other six variables is too large, so they do not have a significant promoting effect. The variables are excluded. The results

of principal factor analysis show that Chengdu, the capital city of Sichuan Province, has the highest score. Chengdu develops its economy under its political, geographical, and resource advantages and becomes the central city of Sichuan Province. The next five cities in the overall ranking are Dazhou, Yibin, Nanchong, and Mianyang respectively. They will develop the advantages of each sub-center city, strengthen their capacity to undertake with the center city, and radiate the neighboring regions in various directions. At the same time, we should seize opportunities such as China's Western Development, Chengdu-Chongqing Urban Agglomeration, and the New Western Land-Sea Corridor to strengthen cooperation between cities and improve the overall efficiency of the region.

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