

Research Article

The Analysis of the Coordination Degree of Higher Education in Yunnan Province

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Abstract

This paper researched the coordination degree of higher education in Yunnan Province. Firstly, the coefficients of weight index were derived from the available value of data reflecting the information entropy. The results show that the index with the highest weight of higher education is the ratio of teachers to students, and the lowest weight is the number of annual core articles. The weight value of each index is between 0.0793 and 0.3964; secondly, the index of higher education was calculated in 2010-2021, and compared the index differences among different cities. The results show that the index score of the higher education scale in Yunnan province increased year by year, but the volatility of the education quality index score decreased. Kunming education scale index score ranked the highest in the province, Qujing, Dali and Honghe higher education scale index score in the province of the second ladder, Chuxiong, Baoshan, Lijiang, Yuxi, Wenshan, Dehong and Zhaotong higher education scale index score in the third ladder, Xishuangbanna, Lincang and Pu'er higher education scale index score in the province the fourth ladder. The higher education quality index score of Kunming city is ranked first in the province, which is consistent with the higher education scale index score in the province. In the second step includes Zhaotong, Wenshan, Dali, Lijiang and other areas, Dehong, Honghe, Yuxi, Lincang, Pu'er, Qujing and other areas are in the third step, and Chuxiong, Baoshan and Xishuangbanna are in the fourth step. Finally, based on coordination and obstacle degree models, researched the main obstacle factors of higher education. The highest obstacles include the ratio of teacher to student, followed by the number of articles and the number of universities, and the number of teachers and students.

Keywords

Higher Education, Coordination Degree, Obstacle Degree Model

1. Introduction

The research results of higher education evaluation are rich. Some scholars have conducted research on the concept of higher education evaluation, such as the dimension of

higher education performance evaluation [1], and the quantitative indicators of China's higher education modernization [2, 3], and some scholars have expounded the concept and

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method of the evaluation of higher education quality [4, 5]. More scholars have established an evaluation index system of higher education, For example, the number of students in higher education and the government expenditure on higher education are all important indicators of higher education research [6], Building higher education indicators from three dimensions of scale, quality and benefit [7], Wang Hongcai constructed the general development ability of higher education, the ability of higher education to meet social needs, and the leading ability of higher education science and technology innovation as the first-level indicators [8], Huang Ting constructed a model of the internationalization of higher education as a first-level index [9], Sun Jian constructs the evaluation index of the development power of higher education cluster [10], Li Jing has constructed 19 indicators of the connotative development of higher education [11], Xu Yijun has constructed the teaching evaluation index of higher education [12], Higher education should include ten dimensions, including social reputation, resource efficiency and teaching quality [13]. And scholars studied the coordinated development of higher education, such as the analysis about the coordinated development between Chengdu and Chongqing [14], the coupling analysis between China's higher education and social economy [15].

2. Coefficients of Weight Index

The index weight should be calculated follow the scientific and objective principle, avoiding the subjective experience as far as possible. Studies have shown that the maximum entropy method overcomes the subjectivity [16]. This paper will use the maximum entropy method to calculate the index weight. For m ($m=14$) evaluated city and n ($n=13$) indices of higher education, which formed the data matrix $X=(x_{ij})_{m \times n}$. and x_{ij} means the i th city and j th index of higher education. For the index x_j , if the value difference is larger, the weight of the index would be higher; otherwise, the weight would be lower. The calculation formula and steps are described as follows:

(1) Standardized processing of the researched data. All the indicators used in this study are positive, which means when the value is larger, the higher education will more attractive:

$$y_{ij} = \frac{x_{ij} - x_{ij}^{\min}}{x_{ij}^{\max} - x_{ij}^{\min}}$$

(2) Calculate the entropy value of each index:

$$e_j = -K \times \sum_{i=1}^m P_{ij} \ln(P_{ij})$$

$$K = \frac{1}{\ln(m)}$$

$$P_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}}$$

(3) Calculate the difference coefficient of the j th index, which named g_j . If the value of g_j was larger, the more important the index would be in the evaluation:

$$g_j = 1 - e_j$$

(4) Calculate the weight of the j th index:

$$\omega_j = \frac{g_j}{\sum_{j=1}^n g_j}$$

(5) Calculate the comprehensive score of higher education in each city:

$$U_i = \sum_{j=1}^{n_j} W_j \times y_{ij}$$

Following the above steps, the information entropy and indices weight of higher education in Yunnan province were calculated, and the results are shown in Table 1. The highest weight of higher education is teacher-student ratio, while the lowest weight is the number of articles in the core journals. The weight value of each index is between 0.0793-0.3964.

Table 1. Weight of the indicators of higher education.

Target layer	Criterion layer	Index layer
(X) Higher education	(X1) Scale of higher education	(X11) Number of institutions of higher education (0.1548)
		(X12) Number of full-time teachers in institutions of higher education (0.1245)
		(X13) Number of students in institutions of higher education (0.1360)
	(X2) Quality of higher education	(X21) Number of articles in the non-core journals (0.1090)

Target layer	Criterion layer	Index layer
		(X22) Number of articles in the core journals (0.0793)
		(X23) Teacher-student ratio (0.3964)

3. Development Trend of Higher Education in Yunnan Province

Based on the entropy value and indices weight of higher education, the index score of the scale and quality of higher education in Yunnan Province from 2010-2021 year is calcu-

lated, and the results are shown in [Table 2](#). It shows that the index score of the scale of higher education in Yunnan Province was increased from 0.0221 to 0.0402, and increasing year by year. However, the index score of education quality decreased from 0.2313 to 0.1195, and showing a trend of decline. The above results indicates that although the scale of higher education has expanded, the education quality has not been improved in the last decade.

Table 2. The Overall Development Trend of Higher Education in Yunnan Province from 2010 to 2021.

Year	Index		
	Scale of higher education	Quality of higher education	Index score
2010	0.0221	0.2313	0.2535
2011	0.0251	0.2117	0.2367
2012	0.0261	0.2786	0.3047
2013	0.0273	0.2279	0.2552
2014	0.0280	0.2336	0.2615
2015	0.0290	0.2389	0.2678
2016	0.0309	0.1987	0.2295
2017	0.0329	0.2115	0.2444
2018	0.0345	0.2005	0.2350
2019	0.0370	0.1541	0.1911
2020	0.0388	0.1275	0.1663
2021	0.0402	0.1195	0.1597

As the same, the index score of the scale and quality of higher education in different cities are calculated, and the results are shown in [Figure 1](#) and [Figure 2](#). (The index score of education scale in Kunming city is very high compared with other cities, so it is not listed in the figure). The index score of the scale of higher education in Kunming city has increased from 0.2296 to 0.4153, with an average annual growth rate of

5.54%, which is the highest in the province. Qujing, Dali and Honghe's score is 0.0128-0.0230, 0.0144-0.0212 and 0.0068-0.0203, which is the second highest in the province. Chuxiong, Baoshan, Lijiang, Yuxi, Wenshan, Dehong and Zhaotong's score is the third highest, Lincang and Pu'er are the fourth highest.

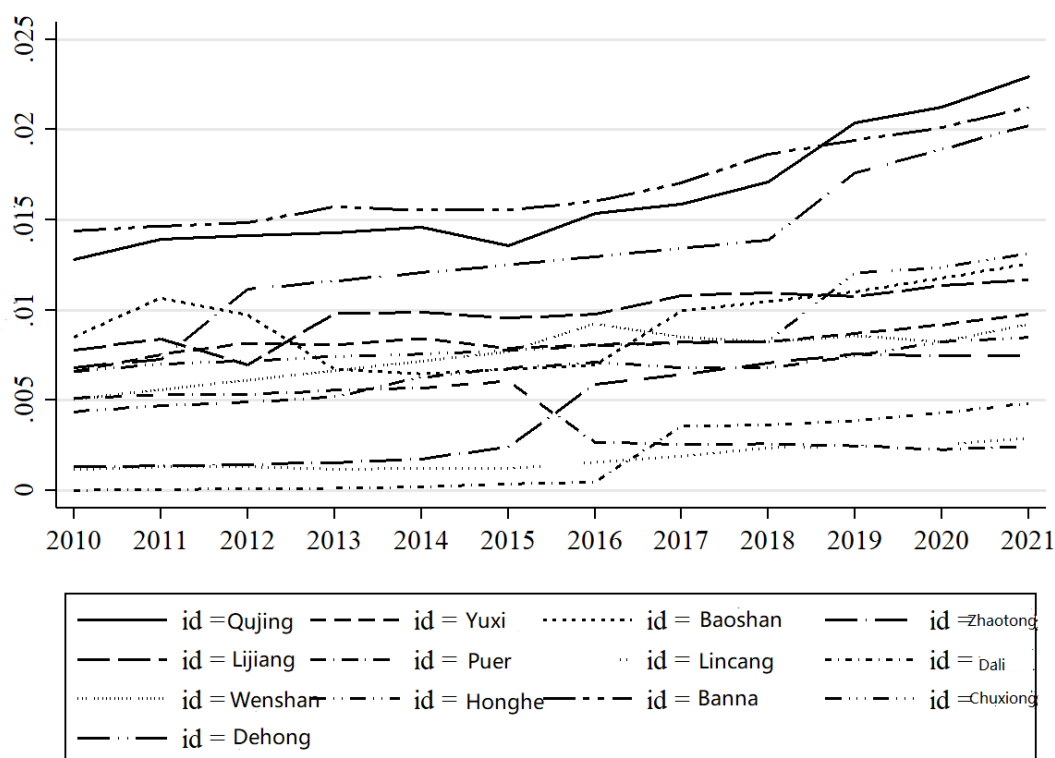


Figure 1. Scores of the scale of higher education of all cities in Yunnan Province form 2010-2021.

It can be seen that the score of quality of higher education in Kunming city is the highest in the province. Zhaotong, Wenshan, Dali and Lijiang are the second highest, Dehong, Honghe, Yuxi, Lincang, Pu'er and Qujing are the third highest, while Chuxiong, Baoshan and Xishuangbanna are the fourth

highest. Except for Kunming city, the scale of higher education is not completely consistent with the quality of higher education quality in other cities, indicating that the scale and quality of higher education in each city failures to keep pace with development.

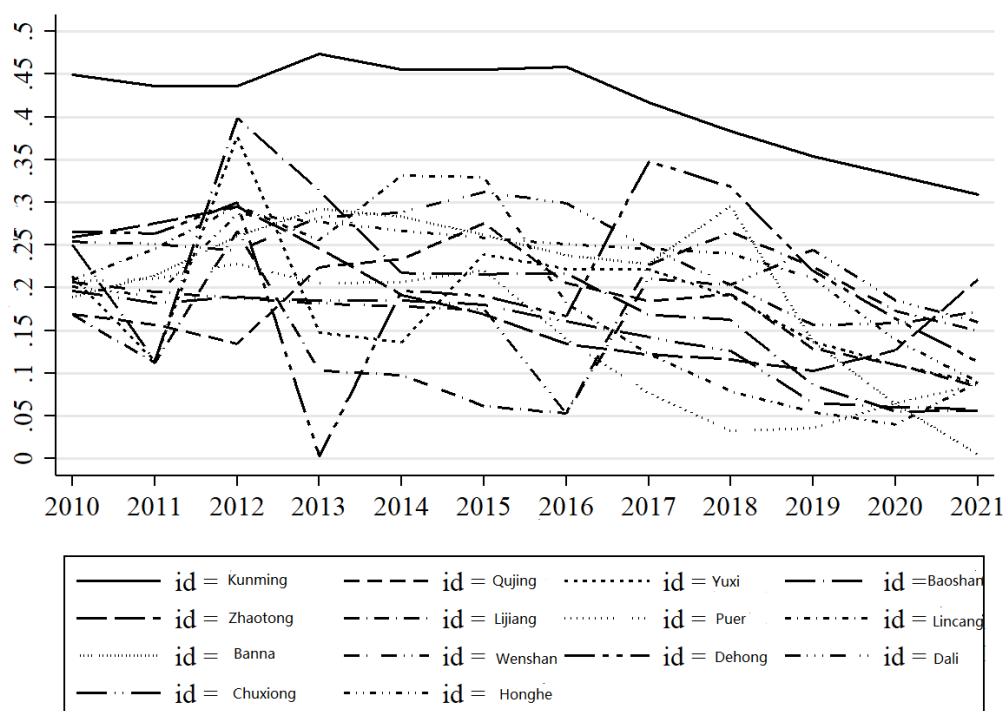


Figure 2. Scores of the quality of higher education of all cities in Yunnan Province form 2010-2021.

4. Analysis of the Coordination Degree Between the Scale and Quality of Higher Education in Yunnan Province

4.1. Evolution of the Coordination Between the Scale and Quality of Higher Education

The coordination coefficient function was used to calculate the coordination degree of the scale and quality of higher education in all cities from 2010 to 2021. The calculation method is as follows: firstly, the coupling coefficient of the system development is calculated, and then the development coordination degree is calculated with the coordination development degree function. Using D_i represents the degree of development coordination between systems, C_i represents the index coupling coefficient of the i th evaluation unit, C_i^s and C_i^q represent the development index of the scale and quality of higher education in

the i th evaluation unit respectively, and F_i represents the total index of higher education development in the i th evaluation unit. The calculation formula is:

$$C_i = \frac{C_i^s + C_i^q}{\sqrt{(C_i^s)^2 + (C_i^q)^2}}$$

$$F_i = C_i^s + C_i^q$$

$$D_i = (C_i \times F_i)^{1/2}$$

In the above formula, if $0 < D \leq 0.4$, that means low level coordination; $0.4 < D \leq 0.6$ is lower level coordination; $0.6 < D \leq 0.8$ is higher level coordination; $0.8 < D \leq 1.0$ is high level coordination. The results are shown in Table 3 and Table 4.

Table 3. Coordination degree between the scale and quality of higher education in different cities in Kunming, Qujing, Yuxi, Baoshan, Zhaotong, Lijiang and Pu'er from 2010-2021.

Year	City						
	Kunming	Qujing	Yuxi	Baoshan	Zhaotong	Lijiang	Pu'er
2010	0.9558	0.4417	0.4760	0.5167	0.5115	0.4295	0.4666
2011	0.9798	0.4305	0.3599	0.3700	0.5272	0.3596	0.4706
2012	0.9898	0.4039	0.6276	0.6471	0.5458	0.5297	0.4887
2013	1.0000	0.5032	0.4048	0.5718	0.4996	0.3502	0.4651
2014	1.0000	0.5131	0.3916	0.4799	0.4418	0.3437	0.4673
2015	1.0000	0.5503	0.5049	0.4791	0.4169	0.2847	0.4825
2016	1.0000	0.4864	0.4884	0.4809	0.3824	0.2703	0.3813
2017	1.0000	0.4655	0.4880	0.4345	0.3674	0.4987	0.2864
2018	1.0000	0.4769	0.4547	0.4286	0.3609	0.5360	0.1941
2019	1.0000	0.4129	0.3934	0.3294	0.3440	0.4962	0.2019
2020	1.0000	0.3927	0.3586	0.2821	0.3772	0.4430	0.2635
2021	1.0000	0.3635	0.3301	0.2871	0.4743	0.4166	0.3028

Table 4. Coordination degree between the scale and quality of higher education in different cities in Lincang, Dali, Wenshan, Honghe, Chuxiong and Dehong from 2010-2021.

Year	City						
	Lincang	Dali	Wenshan	Honghe	Banna	Chuxiong	Dehong
2010	0.4600	0.5320	0.4651	0.4643	0.4351	0.4575	0.5240

Year	City						
	Lincang	Dali	Wenshan	Honghe	Banna	Chuxiong	Dehong
2011	0.4984	0.5302	0.4548	0.4516	0.4631	0.4430	0.5226
2012	0.5465	0.5231	0.4475	0.5560	0.5102	0.4514	0.5563
2013	0.5080	0.5607	0.4421	0.5485	0.5411	0.4472	0.5975
2014	0.5778	0.5658	0.4387	0.5397	0.5327	0.4482	0.4575
2015	0.5763	0.5861	0.4359	0.5327	0.5124	0.4425	0.4520
2016	0.4300	0.5759	0.2688	0.5267	0.4889	0.4202	0.4256
2017	0.3560	0.5304	0.4775	0.5225	0.4849	0.3983	0.6017
2018	0.2889	0.4914	0.4688	0.5181	0.5504	0.3777	0.5762
2019	0.2443	0.5329	0.4172	0.4973	0.3805	0.2998	0.4845
2020	0.2128	0.4760	0.4184	0.4218	0.2695	0.2935	0.4250
2021	0.3079	0.4510	0.4364	0.3631	0.1202	0.2921	0.3615

As can be seen from Table 3 and Table 4, the scale and quality of higher education in Kunming have been coordinated at a high level, indicating that the two systems have basically achieved synchronous development. However, except for Kunming city, the coordination degree of the scale and quality of higher education in other cities is all below a relatively low level. The coordination degree of Qujing, Yuxi,

Baoshan, Zhaotong, Pu'er, Lincang, Xishuangbanna and Chuxiong has shown a gradual downward trend in recent years, changing from low level coordination to low level coordination. Coordination degrees in Lijiang, Dali, Wenshan, Honghe and Dehong remains largely unchanged, but all at relatively low level coordination. The classification results of the coordination degree in each city are shown in Table 5.

Table 5. The coordination degree of scale and quality of higher education cities in different cities from 2010 to 2021.

Year	D value	City
2010	$0.4 < D \leq 0.6$	Qujing, Yuxi, Baoshan, Zhaotong, Lijiang, Pu'er, Lincang, Dali, Wenshan, Honghe, Xishuangbanna, Chuxiong, Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Yuxi, Baoshan, Lijiang
2011	$0.4 < D \leq 0.6$	Qujing, Zhaotong, Pu'er, Lincang, Dali, Wenshan, Honghe, Xishuangbanna, Chuxiong, Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0.4 < D \leq 0.6$	Qujing, Zhaotong, Lijiang, Puer, Lincang, Dali, Wenshan, Honghe, Banna, Chuxiong, Dehong
2012	$0.6 < D \leq 0.8$	Yuxi, Baoshan
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Lijiang
2013	$0.4 < D \leq 0.6$	Qujing, Yuxi, Baoshan, Zhaotong, Pu'er, Lincang, Dali, Wenshan, Honghe, Xishuangbanna, Chuxiong, Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Yuxi, Lijiang
2014	$0.4 < D \leq 0.6$	Qujing, Baoshan, Zhaotong, Pu'er, Lincang, Dali, Wenshan, Honghe, Xishuangbanna, Chuxiong, Dehong
	$0.8 < D \leq 1.0$	Kunming

Year	D value	City
2015	$0 < D \leq 0.4$	Lijiang
	$0.4 < D \leq 0.6$	Qujing, Yuxi, Baoshan, Zhaotong, Pu'er, Lincang, Dali, Wenshan, Honghe, Xishuangbanna, Chuxiong, Dehong
	$0.8 < D \leq 1.0$	Kunming
2016	$0 < D \leq 0.4$	Zhaotong, Lijiang, Pu'er, Wenshan
	$0.4 < D \leq 0.6$	Qujing, Yuxi, Baoshan, Lincang, Dali, Honghe, Xishuangbanna, Chuxiong, Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Zhaotong, Pu'er, Lincang, Chuxiong
2017	$0.4 < D \leq 0.6$	Qujing, Yuxi, Baoshan, Lijiang, Dali, Wenshan, Honghe, Xishuangbanna
	$0.6 < D \leq 0.8$	Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Zhaotong, Pu'er, Lincang, Chuxiong
2018	$0.4 < D \leq 0.6$	Qujing, Yuxi, Baoshan, Lijiang, Dali, Wenshan, Honghe, Xishuangbanna, Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Baoshan, Zhaotong, Pu'er, Lincang, Xishuangbanna, Chuxiong
2019	$0.4 < D \leq 0.6$	Qujing, Yuxi, Lijiang, Dali, Wenshan, Honghe, Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Qujing, Yuxi, Baoshan, Zhaotong, Pu'er, Lincang, Xishuangbanna, Chuxiong
2020	$0.4 < D \leq 0.6$	Lijiang, Dali, Wenshan, Honghe, Dehong
	$0.8 < D \leq 1.0$	Kunming
	$0 < D \leq 0.4$	Qujing, Yuxi, Baoshan, Pu'er, Lincang, Honghe, Xishuangbanna, Chuxiong, Dehong
2021	$0.4 < D \leq 0.6$	Zhaotong, Lijiang, Dali, Wenshan
	$0.8 < D \leq 1.0$	Kunming

4.2. Impact Factors of the Coordination Degree Between the Scale and Quality of Higher Education

To provide scientific decision basis for optimizing the coordination of higher education in Yunnan Province, the obstacle degree model is used to analyze the main influence factors of the coordination degree of higher education. Using W_j represents the j th criterion; U_j represents the weight of the single index of higher education on the total target, R_j represents the weight of the j th criterion; I_j represents the difference between the evaluation value of individual index of higher education and 100%; M_j and C_n respectively represent the influence of individual index and criterion index on the coordination of higher education development. The specific calculation formula and steps are as follows:

$$U_j = R_j \times W_j, I_j = 1 - X_j$$

$$M_j = \frac{I_j \times U_j}{\sum_{i=1}^n (I_j \times U_j)} \times 100\%$$

$$C_n = \sum M_{ij}$$

The calculated results reflect the changing trend of the obstacle degree. From 2010 to 2021, the obstacle degree of the scale of higher education is between 34.92% -47.78%, while the obstacle degree of the quality of higher education is between 52.21% -65.08%. It can be found that the the obstacle degree of the quality of higher education is higher, and increasing year by year.

The obstacle degree of the number of institutions of higher education is between 13.00% and 17.32%, the obstacle degree

of the number of full-time teachers in institutions is between 10.49% and 14.23%, the obstacle degree of the number of students in institutions is between 11.43% -16.23%, the obstacle degree of the number of articles in the non-core journals is between 13.21% and 17.36%, the obstacle degree of the number of articles in the core journals is between 9.57% and 12.68%, and the obstacle degree of the teacher-student ratio is between 22.17% -42.28%. In general, the highest obstacle degree is the teacher-student ratio, followed by the number of articles in the non-core journals and the number of institutions of higher education, the lowest obstacle degree is the number of articles in the core journals. Meanwhile, the obstacle degree of the teacher-student ratio is increasing year by year, but other indices show a trend of decreasing year by year. The above results show that the rapid expansion of higher education and the shortage of teachers are the main reasons for the coordinated development of the scale and quality of higher education in Yunnan Province.

5. Conclusion

This paper uses the maximum entropy method to calculate the index weight of higher education in Yunnan Province, then analyzes the higher education development index and the change trend from 2010 to 2021, and explore the coordination degree and obstacle factors of higher education. The results show that the scale of higher education in Yunnan Province is expanding year by year, but the quality of education is decreasing; the main factors affecting the coordination between the scale and quality of higher education include the teacher-student ratio, the number of articles in the non-core journals and the number of institutions of higher education.

It also shows that Kunming is the only city that the coordinated degree of the scale and quality of higher education is at a high level, but in addition to Kunming, other cities in Yunnan province is at a low level and have a larger space to improve.

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Conflicts of Interest

The authors declare no conflicts of interest.

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