Research on the High-Quality Development of Private Universities in Guangdong Province Based on TOPSIS Model and Coupling Coefficient Model

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Abstract: The high-quality development of higher education is a significant theme for future development in the new era. Private universities have become a force that plays an essential role in constructing modernization and popularizing higher education. It's necessary to analyze whether higher education provided by private universities has achieved high-quality development under the new requirements and what shortcomings and problems it has encountered. We collect the data of twenty-five privately-run universities from the official documents of Guangdong Provincial Department of Education, Guangdong Student Employment and Entrepreneurship Network, CNKI, and the official website of each sample. We use the entropy weight method TOPSIS model and coupling coefficient model by SPSS software to construct a comprehensive index of high-quality development of higher education and analyze the coupling degree from five dimensions of innovation, greenness, openness, coordination and sharing. We find that the innovation and openness indicators have contributed significantly to the high-quality development of higher education. The gap in the comprehensive index is relatively large. The coupling degree of the sub-index of most schools isn't at a suitable level. So private universities in Guangdong Province should not only focus on reducing the development gap, especially in innovative and open development, but also improve the coordination of the five indicators.

1 INTRODUCTION

China's private education has positively contributed to cultivating higher education talents. Seven hundred seventy-one private universities in 2020 accounted for 22.7% of the available colleges and universities in the country, according to the 2020 National Education Development Statistical Bulletin. Private higher education has become an essential part of higher education in China. Based on location advantage, private higher education in Guangdong Province, which is at the forefront of reform and opening up as a central education province, started early and developed rapidly and has a large scale in the country. The quality of privately-run universities is directly related to the high-quality development of higher education in Guangdong Province. Scholars mostly conduct qualitative research on the high-quality development of higher education, and few scholars have quantitatively measured the high-quality development of higher education. This thesis aims to calculate the high-quality development index of twenty-five private universities in Guangdong Province and obtain some conclusions which provide a basis for the decision-making of private universities in Guangdong Province in the future development.

2 LITERATURE REVIEW

Regarding the research on high-quality development of higher education, some scholars have researched connotation, development indicators and driving

third author respectively.

factors of high-quality development of higher education.

2.1 About the Connotation of High-Quality Development of Higher Education

Wang Jianhua (2021) believes that the core connotation of high-quality development of higher education is expanding people's substantial freedom (Wang 2021). He emphasizes that high-quality development of higher education should be based on human development, and evaluating high-quality development requires a more comprehensive perspective. Zhang Jin and Wang Jiayi (2021) believe that the high-quality development of higher education is "comprehensive", "sufficient", and "long-term" development (Zhang, Wang, 2021). Zhong Xiaomin (2020) believes that high-quality development should focus on answering the question of "excellent or not". High-quality development in the new era is mainly characterized by solid characteristics, excellent quality, and a strong ability to meet demand (Zhong 2020). Chen Liang and Yang Juan (2021) believe that the logical framework for the high-quality development of higher education needs to be condensed into three aspects: the spiritual, institutional, and economic dimensions (Chen, Yang, 2021).

2.2 About the Evaluation Indicators and Driving Factors of High-Quality Development of Higher Education

Yang Haochang (2020) constructs a high-quality development evaluation index system from five aspects: innovation, collaboration, greenness, openness, and sharing (Yang 2020). Zhang Li (2021) believes that innovation-driven high-quality development is the future of higher education development and builds a "double first-class" as the quality key indicator system (KPI) (Zhang 2021). Liu Guorui (2021) proposes that we should focus on deepening the supply-side reform of higher education and expanding the opening of higher education (Liu 2021). Wang Zhichao (2021) points out that the high degree of coupling of the development of higher education itself and social development between the overall development of people is an effective way to accomplish the high-quality development of higher education (Wang 2021). Li Decai (2021) believes that the core of high-quality development of higher education lies in the integration of production

and education and the cooperation between schools and enterprises to cultivate people (Li 2021). Liu Yao and Fu Baoying (2019) point out that high-quality development of higher education should promote from six aspects: talent training, teaching reform, subject research, teaching staff and teacher evaluation (Liu, Fu, 2019). Zhao Ji and Xie Yinbo (2019) believe that we should focus on diversity, innovation, openness, clustering and intelligence (Zhao, Xie, 2019). Du Yubo (2020) believes that the high-quality development of higher education needs to enhance the core competitiveness of higher education globalization (Du 2020).

The above scholars mainly focus on qualitative research in education, and few scholars have quantitatively measured the level of high-quality development of higher education. We want to construct an evaluation index which obtains the entropy weight TOSIS and the thermodynamic coupling model to research the high-quality product of private universities and universities in Guangdong province to analyze their progress and problems in higher-quality development.

3 INDICATORS, DATA AND METHODS

3.1 Indicators and Data

Drawing on the method of Yang Haochang (2020), this paper constructs high-quality development indicators of higher education from the five dimensions of innovation, coordination, greenness, openness and sharing. It sets up a hierarchical structure of "1-5-15", one first-level indicator, five secondary and fifteen tertiary indicators. In terms of data collection, this paper collects the three-year cumulative achievements of twenty-five private universities in Guangdong Province from 2019 to 2021. The constructed indicator system and data are shown in Table 1.

Table 1. Comprehensive index of high-quality development (first-level)

Secondary indicator	Tertiary indicator	Xij	Data interpretation
Innovation development	Student innovation	X_{11}	Guangdong University Student Science and Technology Innovation Cultivation Fund
	Faculty innovation	X_{12}	Guangdong Provincial Characteristic Innovation and Young Innovative Talents Research Project
	Student self-employment rate	X_{13}	Self-employment rate of graduates
Greenness development	High-level talents	X_{21}	Teachers with senior professional titles, doctors with non-senior professional titles and PhD candidates
	Key achievements	X_{22}	Key scientific research platform project of Guangdong Province and core journal of the first author unit (CNKI)
	School scale	X_{23}	Cumulative Enrollment Plan
Openness development	Interanion exchange	X_{31}	Overseas joint training program
	Public class project	X_{32}	First-class Courses and Online Opening Courses
	Admission rate for master's degree	X_{33}	Domestic postgraduate enrollment rate
Coordination development	Industrial education Integration Project	X_{41}	Experimental Practice Teaching Base
	Features and Key Professional Rates	X_{42}	The rate of specialty major and key major
	Teaching Reform Project	X_{43}	Higher Education Reform Project
Sharing development	Average salary	X_{51}	Average salary of graduates
	Employment rate	X_{52}	The initial employment rate of graduates
	Major Diversity	X_{53}	The number of majors

The data sources are as follows : X_{11}, X_{12}, X_{32}, X_{41}, X_{42} and X_{43} are derived from the official documents of Guangdong Provincial Department of Education, X_{13}, X_{33}, X_{51} and X_{52} are form Guangdong Student Employment and Entrepreneurship Network, X_{21} is selected form CNKI to get the author information, X_{31} and X_{53} are from the official website of each private college in our sample.

3.2 Measurement Method

We use the entropy weight method to measure the comprehensive index of high-quality development of higher education. The entropy value is a measurement method of the disorder degree of the data. The weight is determined according to the information of the data itself. The greater the entropy value of the index, the more orderly the index is. The less information it contains, the smaller the contribution to the evaluation to have less critical weight.

On the contrary, the smaller the entropy value, the greater disordering of the index, and the more information it contains. The more significant the role it plays in the evaluation, the more influential the weight has. Therefore, the weight calculated by the entropy weight method is more objective, and the

result is more accurate and reasonable (Cai 2014). The specific calculation process is as follows:

The first step is to standardize the variables which are all positive indicators in our index.

$$BX_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{1}$$

The second step is to calculate the information entropy H_i, we assume $\ln(BX_{ij} / \sum_{j=1}^{m} BX_{ij}) = 0$, when $BX_{ij}=0$.

$$H_i = (-1/\ln m)\sum_{j=1}^{m}[(BX_{ij} / \sum_{j=1}^{m} BX_{ij}) \cdot \ln(BX_{ij} / \sum_{j=1}^{m} BX_{ij})] \tag{2}$$

The third step is to calculate the weight of i indicator W_i.

$$W_i = (1 - H_i) / \sum_{i=1}^{n}(1 - H_i) \tag{3}$$

The fourth step is to calculate the comprehensive index of high-quality development of higher education of the sample school of j.

$$Z_j = \sum_{i=1}^{n} BX_{ij} * W_i \tag{1}$$

4 MEASUREMENT RESULTS AND ANALYSIS

4.1 Entropy and Weight Analysis

According to the collected data, the corresponding entropy values and the corresponding weights of indicators are obtained, as shown in Table 2. Among the five secondary indicators, we conclude that the entropy values of the sample schools in innovation and openness are small with considerable weights. The weight of innovation is 29.92% to have the most significant proportion, and the weight of openness is 28.36%. However, the entropy values of coordination and sharing are more extensive, with more petite contributions to the comprehensive index. The innovation and openness of private universities in Guangdong Province have made a more outstanding contribution to the high-quality development of higher education because schools have a significant difference gap in innovation and openness. However, the weights of coordination and sharing are relatively small, with more minor impacts on the high-quality development of higher education.

Table 2. The Entropy and Weight of sub-index of high-quality development

Indicator	Innovation	Greenness	Openness	Coordination	Sharing
Entropy	2.6277	2.7831	2.6471	2.8295	2.8683
Weight	29.92%	17.43%	28.36%	13.71%	10.6%

4.2 Calculation Results of the Comprehensive Index of High-Quality Development of Higher Education

According to the calculation results of the comprehensive index (as shown in Table 3), there is a significant gap in the high-quality development of the twenty-five private universities. The top-ranked school's code is 11545, with a comprehensive index of 720.74. The second is 13684, with a score of 540.96, while the last is only 81.99. The sample's comprehensive index of high-quality development of higher education fluctuates wildly, and there is an enormous gap in the development of sample schools.

Table 3. Calculation of the comprehensive index and the degree of coupling coordination

Code	R	Z (‰)	D(%)	Level	Code	R	Z (‰)	D(%)	Level
11545	1	720.74	82.30	Excellent	12620	14	322.17	56.71	Medium
13684	2	540.96	72.58	Suitable	13656	15	301.98	53.63	Medium
13675	3	488.20	67.43	Suitable	12622	16	289.14	53.03	Medium
13714	4	483.61	62.20	Suitable	12623	17	282.32	50.93	Medium
13177	5	482.52	61.85	Suitable	13720	18	275.41	49.81	Week
12617	6	416.36	63.36	Suitable	12621	19	265.03	48.72	Week
13902	7	386.76	61.74	Suitable	13720	20	250.00	49.36	Week
12618	8	374.44	55.37	Medium	12574	21	239.89	46.74	Week
13844	9	366.78	58.77	Medium	12059	22	223.61	43.81	Week
10822	10	345.33	57.46	Medium	13657	23	153.24	37.0	Week
13667	11	339.84	56.65	Medium	13717	24	119.74	0.00	Poor
12619	12	336.59	57.31	Medium	13721	25	81.99	0.00	Poor
13719	13	336.05	52.31						

Note: R presents the ranking of the comprehensive index, Z and D persent the comprehensive index and the degree of coupling coordination respectively. The code is a number string composed of numbers organized by the Ministry of Education for the school as follows: the code 11545 represents University of Electronic Science and Technology of China Zhongshan College, 13684 represents Zhuhai College of Science College of Science and Technology, 13675 represents Beijing Technology University of Zhuhai College, 13714 represents Guangzhou Industrial and Commercial College, 13177 represents Beijing Normal University of Zhuhai Branch, 12617 represents Guangzhou City College of

Technology, 13902 represents Guangzhou Xinhua College, 12618 represents Guangzhou Software College, 13844 represents Dongguan City College, 10822 represents Guangdong Baiyun College, 13667 represents Guangzhou Business College, 12619 represents Guangzhou Southern College, 13719 represents Guangdong College of Science and Technology, 12620 represents Nanguo Business College, Guangdong University of Foreign Language and Trade, 13656 represents Guangzhou Huali College, 12622 represents Zhanjiang College of Science and Technology, 12623 represents Zhujiang College of South China Agricultural University, 13720 represents Guangdong College of Technology, 12621 represents Guangzhou Huashang College, 13720 represents Guangzhou College of Technology, 12574 represents Guangdong Dongruan College, 12059 represents Guangdong Peizheng College, 13657 represents Guangzhou College of Applied Science and Technology, 13717 represents Guangzhou Vocational and Technical College of Science and Technology, 13721 represents Guangdong Industrial and Commercial Vocational and Technical College.

4.3 Coupling Analysis of Sub-Indices of Private Higher Education in Guangdong Province

This thesis introduces the capacity coupling coefficient model in physics to measure the degree of coupling between five subsystems with high-quality development. The indexes of the five subsystems are calculated separately by the entropy weight method.

Firstly, we should calculate the C according to formula (5).

$$C = \frac{K(Z_1 * Z_2 \cdots * Z_K)^{1/k}}{(Z_1 + Z_2 \cdots + Z_K)/K} \qquad (5)$$

Z_K is the subsystem index of K，C represents the degree of coupling degree, $0 \leq Ct \leq 1$. The bigger the coupling degree, the greater the interaction between the systems; we learn from Wang Yi's method to divide the coupling degree into five levels (Wang 2018): excellent (0.8,1], suitable (0.6,0.8], medium (0.4,0.6], weak (0.2,0.4], and poor [0,0.2].

Secondly, we need to calculate the D, the coupling coordination degree of the five subsystems; we set the same weight of α_K with 20% for each subsystem, α_K indicates the importance of the subsystem index.

$$D = \sqrt{C * G} \qquad (6)$$

$$G = \alpha_1 z_1 + \alpha_2 z_2 + \cdots + \alpha_k z_k \qquad (7)$$

We calculate the degree of coordinated development of the five indicators using the coupling analysis model, as shown in Table 3. We find that only the school of 11545 can reach the coupling degree of excellent level. Six schools' coupling degrees are at a suitable level, the coupling degree of most schools is medium and week; the average value of the coupling degree is 51.97% at the medium coordination level.

5 CONCLUSION

We find that the innovation and openness have made an outstanding contribution to the high-quality development of higher education in private universities in Guangdong Province. Most private colleges and universities have faced tremendous development pressure regarding innovation and openness. There is a massive gap among the twenty-five private universities. That means the samples have improved and developed unbalanced because the private colleges have to consider financial benefits and the achievement that need substantial funding and talent research support. The coupling degree of most schools are at a medium and weak level which isn't an ideal coupling state.

Based on the above conclusions, the high-quality development of private higher education in Guangdong Province should focus on reducing the gap, especially in innovative growth and openness between private colleges with a reasonable balance between short-term and long-term development to achieve better coupling degree of higher development.

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