

Evaluation and Regional Disparities of Modernization of Higher Education in China

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Abstract—This paper evaluates the level of modernization of higher education in China and analyses the regional differences between provincial and provincial levels of modernization of higher education by constructing five objectives and 23 indicators, including modernization of educational concept, content, equipment, contingent and management, in order to provide reference for the reform of modernization of higher education. The results show that: (1) The overall level of higher education modernization in China's provinces is not high, while that in Beijing, Jiangsu, Shanghai, Guangdong and Zhejiang provinces is relatively high. (2) Except for Fujian Province, the modernization of higher education in the eastern coastal areas is relatively high, while the modernization of higher education in the western areas is relatively low, except in Shaanxi Province and Sichuan Province. (3) Compared with the international advanced education in the world, China's higher education shows disadvantage in various indicators, and there is still a big gap compared with the average level of OECD countries.

Keywords—higher education, modernization, evaluation, regional differences

I. INTRODUCTION

The competitiveness and comprehensive national strength of a country will depend on the development of knowledge and science and technology, especially the ability of knowledge innovation and technology innovation[1]. Education is in a basic, comprehensive and leading strategic position in the formation of comprehensive national strength. It plays an important role in providing knowledge contribution for the development of science and technology and talent support for modernization. As the main driving force of economic development, modernization of higher education has been pushed to a more prominent position.

At home and abroad, the evaluation of educational development has been widely discussed, and the evaluation index system of education has been constructed for quantitative evaluation. There are seven major international educational indicators: (1) Educational indicators in the modern indicator system proposed by Alex Inkeles of Stanford University [2]; (2) The system of educational indicators in the World Development Indicators issued by the World Bank every year includes educational input, education, educational effectiveness, educational completion and output; (3) The education index system of the Organisation for Economic Cooperation and Development (OECD), including the output of educational

institutions and the impact of learning, the investment of educational finance and human resources, access to education and participation in progress, learning environment and school organization. (4) The system of educational indicators constructed by UNESCO includes educational resources, educational needs, enrolment and participation, and internal performance of education [5]. (5) Two of the United Nations Millennium Development Goals (MDGs) relate to education indicators [6]. (6) Four international organizations, such as UNESCO, identified 18 monitoring indicators at the World Conference on Comprehensive Education held in Thailand [7]. In view of China's educational development, the *Outline of the National Medium and Long Term Education Reform and Development Plan (2010-2020)* formulates the development goal of "basically realizing the modernization of education and basically forming a learning society by 2020". On this basis, local governments have also formulated corresponding educational development policies. From the existing research and policy, we can find that the evaluation and construction of the whole education system (including primary education, secondary education and higher education) is more in-depth, while the exploration of higher education modernization alone is mostly embodied in the theoretical paradigm of higher education modernization and the practical exploration of local higher education modernization.

Higher education, as an important part of the whole education system, plays a leading role in the modernization of education because of its close relationship with socio-economic development and scientific and technological progress [8,9]. Based on the evaluation index system of higher education modernization, this paper evaluates the level of higher education modernization in China, and analyses the regional differences of higher education modernization between provinces in order to provide reference for higher education policy reform.

II. THE THEORETICAL CONNOTATION OF HIGHER EDUCATION MODERNIZATION

The modernization of higher education is not only the process and result of quantity expansion and quality improvement, but also the process of qualitative change in nature and function of higher education.

A. *Modernization of Educational Ideas*

The modernization of higher education concept should embody the socialization, information, internationalization, diversification, lifelong and popularization of higher education [10]. The socialization of higher education is manifested in the enhancement of social service function of higher education, the cultivation of talents to meet the requirements of the times, and the socialization of higher education quality certification. The information of higher education is manifested in making full use of network technology to thoroughly change the traditional ways and means of knowledge creation, collection, storage and dissemination, and to promote the transformation of unified and modular teaching forms into individualized and individualized ones. The internationalization of higher education is manifested in expanding national exchanges and cooperation, cultivating students' international vision and feelings, and enhancing the international influence and competitiveness of higher education [11]. The diversification of higher education manifests itself in the diversification of subjects, types, levels, disciplines, sources of students, teaching modes and investment channels, as well as the diversification of educational and teaching management. Lifelong higher education is characterized by improving the openness of higher education in time and space, and providing quality services for lifelong learners. The popularization of higher education is manifested in the improvement of the overall education level of the people, and the gross enrollment rate of higher education exceeds 50%.

B. *Modernization of Educational Content*

Higher education should stand at the forefront of various disciplines, timely absorb the latest research results, timely reflect the progress and information of material production and spiritual and cultural production in the modernization drive, so as to synchronize the development of disciplines and teaching contents with the modernization drive. Firstly, we should construct a diversified target training system and an innovative talent training model of "wide caliber, thick foundation and high quality". Secondly, a multi-disciplinary organizational system based on modern science and technology has been gradually formed, which has changed the single and rigid mode of setting up colleges, departments and specialties in the planned economy. Thirdly, the curriculum should be adapted to the needs of modern society, so as to enhance the coordination between higher education and society. In addition, the content of education must keep abreast of the cutting-edge trends of scientific and technological development, reflecting the cross-integration of ideas and cultures of different countries, nationalities and regions [12,13].

C. *Modernization of Educational Equipment*

The modernization of higher education equipment includes the modernization of material equipment and technological means, which involves the development level of national productivity, the comprehensive national strength and the ability to invest in higher education, which directly affects the construction of teaching staff and the transformation of scientific and technological achievements. To a great extent, the modernization of library information retrieval system determines the innovation ability of scientific research and the

quality of teaching. The introduction of advanced scientific research instruments and teaching equipment can enhance the efficiency and effect of scientific research and teaching, and narrow the gap between scientific research and teaching in the world's advanced universities. In addition, network teaching and multimedia teaching can meet the objective requirements of the increasing scale of higher education and the rapid expansion of knowledge.

D. *Modernization of Education Team*

The key to the modernization of higher education is the modernization of administrators and teaching staff in Institutions of higher learning [14]. Modern teachers should have democratic, open, scientific and innovative spirit of the times, maintain the teaching attitude of studying with students, inspiring each other and encouraging each other, master modern teaching contents and methods, cultivate students' independent personality, sense of social responsibility and enterprising spirit, and exercise students' independent thinking and innovative ability. Only by training and bringing up innovative, compound, applied and competitive backbone teachers can we lay a good foundation for the training of high-quality innovative talents. Teaching managers should move from managerial orientation to service orientation, learn advanced management methods, master advanced management skills, and serve teachers and students wholeheartedly.

E. *Modernization of Education Management*

Modernization of education management requires that management system serve teaching and scientific research. Managers should enhance service awareness and service skills to maximize the quality of education and school-running efficiency. Firstly, colleges and universities should run schools independently according to law and implement democratic management. Modern university system requires a correct understanding and clarification of the relationship between University owners and managers, and a comprehensive grasp and implementation of the power and responsibility of the University as a legal entity and the main body of running a school [15]. Secondly, we should establish a scientific university management system to institutionalize, process, standardize and democratize the management of higher education so as to achieve objectivity, feasibility and efficiency. Thirdly, the organizational structure should be flat, the administrative system should be decentralized, the horizontal information exchange and cooperation between different schools and different departments within schools should be strengthened, and the education and teaching autonomy of the educational subjects should be strengthened. Fourthly, managers should position themselves as service providers to provide quality services for all teachers and students. Sixthly, managers should carefully formulate plans and plans for educational modernization and establish a wide-ranging, wide-ranging and open multimedia educational information management system, so as to realize the orderly circulation and sharing of information resources.

III. THE EVALUATION METHOD OF HIGHER EDUCATION MODERNIZATION

The evaluation indicators of higher education modernization should embody the basic connotation of higher

education development, including 23 indicators of five sub-goals: modernization of educational concept, modernization of educational content, modernization of educational equipment, modernization of educational team and modernization of educational management (TABLE I). Analytic Hierarchy Process (AHP) is used in the evaluation method, Delphi method is used to determine the weight of the evaluation index, and the fuzzy membership function is used to standardize the data in the evaluation. The concrete steps are as follows:

(1) Determine the upper and lower limits of "good" and "bad" of each evaluation index. For the positive indicators, "excellent" is the maximum and "bad" is the minimum. For the reverse index, "good" is the minimum value and "bad" is the maximum value.

(2) Determine the type of fuzzy membership function of each index. A real number in the interval of [0,1] is used to express that "0" means no membership at all, and "1" means complete membership. The fuzzy membership function describes the gradual process from membership to non-membership.

The forward index is quantified using a half-lift trapezoidal fuzzy membership function.

$$\tilde{A}(x_i) = \begin{cases} 0 & x_i \leq x_{\min} \\ \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} & x_{\min} < x_i < x_{\max} \\ 1 & x_i \geq x_{\max} \end{cases} \quad (1)$$

The negative index is quantified using a half-fall trapezoidal fuzzy membership function.

$$\tilde{A}(x_i) = \begin{cases} 1 & x_i \leq x_{\min} \\ \frac{x_{\max} - x_i}{x_{\max} - x_{\min}} & x_{\min} < x_i < x_{\max} \\ 0 & x_i \geq x_{\max} \end{cases} \quad (2)$$

In the formula: $\tilde{A}(x_i)$ indicates the membership value of the actual value of the indicator; x_i represents the actual observations of the indicator; x_{\max} indicates the maximum value of the indicator; x_{\min} indicates the minimum value of the indicator.

The data comes from *China Statistical Yearbook 2016*, *China Education Statistics Yearbook 2016*, *China Population and Employment Statistics Yearbook 2016*, the Ministry of Education website, and the statistical yearbooks of 31 provinces, autonomous regions and municipalities in 2016. Data for other typical countries comes from Education at a Glance 2009: OECD Indicators.

TABLE I. CHINA'S HIGHER EDUCATION MODERNIZATION EVALUATION INDEX SYSTEM AND WEIGHT

Target layer	Indicator layer	Unit	Indicator interpretation	Types
Modernization of educational concepts (0.2)	Number of universities (0.2)	office	The number of higher education institutions (including ordinary colleges, private colleges and vocational colleges) in the region reflects the diversity and lifelong education of higher education.	Positive
	Number of students enrolled in higher education per 100,000 people (0.2)	people	The number of students enrolled in higher education institutions per 100,000 people in the region reflects the popularization of higher education	Positive
	Gender Equality Index (0.2)	Dimensionless	The ratio of female students in school to male students in school reflects the equality of education	Positive
	International student size (0.2)	people	The number of students enrolled in the region reflects the level of international higher education competition and internationalization.	Positive
	Graduate employment rate (0.2)	%	The proportion of graduates in employment in the total number of graduates in that year reflects the level of education socialization	Positive
Modernization of educational content (0.2)	Cultivate target diversity (0.2)	Dimensionless	The goal training system of colleges and universities is in line with the degree of modernization construction. The scope is set to 0-10, the lowest is 0, the highest is 10, and it is determined by expert scoring method.	Positive
	The proportion of key universities (0.3)	%	The proportion of universities and colleges affiliated to the central ministries and commissions reflects the completeness of the disciplines and the influence of higher education in the country.	Positive
	Graduate students vs. undergraduate students (0.3)	Dimensionless	The ratio of postgraduate students to undergraduate students reflects the diversity of education levels and the coordination of curriculum and social needs.	Positive
	Number of articles published abroad (0.2)	piece	The number of academic papers published by universities in SCI/SSCI/EI/ISTP reflects the cutting-edge dynamics of teaching content and international	Positive
Modernization of educational equipment (0.2)	Number of national key disciplines (0.2)	/	Regional universities have a number of national key disciplines, reflecting the status of the discipline in the country.	Positive
	Education funds as a percentage of regional GDP (0.2)	%	The ratio of education funding to GDP reflects the investment in higher education	Positive
	Per capita education funding (0.2)	Ten thousand yuan/people	The average amount of education funds per school student reflects the extent to which students have access to education.	Positive

Cont. to TABLE I				
	Ratio of private investment to public investment (0.2)	Dimensionless	The ratio of public education funds to private education investment reflects the social influence and social recognition of education	Positive
	The number of books and audio (0.2)	book/GB	The number of books and electronic resources owned by university libraries reflects the level of educational informatization	Positive
Education team modernization (0.25)	Student-teacher ratio (0.2)	Dimensionless	The ratio of the number of students in school to the number of full-time teachers in schools reflects the efficiency of teaching and the stability of teaching	Negative
	Proportion of full-time teachers (0.2)	%	The proportion of full-time teachers in the faculty and staff of the school reflects the ability of human resources allocation in teaching and research universities	Positive
	Proportion of professors (0.2)	%	The proportion of teachers who are full-time teachers in the title of Professor Zhongzheng reflects the professional development level of teachers and the number of high-level talents.	Positive
	Number of teachers recruited outside the school (0.1)	people	The number of off-campus teachers hired by the school reflects the extent to which the school communicates with peers	Positive
	Research expenditure (0.2)	Ten thousand yuan	Universities receive national and local research funding, reflecting the level of scientific research in universities	Positive
	Transfer of scientific and technological achievements (0.1)	Item	The number of scientific and technological achievements transferred in colleges and universities reflects the ability of combining production, study and research in universities	Positive
Education management modernization (0.15)	Management autonomy (0.4)	Dimensionless	The degree of university management autonomy is set to 0-10, 0 is the lowest, and the highest is 10, which is determined by expert scoring method.	Positive
	Management Informationization (0.3)	Dimensionless	The completeness of establishing an information management system in a university, the scope is set to 0-10, 0 is the lowest, and the highest is 10, which is determined by the expert scoring method.	Positive
	Service Index (0.3)	Dimensionless	The ratio of the number of university management (teaching assistants) to the total number of full-time teachers and students reflects the service level and service efficiency of university management/support personnel	Negative

IV. RESULTS

A. Analysis on the Level of Modernization of Higher Education and Regional Differences

By calculating the scores of the five sub-goals of the modernization of higher education in the whole country and provinces in 2015, we can judge the level of modernization of educational concept, content, equipment, contingent and management in the whole country and provinces respectively.

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In the modernization of educational content, the highest scores were Beijing, Shanghai and Jiangsu, which were 0.2000, 0.1021 and 0.0855, respectively. And because Beijing is significantly higher than other provinces in the proportion of key universities, graduate students to undergraduate students and the number of articles published abroad, the modernization of education content in Beijing is far ahead. The scores of nine provinces such as Hubei are between [0.05, 0.08], 11 provinces such as Heilongjiang are between [0.02, 0.05], and the scores of the other eight provinces are lower, between [0.00, 0.02] (Fig. 2).

In the modernization of educational equipment, the four provinces of Hubei, Jiangsu, Guangdong and Zhejiang have the highest scores of 0.1082, 0.1061, 0.0957 and 0.0945, respectively. As Hubei Province is the most prominent in terms of the ratio of private investment to public investment and the

number of books, audio and video, it has replaced Beijing as the province with the highest score. The scores of 7 provinces such as Beijing are between [0.07, 0.09], 15 provinces such as Shandong are between [0.05, 0.07], and 5 provinces such as Jilin are between [0.04, 0.05] (Fig. 3).

In the modernization of education team, Jiangsu, Shandong and Guangdong provinces have the highest scores, which are 0.1767, 0.1455 and 0.1421, respectively. In Shandong Province, the number of employed professors outside school and the income index of research funds in Guangdong Province are prominent, so the calculated value is relatively high. Seven provinces such as Beijing and Zhejiang followed, with scores between [0.12, 0.14], 10 provinces such as Tianjin between [0.10, 0.12], and the remaining 11 provinces such as Chongqing between [0.06, 0.10] (Fig. 4). In the modernization of education management, Jiangsu, Guangdong and Zhejiang have the highest scores, 0.1271, 0.1193 and 0.1151 respectively, followed by Shanghai and Beijing, with scores between [0.07, 0.10], Hubei and other 10 provinces between [0.05, 0.07], and Guangxi and other 12 provinces between [0.02, 0.05] (Fig. 5).

According to the calculated index of modernization of higher education, the overall level of modernization of higher education in China's provinces is not high. The modernization index of higher education is divided into four levels. The modernization index of higher education in five provinces is greater than 0.5, the modernization index of higher education in five provinces is between 0.4 and 0.5, the modernization index of higher education in 10 provinces is between 0.3 and 0.4, and the modernization index of higher education in the remaining 11 provinces is between 0.2 and 0.3 (Fig. 6). Higher education modernization in Beijing, Jiangsu, Shanghai,

Guangdong, Zhejiang and other economically developed areas is relatively high. The modernization index of higher education in Beijing is the highest, which is 0.6595. The second is Jiangsu Province, which is 0.6079. Shanghai ranked third, with the modernization index of higher education at 0.5437. Higher education modernization in underdeveloped areas such as Qinghai, Guizhou, Hainan, Ningxia Autonomous Region and Gansu Province is relatively low. Among them, Qinghai Province has the lowest modernization index of higher education, which is 0.2240. The second is Guizhou Province, which is 0.2290. Generally speaking, except Fujian Province, the modernization of higher education in the eastern coastal areas is relatively high; in addition to Shaanxi Province and Sichuan Province, the modernization of higher education in the western areas is relatively low.

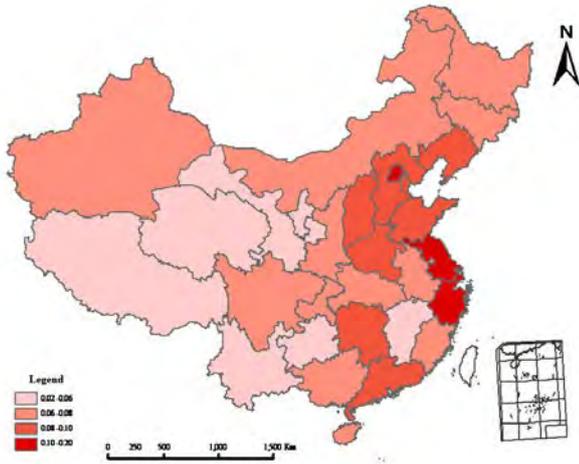


Fig. 1. Modernization of the concept of higher education

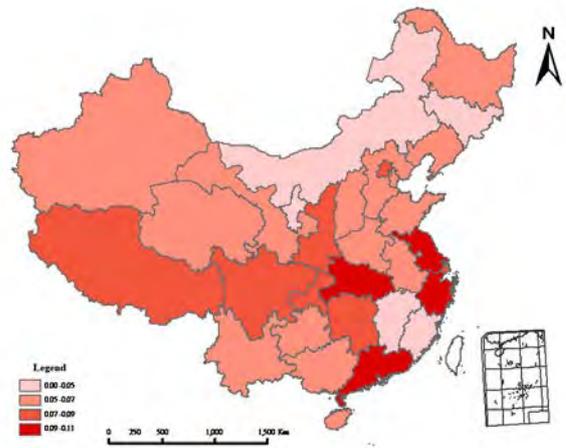


Fig. 3. Modernization of higher education equipment

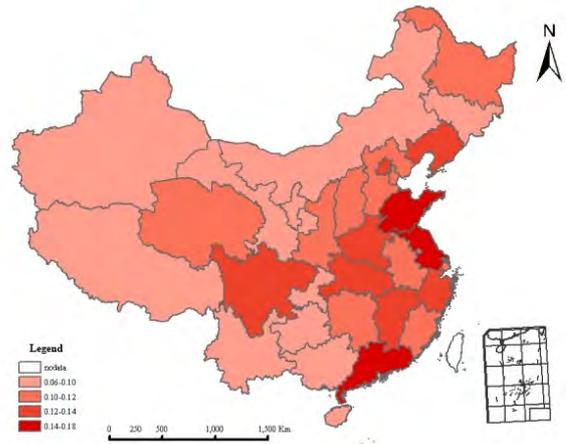


Fig. 4. Higher education team modernization score

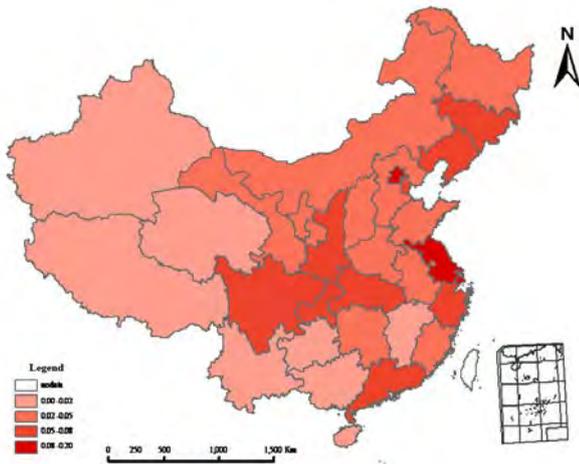


Fig. 2. Modernization content of higher education content

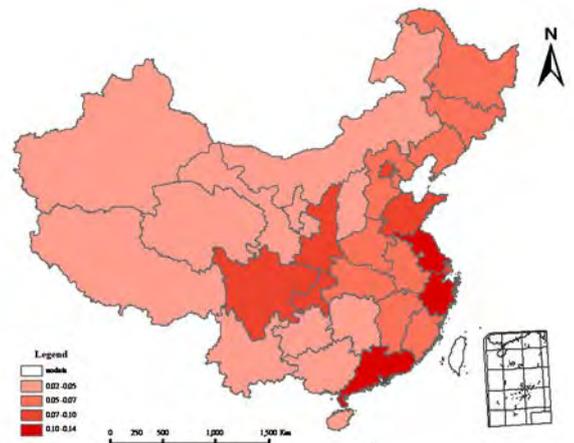


Fig. 5. Higher education management modernization score

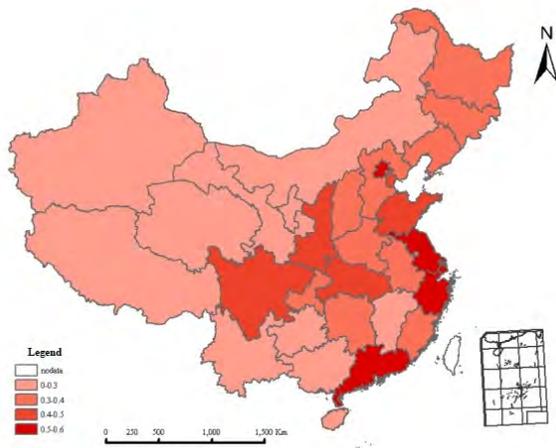


Fig. 6. Evaluation of Higher Education Modernization

TABLE II. INTERNATIONAL COMPARISON OF HIGHER EDUCATION INDICATORS

Index	Japan	Korea	United States	France	Germany	OECD	China
Higher education gross enrollment rate	57	93	82	56	-	-	26.5
Student-teacher ratio	-	-	-	-	-	15.3	20.77
Per capita education funding (US\$)	13418	8564	25109	11568	13016	15791	7021
Education expenditure as a share of GDP	1.5	2.5	2.9	1.3	1.1	1.9	3.82
Public education expenditure as a share of public expenditure	1.7	2.2	3.9	2.3	2.5	3.1	-
Public investment and private investment	0.47	0.30	0.52	5.13	5.67	2.65	3.02

Note: (1) Data for Japan, Korea, USA, France, Germany, and OECD are for 2009, China for 2015; and (2)- for missing data.

B. Comparison of the Modernization Levels of China and International Higher Education

Compared with the international higher education indicators (TABLE II), the gross enrollment rate of higher education in China is 26.5%, which is significantly lower than that in developed countries. The ratio of students to teachers in Higher Education in China is more than 20, which is higher than the average of 15.3 in OECD countries. The per capita education expenditure is about \$7,000, almost half of that in developed countries. The proportion of public investment and private investment in Higher Education in China is 3.02. This shows that public investment is still the main source of higher education in China, and to some extent, the social influence of higher education is worse than that of universities in Japan, Korea and the United States, and lower than the average level of OECD. Among these indicators, only the proportion of education expenditure in GDP exceeds that of developed countries, but few universities in China rank among the top 100 in the world, and the level of education in Chinese universities is relatively low, which also shows that the effect of education investment is not good. Generally speaking, compared with the international advanced education in the world, China's higher education shows disadvantage in various indicators, while compared with the average level of OECD countries, there is still a big gap. Therefore, the modernization of higher education in China has a long way to go.

V. CONCLUSIONS

Based on the theoretical connotation of the modernization of higher education, this paper constructs five goals and 23 indicators, including the modernization of educational concept, content, equipment, contingent and management. It also

evaluates the level of modernization of higher education in China and analyses the regional differences, and draws the following conclusions:

(1) The overall level of modernization of higher education in China's provinces is not high. The modernization of higher education in Beijing, Jiangsu, Shanghai, Guangdong and Zhejiang provinces is relatively high. In addition to Fujian Province, the modernization of higher education in the eastern coastal areas is relatively high; in addition to Shaanxi Province and Sichuan Province, the modernization of higher education in the western areas is relatively low.

(2) Compared with the international advanced education in the world, China's higher education shows disadvantage in various indicators. Compared with the average level of OECD countries, there is still a big gap, which is also related to the system of separating Chinese scientific research institutions from Chinese higher education.

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