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Research on Index Evaluation system of higher Education Health system based on Entropy weight method

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Abstract: Higher education determines the level of economic development and the level of science and technology of a country. The current analysis is mainly focused on the qualitative evaluation of the level of education development, lack of quantitative analysis of the education system. Therefore, this paper constructs a comprehensive evaluation system based on entropy method, and constructs a variable coefficient to select the appropriate goal through the gap between the national comprehensive level and its education level. Then carry on the factor analysis to it, extract the common factor to reduce the dimension of the index. Then the annual comprehensive level coefficient of each country is calculated.

1. Introduction

Looking across all over the world in the day of 2021, from Germany to the United States, from Japan to Australia, the paper shall see a variety of national approaches to higher education [1-3]. Some of them have reached higher educational level, with each of these nations not only educating their own students, but also drawing large numbers of international students every year [4-5]. How to evaluate a country's system of higher education which is healthy and sustainable? Establishing an appropriate evaluation model to quantify the education system is required.

2. Establishment of Index weight by Entropy method

The entropy is an index to measure the disorder and degree of confusion in a system [6]. Then, the occurrence of debris flow is a dynamic process affected by many indices [7]; it is highly uncertain. Its calculative process is shown as follows:

After the standardization of each data [8], the determination of proportion about the j_{th} evaluation index in the i_{th} scheme y_{ij} is expressed as follows:

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad \left(0 \le y_{ij} \le 1\right) \tag{1}$$

The entropy of j_{th} evaluation index, e_j is shown as follows:

$$e_{ij} = -k\sum_{i=1}^{m} y_{ij} \ln\left(y_{ij}\right) \tag{2}$$

We can see k > 0, *ln* is the natural log, $e_j \geq 0$. If *xij* for a given j all are equal, then

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} = \frac{1}{m} \tag{3}$$

$$e_{ij} = -k\sum_{i=1}^{m} \frac{1}{m} \ln\left(\frac{1}{m}\right) = k \ln m \tag{4}$$

Now the e_j takes maximum, when set $k = \frac{1}{\ln m}$, and $0 \leq e_j \leq 1$, since the entropy ej is used to measure the utility value of various indicators. When information is completely disorder, $e_j = 1$, The utility value of the e_j information to comprehensive evaluation is 0. *dj* is defined as the *jth* information utility value, then $dj = 1 - ej$. The larger *dj* is, the more important the indicators are.

The weight of j_{th} evaluation index w_j is depicted as follows:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{5}$$

The paper can get a comprehensive score through simple weighting according to w_j

$$f_i = \sum_{i=1}^{n} w_i x_{ij} \tag{6}$$

From the size of *fi* we can observe the merits and demerits of the research object *i(i = 1, ..., m)*. It is obvious that, the larger *fi* is, the better the evaluation of the sample will be.

3. The result of establishing index weight

According to the established entropy weight model, the average score of each country and the average weight of each indicator in 10 years are obtained as follows:

Table 1: The average weight of each indicator

Indicator	Result
GDP	0.265080438
Graduation rate	0.026367027
Enrollment rate	0.034241983
QS rank in the top 200	0.312828912
Spending on higher education as a percentage of GDP	0.042391807
Number of scientific	0.205362732
Spending on higher education as percentage of GDP	0.079130313
The government’s financial expenditure on college students	0.034596788

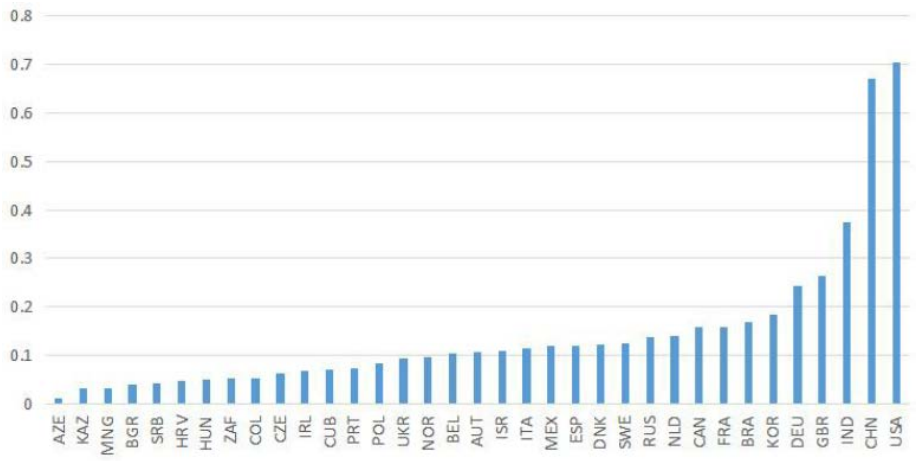

Figure 1: The average score of each country

It can be seen from the results that, the score of Azerbaijan, Frankenstein and Mongolian are lower, and the score of the United States, China and India are higher. In terms of weight, enrollment date, QS rank in the top 200, number of teachers account for a high proportion. It can be seen that the number of people receiving higher education is an important criterion to evaluate the quality of a country's higher education system.

4. Evaluation of Higher educational system's alterability

4.1 Selection of Outside Indexes

The paper has selected 12 outside indexes which can show a nation's capability. The indexes can be as follows:

Figure 2: 12 outside indexes

The original data comes from United Nations Development Programme, UIS.Stat and FRAGILE STATES INDEX, which the index value will be obtained through corresponding calculation, so that the objectivity and accuracy of the index value are guaranteed

4.2 Correlational Analyses

The correlation difference of indicators in each year is small, so we select the data of 2018 for correlation analysis first to determine whether there is correlation between these indexes in order to check whether the data is suitable for factorial analysis. We can conduct KMO and Bartlett's Test. The results are as follows:

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.921
Bartlett's Test of Sphericity	Approx.Chi-Square	2672.1
	df	66
	Sig	0

The value of KMO is larger than 0.7, and the value of Sig. is 0, indicating that it is very suitable for factorial analysis. Then factorial analysis is conducted and the results can be as follows. It shows that the component 1,2 already accounts for most of the variance.Finally, the component score coefficient matrix is obtained. The value of the public variable can be calculated with the coefficient in the matrix and the number of components, which can be seen as the annual comprehensive coefficient of the country. The annual score coefficient of factors are shown as follows:

Table 3: Score coefficient of factors from 2009 to 2018

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
	1	1	1	1	1	1	1	1	1	1
C1	0.099	0.099	0.1	0.101	0.1	0.1	0.102	0.104	0.105	0.105
C2	0.097	0.096	0.096	0.098	0.097	0.097	0.099	0.101	0.102	0.102
C3	0.09	0.089	0.087	0.088	0.086	0.085	0.082	0.082	0.081	0.079
E1	0.089	0.088	0.089	0.091	0.09	0.09	0.09	0.094	0.096	0.098
E2	0.092	0.093	0.094	0.095	0.095	0.096	0.096	0.098	0.1	0.101
E3	0.087	0.088	0.086	0.084	0.086	0.088	0.089	0.092	0.092	0.093
P1	0.1	0.099	0.1	0.1	0.099	0.099	0.099	0.101	0.101	0.1
P2	0.097	0.097	0.098	0.098	0.098	0.099	0.1	0.103	0.105	0.106
P3	0.097	0.096	0.096	0.096	0.095	0.095	0.095	0.097	0.098	0.098
S1	0.098	0.097	0.098	0.096	0.097	0.098	0.099	0.101	0.103	0.104
S2	0.087	0.087	0.089	0.092	0.094	0.095	0.096	0.089	0.09	0.092
X1	0.092	0.092	0.093	0.095	0.095	0.096	0.097	0.099	0.1	0.097

4.3 Higher educational system's alterability

Then the score coefficient matrix of each component is established. The value of the public variable can be calculated by the coefficient and component in the matrix, which can be regarded as the annual comprehensive coefficient of the country, collate the annual score coefficient of each factor and establish the annual comprehensive coefficient of social environment of different countries.

Combined with the higher educational health index ranking (*RE*), we can get the following figure: *RS* represents one nation's economic, political and social security. It is believed that the bigger *RS* is, the higher the education level of a country should be, and there should be a positive correlation between the two. So if one nation's *RS* is high but *RE* is low, we can assume that there's no adequate investment in higher education, and this nation has plenty of room for improvement. At the same time, as for the developing countries, due to the incomplete system and infrastructure, they should be more suitable for conducting policies. Therefore, we design a variable called the alterability coefficient(A). The expression can be as follows:

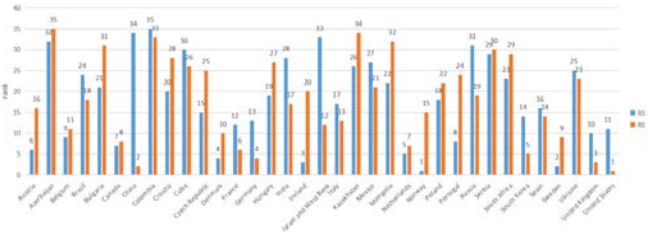

Figure 3: The average score of each country

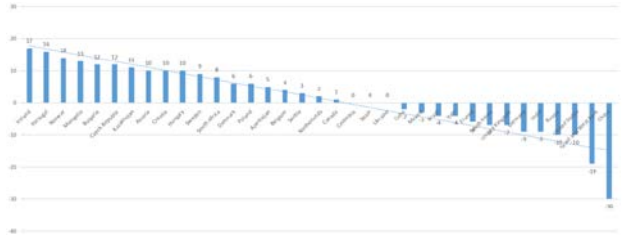

Figure 4: The average score of each country

(D represents the state of a nation's Development. If it's a developing country, D=2. Otherwise D=0)

$$A = R_E - R_S + D \tag{7}$$

The results are as follows: Among the top three countries, Portugal is a less developed country.

5. Conclusion

In this paper, according to the health situation of higher education, an index system is established by entropy method, and the data sets of 120 countries are screened to make a normalized evaluation. Then the common factor of the index is used to reduce the dimension and comprehensively analyze the comprehensive level score of each country, and the variable coefficient is defined according to the development level of the country. It provides some reference for the evaluation of higher education health system.

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