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A COMPETITIVE STUDY ON EFFECTIVE USE OF HUMAN RESOURCES IN CHINA'S PROVINCES

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The principal component analysis is a practical method for multivariate statistical analyses. It can eliminate the correlation between sample indexes, and on the premise of keeping the main information of samples, extract a few representative principal components. This article adopts the input–output method and principal component analysis. It carries on the transverse comparison research on the effective utilization situation of human resources in China in 2008 and reveals the actual situation of efficient use of human resources in the provinces in China. The degree of effective use of human resources in Beijing is the highest, while in Ningxia is the lowest. It is closely related to the economic development. Finally, it puts forward the thoughts and suggestions of improving the effective use of human resources in China.

Keywords: country, human resources effective use, comparison principal component analysis

1. INTRODUCTION

Human resources are a comparative way of saying about material resources. It is a kind of intangible resources, which is embodied in workers, expressed by the quantity and quality of labors. In the modern world, economic competition is actually the competition of human resources and technology knowledge (Huang 2014). Therefore, any countries or companies in modern society should not only pay attention to the effective use of natural resources and capital resources, but should also take the development and utilization of human resources seriously. Thus, it is of great practical and social significance to evaluate the effective utilization of human resources in China (Zbranek 2013). This paper makes an

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empirical analysis on the effective use of human resources in the provinces in China from five aspects, namely the number of human resources, the unemployment rate of human resources, the provincial GDP, the number of science and technology papers published at home and abroad, and the number of authorized invention patents in each province. It reveals the actual situation of the effective use of human resources and therefore provides evidences for the scientific and comprehensive understanding of human resources in China and making right decisions.

1.1. Research category

In China, the research on the regional effective use of human resources is still little. The current research is limited to the microlevel of industry and enterprise, such as Jian Gong's (2010) exploration of the effective use of nursing human resources, Jun Xue's (2010) brief introduction about how the enterprise effectively uses the incentive theory to manage the human resources, and Guofang Cheng's (2008) research on the effective utilization of human resources mechanism.

1.2. The connotation of the research

Few scholars have studied the connotation of effective utilization of human resources. The author thinks that the effective utilization of human resources is the human resources on full employment, reasonable configuration, and playing an important role. Because there is no statistics of human resources in relevant institutions in China, this study replaces it with the similar concept "employment" in China's statistical yearbook, published by China's national bureau of statistics. Specifically, it refers to the personnel engaging in a certain social labor and getting labor payment and business income, including on-the-job workers, re-employment of retired personnel, private owners, heads of the household, private and individual employers, employees of township enterprises, rural employees and other employees (including private teachers, religious professionals and active servicemen, etc.). This indicator reflects the actual utilization of all labor force during a certain period of time. Besides, it is one of the important indexes in studying the basic national conditions and strength of China (Liu 2014).

1.3. The research on the index system of effective use of human resources

In 2005, professor Yang Xiaoming, in "The study of the measure problems of effective utilization of talent resources" put forward the display indicator and explanatory indicator system of the effective utilization of talent resources and directly used principal component analysis to carry out the principal component analysis calculation and work out the effective utilization of talent resources index in various provinces. This paper designs both input index system and output index system. It adopts the principal component analysis to calculate human resource input index and output index and uses the input–output method to calculate the degree of effective utilization of human resources in various provinces.

2. RESEARCH METHOD

2.1. This research uses the principal component analysis for index computation

Principal component analysis tries to reassemble the original indicators which are of certain relevance into a new set of comprehensive indexes that have nothing to do with each other. Namely, it is the idea of dimension reduction. Multiple variables are divided into a handful of unrelated principal components so that the internal structure of the data set can be described. Principal component analysis is calculated by getting the eigenvalues and characteristic root of the covariance matrix or correlation coefficient matrix. According to the specified contribution rate, it calculates the relative gap of each candidate indicator in each sample, which is the basis of index selection. It extracts the indexes that have a relatively large gap in each sample, which will be taken as the elements to build a comprehensive evaluation index system, while the indexes which have a very small gap will be eliminated. In that way, the main components which gather the main information of original random variables but are not related to each other to construct a comprehensive evaluation function can be acquired. It cannot only exclude the subjective and objective factors when choosing the index and determining the weight, but can also eliminate the overlapping information between indexes, make quantitative analyses involve in less variables, and get more information. Thus, it will be easier to seize the main contradiction and make an overall evaluation of the results uniquely, objectively and reasonably.

Principal component analysis can be used for calculating the relative number of multivariate samples, namely tectonic sample index, and can also sort the samples. Some of the indexes constructed by principal component analysis are negative, which do not represent the true meaning of the utilization degree, but rather

show the region's relative position in the selected region which is below the average level. Therefore, the principal component analysis is an ideal analysis tool. This study is conducted by using SPSS18.0 data statistics software.

2.2. The method of input and output is used for the calculation of effective use

The calculation formula of input–output analysis, which is commonly used in economics, appears the input and output ratio = output/input × 100%. This paper adopts this formula to reflect the effective utilization of the organization group or individual. The bigger ratio shows the higher effective utilization degree; while the smaller ratio reveals the lower effective utilization degree.

3. THE ESTABLISHMENT OF INDEX SYSTEM AND THE SOURCE OF DATA

On the basis of scientific, systemic, comparable and operable principles, the index system of the effective utilization of human resources in the present study includes the quantity of human resources, the unemployment rate of human resources, the GDP of each province, the number of science and technology papers published both at home and abroad, and the provincially authorized invention patent number and so on. These indicators are the data published by related national departments and international authority. The details are shown in the following table.

Table 1. The original index of effective use of human resources in 2008

The serial number	Indicators	
1	input indicator	amount of human resources (employment) (thousand)
2		unemployment of human resources
3	output indicator	GDP of each province (100 million yuan)
4		number of science and technology papers published both at home and abroad (piece)
5		provincially authorized invention patent number (piece)

Data source:

1. *International Statistical Yearbook 2009* complied by the National Bureau of Statistics of the People's Republic of China

2. The statistic results of China's science and technology papers in 2009 published by the Science and Technology Information Institute of China.

3. The statistic bulletin of the human resources and social security in 2008 published by the Ministry of Human Resources and Social Security.

4. THE EMPIRICAL STUDY ON EFFECTIVE USE OF HUMAN RESOURCES BASED ON PRINCIPAL COMPONENT ANALYSIS

4.1. The calculation of input and output index

1) Original data standardization transformation

First, the "analysis" menu of "statistical" in Spss18.0 software (localization version) is opened to make use of "describing statistical analysis" to carry out the dimensionless processing of the original index data and get the standardized variables.

In this paper, the explanation about the output index calculation is just made as following.

2) The judgment of the correlation between indicators

Use "factor analysis" option of "data reduction" in the menu of "analysis" to test the correlation of standardized variables. KMO test is used for determining whether the factor analysis can be carried out. The KMO value in this test is as low as 0.500, which represents that this study (principal component analysis is one of the factor analysis) is suitable for factor analysis. Bartlett ball test shows whether the sample correlation matrix is the consistency matrix (identity matrix). The consistency matrix represents that variables are not related. Significance level value (Sig) is the result of this test. When the value is less than 0.05, there may be a significant correlation among variables. When this value is more than 0.10, the correlation between variables is not strong that the data set is unfavorable for factor analysis. In this paper, when taking the ball test on the index of indicator, the value of Sig conforms to the requirements, passing the Bartlett ball test. So, it is reasonable to adopt principal component analysis method, and the correlation coefficient matrix is omitted.

3) Determine the number of principal components

Open the "data reduction" of the "analysis" menu to use the factor analysis for carrying out the principal component analysis of the standard variables.

The principle for selecting the number of principal components mainly includes two standards. The first is the corresponding characteristic value, namely the first *m* principal component whose variance is greater than 1, and the second is the contribution rate of the first *m* principal component being more than 85%.

As for the first principle, to some extent, the character value can be seen as the marker of principal component influence. If the characteristic value is less than 1, it manifests that the explanation power of the principal component is less than the explanation power of directly importing an original variable. So, the general eigenvalues being greater than 1 can be used as the inclusion criteria. For the second principle, the cumulative contribution rate reflects the first *m* principal

Table 2. Total variance explanation

Principle component	The variance of principle components			Extraction sums of squared loadings		
	Total character roots	The variance contribution rate (%)	Cumulative contribution rate of principle component variance (%)	Total character roots	The variance contribution rate (%)	Cumulative contribution rate of principle component variance (%)
1	2.363	78.767	78.767	2.363	78.767	78.767
2	.478	15.931	94.698	.478	15.931	94.698
3	.159	5.302	100.000			

Extraction method: Principal component analysis.

components, reflects more than 85% of the original information of the overall sample and basically reflects the general characteristics of the original data.

Table 2 shows that only the first principal component of eigenvalues is greater than 1 and the cumulative contribution rate is 78.767%, which do not meet the above two standards. Thus, to extract the first two principal components, the characteristic value reaches 94.689%, and the cumulative contribution rate of the principal component meets the two choices of the standard of main components. From *Table 3*, Z score (the number of scientific papers published at home and abroad), Z score (province authorized invention patent number) and Z score (the CDP of each province) all have a high load on the first principal component, which manifests that the first principal component reflects a vast majority of information of the three variables. Besides, Z score (the CDP of each province) in the second principal components also has higher load. So, the author decides to use two new variables to replace the original three variables.

4) Identify and name the principal component expression

Using the data in *Table 3*, the main component of load matrix (each column represents the corresponding principal components and the corresponding variable correlation coefficient) is divided by the principal component corresponding to the open square root of the eigenvalue and acquires the correlation coefficient of each index in the main component. For example, the square root of the first characteristic value 2.363 is 1.537. Then, the first principal component is used in each value (0.892, 0.944, 0.823) to be divided by 1.537 for acquiring the corresponding coefficient of each value in the first principal component (unit vector), 0.58, 0.61, 0.54. In the same way, corresponding coefficient of each value

Table 3. Component matrix (a) (principal component initial factor loading matrix)

Standardized variables	Component (principle component)	
	1	2
Z score (the number of scientific papers published at home and abroad)	.892	–.385
Z score (province authorized invention patent number)	.944	–.124
Z score (the GDP of each province)	.823	.560

Extraction method: Principal component analysis.

in the second principal component (-0.56, -0.18, 0.81) can be acquired. So, the principal component function of expression can be obtained (linear combination) as follows.

Output the first principal component score = 0.58 * Z score (the numbers of science and technology papers published at home and abroad) + 0.61 * Z score (province authorized invention patent number) + 0.54 * Z score (the GDP of each province).

The second principal component score = 0.56 * Z score output (the number of science and technology papers published at home and abroad) - 0.18 * Z score (province authorized invention patent number) + 0.81 * Z score (the GDP of each province).

5) The determination of the evaluation formula of output comprehensive principal component (index)

The proportion of corresponding characteristic value of each principal component in the sum of overall eigenvalues extracted from principal components, as shown in *Table 2*, is 78.767% and 15.931%, respectively. With above data as a weight, the comprehensive evaluation model of principal components is calculated.

$$F = \frac{\lambda_1}{\lambda_1 + \lambda_2 + \cdots + \lambda_n} F1 + \frac{\lambda_2}{\lambda_1 + \lambda_2 + \cdots + \lambda_n} F2 + \frac{\lambda_3}{\lambda_1 + \lambda_2 + \cdots + \lambda_n} F3 + \cdots + \frac{\lambda_n}{\lambda_1 + \lambda_2 + \cdots + \lambda_n} Fn$$

λ_i represents the eigenvalue of the principle component *i*. So, the comprehensive evaluation function expression of principle components is:

output comprehensive index = input the first principal component score * 0.78767 + input the second principal component scores * 0.15931. In the same way, the input composite index, the human resources input of each province and output index and places can be found out, such as in *Table 4*.

6) Use and get the comprehensive principal component values of regional talent competitiveness, see *Table 4.*

Table 4. Input and output index of human resources, effective use and rankings of each province, 2008

Serial number	Province and city	Output index of human resources		Input index of human resources		The index of effective use of human resources	
			sorting		sorting		sorting
1	Beijing	7.66	2	3.43	30	223.32	1
2	Tibet	3.68	31	1.9	31	193.68	2
3	Guangdong	8.4	1	4.35	29	193.10	3
4	Jiangsu	7.39	3	4.85	25	152.37	4
5	Zhejiang	6.37	6	4.97	21	128.17	5
6	Shandong	6.61	4	5.24	13	126.15	6
7	Shanghai	6.43	5	5.38	7	119.52	7
8	Henan	5.35	7	5.02	19	106.57	8
9	Liaoning	5.35	8	5.21	15	102.69	9
10	Tianjin	4.74	14	4.87	24	97.33	10
11	Hubei	5.26	9	5.5	4	95.64	11
12	Hebei	5.11	11	5.38	8	94.98	12
13	Shaanxi	4.93	13	5.2	17	94.81	13
14	Shanxi	4.32	20	4.68	27	92.31	14
15	Hunan	5.1	12	5.55	2	91.89	15
16	Fujian	4.65	16	5.21	16	89.25	16
17	Gansu	4.07	25	4.59	28	88.67	17
18	Jiangxi	4.23	22	4.8	26	88.13	18
19	Anhui	4.62	17	5.3	10	87.17	19
20	Sichuan	5.18	10	5.95	1	87.06	20
21	Heilongjiang	4.72	15	5.43	6	86.92	21
22	Jilin	4.43	18	5.23	14	84.70	22
23	Guangxi	4.3	21	5.17	18	83.17	23
24	Chongqing	4.36	19	5.27	12	82.73	24
25	Xinjiang	4.02	26	4.97	22	80.89	25
26	Inner Mongolia	4.22	23	5.31	9	79.47	26
27	Yunnan	4.22	24	5.49	5	76.87	27
28	Hainan	3.79	28	4.94	23	76.72	28
29	Guizhou	4	27	5.3	11	75.47	29
30	Qinghai	3.73	30	5.02	20	74.30	30
31	Ningxia	3.75	29	5.51	3	68.06	31

Note: Part of the input index and output index are negative. In order to facilitate the next step of calculation, 5 is added to each input and output index to get the positive index (as the index only represents the relative position, plus 5 does not change its relative position).

4.2. The calculation of index of effective use of human resources

According to the formula of input and output ratio = output/input×100%, the following formula is concluded. The degree of effective use of human resources = output/input index×100%

Specific results are shown in *Table 4.*

4.3. The analysis of the degree of effective utilization of human resources

According to the sorting table, Beijing shows the highest degree of effective use of human resources, and Tibet is the second. Except for Tibet and Henan, the others of the top 10 are relatively economic developed areas. The provinces and cities which are ranked 11–20 are mostly in central China. The provinces and cities which are ranked in last 21–31 are mostly in the western region.

5. CONCLUSION

Through the empirical analysis, this paper finds that

1. there are many differences in the degree of effective use of human resources among the provinces in China,
2. the more input and output of the degree of effective use of human resources does not show the higher degree of effective use of human resources,
3. the degree of effective utilization of human resources has a close relationship with economic development; in general, the more developed economy, the higher degree of effective utilization of human resources,
4. although part of the provinces input more, the output is low, causing the low degree of effective utilization of human resources, which means that there is a large amount of waste and inefficiency. Some effective measures need to be taken to change this situation and finally step onto the road of high production and lower consumption.

6. THOUGHTS AND SUGGESTIONS

China is trying to achieve sustainable, rapid and healthy economic development. Developing the enthusiasm, initiative and creativity of human resources, improving the effective use and benefit of resources, and reducing waste have become

more and more important. Therefore, aiming at the problems found out in this study, the author proposes the following suggestions.

1. Strengthen the competitiveness of human resources.
   The increase of the competitiveness of human resources requires a large number of human resources, a high level of human resource density. But the most important is the output and production efficiency of human resources being high. Therefore, on the one hand, it is necessary to improve the quality of education and national quality and cultivate more human resources. On the other hand, different ways are needed to attract human resources.
2. Do best on the "hope project" of the development of potential human resources.
   The development of potential human resources in fact is to develop the "hematopoietic capacity" of regional human resources. Seeing all the developed countries throughout the world, they not only introduce human resources but also attach the importance to human resources cultivation. Therefore, China must increase investment in human resources training and should not be "once the emperor, once a courtier" and devote to the so-called "achievements".
3. Create human resources and make use of the conditions to improve the degree of effective utilization of human resources.

In today's China, the production model are being transformed to pursue green development, cultural development and low carbon development. It should try to provide developing spaces for human resources, reduce waste, improve efficiency, and thus improve the degree of effective utilization of human resources.

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