Study on Fuzzy Comprehensive Evaluation of Regional Technological Innovation Ability of China Changzhutan "3 +5" Urban Agglomeration Based on AHP*

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Abstract Based on the relevant statistical data of 2008,taking regional technological innovation ability of Changzhutan "3+5" urban agglomeration as a study object , constructing the objective and comprehensive index system of regional technological innovation ability, combining Analytic Hierarchy Process(AHP) and fuzzy, this paper conducts a comprehensive evaluation of the technological innovation ability of the region. The result shows that the greater differences on technological innovation ability are existed in different cities of this region. the overall level of the technological innovation ability also needs to be enhanced. Based on the analysis, this paper tries to find the differences on technological innovation ability in different cities of this region and puts forward some related policy proposals on the development of regional technological innovation ability of Changzhutan "3 +5" urban agglomeration.

Key words Regional technological innovation ability; AHP; Fuzzy comprehensive evaluation; Index system

1 Introduction

In the era of knowledge economy, the imbalance of regional economic development is caused mainly by the differences of regional technological innovation ability, and the evaluation of regional technological innovation ability depends on an objective and comprehensive index system of regional technological innovation ability. Many scholars had conducted studies on index system of regional technological innovation ability from different aspects, foreign studies mainly focused on regional innovation strategy, regional technical planning and transfering, regional innovation policy, and so on. There are also relatively large number of studies on literature and many types of index system designs of regional technological innovation ability in China. But from the general point of view, present studies on index system of regional technological innovation ability are in the exploratory stage, mainly using qualitative research methods, thus the index system designs of regional technological innovation ability also needed to be improved. this paper selects regional technological innovation ability of Changzhutan "3 +5" urban agglomeration as study object to improve index system, gather first-hand information to undertake research, and hoping the research result has a certain reference value.

2 Establishment of the Evaluation Index System

Based on the former index system of regional technological innovation, under the principle of science, comparability, feasibility, system integration, ease of use and combining characteristics of regional economic development of Changzhutan "3+5" urban agglomeration, this paper has constructrured the new index system which constitutes of 5 one grade indexes,18 secondary indexes, 38 tertiary indexes, on regional technological innovation ability, showed in Table 1.

3 Determine the Evaluation Model of Regional Technological Innovation Ability

* 1.soft science research projects of Science and Technology Department in Hunan Province(2009ZK3198): performance evaluation and countermeasures upgrade for industry cluster in Hunan Province;
2.2009 Youth Foundation in CSUFT: Research on the Industry Cluster Development Based on Ecological Theory;

Table 1 Regional Technological Innovation Ability Index System of Changzhutan "3 +5" Urban Agglomeration

One Grade Index	Secondary Index	Tertiary Index
Knowledge Creation Ability	scientific and technological activities input	input intensity of science and technology research fund input intensity of science and technology researcher scientific and technological activity unit per 10,000 people
	scientific achievement	number of patent per 10,000 people number of new product development per 10,000 people
Knowledge Flows Ability	scientific and technological cooperation	contract amounts per 10,000 people
	science and technology transfer	application rates of industrial technology achievement transformation
	foreign direct investment	proportion of foreign investment accounts for total investment number of foreign-invested project per 10,000 people
Enterprise Technology Innovation Ability	research and development ability	proportion of enterprise-run science and technology institutions's number accounts for total number of enterprises proportion of senior corporate staff's number accounts for number of scientific and technological personnel proportion of total amount of science and technology funds expenses accounts for total amount of science and technology funds raised that year
	design ability	number of patent applications per 10,000 people proportion of patents' number accounts for number of patent applications
	manufacturing ability	sales income of new products per capita
	innovation output ability	proportion of added value of hi-tech products accounts for total output value of hi-tech products proportion of output value of new products accounts for regional GDP
Environment For Technology Innovation	service environment	composite index of financial service capacity composite index of science and technology funds supply
	human environment	proportion of senior and intermediate professional titles' number accounts for number of people involved in the project proportion of expenditure on science and technology accounts for GDP
	infrastructure	transport vehicles per 10,000 people road area per capita number of mobile phones per capita
Economic Performance Of Innovation	macroeconomy	GDP per capita investment rate
	industrial structure optimization	contribution of tertiary industry rate of new product development proportion of high-tech products output value accounts for GDP
	international competitiveness of products	proportion of total export value accounts for total value of imports and exports proportion of high-tech products export earnings accounts for their sales revenue
	employment level	proportion of number of end-job workers in urban collective economy accounts for the-job workers proportion of the end of collective economy of urban employees accounts for total urban employees
	the degree of openness	utilization of foreign investment per capita number of foreign investment per million
	living standards of residents	per capita net income of rural people disposable income of urban residents proportion of household consumption accounts for total amount of spending

3.1 Determine the evaluation factors set

Suppose regional technological innovation ability evaluation factors set $U=\{U_1,U_2,\cdots\cdots U_n\}$, according to the assessment criteria by the property of the factors set $Ui=\{U_{i1},U_{i2},\cdots\cdots U_{ij}\}$, i=1,2,$\cdots\cdots m$; j=1,2, $\cdots\cdots,t$.

3.2 Carrying out the first level evaluation

(1)comments set : symbolize by $V=\{V_1,V_2,V_3,V_4\}$, the comments set which is defined by the evaluation model can be divided into four grades V={ excellent, good, fair , poor }.

(2) weight index set : Let a number of senior experts evaluate index system in their respective, given the relative scale of the index and calculate the corresponding index weight. Then add expert weight and get average value to determine the final weight of the evaluation weight, symbolizing by $\boldsymbol{A}_i=(a_{i1},a_{i2},\cdots\cdots a_{ij})$.

(3)fuzzy evaluation matrix：Seeing factors set U_i to comments set V of the regional technological innovation ability evaluation as a fuzzy mapping, and determining the fuzzy evaluation matrix R_i .

$\boldsymbol{R}_i$={rijk}

In the formula above, rijk = dijk/d, dijk is the number of experts which assess V_k,the first K assment in the comments set,to the first ij evaluation index in sub-factors U_i set,d is the total number of experts participating in the evaluation.

(4)According to FUZZY theory， using fuzzy matrix's synthetic operation ,getting comprehensive cvaluation of vector B_i of U_i

$$\boldsymbol{B}_i=\boldsymbol{A}_i*\boldsymbol{R}_i=(b_{i1},b_{i2},\cdots\cdots,b_{i4})$$

3.3 Carrying out a secondary evaluation

seeing each sub-factor set U_i as a factor which is with $\boldsymbol{B}_i$ as its single-factor evaluation , that is to get a fuzzy mapping from factors set U of the regional technological innovation ability evaluation to comments set V, $U=\{U_1,U_2,\cdots\cdots U_s\}$.

Seeing each U_i as a part of U，that can follow their importance to give the weight distribution $\boldsymbol{A}=(a_1,a_2\cdots a_s)$，so the secondary comprehensive evaluation is: $\boldsymbol{B}=\boldsymbol{A}*\boldsymbol{R}=(b_1,b_2,\cdots,b_m)$，normalizing the evaluation results,and according to the principle of maximum degree of membership：$\boldsymbol{C}_k$=max $(c_1,c_2,\cdots,c_m)$，getting fuzzy comprehensive evaluation V_k.

4 Empirical Analysis of Regional Technological Innovation Ability of Changzhutan "3 +5" Urban Agglomeration

4.1 Source of data

The data in this paper are abstracted from Hunan Statistical Yearbook-2008 and Hunan Science and Technology Yearbook-2008

4.2 Data analysis and finishing

(1) Determining the weight of index layers of each indicator based on the above defined method of judging，after the data processing， with the application of AHP method to set the weight of one grade index:

$\boldsymbol{A}$=（0.2 0.15 0.25 0.15 0.25）

the weight of factor and the weight of sub-factor can be set to:

$\boldsymbol{A}_1$=（0.6 0.4）;$\boldsymbol{A}_{11}$=(0.4 0.3 0.3);$\boldsymbol{A}_{12}$=(0.5 0.5)

$\boldsymbol{A}_2$=(0.3 0.4 0.3);$\boldsymbol{A}_{21}$=(1)； $\boldsymbol{A}_{22}$=(1)； $\boldsymbol{A}_{23}$=(0.6 0.4)

$\boldsymbol{A}_3$=(0.3 0.25 0.25 0.2);$\boldsymbol{A}_{31}$=(0.3 0.3 0.4);$\boldsymbol{A}_{32}$=(0.4 0.6);$\boldsymbol{A}_{33}$=(1);$\boldsymbol{A}_{34}$=(0.6 0.4)

$\boldsymbol{A}_4$=(0.4 0.3 0.3);$\boldsymbol{A}_{41}$=(0.6 0.4);$\boldsymbol{A}_{42}$=(0.5 0.5);$\boldsymbol{A}_{43}$=(0.3 0.3 0.4)

$\boldsymbol{A}_5$=(0.2 0.2 0.1 0.15 0.15 0.2);$\boldsymbol{A}_{51}$=(0.6 0.4);$\boldsymbol{A}_{52}$=(0.4 0.3 0.3);$\boldsymbol{A}_{53}$=（0.45 0.55);$\boldsymbol{A}_{54}$=(0.4 0.6);$\boldsymbol{A}_{55}$=(0.5 0.5);$\boldsymbol{A}_{56}$=0.35 0.35 0.3)

(2) Determining the comments set V={ excellent, good, fair , poor }, excellent here means the score is over 70, good here means the score is between 65 and 70 , fair here means the score is between 60and 65,and below 60 is poor.

(3) Carrying out the first class evaluation of U_1~U_5 based on the above comments set and establishing fuzzy evaluation matrix , and then carrying out a secondary evaluation, finally the conclusions were obtained as following:

$\boldsymbol{B}_1=\boldsymbol{A}_1*\boldsymbol{R}_1$=（0.4248 0.2710 0.1620 0.1422）

$\boldsymbol{B}_2=\boldsymbol{A}_2*\boldsymbol{R}_2$= (0.2037 0.2980 0.2897 0.2086)

$\boldsymbol{B}_3=\boldsymbol{A}_3*\boldsymbol{R}_3$= (0.1619 0.2679 0.2687 0.3015)
$\boldsymbol{B}_4=\boldsymbol{A}_4*\boldsymbol{R}_4$= (0.1065 0.2117 0.2985 0.3833)
$\boldsymbol{B}_5=\boldsymbol{A}_5*\boldsymbol{R}_5$= (0.1414 0.1938 0.2807 0.3841)
$\boldsymbol{B}_6=\boldsymbol{A}_6*\boldsymbol{R}_6$=（0.2067 0.1268 0.2063 0.4603）
$\boldsymbol{B}_7=\boldsymbol{A}_7*\boldsymbol{R}_7$=（0.1065 0.2117 0.2985 0.3833）
$\boldsymbol{B}_8=\boldsymbol{A}_8*\boldsymbol{R}_8$= (0.0630 0.1175 0.2587 0.5607)
according to the principle of maximum degree of membership：
C_1=max（$c_1,c_2,\cdots,c_m$）=max(0.4248 0.2710 0.1620 0.1422)= 0.4248
C_2=max（$c_1,c_2,\cdots,c_m$）=max(0.2037 0.2980 0.2897 0.2086)= 0.2980
C_3=max（$c_1,c_2,\cdots,c_m$）=max(0.1619 0.2679 0.2687 0.3015)= 0.3015
C_4=max（$c_1,c_2,\cdots,c_m$）=max(0.1065 0.2117 0.2985 0.3833) =0.3833
C_5=max（$c_1,c_2,\cdots,c_m$）=max(0.1414 0.1938 0.2807 0.3841)= 0.3841
C_6=max（$c_1,c_2,\cdots,c_m$）=max(0.2067 0.1268 0.2063 0.4603)= 0.4603
C_7=max（$c_1,c_2,\cdots,c_m$）=max(0.1065 0.2117 0.2985 0.3833)= 0.3833
C_8=max（$c_1,c_2,\cdots,c_m$）=max (0.0630 0.1175 0.2587 0.5607)= 0.5607
We can get all the city's final scores and sort at the same time, which can be seen in Table 2.

Table 2 Evaluation Index's Scores and Sort of Regional Technological Innovation Ability of Changzhutan "3 +5" Urban Agglomeration

City	Score	Sort
Changsha	79.57	1
Zhuzhou	69.93	2
Xiangtan	65.80	3
Yueyang	60.83	7
Changde	53.66	8
Yiyang	62.11	4
Hengyang	61.85	5
Loudi	61.60	6

From the above analysis, assessment shows that only Changsha is V_1 (excellent), Zhuzhou is V_2(good), other cities is V_4(bad). as can be seen, in the column of score, Changsha is listed the first with79.57, thus its regional technological innovation ability is strongest. Zhuzhou is second with 69.93, Xiangtan is the third with 65.80,thus they are ranked in the second group. as for their overall technical ability innovation, it is lower than Changsha, but it is higher than the average level,Yiyang gets 62.11 ,Hengyang gets 61.85, Loudi gets 61.60, Yueyang gets 60.83. They can be ranked in the third Group, from these figures, their ability of technological innovation have the highest concentration, but they lowered the overall level.Changdegets 53.66 which ranked in the fourth group, its technical innovation is lower than other cities and the average level. This shows that regional technological innovation ability level of Changzhutan "3+5" urban agglomeration is not high and the big gaps are existed between cities in regional innovation ability.

5 Conclusion

Exploring regional technological innovation ability of Changzhutan "3+5" urban agglomeration deeply, and integration regional innovational resource to enhance original power of the knowledge. Increasing the intensity of investment in science and technology funding, vigorously develop the diversity of scientific research institutions

Accelerating industrial restructure of Changzhutan "3+5" urban agglomeration .According to the data of yearbook, proportion of the first industry of other large cities is high, while the proportion of the second industry and third industry is low except Changsha, and urbanization level is lower too. Therefore, improving its industrialization and urbanization has become a key to enhance technological innovation regional ability and regional economic development.

A favorable environment for innovation should be built. As a comprehensive reform area

of a "two-oriented society", Changzhutan "3+5" urban agglomeration is different from Shenzhen Special Economic Zone and other Pudong, Binhai new economic areas. It is mainly an exploration based on domestic market, domestic resources, and domestic technology development model. Therefore, government's active guide is needed while the cluster has its own self-exploration and self-innovation.

Strengthening collaborative innovation within the cluster, the regional technological innovation and regional economic development should be combined effectively. As an innovative city, Changzhutan "3+5" group should not be isolated. In order to strengthen the city's exchanges and cooperation, generally, Changsha should be made as regional economic development engine, while Zhuzhou and Xiangtan as two wings, then to promote around city's development and make the weak strong ultimately, and the coordinated development of the regional technological innovation ability will arrive.

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