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China's Regional Knowledge Innovation Capability Assess:

Based on a Factor Analysis Methodology

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Abstract: The capability of knowledge innovation of a country or an area is gradually becoming one of the most important motility to develop local economics. Using Factor Analysis methodology to do a positive research on regional knowledge innovation capability is the main content of this paper. This paper analyzes the statistics of main indicators to conclude the situation of China's local knowledge innovation capability. At the same time, it put forward the counterpart suggestions to improve the capability of knowledge innovation capability.
Key words: regional innovation capability; regional knowledge innovation capability; factor analysis

1. INTRODUCTION

Regional knowledge innovation capability is a new concept and still has no unified definition. Scholars from in and abroad gave various definitions to it. Riddel and the colleague confirm that the potentiality to create new products relating to commerce within a certain area is a kind of regional innovation capability. Zhao and the colleague confirm that the capability of regional development and the capability of utilize the science and technology together form the regional knowledge capability. Huang thinks that the regional knowledge capability is based on the inner technology availability, and mainly includes products innovation and techniques innovation. Yan puts forward a national innovation system as the main body of regional innovation, which calls for a kind of compound capability, consists of how to use government, institutions, and policies to arouse and organize national innovative recourses, and how to adjust and improve the activity regional innovative capability. Liu and the colleague, who became the China Technology Development Strategy Analysis Group, have this point of view that the regional knowledge innovative capability is the capability, which decides the long term developing possibility of an area; and it is the capability to transfer knowledge to new products, new techniques, and new services.

Up to now, scholars on regional innovation from in and broad concentrate their interests on how to evaluate the regional knowledge innovation capability.

Professor Robert from Harvard University and Professor Stern from MIT search on the indicators

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based on which to evaluate the innovative capability of the USA. International Institute for Management and Development in Lausanne, Switzerland publishes a Lausanne Report, which provides a basis and a methodology to compare between countries with the international competition power.

Luo and Zhen (2000) decompose the indicator system of regional innovative capability into 6 norms, which are consist with regional compound strength, education resources and potentiality, technology resources and potentiality, enterprises innovation strength, information condition, and regional policy and management level. Based on that they choose from above and bottom to select, match, assemble, and in the end to decide 52 evaluating factors.

Wei, Liang, and the other team members (2002) also divide the indicator system into 6 subsystems, which they call as first class indicator, according to their various appearances. They are infrastructures, economic strength, intermediary, technology strength, enterprises' technology innovation and government, which include 50 indicators (second class indicators) all together. They use that to evaluate the capability of regional innovation capability of Anhui Province of China.

Zhu (2004) divides regional innovation capability in two parts which are internet innovation capability, and enterprises' innovation capability and environment. He concludes that regional innovation capability is very just the internet innovation capability, while the environment of innovation is the supporting condition. At the same time, he refers that non-R&D indicators still have their importance.

Mo, Liu and the colleague put forward a Grey Comprehensive Evaluating Methodology to grossly evaluate the regional innovation capability of Guangdong Province of China. They divide the indicator system into 4 aspects, which are regional innovation level, regional innovation inputs capability, regional innovation output capability, and technology incentive economic and society development. They use that to evaluate the regional capability of Guangdong Province.

China Technology Development Strategy Group designs an indicator system to evaluate China's regional innovation capability. They divide the regional innovation capability into 5 aspects that knowledge creativity, knowledge mobility, enterprises' technical innovation capability, technology innovation environment and economical performance of innovation.

Generally speaking, there are seldom any researches take knowledge innovation itself as an aspect to analyze and evaluate regional innovation capability. This paper aims to put knowledge innovation itself as an indicator to restructure the regional innovation capability evaluating system. It uses factor analysis as the main methodology to finish the positive research.

2. POSITIVE ANALYSES

2.1 Positive Model

Factor analysis is a statistic method which enables to conclude a chaos of complicated variables to a small number of factors, in order that the relationship between initial factors and the factors could be well revealed. The model is like below:

$$X = AF + \xi$$

Among above, $X = (X_1, X_2, X_3, \cdots, X_N)$ refers to N individual initial factors, standardized by a typical value that equals to 0, and a standard deviation that equals to 1.And $F = (F_{,1} F_2, F_3, \cdots, F_M)$ refers to M individual factors, and $N \succ M$. A is factor matrix, which reveals the relatively importance of initial factor variables. While ξ is a special factor reveals the part of initial factors that cannot be explained by factor variables.

2.2 Variables and samples

This paper takes the Report of Regional Innovation Capability of China as a reference in regional knowledge innovation capability constructing and the theory of national innovational system, and constructs a regional knowledge innovation capability indicator system as below: X_1 refers to the number of accepted patent applications, X_2 refers to authorizations of patent applications, X_3 refers to the expenditure of technology fund, X_4 refers to number of scientists, X_5 refers to volume of business in technology market, X_6 refers to growth rate of the deals in technology market, and X_7 refers to total investment.

According to China Statistic Year Book 2009, this paper sorts out the indicators of knowledge innovation capability in 30 provinces and cities of 2008, shown as table 1.

2.3 Positive Analysis

After standardizing the relative statistics of Year Book 2009 with Markowitz Software, this paper gets the indicators including descriptive, correlation matrix, characteristic value, and characteristic vector and so on.

According to accumulative contribution acceding 90%, and characteristic root larger than 0.5, this paper can conclude three main factors from table 1, whose variance's gross contribution is 96.5114%, and can reveal information in a more comprehensive way.

According to common covariance matrix in the table 3, this paper concludes that the selected factors above can reveal over 89% of the whole information.

According to rotated factor matrix in table 4, there are 3 factors which can form a factor model as below:

X1=0.9781F1+0.0404 F2-0.0343 F3

X2=0.9757F1+0.0108 F2-0.0283 F3

X3=0.8725F1+0.4538 F2-0.0717 F3

X4=0.9409F1-0.1488 F2-0.0706 F3

X5= 0.2830F1+0.9510 F2-0.0484 F3

X6=-0.0877F1-0.0502 F2+0.9934 F3

X7=0.9255F1+ 0.0858 F2+0.0966 F3

The model above shows that, patents accepted number X1, authorizations of patent applications X2, expenditure of technology fund X3, number of scientists X4, and total investment X7, they five load concentrated on the first factor. Volume of business in technology market X_5 loads concentrated on the second factor. Growth rate of the deals in technology market X_6 loads concentrated on the third factor. Therefore, the main factors that influence regional innovation capability are regional inputs and outputs, market trade activity and the basic of innovation capability.

The model pasts the Bartlett Test by smaller than 0.5, with a significance of 0. Therefore, it is reliable to use this factor analysis.

2.3 Positive conclusion

a. According to results above, the factors could be transferred to a function with variables as below:

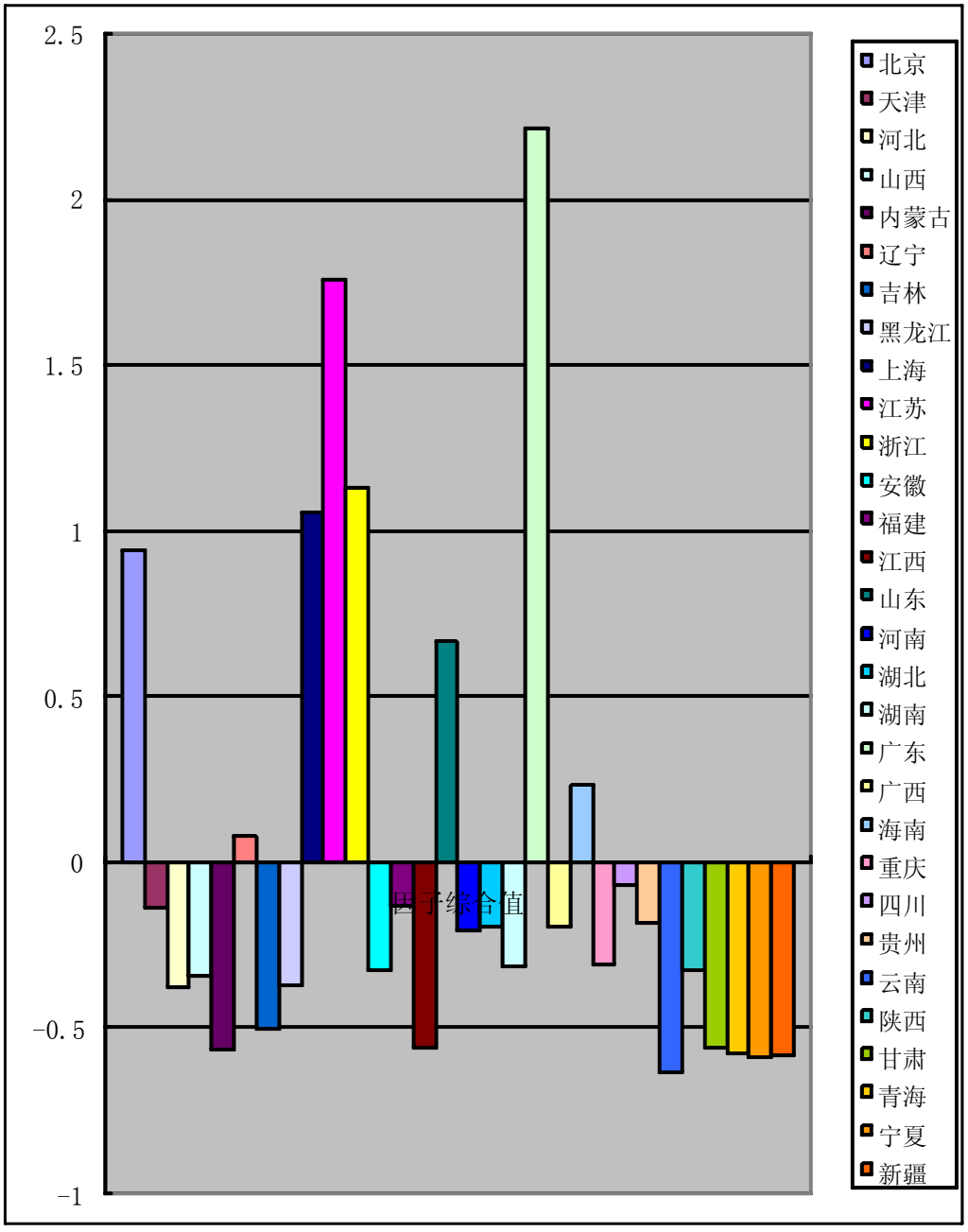
F1= 0.9781X1+0.9757X2+0.8725X3+ 0.9409X4+ 0.2830 X5-0.0877X6+ 0.9255 X7

F2= 0.0404X1+0.0108X2+ 0.4538X3-0.1488X4+ 0.9510 X5-0.0502 X6+0.0858 X7

F3=-0.0343X1-0.0283X2-0.0717X3 -0.0706X4-0.0484 X5+ 0.9934 X6+ 0.0966X7

Thereby the evaluating factors of China's every area could be given in Table 6.

b. According to statistics in Table 6, using statistical software, this paper gets a compound evaluating factor value system of knowledge innovation capability of every area of China.



From the charter above, Guangdong Province has a relatively high regional knowledge innovation capability in 2008, while most of the other provinces have a relatively low capability to innovate. It is largely related to national and regional innovation inputs. And it is largely related to the structure of local

intellectuals and the situation of foreign finance utilization.

In order to enhance regional knowledge innovation capability, this paper suggests several steps as below:

First, increase numbers of scientists to do research and development. Number of R&D people is the most important symbol of the level to organize knowledge innovation capability. Organizations should enhance the ratio of their R&D people.

Second, increase the government financial inputs. Government should guide the market and society with the R&D funds, and restricts key regional innovation areas. The government should focus on fundamental research and public research in order to complete the regional innovation system.

Third, enforce technical market construction, actively introduce foreign advance techniques. The government should provide well constructed local technology communication mechanism.

Fourth, enforce regional specialists training. Government should actively encourage individual inventions and patent application. At the same time, the government should also try to train scientific, technological and management intellectuals.

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TABLES

Table 1. Knowledge innovation capability indicators of 30 China provinces and cities in 2008

	Accepted patents	Authorized patents	R&D expenditure	R&D people	Deals in technique market	Increasing rate of deals in technique market	Total investment (100million dollar)
BJ	43508	17747	1121886	26892	10272173	0.163906081	982.95
TJ	18230	6790	286530	21799	866122	0.197366165	938.14
HB	9128	5496	216674	25365	165906	0.009596602	338.41
SHX	5386	2279	176381	29905	128425	0.553334059	180.00
NMG	2221	1328	153634	11290	94423	-0.14031957	221.55
LN	20893	10665	490226	39987	997290	0.073174144	1247.56
JL	5536	2984	134116	8273	196066	0.121370357	174.89
HLJ	7974	4574	200885	26642	412565	0.178053677	161.70
SHH	52835	24468	1202743	36692	3861695	0.08814563	2939.91
JS	128002	44438	915173	119553	940246	0.199028786	4159.30
ZHJ	89931	52953	867928	79366	589189	0.299278459	1582.55
AH	10409	4346	237788	27693	324865	0.228153413	254.65
FJ	13181	7937	256281	32199	179690	0.234312641	1121.29
JX	3746	2295	111406	14420	77641	-0.219947153	334.85
SHD	60247	26688	571333	107535	660126	0.466050747	1011.63
HEN	19090	9133	304389	46407	254425	-0.028567392	293.05
HUB	21147	8374	230584	35625	628971	0.204588372	340.30
HUN	14016	6133	265893	25542	477024	0.03517239	266.22
GD	103883	62031	1325155	177500	2016319	0.517800471	3726.46
GX	3884	2228	162149	7083	26996	1.70772317	258.26
HN	873	341	44981	417	35602	3.859014604	966.59
CHQ	8324	4820	151279	20872	621884	0.571771581	238.48
SCH	24335	13369	258150	38298	435313	0.432525553	421.13
GZH	2943	1728	129878	5659	20356	2.10304878	32.15
YN	4089	2021	176695	6921	50547	-0.481547961	141.06
SHAX	11898	4392	171448	24859	438300	0.452719499	136.92
GS	2178	1047	94743	9466	297560	0.135261553	38.27
QH	431	228	39664	784	77033	0.452986778	33.11
NX	1087	606	43265	2831	8898	0.339858455	24.49
XJ	2412	1493	148358	4346	73963	0.031216887	45.60

Table 2. Characteristic root and accumulative contribution

Factors	Characteristic roots	Variance contribution ratio%	Accumulating contribution rate%
1	4.6376	66.2515	66.2515
2	1.0809	15.4416	81.6930
3	0.9358	13.3685	95.0615
4	0.1913	2.7325	97.7941
5	0.0863	1.2326	99.0267
6	0.0561	0.8018	99.8285
7	0.0120	0.1715	100.0000

Table 3. Common covariance matrix

	Extracting Value
Accepted patent applications	0.9595
Authorized patent applications	0.9529
R&D expenditures	0.9724
R%D people	0.9125
Volume of R&D market	0.9868
Increasing rate of R&D market	0.9970
Total investment	0.8732

Table 4. Rotated factor matrix

Rotating method: Founder of four cross-rotation

	Factor1	Factor2	Factor3
Accepted patent applications	0.9781	0.0404	-0.0343
Authorized patent applications	0.9757	0.0108	-0.0283
R&D expenditures	0.8725	0.4538	-0.0717
R%D people	0.9409	-0.1488	-0.0706
Volume of R&D market	0.2830	0.9510	-0.0484
Increasing rate of R&D market	-0.0877	-0.0502	0.9934
Total investment	0.9255	0.0858	0.0966

Table 5 Bartlett Test of Sphericity

Parameters	Value
Chi-square value	254.7480
Degree of freedom	21
Significance	0.0000

Table 6. Factor values of every area of China

Areas	Factor 1	Factor 2	Factor 3
BJ	0.2512	4.8220	-0.1200
TJ	-0.1683	0.0723	-0.2388
HB	-0.3622	-0.2793	-0.5594
SHX	-0.4431	-0.2928	0.0737
NMG	-0.6126	-0.2161	-0.7396
LN	0.1621	0.1225	-0.3743
JL	-0.5983	-0.1740	-0.4210
HLJ	-0.4227	-0.1654	-0.3744
SHH	1.1178	1.7848	-0.0937
JS	2.6988	-0.7835	0.0495
ZHJ	1.7707	-0.5567	-0.1068
AH	-0.3641	-0.1867	-0.3055
FJ	-0.0737	-0.3344	-0.1961
JX	-0.5633	-0.3024	-0.8251
SHD	1.1105	-0.6534	-0.0157
HEN	-0.0819	-0.3716	-0.6373
HUB	-0.1739	-0.1804	-0.3261
HUN	-0.3209	-0.1141	-0.5326
GD	3.2055	-0.3909	0.3227
GX	-0.5582	-0.1283	1.5129
HN	-0.5042	-0.0689	4.2245
CHQ	-0.4554	-0.0587	0.1257
SCH	-0.0209	-0.3030	-0.0450
GZH	-0.6313	-0.1142	1.9664
YN	-0.6299	-0.2109	-1.1593
SHAX	-0.4204	-0.1620	-0.0406
GS	-0.6904	-0.1398	-0.4211
QH	-0.7788	-0.1969	-0.0280
NX	-0.7563	-0.2494	-0.1703
XJ	-0.6859	-0.1679	-0.5448