An Empirical Study on Technological Innovation Index of National Innovation Base

----Based on the Empirical Analysis of National Engineering Research Center

Q.Q ZHOU
School of Economics and Management, Southwest Jiaotong University, Chengdu, China
National Science and Technology Infrastructure Center, Ministry of Science and Technology of the People's Republic of China, Beijing, China

Q.S HUA
Qingdao University, Qingdao, China

ABSTRACT: Based on the foreign and domestic research on innovation index and the data from National Engineering Research Center, this paper calculates the innovation indexes by industry, unit character and region, as the view from the classification of disposition of S&T resources and S&T input-output, using AHP method. The purpose of this paper is to provide some relevant suggestions for the evaluation on development and management of National Innovation Base.
KEYWORD: Technological Innovation Index; Innovation Base; National Engineering Research Center; AHP Method

1 INTRODUCTION

Innovation base as an important symbol [1] of national innovation ability, refers to an innovation organization which has strong innovation ability and plays a leading and supporting role in certain industry or industrial innovation and development. Currently, China is at the important development stage for the implementation of innovation-driven strategy and the construction of innovation-oriented country. The strengthen of innovation base construction is an important way to realize coordinative development of different circles among fundamental research, technological development, engineering and industrialization, construction of complete innovation chain and improvement of innovation ability.

2 LITERATURE REVIEW

With the continuous development of innovation theory, scholars at home and abroad have made many attempts on the study of innovation ability index. At present, the domestic and foreign research on innovation index: The EU's innovation index [2], National innovation ability index [3], WKCI [4], The silicon valley index [5], China's urban innovation ability index [6], Zhongguancun index [7], Zhangjiang innovation index [8], etc (as table1).

The theory and practice research of innovation base are mainly based on the research of Chinese scholars. In terms of research object, the innovation base is mainly served as national key laboratory, national engineering center, high-tech business incubator, enterprise technology center, university science park, etc. In terms of research contents, innovation center mainly focuses on the brief introduction [9-10] to the category, concept, and function and development demand of innovation base, the current situation and existing problem of certain innovation base in the course of development, as well as some countermeasure on the solution to this problem. The research hotspot also largely concentrate on the operation system, management system, overall arrangement, etc [11-13]. In terms of evaluation method, Chinese scholars mainly adopt balanced scorecard, DEA method, BBC model and fuzzy method, etc. Based on the research of domestic innovation evaluation, this article conducts a rigorous segmentation on various scientific and technological resources of innovation base. And from the input-output perspective, this article has established an evaluation indicator model and obtained innovation ability index. The guarantee of comprehensive and scientific conclusion is of practical significance in strengthening the capacity construction of innovation base.

Table1 Innovation index research

Innovation index	Institutions	Object	Evaluation indicators
The EU's innovation index	In October 2010, the European commission	European Union countries the United States to Japan	innovation-driven, innovative behavior, innovation output
National innovation ability index	1999, Freeman,C	1973-1995 data To measure the seven countries	the government's policy, Political education and training, industrial structure, Enterprise research and development
	2002, Furman Porter and Scott Stern	OECD The 17 member states	innovation-driven, Public innovation quality of infrastructure, Under special industry innovation environment, Innovation quality of contact, Factors associated with output
WKCI	2002 The British association of Robert hutchins	The world's major city	human capital, knowledge capital financial capital region economic output knowledge sustainability
Silicon valley innovation index	2010, Specialized agencies to be in silicon valley Venture	Silicon valley	population, economic , and social management
China's urban innovation ability index	2010, Chinese society for the study of urban development	In 661 cities in mainland China	technology industrialization brand innovation ability and the innovation foundation and supporting capacity
Zhongguancun innovation index	2007, Zhongguancun innovation and development research institute, Beijing academy of social science Caleb fundi of Beijing institute of economic development	Six new and high technology industries	economic growth index; Economic benefit index; Technology innovation index; Human capital enterprise development index
Zhangjiang innovation index	2008, Zhangjiang Hi-tech Park	Zhangjiang Hi-tech Park	Innovation environment; Innovation main body; Innovative talents; Innovation investment; Innovation level; Innovation; Quantitative original innovation; Integrated innovation

3 BUILDING INDEX SYSTEM OF INNOVATION EVALUATION

3.1 *Innovation Base*

Most innovation bases are professional organizations mainly engaged in the innovation (or supporting service) ability of the certain part of the innovation link, such as research and development, experimental observation, pilot plant test, promotion and demonstration, industrialization and innovation service. The service scope has shifted from the local area (e.g. incubator), to region (e.g. technology transfer center) or to the nationwide (e.g. national key laboratory). According to the preliminary estimates the state-level innovation bases that are distributed on the innovation chain are more than 20 categories, exceeding 2,500 bases. Under the guidance of scientific development strategy of different stages, and supported by the key projects and plans such as national key scientific and technological infrastructure, national science and technology plan, scientific condition platform, government at all levels as well as research and development institution, based on the preponderant discipline, has preliminary constructed a series of innovation based with a whole process of innovation chain.

3.2 *Evaluation Index System*

The construction of evaluation index system from innovation input and output is one of the ways adopted by the scholars at home and abroad, which is to evaluate the innovation ability from innovation input to innovation output. Based on the essential feature of technological innovation activity of innovation base, this research classifies the resource allocation element involved in the innovation activity, and proposes such indicator system as two levels I indicators, four level II indicators and 19 level III indicators according to the input-output evaluation principle(as Table 2).

Table 2 Innovation capability index evaluation index system

Object A	Object B	Object C	Object D	Code
Innovation ability A	Innovation investment ability B_1	Investment in human resourcesC_1	technical personnel	D_1
			R&D personnel	D_2
			senior engineer	D_3
		Financial Investment C_2	government investment	D_4
			market investment	D_5
	Innovation achievement and contribution B_2	Knowledge of technology innovation C_3	papers	D_6
			be retrieved papers	D_7
			projects	D_8
			national projects	D_9
			province projects	D_{10}
			winning project	D_{11}
			R&D achievements	D_{12}
			publishing books	D_{13}
			patents	D_{14}
			authorized patents	D_{15}
		Economic contribution C_4	products revenue (ten thousands)	D_{16}
			technological revenue (ten thousands)	D_{17}
			projects revenue (ten thousands)	D_{18}
			taxes(ten thousands)	D_{19}

4 EMPIRICAL ANALYSIS

4.1 *Descriptive Statistics*

This article is taken the engineering center as the empirical analysis object. The reason for choosing the engineering center as the empirical analysis object lies in the fact that engineering center is an important part of innovation base in China. The supporting organizations of engineering center are composed of colleges and universities, scientific research institutions and enterprise so that the engineering center is existed in each link of innovation chain and industrial chain. The data source of this article comes from 226 annual report samples of engineering center in 2012. To obtain accurate data analysis, this article has deal with the sample data in the following ways: 1) Delete the sample with missing value in government input and market input; 2) Delete the sample with missing value in the total number of people that engage in science and technology; 3) Delete sample with missing value in total income; Finally, 162 samples are valid.

4.2 *Factors Judging Matrix*

In this paper, the empirical analysis using analytic hierarchy process (ahp). In the hierarchical analysis method, the judgment matrix assignment for the final index is very important for the scientific nature and rationality. In this paper, the judgment matrix by a number of senior technical and management innovation base of expert evaluation, and then weighted average integrated, as table 3 to table 10.

Table 3 Innovation index level (A-B level) Index judgment matrix

A-B	B_1	B_2
B_1	1	1/2
B_2	2	1

Table 4 Science and technology innovation investment ability at a lower (B_1- C) level index judgment matrix

B_1-C	C_1	C_2
C_1	1	1/2
C_2	2	1

Table5 Science and technology innovation output at a lower level (B_2-C) index judgment matrix

B_2-C	C_3	C_4
C_3	1	1/2
C_4	2	1

Table 6 Investment in human resources at a lower level (C_1-D) index judgment matrix

C_1-D	D_1	D_2	D_3
D_1	1	1	1
D_2	1	1	1
D_3	1	1	1

Table 7 Investment in finance a lower level (C_2-D) index judgment matrix

C_2-D	D_4	D_5
D_4	1	1
D_5	1	1

Table 8 Knowledge of technology innovation at a lower level (C_3-D) index judgment matrix

C_3-D	D_6	D_7	D8	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}
D_6	1	1/2	2	1/2	1	1	1/3	2	1/2	1/3
D_7	2	1	3	1	2	2	1/2	3	1	1/2
D_8	1/2	1/3	1	1/3	1/2	1/2	1/4	1	1/3	1/4
D_9	2	1	3	1	2	2	1/2	3	1	1/2
D_{10}	1	1/2	2	1/2	1	1	1/3	2	1/2	1/3
D_{11}	1	1/2	2	1/2	1	1	3	2	1/2	1/3
D_{12}	3	2	4	2	3	3	1	4	2	1
D_{13}	1/2	1/3	1	1/3	1/2	1/2	1/4	1	1/3	1/4
D_{14}	2	1	3	1	2	2	1/2	3	1	1/2
D_{15}	3	2	4	2	3	3	1	4	2	1

Table9 Contribution to the overall economy at a lower level (C_4-D) index judgment matrix

C_4-D	D_{16}	D_{17}	D_{18}	D_{19}
D_{16}	1	1/2	1	1/2
D_{17}	2	1	2	1
D_{18}	1	1/2	1	1/2
D_{19}	2	1	2	1

Table10 A grade B level indicators relative index weight calculation

K	0	1	2	3
X(k)	1	1.5	1	1
	1	3	2	2
M(k)	1	3	2	2
Y(k)	1	0.5	0.5	0.5
	1	1	1	1
$\lvert m(k+1)-m(k)\rvert<\varepsilon$		No	No	Yes
The main characteristic vector (index weight)	Knowledge of technology innovation B_1			0.3333
	Economic benefit B_2			0.6667

4.3 *Test Standard*

Consistency and randomness test are conducted on the constructed judgment matrix, and the test formula is: CR=CI/RI, among which CR refers to the random consistency ration to judge the matrix; CI refers to the coincidence indicator of the judgment indicator, and its expression is CI=(λ_{max}-m)/(m-1), among which CI is the largest eigenvalue; m refers to judgment matrix order, RI refers to the average random consistency index of judgment matrix. RI is drawn from large amount of tests. In terms of low order judgment matrix, the value of RI is as follows. In terms of judgment matrix that is above 12 order, approximation method is adopted, take CR=(λ_{max}-m)/(m-1).

Table 11 Mean random consistency index

M	1	2	3	4	5	6
RI	0.00	0.00	0.58	0.90	1.12	1.24
M	7	8	9	10	11	12
RI	1.32	1.41	1.45	1.49	1.51	1.54

When CR<0.1, the judgment matrix be showed consistency, weight distribution is reasonable; or it needs to be adjusted as to be showed consistency (as table 11). As table 19, the above tests meet the consistency check. Here omit calculation process, only all levels of index weight calculation results are given as table 12-13.

Table 12 Science and technology innovation investment ability (B-C) at a lower level index weight

Index C	Weight
Investment in human resources C_1	0.3333
Investment in finance C_2	0.6667
technology innovation C_3	0.3333
overall economy C_4	0.6667

Table 13 Science and technology innovation investment ability (C-D) at a lower level index weight

Index D	Weight
technical personnel D_1	0.3333
R&D personnel D_2	0.3333
senior engineer D_3	0.3333
government investment D_4	0.5
market investment D_5	0.5
papers D_6	0.061047
be retrieved papers D_7	0.109752
projects D_8	0.035911
national projects D_9	0.109752
province projects D_{10}	0.061047
winning project D_{11}	0.106669
R&D achievements D_{12}	0.035911
publishing books D_{13}	0.035911
patents D_{14}	0.109752
authorized patents D_{15}	0.18508
products revenue D_{16}	0.1667
technological revenue D_{17}	0.3333
projects revenue D_{18}	0.166667
Taxes D_{19}	0.3333

4.4 *Computing Results*

According to the technical field, this paper measures the innovation capability index and average index. (as Figure 1, Figure 2, Figure 3 and Table13).

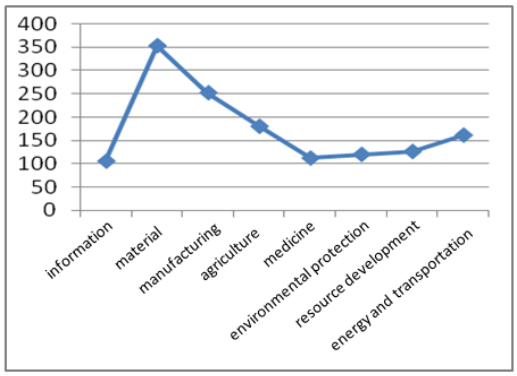

Figure 1 Technical field of innovation ability index

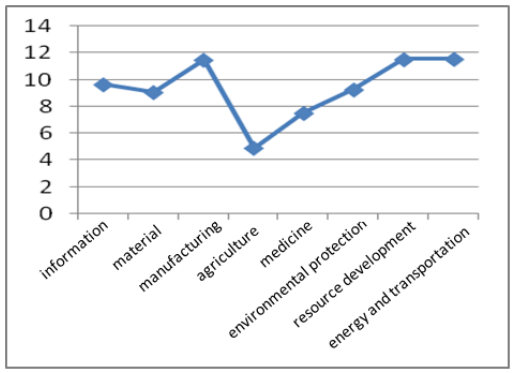

Figure 2 Average of the technical field of innovation ability index

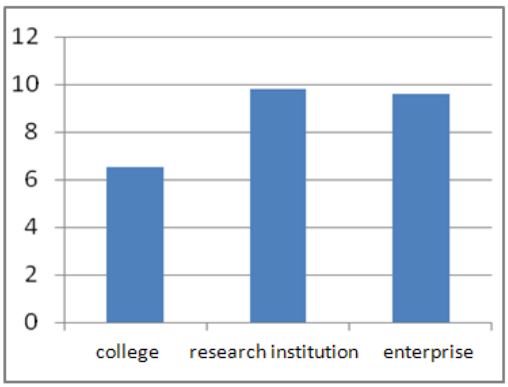

Figure 3 Innovation ability index according to the quality unit division

5 CONCLUSION

From the analysis above we can see that, in terms of technology field, innovation base of material, manufacture area, energy and transportation area enjoy a strong innovation ability, which is closely related with the current situation and feature of industrial development in China. In terms of the quality unit, Innovation base constructed by enterprise has a higher innovation ability compared with that by scientific research institution and college.

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