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 table 1).

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.
### Table 1 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 B₁ | Innovation investment ability C₁ | Investment in human resources C₂ | Financial Investment C₃ | Code |
| Innovation achievement and contribution B₂ | Knowledge of technology innovation C₄ | Economic contribution C₅ | |
| | | | technical personnel | D₁ |
| | | | R&D personnel | D₂ |
| | | | senior engineer | D₃ |
| | | | government investment | D₄ |
| | | | market investment | D₅ |
| | | | papers | D₆ |
| | | | be retrieved papers | D₇ |
| | | | projects | D₈ |
| | | | national projects | D₉ |
| | | | province projects | D₁₀ |
| | | | winning project | D₁₁ |
| | | | R&D achievements | D₁₂ |
| | | | publishing books | D₁₃ |
| | | | patents | D₁₄ |
| | | | authorized patents | D₁₅ |
| | | | products revenue (ten thousands) | D₁₆ |
| | | | technological revenue (ten thousands) | D₁₇ |
| | | | projects revenue (ten thousands) | D₁₈ |
| | | | taxes (ten thousands) | D₁₉ |

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
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 ratio to judge the matrix; CI refers to the coincidence indicator of the judgment indicator, and its expression is CI=(λmax-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=(λmax-m)/(m-1).

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).

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

| C-D | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 |
|-----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| C6  | 1  | 1/2| 2  | 1/2| 1   | 1/3| 2   | 1/2| 1/3| 1/4 |
| C6  | 1/2| 1  | 1/2| 1/2| 1   | 1/3| 2   | 1/2| 1/3| 1/4 |
| C9  | 1/2| 1  | 1/2| 1/2| 1   | 1/3| 2   | 1/2| 1/3| 1/4 |
| C9  | 1/2| 1  | 1/2| 1/2| 1   | 1/3| 2   | 1/2| 1/3| 1/4 |
| D13 | 1/2| 1/3| 1  | 1/3| 1/2| 1/2| 1/4| 1   | 1/3| 1/4 |
| D14 | 1/2| 1/3| 1  | 1/3| 1/2| 1/2| 1/4| 1   | 1/3| 1/4 |
| D15 | 1/2| 1/3| 1  | 1/3| 1/2| 1/2| 1/4| 1   | 1/3| 1/4 |

Table 9 Contribution to the overall economy at a lower level (C-D) index judgment matrix

| C-D | D16 | D17 | D18 | D19 |
|-----|-----|-----|-----|-----|
| C6  | 1   | 1/2 | 1   | 1/2 |
| C6  | 1/2 | 1   | 1/2 | 1   |
| D16 | 1   | 1/2 | 1   | 1/2 |
| D19 | 1   | 1/2 | 1   | 1/2 |

Table 10 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   |
|      | 1   | 3   | 2   | 2   |
|      | 1   | 0.5 | 0.5 | 0.5 |
|      | 1   | 1   | 1   | 1   |
| Mn   | No  | No  | Yes |

The main characteristic vector (index weight)

| Knowledge of technology innovation B1 | 0.3333 |
| Economic benefit B2                  | 0.6667 |

| Index C                                      | Weight |
|----------------------------------------------|--------|
| Investment in human resources C1             | 0.3333 |
| Investment in finance C2                     | 0.6667 |
| technology innovation C3                     | 0.3333 |
| overall economy C4                           | 0.6667 |

| Index D                                      | Weight |
|----------------------------------------------|--------|
| technical personnel D1                       | 0.3333 |
| R&D personnel D2                             | 0.3333 |
| senior engineer D3                           | 0.3333 |
| government investment D4                     | 0.5    |
| market investment D5                         | 0.5    |
| papers D6                                    | 0.061047 |
| be retrieved papers D7                       | 0.109752 |
| projects D8                                  | 0.035911 |
| national projects D9                         | 0.109752 |
| province projects D10                        | 0.061047 |
| winning project D11                         | 0.106669 |
| R&D achievements D12                         | 0.035911 |
| publishing books D13                         | 0.035911 |
| patents D14                                  | 0.109752 |
| authorized patents D15                       | 0.18508 |
| products revenue D16                         | 0.1667 |
| technological revenue D17                   | 0.3333 |
| projects revenue D18                         | 0.166667 |
| Taxes D19                                    | 0.3333 |
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.

REFERENCES

[1] Liu Yan, Cheng Guangyu, Duan Xiaohua. Analysis of the Development and Needs of Chinese Innovation---based on the Investigate of State Key Laboratories and National Engineering Research Center. Forum on Science and Technology in China, 2011-04:5-10.
[2] EUROPEAN COMMISSION. European innovation score-board 2001.
   http://www.proinno-Europe.eu/sites/default/files
[3] JEFFREY I., FuRMAN, MICHAEL E PORTER, SCOTTSTERN. The determinants of national innovative capacity. Research Policy, 2002(31): 899-933.
[4] "Zhongguancun Index 2013" six dimensions increased year by year, People's Daily Online.
   http://finance.people.com.cn/n/2013/0913/c1004-22915990.html, 2013-9-13.
[5] Joint Venture,Silicon Valley Community Foundation. Index of sillicon valley 2010.
   http://www.jointventure.org/images/stories/pdf/2010%20Index-final.pdf,2010-02-11.
[6] Zhou Tianyong.2009: China's urban innovation report. Beijing: The Red Flag Group, 2010.
[7] Wang Zhaohua, Yu Jiang. Research on “Zhongguancun Index” Evaluating System and Its Revelation for High-Tech Industrial Parks’ Development in Our Country. Science of Science and Management of S& T. 2007(2): 114-119.
[8] Wu Linhai. Research on the Evaluation Index System of Innovative City. Science and Technology Management Research, 2008(1): 79-81.
[9] Cheng Guangyu, Liu Yan, Duan Xiaohua. Analysis on Intension, Features and Function of Nation Grave Innovation Base. Forum on science and technology in China, 2010, (07): 14-15.
[10] Cheng Guangyu, Liu Yan, Duan Xiaohua. Analysis of the Development and the Needs of Chinese Innovation. Forum on science and technology in China, 2011, (04):7-12.
[11] Duan Xiaohua. The Experiences, Difficulties and Suggestions on the Development of Innovation Bases of Universities. Forum on science and technology in China, 2010(7): 22-25.
[12] Sun Dong, Zhou Yijun. Science and technology business incubators present situation and development countermeasure research. Science & Technology Progress and Policy, 2013(9): 120-123.
[13] Zhou Qiongqiong, Cao Yuzhong, Chen Cunyang. National Engineering Technology Research Center Operation Evaluation Based On Principal Component Analysis (Pca). China Information Review, 2012, 44(1): 80-83.