Design and Empirical Study on Innovation-driven Development Index System

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ABSTRACT : *In this paper, we combine with the research background of innovation-driven development, summarize the basic viewpoints of domestic and foreign relevant research. By defining the connotation of innovation-driven development, in accordance with the concept of the innovation source come from technology, and the innovation aims at development design evaluation indexes system and evaluation method, then carry out an empirical analysis and prospect combining with the situation of Beijing.*

Keywords- *innovation-driven, science and technology innovation, index system, design and empirical*

1. Introduction

This paper focus on constructing an index system in order to evaluate a region's ability of innovation-driven development, which can use in not only horizontal comparison but also longitudinal comparison.

The part 2 is background an significance, it lead to needs of research in this field. Part 3 is the specific index system, summarize the existed research achievements and construct it base on series principles. Part 4 introduct the connotation of indexes to clear statistical caliber in calculation. Part 5 apply the index system by taking Beijing city as an example. Finally we make the conclusion in the end.

2. Background and Significance

2.1 Policy Driven

The 18th Congress of China's Communist Party clearly pointed out the need to implement innovation-driven development strategy, technological innovation should be an important foundation to the implementation of structural adjustment, economic structure transformation, sustainable development. Beijing formulated the 《suggestions on deepening the system reform to accelerate the construction of the capital innovation system 》. Defined Beijing to be the leader in the formation of innovation driven development pattern in 2020.

2.2 Economic Restructuring Require

After thirty years of rapid development, the old industrial base which plays an important role in the early economic development, gradually revealed large energy consumption, low efficiency, serious pollution and other defects. A series of emerging high-tech industry is showing vigorous vitality. Industrial structure and mode of production adjustment, become the inevitable trend of economic development.

2.3 International Development Trend

Comparison of international Organization for Economic Co-operation and Development (OECD) research data shows that, the developed country scientific and technical investment accounted for about 2.5% to 3% of GDP, while the developing countries are basically below 2%. Increase investment in scientific and technical is becoming the only way to adjust the industrial structure to the developing country.

As the political and cultural center of China, Beijing should be the research subject, which not only has theoretical significance, but also is the practical requirements of Beijing innovation-driven development work.

3. Design of the Index System

3.1 Research Summary.

In recent years, more and more research institutes and scholars make in-depth research on it. In foreign countries, the US national innovation

capability index measured of innovation ability from three aspects——basis, environment and output, emphasized the importance of innovation environment. Scientific and technical indicators [1] proposed in 《OECD Science, Technology and Industry Bulletin》,was settled out from the knowledge perspective, which extremely stressed the internationalization of the industry. European innovation scoreboard was more comprehensive and specific, which carried out the enterprise innovation as a separate section creatively. In China, most were made from the perspective of input-output, measured on regional innovation from innovation environment, innovation-based and innovation performance etc.. Among them, the Chinese innovation index (CII) released by National Bureau of statistics, the capital scientific and technical innovation and development index [2] , Zhongguancun index [3] and the Zhang Jiang index released by Shanghai government are very comprehensive and scientific.

Based on these research findings, we can summed up the generality of excellent innovation-driven index system, namely hierarchical, dynamic input-output system, similar core index, keeping pace with the times, etc..

3.2 Design Principles.

The design process should abide by the following principles of combination of systematic and comprehensive、combination of dynamic and static and accessibility of index data.

3.3 Specific Index System.

Construct the innovation driven development index system from four dimensions of Innovation foundation、Innovation service、internationalization of Scientific and technicalindustry and Innovation performance. Innovation-driven development, is to strengthen the cultivation of innovation basic ability of science and technology, and guarantee it by through effective innovation services, especially the strengthening of international industrial cooperation, drive to improve the innovation performance continuously.as shown in Table 1.

Table 1. Innovation-driven Development Evaluation Index System

First grade	Second grade	No. of index
Innovation foundation	equivalent full-time equivalent of R&D staff	1
	number of graduate students per million population	2
	proportion of the R&D internal expenditure accounts for regional GDP	3
	per capita funds of R&D staff	4
	level of Informatization	5
Innovation service	number of scientific and technical communication and services promotion unit	6
	number of incubating enterprises incubated by national scientific and technical business incubator	7
	implementary funds of national industrialization project	8
	Technology contract turnover	9
Internationalization of scientific and technical industry	scientific papers are cited among SCI retrieve	10
	International Patent	11
	number of R & D projects in cooperation with foreign institutions	12
	the proportion of export high-tech products	13
	foreign exchange income by intellectual property and information technology	14
	sum of foreign technology import contract	15
Innovation performance	the per capita GDP	16
	added value of high-tech industry	17
	rate of reduce energy	18

	consumption	
	contribution rate of scientific and technical progress	19

4. Connotation of Specific Index

4.1 Indexes among Innovation Foundation.

Innovation foundation is the fundamental of innovation development strategy. From the perspective of the dynamic process of innovation, innovation foundation is the input stage of innovation, at the beginning of the innovation system. Without innovation foundation, the entire process of innovation could not be started. It includes three aspects of innovative talents, innovative fund support and the level of informatization. Some indexes have calculation formulas.

(1): Index 2 = $\frac{\text{number of graduate students}}{\text{number of resident population}} \times 10000$

Instruction: The students contain masters and doctors.

(2): Index 3 = $\frac{\text{R\&}D\ internal\ \ expenditure}{\text{regional GDP}} \times 100\%$

(3): Index 4 = $\frac{\text{R\&}D\ internal\ \ expenditure}{\text{equivalent full-time equivalent of R\&}D\ staff}$

Instruction: R&D internal expenditure contains enterprise、scientific research institutions、universities and institutions

(4): Index 5 = $\frac{1}{2} \times$ (mobile phone penetration rate + internet penetration rate)

4.2 Indexes among Innovation Service.

The promotion of innovation service is an important part among the process of innovation-driven, it is not only the social development base on the sustain of innovation foundation, but also an important driving force of producing innovative fruit, which undertake the connecting and servicing function. Innovation service reflect the ability of a region that transfer knowledge into social development. It has function of integrating scientific and technical resources, providing innovation service and connecting various innovative subject.

Index 7 is based on China torch statistical yearbook, which records relevant situation of each national scientific and technical business incubator, sum of incubating enterprises' are requested. The national industrialization project contains torch plan and spark program.

4.3 Indexes among Internationalization of Scientific and Technical Industry.

In the long run, we can integrate into the international trading system smoothly or not, fundamentally depends on whether Chinese can improve the technical content and added value of foreign economic and trade as soon as possible. This paper is made on principle of strengthen scientific and technological innovation, promote the industrialization and internationalization of high-tech achievements. It measures the international innovative level mainly from two aspects: one of them is papers、patents and other intellectual achievements, the other one is international communication such as project cooperation and technology import.

Some indexes need a instruction. Index 10 is gained from 《Chinese Science and Technology Statistics and Analysis Briefing》. The scientific papers are defined in published in five years. Index 11 is gained from 《Statistics Annual Report of The State Intellectual Property Bureau》.

Some indexes have calculation formulas.

(5): Index 13 = $\frac{\text{Exports of high-tech products}}{\text{Year's total exports}} \times 100\%$

(6): Index14=Foreign exchange income from computer and information services + foreign exchange income from royalties and license fees

4.4 Indexes among Innovation Performance.

The purpose of measure the innovation performance is to comprehend whether a region can transform innovative achievements into development performance or not, rather than satisfied with the knowledge itself. A region can tranform innovative achievements into development performance or not, is the key to measure the effectiveness of innovation-driven development strategy [4].

Some indexes have calculation formulas.

(7): Index 18 = $\frac{1}{2}\times$ (rate of decline of energy consumption every 10000 yuan GDP + rate of decline of water consumption every 10000 yuan GDP)

Index 19 is calculated at the solow growth rate equation.(8): $y=a+\alpha k+\beta l$

5. Empirical Measurement and Analysis

Format the composite index according to the above design. Then empirical analyze the innovation driven development of Beijing.

5.1 Steps of Empirical Analyze.

First, design the index. Synthetise low-level indexes to senior-level indexes, empowering low-level indexes with equal weight. For example: innovation foundation index contains five second grade indexes, each of them is empowered as 0.2; innovation-driven development index is synthesized by four classification index, each of them is empowered as 0.25.

Second, process data. Collect data from 2005 to 2012 of Beijing according to the index system. Pretreat the data, such as filling missing data、adjusting abnormal value and data standardization [5].Then make calculation with treated data and obtain the score of each index. Treat 2005 as the base year with score of 60, adjust the score to 60 to 100 points. Due to the standardized method of 0-1, scores mainly reflect the degree of change between each year, the adjusting method does not affect the evaluation result, and can make the comparison between each index more meaningful.

Thirdly, calculation and analysis. Arrange calculating results, draw the corresponding graph, Analysis of the specific measured data.

5.2 Analysis of the Specific Measured Data.

Based on the above index design ideas and calculating process of data, the calculated results are shown in Table 2.

Table 2. Measuring Results of Index

Year	Total Index	Found-ation index	Service index	Internationalization Index	Perform-ance Index
2005	60	60	60	60	60
2006	64.92	63.15	66.67	63.33	66.62
2007	75.84	69.7	81.69	75.5	77.04
2008	72.04	73.8	69.99	70.3	73.84
2009	76.96	76.55	72.1	79.78	79.64
2010	80.15	86.11	79.78	70.75	82.94
2011	86.29	92.6	85.61	83.45	82.71
2012	91.28	100	92.09	88.29	83.67

According to the analysis of index calculating results, the innovation-drive index of Beijing present trend of fluctuating upward, Beijing innovation-driven index increased greatly which rise from 60 points in 2005 to 91.28 in 2012, the average annual growth rate is 6.18%. The innovation driven development work in Beijing are very remarkable.

The total index declined in 2008, it was mainly caused by scores' dropping of innovation service and internationalization of scientific and technical industry, this situation was also consistent with global financial crisis background at that time. In addition, the rest of the year scoring growed positively, especially 2007, while made largest growth rate at 16.82%. It is mainly thanks to index 7 and index 8, which have the largest data within these years.

6. Conclusion

This paper provides certain support to Beijing on making innovation-driven development policy. For example, index of internationalization of scientific and technical industry fluctuate strongly, we should strengthen its support of government to stabilize it. The index system also can used to other regions to

make a transverse comparison between regions. At the same time, there still exist some problems. Some index can't be adopted because they are not included in the scope of statistics or their statistical caliber is inconsistent [6] . Data is the basis of the statistical analysis, this problem also reflect that the field isn't noticed enough. Recommend to establishing the relevant statistical report forms system to meet the research demand .

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