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Research on the Evaluation System Construction of County Innovation Driven Development—-Based on Hubei

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Research on the evaluation system construction of county innovation driven development——Based on Hubei [1]

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Abstract: County territory is the cornerstone of China's economic and social development, and county innovation is an important part of the national innovation system. The implementation of innovation driven development strategy is based on the county, vitality in the county, and difficulties are also in the county. In order to further grasp the current situation of county innovation driven development and clarify the obstacles of county innovation development, based on the county innovation activity data of Hubei Province,this paper constructs the county (city) innovation ability evaluation index from the aspects of innovation input, innovation environment, enterprise innovation, and innovation performance, aiming at comprehensively and accurately reflecting the basic law and evolution characteristics of county innovation ability This paper puts forward the countermeasures and suggestions to improve the innovation ability of counties (cities), and provides reference for regional innovation policy formulation and innovation work.

Keywords: County Economy;Regional Evaluation;Innovation System

0 Introduction

County level is the cornerstone of China's economic and social development, and county innovation is an important part of the national innovation system.In 2019, the national level and Hubei Provincial Government successively issued guiding documents on the Implementation Opinions on County Innovation-driven Development, further clarifying the supporting role of county innovation in promoting regional coordinated and high-quality development[1-2].The implementation of the innovation-driven development strategy is based on the county level, vitality and difficulties in the county level. Compared with other types of regions, it is difficult to form a complete scientific and technological innovation system for counties, most counties lack universities, research institutes, and large backbone enterprises, and rarely conduct scientific and research activities. Secondly, the county is an open system, scientific and technological innovation needs to utilize a large number of external talents, capital, and technology. Thirdly, the county is subordinate to the state, the province and the city, so there is relatively little room for innovation in institutional mechanisms and other aspects.

Therefore, considering of the characteristics of the county, carrying out the evaluation and research of the county innovation ability can grasp the current situation of the county innovation, clarify the obstacle factors of the county innovation and development, and as a result it can provide strong support and guidance to break down the problems and difficulties existing in the county innovation and open through the endings of the county innovation and management.

1 Research Background

Innovation ability evaluation is a comprehensive analysis, comparison and judgment of innovation ability such as national, regional, enterprises, research institutions, colleges and universities, and innovation-intensive areas through the construction of an index system[3].At present, the domestic research on county innovation evaluation mainly includes: Lei Yong[4]established the evaluation index system of county science and technology

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innovation ability based on science and technology input, science and technology output, science and technology environment. Sun[5]evaluates the index system of county innovation ability from four dimensions of innovation input ability, innovation economic performance, innovation output ability and innovation environment support. Wang Miao[6]valuated the county's scientific and technological innovation ability in Guizhou Province from the aspects of scientific and technological innovation service system construction, scientific and technological output and fiscal scientific and technological input, and put forward corresponding policy suggestions, such as accelerating the transformation of economic development mode and improving the basic level scientific and technological innovation infrastructure construction, self-capacity construction, scientific and technological innovation talent fiscal scientific and technological input. Li Xuyang[7] combined with the overall characteristics of the scientific and technological innovation ability of 80 counties (cities) in Inner Mongolia and the common problems common in the process of scientific and technological innovation, built the Inner Mongolia county scientific and technological innovation ability evaluation index system, including three dimensions, scientific and technological innovation investment and scientific and technological innovation performance. Guo Zheng[8]took the county region of Anhui Province as the research unit, selected 11 indicators from the two time sections of Anhui Province in 2000 and 2014 that could reflect the county economic development status of Anhui Province, and established the comprehensive evaluation index system of the county economic development level of Anhui Province. Zhang Peng[9]constructed an index system of county economic development evaluation in Anhui Province, including 43 specific indicators in 5 criterion layers, from five levels of innovative development, coordinated development, green development, open development and shared development.Liu Hongjiu[10] constructed an input-output index system for innovation ability evaluation, including two first-level indexes of scientific and technological innovation input and output, and 10 secondary indexes such as the volume of county professional and technical personnel, the number of county patent applications and grants, based on the commonness of domestic and foreign researches. Wang Zhixin[11]divided the county innovation-driven development process into two stages: innovation-driven knowledge development and innovation-driven economic development, and constructed the evaluation index system of county innovation-driven development efficiency. Shi Lei [12] based on the formal features and problems of innovation-driven development at county level in Shaanxi Province in the new era, systematically constructed an evaluation index system for innovative counties (urban areas), which included quantitative indicators from three dimensions of innovation factor vitality performance, and qualitative indicators from two levels of innovation management policy features and advantages. In addition, some scholars took Schumpeter's innovation theory [13] as a starting point to elaborate on the composition characteristics of regional innovation ecosystem [14-16].

To sum up, in the process of selecting evaluation indicators indexesthe academia is usually based on a specific research background or specific field, thus showing the overall difference among the constructed evaluation index systems, which may easily lead to the evaluation results of the same object varies according to the final choice of the index system. It is mainly manifested in the following aspects: firstly, the index connotation is similar and the evaluation differentiation is not obvious; secondly, the index definition is vague and the evaluation positioning is inaccurate; thirdly, the index level is misplaced and the evaluation scope is not clear; fourthly, the index structure is poor and the evaluation correlation is not strong.Considering of this, in order to further grasp the county innovation-driven development, this paper constructed a set of county (city) innovation ability evaluation system composed of innovation input, innovation environment, social output, and 20 indexes, by consolidating the statistical data of relevant indexes that are in line with the county's economy, society and technological innovation and development, comprehensively, objective and accurately reflecting the county innovation ability.

2 Evaluation model construction

2.1 Principles of index design

In the design of county index system, the system needs to comply with the following principles:Firstly,

comprehensiveness and objectivity.The selection and determination of monitoring and evaluation indexes fully consider the integration of the innovation chain and industrial chain, information chain, financial chain, policy chain and other chains, interweaving and supporting with each other. Secondly, highlight of the key points， the monitoring and evaluation index system highlights the key points. Highlight of the scientific and technological innovation ability and is the key content of the county innovation ability, which embodies the guiding role.Thirdly, accuracy and reliability. The design of the monitoring and evaluation index system, fully considered the accuracy and authority, and select the statistical data and public data released by the statistical department as far as possible to ensure the true and reliable data. Fourthly, making overall plans and taking all factors into consideration. The design of the monitoring and evaluation index system, combined with the actual development situation of different regions, fully took account the county development differences, but also takes into account the stock, relative level and growth rate of the county development.Fifthly, conciseness and easy operation. The design of the monitoring and evaluation index system should not only betterly reflect the focus and main content of the county scientific and technological innovation, but also be as concise as possible, to objectively reflect the county innovation activities through a unified caliber.

Regional innovation system is an ecosystem of multi-dimensional interaction and integration of innovation elements, including direct elements (innovation activity talents, infrastructure, capital investment, etc.), indirect elements (scientific and technological innovation policies and regulations, environmental construction, etc.), and outcome elements (economic and social output and scientific and technological innovation efficiency, etc.). Therefore, the evaluation index system should cover all the elements that affect the regional innovation level, and emphasize the correlation between the elements, so as to comprehensively and objectively reflect the effectiveness of the regional scientific and technological innovation activities. In view of this, on the basis of comprehensive analysis and absorption of the research experience from home and abroad, plus the characteristics of county-level innovation activities, the county (city) innovation ability evaluation indexconsists of innovation input, innovation environment, innovation output, social contribution and 20 secondary indexes. The index system is shown in Table 1 below.

2.2 Determine the index weight

On the basis of following the principle of objectivity, operability and effectiveness, and combining the statistical characteristics of county innovative science and technology, the international universal benchmark analysis method (Benchmarking), namely Lausanne International competitiveness evaluation method, is adopted to ensure the scientific nature and objectivity of the results.

According to the index acquisition data, the min-max standardization method is adopted to conduct the index linear dimensionless normalization processing, that is, the deviation standardization, which is a linear transformation of the original data to solve the comprehensive problem of the index. The conversion function is as follows:

$$y_{ij} = \frac{x_{ij} - x_{i\min}}{x_{i\max} - x_{i\min}}$$ (effective indicator), or $$y_{ij} = \frac{x_{i\max} - x_{ij}}{x_{i\max} - x_{i\min}}$$ (negative indicator)

Among them, the x_{ij} means the index i value of the j county (city), the y_{ij} means the standardization value of index i on j county (city) ; x_{imax} means the maximum value of sample data and x_{imin} means the minimum value of sample data.

Information entropy of each index : $E_i = -\ln(n)^{-1} \sum_{j=1}^{n} p_{ij} \ln p_{ij}$

Among them, $p_{ij} = y_{ij} / \sum_{j=1}^{n} y_{ij}$

If $p_{ij}=0$,then $\lim_{p_{ij}\to 0} p_{ij}\ln p_{ij}=0$

According to the calculation formula of the information entropy, the information entropy of each index is $E_1, E_2, \cdots\cdots E_k$.

The *i* index weight is calculated by the information entropy: $w_i^E=\frac{1-E_i}{k-\sum E_i}\left(i=1,2,\cdots,k\right)$

Calculate the combined weights: $w_i=\alpha w_i^E+\left(1-\alpha\right)w_i^D$

Among them, w_i^E for the objective empowerment weight, w_i^D for the subjective empowerment weight.

This study takes the average mean value of the weights obtained by the master and objective empowerment methods, that is , the determined index weights are as shown in Table 1.

Table 1 Evaluation Index System of County Innovation Ability

Primary Indexes	Secondary Indexes	Unit	Weight
Innovation input	Financial expenditure on science and technology at the corresponding level: X_1	*Ten thousand yuan*	5.11
	Proportion of expenditure on science and technology in the general public budgetX_2	*%*	4.16
	R&D expenditure of industrial enterprises above scale in main business income X_3	*%*	5.46
	R&D personnel of industrial enterprises above scale: employees of industrial enterprises above scale: X_4	*%*	4.61
Innovation environment	Innovation intensive Zone X_5	*Number*	8.58
	The number of popular science bases owned by ten thousand people X_6	*number / capital*	2.56
	Unit GDP above the provincial level scientific research platform X_7	*number / Ten thousand yuan*	3.14
	Technology and finance support scale X_8	*Ten thousand yuan*	6.52
Innovative output	Portion of new product sales income of enterprises above scale in the income of the main business X_9	*%*	5.95
	Amount of invention patent application: X_{10}	*Parts*	4.04
	Number of invention patents owned by ten thousand peopleX_{11}	*number/ capital*	3.46
	Number of high-tech enterprisesX_{12}	*number*	4.20
	Value-added of high and new technology industries X_{13}	*Hundred million yuan*	8.35
	Proportion of added value of high-tech industries in GDP X_{14}	*%*	7.32
	Number of technology SMEs X_{15}	*number*	4.30
	Number of listed technology enterprises on the New Third Board X_{16}	*number*	7.98
	Number of scientific and technological achievements introduced and transformed in the current year X_{17}	*number*	3.72
Social contribution	Energy consumption reduction rate of unit GDP X_{18}	*%*	3.51
	GDP per capita X_{19}	*Yuan*	3.46
	Residents' per capita disposable income X_{20}	*Yuan*	3.57

Note: The data comes from *Hubei Provincial Statistical Yearbook*, *County Statistical Yearbook*, *National Economic and Social Development Statistical Bulletin*, and authoritative research reports. The data have authenticity, authority and timeliness.

2.3 Evaluation and measurement model

Based on the above evaluation method and index weight results, the comprehensive evaluation of scientific and technological innovation ability in Hubei province is adopted. The efficacy coefficient scoring method is based

on the efficacy coefficient, adopting a percentile system and subject to the average value of Hubei province county (city). If the average of a certain index in a certain area reaches its average value of 60%, then the other 40% is determined according to the specific index value of a certain region.

Index effect coefficient score. Select the value of x_{ij}^{h} and x_{ij}^{s} according to the positive and negative efficiency of the index *i*, and then the efficacy coefficient score of the *j* county (city) under the *i* index is calculated according to the following formula:

$$d_{ij} = \frac{x_{ij} - x_{ij}^{s}}{x_{ij}^{h} - x_{ij}^{s}} \times 40 + 60$$

By this analogy, the efficacy coefficient score of the *j* county (city) under all indexes is figured out, namely $d_{1j}, d_{2j}, \ldots\ldots, d_{20j}$.

Weighted average comprehensive score: due to the different weights of each index, the comprehensive score of each county (city) is calculated using the weighted average method based on the each index weight w_i obtained by the entropy weight method. The comprehensive score of the *j* county (city) is:

$$E_{\mathrm{j}} = \frac{\sum_{i=1}^{20} w_i d_{ij}}{\sum_{i=1}^{20} w_i} = \frac{w_1 d_{1j} + w_2 d_{2j} + \ldots\ldots + w_{20} d_{20j}}{w_1 + w_2 + \ldots\ldots + w_{20}}$$

Similarly, the comprehensive score of each county (city) is obtained and ranked from high to low according to the score results.

3 Empirical Study on Innovation Capacity Evaluation of Hubei County (City)

3.1 Study objects

At present,the integration of “the Belt and Road Initiative”,the Yangtze River Economic Belt, Guangdong-Hong Kong-Macao Greater Bay Area, Yangtze River Delta and other national strategies have boosted the high quality development of middle areas into the fast lane with anobvious later-mover advantage, turning into the key area of our national new round of industrialization, urbanization, informatization and coordinated development of agricultural modernization, which is also an important area to support China to maintain rapid economic growth. As a large province of scientific and educational resources, Hubei's scientific and technological innovation has continued to maintain the development momentum of the top central region and the first square in China, and the counties innovation and development has also made obvious progress. Yidu, Daye and Xiantao are the first batch of national innovative counties (cities), and many counties (cities) have been shortlisted for the top 100 industrial economy.

What need to explain is that because some municipal areas (including central city, county level) have some overlap on the space position with its national high and tech park, agricultural science and technology park and other national core areas, they are entitled to the national strategy, innovation elements, platform carrier, talent agglomeration and various policy support. And the statistical caliber with countiesand county-level cities have certain differences, which is not generally representative compared with the county development, this study did not take central citiesand counties into the evaluation category, just selected 63 counties (cities) as the evaluation objects.

3.2 Analysis of the evaluation results

From the overall results, Xiantao City, Daye City, Qianjiang City, Yicheng City, Anlu City, Zhongxiang City, Gucheng County, Wuxue City, Yicheng City, Laohekou City, Shayang County and Zaoyang City ranked in the top 12 respectivelyand in the top 20% of counties (cities) in Hubei Province, with strong comprehensive scientific and technological innovation ability. From the perspective of total score, only 6 counties (cities) such as Xiantao, Daye and Qianjiang were above 80 points, 25 counties (cities) below 70 points, most counties (cities) ' scientific and technological innovation ability is at the medium level, and the overall development is unbalanced. As shown in Table 2.

Table 2 Evaluation Results of Innovation-Driven Development in 63 counties (cities) in Hubei Province

Category	Area	County (City)
First square	Innovation-Leading area	Xiantao , Daye , Qianjiang, Yicheng , Anlu , Zhongxiang , Gucheng ,

		Wuxue , Yicheng , Laohekou , Shayang, Zaoyang , Tianmen, Jingshan , Yuan'an , Yingcheng, Hanchuan, Zhijiang, Gong'an, Chibi
Second square	Innovation demonstration area	Dangyang, Macheng, Xishui
Third square	Innovation agglomeration area	Enshi, Luotian , Xingshan, Honghu, Tongcheng, Yunmeng
Fourth square	Innovative growth area	Xiaochang, Danjiangkou, Songzi , Guangshui, Baokang, Yangxin , Jiayu ,Shishou , Qichun , Nanzhang , Changyang , Tuanfeng , Zigui , Huangmei,Jianli , Hong'an , Fangxian, Zhushan , Yingshan , Zhuxi , Dawu ,Tongshan, Wufeng , Chongyang , SuiXian, Xuanen , Lichuan , Jiangling,Yunxi , Badong, Laifeng, Jianshi, Xianfeng , Hefeng

3.3 Regional distribution characteristics

In order to more intuitively reflect the innovation ability of counties (cities) in Hubei Province, taking the sum of the county (city) innovation input as the horizontal axis, the sum of the innovation output and social contribution of each county (city) as the vertical axis, the distribution space is divided into four quadrants, and 63 counties (cities) in Hubei Province are distributed in the four quadrants. As shown in Figure 1.

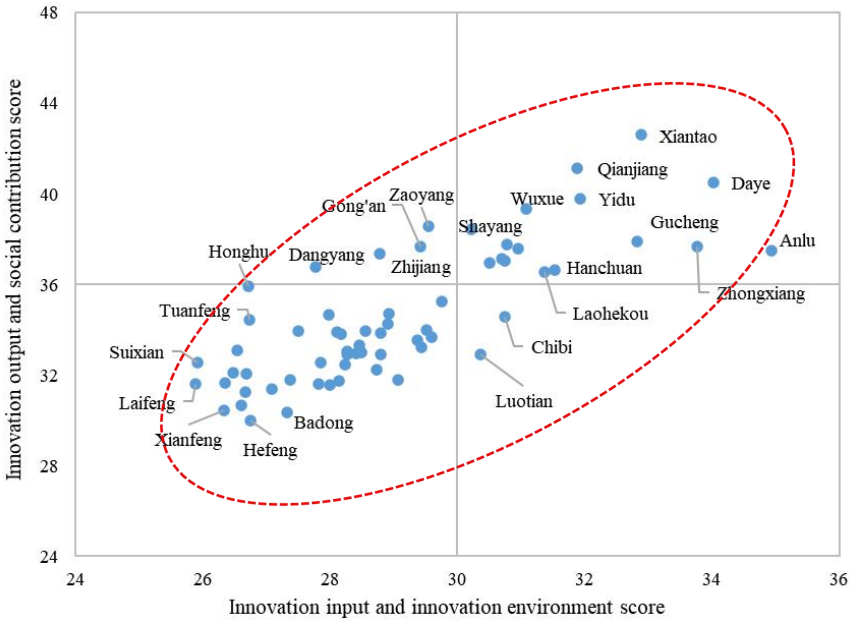

Figure 1 Distribution of innovation capacity scatter in 63 counties (cities) of Hubei Province

Figure 1 Scattered distribution of innovation ability in 63 counties

Note: The horizontal coordinate is the sum of innovation input and innovation environment score, and the vertical coordinate is the sum of innovation output and social contribution score. Only some representative counties and cities are shown in the figure.

From the perspective of innovation investment, innovation environment and innovation output and regional distribution of social contribution, it shows as a overall ellipticalness, with relatively dense double low area distribution. It can be seen that most counties whether in innovation capital, talents, platform basic investment and innovation ecology, or intellectual property, industrial cultivation and other output and support economic and social development, there are certain development bottlenecks and difficulties. The first quadrant is high-high area, namely innovation investment, innovation environment and innovation output, social contribution are all in high rank, belonging to the hot spot area,. It has good regional innovation ability, distributed by Xiantao, Daye, Qianjiang, Yicheng, Anlu, and other 18 counties (cities), which mainly distributed in Wuhan, xiangyang, yichang comprehensive innovation center radiation area, indicating the obvious spillover effect on the scientific and

educational resources and innovation resources, namely *"Innovation-Leading Area"*. The second quadrant is low-high area, namely low innovation investmentand innovation environment, high innovation output and social contribution, high regional innovation efficiency, good innovation ability, with Zaoyang City, Dangyang, Honghu, Zhijiang, public security county distributed in the quadrant, five counties (cities) in multiple regional innovation center radiation cross position.The traditional industry has a good development foundation, and has a good comparative advantage, while in the rapid transformation and upgrading stage, namely *"Innovation Demonstration Area"*. The fourth quadrant is the high-low region, that is, high innovation investmentand innovation environment, low innovation output and social contribution,. The regional innovation efficiency is slightly weak and the overall innovation ability level is good. Chibi City, Luotian City are in the period of innovation elements agglomeration and development, that is,*"Innovation Agglomeration Area"*. The third quadrant is low-low area, namely innovation investment, innovation environment and innovation output, social contribution are low, belonging to the blind spot, with weak regional innovation ability . 38 counties (cities) are distributed in the quadrant, mainly concentrated in the Dabie mountain area, Mufu mountain, qinba mountain, wuling mountain and other four contiguous poor areas, where scientific and technological innovation level is relatively weak, and still in the innovation-driven development period, namely *"Innovative Growth Area"*.

4 Conclusion

Starting from the connotation of regional innovation ecosystem and the actual characteristics of county innovation, this paper comprehensively considers the integration and development perspectives of innovation chain, industrial chain, value chain and service chain from the perspective of high-quality development path of county innovation. Based on the analysis of existing scientific and technological innovation evaluation literature, this paper analyzes innovation input, innovation environment and innovation output, a set of evaluation system composed of 20 indexes is constructed from four dimensions of social contribution.On this basis, we will carry out the evaluation and research of science and technology innovation ability in Hubei Province, objectively and accurately describe the current situation and crux of science and technology innovation in Hubei County, and explore the correct mode and development of county innovation and path.The main conclusions are as follows:

The index system should reflect the innovation ability of the county from "many perspectives" as possible.Integrating the innovation ecology of innovation carriers, platforms and policies in Hubei County, the innovation investment of Hubei County itself and its main innovation subject enterprises in capital, personnel, infrastructure, as well as the output and performance of innovation support industrial structure adjustment, innovation subject cultivation, and science and technology benefit the people. In addition, the index design layout has both total indicators, and proportional indicators, and can fully consider the objective conditions of cities and development foundation and other factors.

Empirical model adopts the international universal competitiveness evaluation method, uses max-min extreme difference method to outline linearity the collected statistical index data, uses objective index assignment method to determine the weight coefficient of each index, the evaluation results are more accurate and reliable, in line with the actual characteristics of county innovation in Hubei Province.

The empirical research results of evaluation model show that it can be divided into *innovation-leading area, innovation demonstration area, innovation agglomeration area and innovation growth area*. The regional scatter distribution is elliptical, and most scientific and technological innovation ability of counties (cities) is at the medium level, and the phenomenon of unbalanced development is obvious. Among them, *the innovation-leading area* is mainly distributed in the radiation area of Wuhan, Xiangyang and Yichang comprehensive innovation centers, indicating that the spillover effect of scientific and educational resources and innovation resources is obvious. *The innovation demonstration areas* are mainly in the cross position of multiple regional innovation

centers, with a good traditional industrial foundation and unique advantages in transformation and upgrading.Innovation agglomeration area The innovation efficiency of *innovation agglomeration area* is slightly weak, the overall innovation capacity is good, and is in the period of agglomeration and development of innovation elements.*Innovation growth area* for innovation investment, innovation environment and innovation output and social contribution double low areas, distribution is relatively dense, and in contiguous poverty areas, affected by location, science and education, resources, comprehensive factors, innovation foundation investment, innovation ecological construction, innovation output and there are certain difficulties on supporting economic and social development.

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