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Evaluation and Optimization of Scientific and Technological Innovation Environment in the Yellow River Basin in China

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While the implementation of the major national strategies for high-quality development of the Yellow River Basin in China cannot be separated from the support of scientific and technological innovation, the role of scientific and technological innovation as a driver depends on the favorable environment of it. In this paper, the practice environment supported by scientific and technological innovation was studied by factor analysis in various provinces and regions in the Yellow River Basin in China and found that the overall scientific and technological innovation environment of each province and region in the Yellow River Basin was poor but had certain complementarity with each other. Paying attention to the incentive of green science and technology innovation, strengthening the transfer and transformation of scientific and technological achievements, promoting the sharing of large instruments and equipment, and optimizing the collaborative innovation in multiple fields are important institutional guarantees for optimizing the scientific and technological innovation environment in the Yellow River Basin in China.

Keywords: Yellow River Basin, scientific and technological innovation, factor analysis, environment optimization

Introduction

During the inspection about the Yellow River in Zhengzhou on September 18, 2019, President Xi Jinping put forward an important national strategy of "ecological protection and high-quality development of the Yellow River Basin" and emphasized that ecological protection and high-quality development of the Yellow River Basin should be regarded as a long-term plan concerning the great rejuvenation of the Chinese nation (Xi, 2019). Undoubtedly, science and technology development will provide corresponding theoretical and technological support for high-quality development of all the Yellow River Basin provinces (Liu, Zuo, & Diao, 2021). Scientific and technological innovation is the inexhaustible driving force for the Yellow River Basin governance to adapt to new development and face new challenges.

At present, there is no special research on environmental assessment and institutional guarantee analysis of scientific and technological innovation in the Yellow River Basin. In view of this, this paper aims to comprehensively evaluate and analyze the scientific and technological innovation environment of the Yellow River Basin and put forward optimization suggestions from the perspective of system guarantee through empirical and normative comprehensive analysis.

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Establishment of Environmental Assessment Index and Result Analysis for Scientific and Technological Innovation in Yellow River Basin

The Yellow River Basin covers nine provinces in China, and there is a large gap in science and technology innovation ability and the environment among the regions. To objectively evaluate the scientific and technological innovation environment of each region in the Yellow River Basin, it is necessary to determine the core evaluation indicators that affect the scientific and technological innovation environment. In this way, the core areas and factors affecting the environment for scientific and technological innovation are determined, to optimize the environment for scientific and technological innovation in the Yellow River Basin and promote the scientific and technological innovation and application that support the high-quality development of the Yellow River Basin.

Initial Evaluation Index

According to the connotation and extension of scientific and technological innovation, the corresponding primary evaluation index of scientific and technological innovation is set up from three aspects: investments in scientific and technological innovation, scientific and technological innovation output, and technological innovation environment (See Table 1). Then collect the indicator data of the Yellow River Basin provinces and other provinces in the past five years released by the country to form a sample. The data are respectively from the National Bureau of Statistics and the National Intellectual Property Office, and Peking University Legal Information Network.

Table 1

Primary Evaluation Indicators of Scientific and Technological Innovation

First level index	Second level index	Variables
Investments in scientific and technological innovation	R&D funds of industrial enterprises above designated size	I1
	Full time equivalent of R&D personnel in industrial enterprises above designated size	I2
	Number of R&D projects of industrial enterprises above designated size	I3
	Science and technology expenditure of local finance	I4
	Scientific researchers in public enterprises and institutions	I5
Scientific and technological innovation output	Number of patent applications of industrial enterprises above designated size	I6
	Number of invention patent applications of industrial enterprises above designated size	I7
	Number of domestic patent applications authorized	I8
	Number of domestic invention patent applications authorized	I9
	Technical market turnover	I10
Technological innovation environment	Number of colleges and universities	I11
	Number of public library institutions	I12
	Number of patent application agents	I13
	Intellectual property demonstration city	I14
	Local regulations on scientific and technological innovation	I15

Comprehensive Evaluation Index

Kaiser-Meyer-Olkin (KMO) and Bartlett Test of Sphericity were performed on the sample data in 2020. According to the data of test, the fitness quantity of KMO sampling is 0.844, the approximate chi-square value of Bartlett test is 1,004.183, the degree of freedom is 105, and the significance is 0. Therefore, these sample data are very suitable for factor analysis.[1]

[1] The closer the KMO value is to one, the stronger the correlation between variables, which means the original variables are suitable for factor analysis. Generally, if the KMO value is greater than 0.5, it means that factor analysis can be carried out. The test statistic

Factor analysis can extract common factors from index variable groups by dimensionality reduction and use the structure and characteristics of sample data to find common factors affecting the environment of scientific and technological innovation, so as to improve the objectivity and science of evaluation (Zhao, Chen, & Li, 2019). Thus, the scientific and technological innovation of the regions in the Yellow River Basin can be objectively evaluated and analyzed. In this paper, factor analysis was carried out on the sample data, and principal component analysis was used to extract common factors according to the standard of eigenvalue greater than one. The three common factors F1 to F3 are obtained, and the cumulative variance contribution rate is 89.722%, which can fully reflect the data information of the original observed variables (See Table 2). When combined with the fourth common factor in the crushed stone diagram, the eigenvalue began to be stable, and the three common factors F1 to F3 were determined to be extracted.

Table 2

Population Variance Analysis

Component	Initial eigenvalues			Extraction sums of squared loadings			Sum of squares of rotational loads		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	10.554	70.358	70.358	10.554	70.358	70.358	7.722	51.477	51.477
2	1.682	11.211	81.569	1.682	11.211	81.569	3.128	20.852	72.329
3	1.223	8.153	89.722	1.223	8.153	89.722	2.609	17.393	89.722

Results Analysis

To explain and name the factors better, the Kaiser normal maximum variance method is used to rotate the factors and form the rotated factor loading matrix. Among them, I1, I2, I3, I4, I6, I7, and I8 have a greater impact on F1, including R&D funds of industrial enterprises above designated size, full time equivalent of R&D, personnel in industrial enterprises above designated size, science and technology expenditure of local finance, number of R&D projects of industrial enterprises above designated size, number of patent applications of industrial enterprises above designated size, number of domestic patent applications authorized, and number of invention patent applications of industrial enterprises above designated size.

Those mainly reflect the contribution rate of enterprise input, government input, and patent application and authorization to scientific and technological innovation, which can be summarized as scientific and technological innovation input and output factor. I10 has a greater impact on F2, including technical market turnover. It mainly reflects the contribution rate of technology market transaction to scientific and technological innovation, which can be summarized as scientific and technological transformation factor. I5, I11, and I12 have a greater impact on F3, including scientific researchers in public enterprises and institutions, number of colleges and universities, and number of public library institutions. It mainly reflects the contribution rate of public research institutions and personnel to scientific and technological innovation, which can be summarized as research institutions and cultural factors. By calculating the scores of provinces in the comprehensive evaluation factors, it is found that the technological innovation environment in the Yellow River Basin in China has great differences, and has a

of Bartlett test of sphericity is calculated according to the determinant of the correlation coefficient matrix and approximately follows the chi-square distribution. If the obtained probability p-value is less than the given significance level α, the null hypothesis should be rejected and the original variable is suitable for factor analysis, and the significance level is assumed to be 0.05 here. See Qi Wei: *Statistical Analysis and Application of SPSS* (3rd ed.), China Renmin University Press, 2011.

gap compared with the national level. At the same time, it shows certain typical characteristics in the provinces (See Table 3).

Table 3

Factor Ranking of Provinces in the Yellow River Basin

Province	F1	F2	F3
Shanxi	-0.44067	-0.63373	0.06028
Inner Mongolia	-0.22674	-0.88123	-0.38226
Shandong	-0.53127	1.35087	3.10177
Henan	-0.06327	-0.43008	1.26088
Sichuan	-0.24219	-0.30087	1.58438
Shaanxi	-0.62883	0.40504	0.25469
Gansu	-0.3126	-0.67886	-0.55156
Qinghai	-0.37702	-0.36092	-1.45697
Ningxia	-0.29503	-0.29348	-1.59022
The highest value in China	4.23315	4.33345	3.10177
The lowest value in China	-1.21265	-0.88123	-1.62974

The Necessity of Environmental Optimization for Scientific and Technological Innovation in the Yellow River Basin

By studying above, obviously, the generally environment for scientific and technological innovation in the Yellow River Basin is poor. The scores of provinces in the Yellow River Basin are all below the mean in F1, which is the furthest from the highest score. This indicates that in terms of input and output of scientific and technological innovation, the provinces in the Yellow River Basin generally have insufficient input in innovation, low awareness of intellectual property protection, and insufficient enthusiasm for patent application. The scores of provinces in the Yellow River Basin are generally low, but a few provinces are above the mean in F2. This indicates that the level of transfer and transformation of scientific and technological achievements in some provinces of the Yellow River Basin is high, but the level of most provinces is low. In terms of scientific research institutions and culture, the overall level of the Yellow River Basin is relatively high, which also lays a good foundation for the protection, inheritance, and development of the Yellow River culture.

At present, the environment guaranteed by legal for high-quality development of scientific and technological innovation in the Yellow River Basin is poor. To sum up, it can be proved from various kinds of scattered legislation that scientific and technological innovation support is a necessary condition for high-quality development of the Yellow River Basin. However, there are still some prominent problems such as low legal rank, lack of clarity, and lack of incentive, which make it difficult to give full play to the effect of legal protection.

All in all, it is the necessary way to realize high-quality development in the Yellow River Basin by means of optimizing the environment for scientific and technological innovation in the Yellow River Basin.

Legal Guarantee for the Optimization of Scientific and Technological Innovation Environment in the Yellow River Basin

The design of the incentive system for green science and technology innovation, the transfer and transformation system of scientific and technological achievements, the sharing system of large instruments and equipment, and the collaborative innovation system in multiple fields are conducive to make up for the lack of

innovation input in the provinces in the Yellow River Basin. At the same time, innovation subjects are encouraged to create and protect intellectual property rights, and to improve the ability of scientific and technological innovation in the Yellow River Basin. This is a strong guarantee for the implementation of the major national strategy for high-quality development of the Yellow River Basin.

Incentive System for Green Science and Technology Innovation in the Yellow River Basin

"The Outline of the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the 2035 Vision and Goals" clearly states that it should be upgraded to a higher green development level in the Yellow River Basin. In the high-quality development chapter of "The Yellow River Protection Legislation (Draft for Public Comment)", there are special provisions for green development. The application and promotion of green technology is a powerful way to improve the ecological environment or save resources and energy. It is necessary for high-quality development of the Yellow River Basin to hedge the risks of innovation acquisition caused by relying solely on patent system to solve technological needs through legal improvement or measures (Joshua, 2011). To enhance the technological innovation capacity of the Yellow River Basin, a special incentive system for green technological innovation in the Yellow River Basin should be established from the perspective of convenient operation and the implementation of the concept of ecological civilization.

The specific system design of green science and technology innovation incentive in the Yellow River Basin should emphasize guidance, incentive, and operability. For one thing, the authorization of green patents is accelerated through the rapid review system of green patents. Environmentally friendly patented technologies are encouraged by the patent system within the technology category (Jeremy, 2007). Provinces in the Yellow River Basin can give priority to green inventions in the recommendation for rapid review of patent applications. The administrative units in the Yellow River Basin can cooperate in legislation and establish specific rules for priority recommendation scope and level. For another, the resources and economic input of green technology innovation should be increased, to set up incentive mechanisms such as subsidies and rewards for green patent creation.

Transfer and Transformation System of Scientific and Technological Achievements in the Yellow River Basin

The transfer and transformation of scientific and technological achievements is the core value of scientific and technological innovation. It can be seen from the above empirical analysis that the transfer and transformation of scientific and technological achievements in the Yellow River Basin is relatively high in some provinces, but relatively low in most provinces. The level of transfer and transformation of scientific and technological achievements in different provinces is differentiated, which reflects the promoting effect of regional legal policy environment on the transfer and transformation of scientific and technological achievements. Therefore, the transfer and transformation of scientific and technological achievements in the Yellow River Basin can be effectively improved through resource flow and experience learning between superior and inferior provinces.

The specific design can be carried out from three aspects: optimizing and constructing the patent information sharing mechanism of the Yellow River Basin, promoting the incentive mechanism, and guaranteeing mechanism of the transfer and transformation of scientific and technological achievements. Patent information contains rich technical, legal, and economic information, which is conducive to the subject of innovation to find the required information at the minimum cost and provides extremely valuable reference for the market subject's scientific and technological innovation and strategic decision-making (Wan, 2017). WIPO estimates that the use of

professional patent databases can save 40% of the economic cost and 60% of the time of research projects (Zhao, 2008).

Sharing System of Large Instruments and Equipment in the Yellow River Basin

To promote the sharing of science and technology resources and to break down barriers are an important measure to optimize the allocation of science and technology resources and enhance the ability of science and technology innovation (Zhou & Hua, 2017). As important material of science and technology resources, large scientific instruments and equipment are the basis for scientific and technological activities, and also the scientific and technological resources with the largest demand for economic and space input in scientific and technological research and development. At present, the provinces in the Yellow River Basin are seriously under-invested in scientific and technological innovation. Based on the limitations of the local economic, promoting the sharing of large-scale instruments and equipment is an important solution mechanism. The whole geographical location of the Yellow River Basin is not too scattered, so it is convenient to share and cooperate in the Yellow River Basin. Thus, it can effectively solve the problem of low utilization efficiency of large instrument resources and promote scientific and technological innovation activities.

There are many kinds of fund channels for the purchase of large scientific instruments and equipment, and its management involves many stakeholders. Therefore, it is necessary to establish the sharing mechanism of large instruments and equipment for scientific and technological innovation in the Yellow River Basin by drawing on the experience of some local provinces.

Collaborative Innovation System in Multiple Fields in the Yellow River Basin

The main goals and tasks of high-quality development in the Yellow River Basin cannot be achieved without the support of multi-field, cross-regional, and multi-subject collaborative innovation in the Yellow River Basin. It is a cross-regional initiative for high-quality development in the Yellow River Basin. Strengthening regional linkage and expanding the openness of the Basin are conducive to enhancing the positive impact of industry-university-research cooperation on scientific and technological innovation (Xia, Song, & Qian, 2019). In terms of scientific research units and cultural foundation, the whole level of the Yellow River Basin is relatively high, which lays the foundation for the protection, inheritance, and development of the Yellow River culture. But Inner Mongolia, Qinghai, Gansu, and Ningxia are still lower than the national average and need to improve. It should be supported the development of local universities and research institutes as well as the establishment of public libraries, in depth, breadth, and abundance, for the foundation of scientific research and culture. In terms of regional coordination, we should strengthen exchanges and cooperation among different regions in the Yellow River Basin, actively guide the full flow of energy and resource elements, so the weak provinces should learn from the strong provinces with a better cultural foundation.

It is necessary particularly to build a collaborative innovation mechanism in multiple fields in the Yellow River Basin. Firstly, collaborative innovation is carried out in new energy, new materials, new technology, infrastructure, cultural preservation, and other fields. Secondly, the government, enterprises, universities, research institutions, and other subjects participate in collaborative innovation in an orderly manner. The linkage among provinces in the Yellow River Basin should be promoted to form a new type of open and collaborative scientific research institution, providing a platform for scientific research and innovation across the whole Basin, provinces, and disciplines. Therefore, the key scientific issues of the Yellow River governance will be addressed jointly, and the application and innovation of key technologies of the Yellow River governance will be promoted.

In the legislation of supporting local science and technology innovation, we should pay attention to the coordination of classified policy and core system.

Conclusion

The high-quality development of the Yellow River Basin cannot be achieved without the classified policies and innovative development of the administrative regions in the Basin, and more importantly, the collaborative innovation and overall planning of the Basin. In terms of scientific and technological innovation support for high-quality development in the Yellow River Basin, the basic environment of provinces is generally poor, and the legal system is not yet perfect, so it is urgent to improve and optimize the institutional environment of scientific and technological innovation. We should adhere to the new development concept of innovation, coordination, green, open and shared development, and promote ecological and environmental protection, high-quality development, and cultural protection and innovation of the Yellow River Basin. It is hoped to carry out more in-depth and comprehensive research, and constantly improve the institutional guarantee of high-quality development of the Yellow River Basin.

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