

Evaluation and Countermeasures of Science and Technology Resource Allocation in Hubei Province Based on Factor Analysis

Yan Wang¹

¹*Wuhan Huaxia University of Technology, Wuhan, Hubei, 430223, China*

ABSTRACT

Hubei is a big province of science and education, and it is an important and urgent task for our province to further optimize the allocation of scientific and technological resources and improve the efficiency and benefits of the output of scientific and technological activities. This paper first introduces the index of scientific and technological resources input, such as scientific and technological human resources, scientific and technological financial resources, scientific and technological material resources, and establishes a model for the evaluation of scientific and technological resources allocation in Hubei Province. Then, using the factor analysis method, this paper makes a comparative study on the allocation of scientific and technological resources in seven provinces and cities, including Beijing, Shanghai, Jiangsu, Zhejiang, Guangdong, Shandong and Hubei. The calculation results show that the allocation of scientific and technological resources in Hubei Province is at the downstream level. Finally, from the construction of scientific and technological talent development platform, broaden the sources of scientific and technological funds, it promotes the transformation mechanism of scientific and technological achievements and other aspects to improve the efficiency of scientific and technological resources allocation in Hubei Province.

Keywords: *allocation of scientific and technological resources, scientific and technological talents, scientific and technological funds, scientific and technological achievements, factor analysis*

1. INTRODUCTION

Scientific and technological resources are the general name of all kinds of material and spiritual resources needed for scientific and technological activities, are all resources that can promote scientific and technological progress and economic development, and are also the core of sustainable development of countries and regions[1]. In the 13th Five-Year Plan for Science, Technology and Innovation in Hubei Province, the track of transforming economic and social development into factor-driven and innovation-driven, relying on both scientific and technological progress and innovation-driven. Science and technology enterprises are the main body of science and technology innovation in Hubei Province, and a large number of science and technology enterprises in Hubei Province are in a certain weak position in the distribution and sharing of science and technology resources. Therefore, to evaluate the current situation of science and technology resource allocation in Hubei Province, to excavate the deficiency in the process of science and technology resource allocation, and to put forward the countermeasures and suggestions to optimize the allocation of science and technology resources, it is of great practical significance to strengthen the core competitiveness of science and technology enterprises in Hubei Province and enhance their independent innovation

ability and promote the construction of “innovative Hubei”. Based on this, this paper and Hubei Province as the object, using factor analysis method, selected Beijing, Shanghai, Jiangsu, Zhejiang, Guangdong, Shandong and other provinces and cities for comprehensive comparison, in order to analyze and judge the current situation and problems of science and technology resources allocation in Hubei Province.

2. CONSTRUCTION OF EVALUATION INDEX SYSTEM OF SCIENCE AND TECHNOLOGY RESOURCE ALLOCATION IN HUBEI PROVINCE

2.1. Classification of scientific and technological resources

Shi Ping et al. (2000) divided the system of scientific and technological resources into tangible resources and intangible resources, the former including material resources, manpower and through certain carriers such as information, data, programs, documents, patents, etc., the latter includes scientific and technological consultation, services, training and so on in the form of labor. Yang Zijiang (2007) thinks that science and technology

resources are a complete dynamic system, including the basic core, the whole functional science and technology resources element subsystem, the former includes science and technology manpower, science and technology funds, science and technology material resources and science and technology information, the latter includes three kinds of resource elements, such as science and technology market, science and technology system and science and technology culture. P.Milieus, J.Sardine (2014) has carried on the research to the science and technology resources important component, points out the manpower, the creativity is the science and technology resources important component. Ravi K.Birla (2017) estimate the role of human, creative and time in scientific and technological resources, and point out that human resources with subjective initiative, information resources and so on will receive more attention in scientific and technological resources. This paper draws lessons from Zhou's classification of Science and Technology Resource Theory, and divides science and technology resources into four aspects: science and technology human resources, science and technology financial resources, science and technology material resources, science and technology information resources[2].

2.2. Selection of science and technology resource index allocation

Scientific and technological human resources refer to people who directly or indirectly engage in scientific and technological activities, including scientists, engineers, scientific researchers, professional and technical personnel, achievements application personnel, scientific and technological auxiliary personnel, scientific and technological management personnel, etc. Scientific and technological financial resources refer to all kinds of funds needed for scientific and technological activities, including government funds, self-financing of enterprises, bank financial loans and other social inputs. Scientific and technological material resources refer to the input of scientific and technological instruments and equipment, the labor expenditure of scientific and technological personnel, the number of various(R&D) institutions, the state key laboratories, test bases, research centers, technology development institutions, scientific and technological service institutions, etc. Scientific and technological information resources include all kinds of scientific and technological documents, books, periodicals, patents and so on.

Because science and technology human resources, science and technology financial resources, science and technology material resources belong to the science and technology resources input part, science and technology information resources is the result produced by the science and technology resources input, belongs to the science and technology resources output part, therefore this paper studies Hubei province science and technology resources allocation present situation only to the science and

technology resources input. According to the evaluation index of the allocation of scientific and technological resources and the need to ensure the reliability and quantification of the data sources,15 indicators of research and experimental development (R&D) personnel, professional and technical personnel, engineering and technical personnel, scientific research personnel, research and development personnel, research and development personnel, the total internal expenditure of (R&D)funds, financial allocation, investment in high-tech industries, investment intensity of funds, expenditure on instruments and equipment, personnel labor expenditure, project situation, number of research and development institutions, number of high-tech industrial projects are selected to evaluate[3].

3. EVALUATION OF STATUS OF SCIENTIFIC AND TECHNOLOGICAL RESOURCES ALLOCATION IN HUBEI PROVINCE

3.1. Data sources

According to the above evaluation index system of scientific and technological resources allocation, the scientific and technological resources data of Beijing, Shanghai, Jiangsu, Zhejiang, Guangdong, Shandong and Hubei provinces and cities in China Science and Technology Statistics Yearbook 2019 are selected and evaluated by factor analysis method.

3.2. Selection of models

Based on the calculation of SPSS22.0 factor analysis and the idea of dimension reduction, this paper classifies and merges 15 evaluation indexes, determines some comprehensive evaluation indexes, represents the original 15 evaluation index information to the maximum extent, and calculates the comprehensive evaluation value of scientific and technological resource allocation in 7 provinces and cities. To find out the main factors affecting the allocation of scientific and technological resources in various regions and the countermeasures to improve the ability of scientific and technological resources allocation.

Table 1. Raw data of the evaluation index of science and technology resource allocation in 7 provinces and cities in 2018

	Subdivision indicators	Beijing	Shanghai	Guangdong	Jiangsu	Zhejiang	Hubei	Shandong
Science and technology Human Resources	Research and Experimental Development (R&D) (Human)	397034	271223	652405	794123	627330	257427	509348
	Professional and technical personnel (persons)	491320	650331	1455605	1171131	941912	824379	1805069
	Engineering technicians (persons)	118810	127830	139807	109861	110547	80713	289900
	Scientific researchers (persons)	6989	6284	3813	8166	5437	3441	20750
	Research and Development personnel (R&D)(individual)	107769	30844	14868	23447	6295	15960	12893
Science and technology Financial Resources	Research and Experimental Development (R&D) Internal Expenditure (\$10,000)	18707701	13592023	27046969	25044293	14456893	8220501	16433300
	Financial allocation for research and experimental development (R&D)	6981994	3109040	610576	1379135	352572	891641	526063
	Investment in high-tech industries (100 million yuan)	138.7	308.2	934.6	2617.8	551.1	909.1	1277.7
	Investment intensity (%)	6.17	4.16	2.78	2.70	2.57	2.09	2.15
Science and technology Material Resources	Expenditure on equipment and equipment (10,000 yuan)	30587	17793	39606	23212	28679	4297	28229
	Expenditure on personnel services (10,000 yuan)	1212296	2207429	8363895	5695391	4264939	1162308	3391785
	R&D program (item)	34583	10497	7775	7455	3782	3813	5079
	Regional R & D institutions (individual)	382	128	182	130	97	106	189
	R&D institutions in high-tech industries	228	154	5823	3631	1495	294	591
High-tech industry R&D projects (items)	7039	12442	76985	72426	77940	13574	46625	

Source: China Science and Technology Statistics Yearbook 2019

which indicates that the data is more suitable for factor analysis.

3.3. Factor Analysis Condition Test

Prior to factor analysis, it is necessary to test whether the original data composed of 15 indexes in 7 provinces and cities are suitable for factor analysis, including calculation KMO and Bartlett spherical test. The calculation results show that the KMO value of this original data is 0.727, the data is better, and the Bartlett spherical test value is 0, which accords with the multivariate normal distribution,

3.4. Data processing

According to the principle of factor analysis, the characteristic value, contribution rate, cumulative contribution rate of each factor and factor load matrix of each index variable after orthogonal rotation are calculated by SPSS22.0.

Table 2. Total variance explained by technology resource allocation factor

Composition	Initial eigenvalues			Extracting squared sum load			Rotation Square and Load		
	Total	Variance %	Cumulative%	Total	Variance %	Cumulative %	Total	Variance %	Cumulative%
1	5.863	39.085	39.085	5.863	39.085	39.085	4.690	31.268	31.268
2	5.114	34.093	73.177	5.114	34.093	73.177	3.720	24.800	56.068
3	2.421	16.143	89.320	2.421	16.143	89.320	3.652	24.349	80.417
4	1.174	7.824	97.144	1.174	7.824	97.144	2.509	16.728	97.144
5	.292	1.945	99.089						
6	.137	.911	100.000						
7	4.057E-16	2.704E-15	100.000						
8	3.157E-16	2.105E-15	100.000						
9	2.695E-16	1.796E-15	100.000						
10	1.331E-16	8.872E-16	100.000						
11	5.556E-17	3.704E-16	100.000						
12	-4.688E-17	-3.125E-16	100.000						
13	-1.259E-16	-8.394E-16	100.000						
14	-2.170E-16	-1.447E-15	100.000						
15	-4.101E-16	-2.734E-15	100.000						

According to the principle that the set eigenvalue is greater than 1, the results show that the initial eigenvalue of the first four factors is greater than 1, and the four common factors extracted SPSS22.0 replace the original 15 indexes. After the variance rotation, the variance contribution rate is 31.268%, 24.800%, 24.349%, 16.728%, respectively,

and the cumulative variance contribution rate reaches 97.144%, which indicates that the four factors contain the information of the original 15 evaluation indexes, which can be used to replace the original 15 evaluation indexes to evaluate the allocation of scientific and technological resources in each province and city.

Table 3. Science and technology resource allocation principal component factor score coefficient matrix

	Composition			
	F 1	F 2	F 3	F 4
Research and Experimental Development Staff	.025	-.148	.352	-.025
Professional and technical personnel	-.040	.052	.018	.294
Engineering technicians	.119	-.116	.088	.449
Scientific researchers	.061	-.050	.179	-.240
Research and development staff	.221	-.052	.041	.020
Internal expenditure on R & D	.064	.164	.044	.114
Government funding	.216	-.035	.018	.014
Investment in high-tech industries	-.002	-.171	.344	.108
R & D investment intensity	.205	-.017	.005	-.007
Equipment and equipment expenditure	.098	.020	.196	.138
Staff costs	-.055	.379	-.181	-.068
Project status	.063	.226	-.050	-.111
Number of research and development institutions	.239	-.028	.010	.200
Number of R & D institutions in high-tech industries	-.048	-.002	.226	-.071
Number of R & D projects in high-tech industries	-.130	.403	-.203	-.112

According to the factor score coefficient matrix shown in Table 3, the factor score function is:

$F1=0.025 \times$ Research and Test Development Personnel - $0.040 \times$ Professional and Technical Personnel $+0.119 \times$ Engineering and Technical Personnel $-0.130 \times$ R & D projects in high-tech industries

$F2=-0.148 \times$ Research and Test Development Personnel $+0.052 \times$ Professional and Technical Personnel $-0.116 \times$ Engineering and Technical Personnel $+..... +0.403 \times$ R & D projects in high-tech industries

$F3=0.352 \times$ Research and Test Development Personnel $+0.018 \times$ Professional and Technical Personnel $+0.088 - 0.203 \times$ R & D projects in high-tech industries

$F4=-0.025 \times$ R & D personnel $0.294 \times$ Professional and technical personnel $+0.449 \times$ Engineering and technical personnel -0.112

3.5. Comprehensive evaluation

F1, F2, F3, F4 four factors reflect the current situation of provinces and cities in the allocation of scientific and technological resources from different aspects, and calculate the comprehensive score according to the variance contribution corresponding to each common factor as the weight value, that is, $F=0.3219F1+0.2553F2+0.2506 F3+0.1722 F4$, The

calculation results are shown in Table 4. The calculation results show that the allocation of scientific and

technological resources in Hubei Province is at the downstream level.

Table 4. Factor score and combined score of seven provinces (municipalities)(2018)

	F1	F2	F3	F4	F	Overall ranking
Beijing	2.15005	0.12268	-0.30526	-0.30116	0.595063	1
Jiangsu	-0.16284	0.33502	2.19171	-0.41191	0.511424	2
Shandong	-0.04587	-0.44428	0.1177	2.17557	0.275939	3
Guangdong	-0.54567	1.87223	-0.75069	0.18822	0.146618	4
Shanghai	0.05069	-0.6762	-0.38595	-0.54667	-0.34717	5
Zhejiang	-0.75769	0.09578	-0.45133	-0.72919	-0.45812	6
Hubei	-0.68867	-1.30524	-0.41617	-0.37486	-0.72375	7

4. COUNTERMEASURES AND RECOMMENDATIONS

4.1. Construction of "Three Platforms" for the Development of Scientific and Technological Talents

One is the industrial development platform. With the science and technology enterprise park as the platform and the science and technology enterprise special project as the grasp, has created a batch of function complete, the matching perfect, each has the characteristic science and technology enterprise characteristic industry development platform, enhances the science and technology enterprise talented person market hard environment attraction. Second, livable home platform. With the enterprise park as the platform, the policy of stratified housing subsidy is introduced for different levels of scientific and technological talents, and the leading talents and backbone scientific and technological talents enjoy special housing for talents or issue housing purchase subsidies; ordinary scientific and technological personnel carry out "excellent rental housing" or "limited price property right housing model" which is less than one third of the market price. Third, the talent circulation service platform. To build an innovative atmosphere that is most suitable for the work and life of scientific and technological talents, to construct a channel of talent service (employment, information, life service), to create a pragmatic and efficient government environment, to improve the level of government public service, and to perfect the soft environment for the development of the talent market of scientific and technological enterprises.

4.2. To enhance the attractiveness of social capital by expanding financing channels

Establish science and technology enterprise growth fund, strengthen government fund support function. It can promote the regional economic development of Hubei province with advanced industrialization technology and patent, great development potential and good industry

background. Take the growth fund as the seed, enhances the attraction to the finance, the venture capital, the fund and so on the social fund, establishes the government - bank - venture capital cooperation science and technology fund continuous flow platform[4].

4.3. Construction of scientific and technological achievements seamless transfer of information cloud platform

On the one hand, play the role of market competition mechanism. Support the development of private science and technology intermediary institutions, through the establishment of scientific and technological achievements transformation intermediary service subsidy special, entrusted organizations to undertake the province's major scientific and technological achievements transformation task of intermediary institutions, government purchase of services to support, improve the quality of intermediary institutions in Hubei Province[5]. On the other hand, improve the platform for the exchange of information on scientific and technological achievements, and under the impetus of the government, lead by industry associations to establish a national big data cloud platform for scientific and technological information (patents, technologies)[6].

5. CONCLUSION

In order to break through the bottleneck of the allocation of scientific and technological resources in our province, we need to break through the key points of scientific and technological talents, scientific and technological funds and scientific and technological material resources. To build three platforms for the development of scientific and technological talents, to stabilize the talent team and give full play to the maximum benefits of scientific and technological human resources; to establish a continuous flow system of scientific and technological funds in cooperation between government, bank and venture capital, and to strengthen the ability to absorb the funds of scientific and technological enterprises; to build a seamless transfer cloud information base for scientific and technological achievements, and to promote efficient cooperation between the supply side and the demand side

of scientific and technological achievements under the role of the market, so as to optimize the allocation of scientific and technological resources in our province.

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