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Evaluation of Innovation Ecosystem in High-Tech Industry Based on Factor Analysis

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***Abstract*—This paper selects the factors that influence the development of high-tech industry from the perspective of innovation ecosystem and uses the factor analysis method to evaluate the innovation factor of high-tech industry. And ultimately the factor of high-tech industry innovation output, innovation achievements transformation and innovation support is extracted. It is found that the key to the development of high-tech industry lies in the effective transformation of innovation achievements in high-tech industries, including effective output of innovative products and effective input of innovative capital. Under the guidance of innovation results and innovation process, the author proposes to enhance innovation technology, train creative talents, and transform extensive innovation investment-output economic growth mode and innovative management concept and countermeasures. Compared with the previous research, the article is more profound evaluation of the current development of high-tech industry. On the basis of researching the innovation factors of high-tech industry, the development countermeasures of high-tech industry are put forward.**

Keywords—High-tech industry; innovation ecosystem; innovation factor; factor analysis

I. INTRODUCTION

The development of high-tech industry can reflect the comprehensive competitiveness of a country or region and plays an important role in stimulating the growth of national economy. The development trend of high and new technology industry is swift and violent.

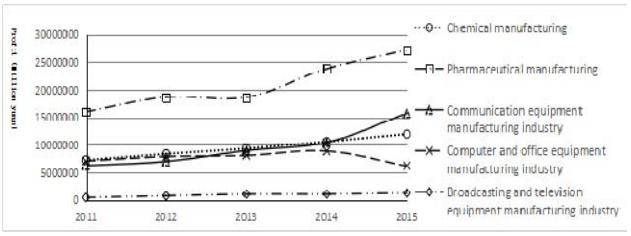

Fig. 1. 2011-2015 Total profit for High-tech industries

But from the development level and speed of the high-tech industry, there is a big difference between the industries, as shown in the high-tech industry selected in Fig. 1. The development of each industry has its own characteristics. In different environments, it eventually presents different development status.

II. EMPIRICAL STUDY

This paper analyzes the 15 common indexes of five major categories of high - tech industry through SPSS. Through the extraction of the main factors, the author shows the new factors on the impact of various high-tech industries and the overall evaluation of the development of various industries under the new evaluation indicators.

A. Innovation System of High-tech Industry Innovation Ecosystem

TABLE I. INDEX SYSTEM OF INFLUENCING FACTORS OF INNOVATIVE ECOSYSTEM IN HIGH - TECH INDUSTRY

First level index	Two level index	Three level index
Innovative state	Capital status	R&D internal spending funding X_1
		Amount of investment X_2
		New fixed assets X_3
		R&D project funding X_4
	Talent status	R&D personnel equivalent to full time equivalent of X_5
Innovation potential	Material potential	Number of enterprises X_6
		Number of R & D institutions X_7
		Number of new product development projects X_8
		The total number of projects completed and put into operation X_9
	Fund potential	Main business income X_{10}
		Total profit X_{11}
		New product sales revenue X_{12}
	Technological potential	Number of patent applications X_{13}
Innovation flow	Technology flow	Technology introduction expenditure X_{14}
		Purchase of domestic technology expenditure X_{15}

There are mainly two research perspectives on the innovation factors of high and new technology industry. One is from the angle of efficiency to analyze and evaluate the influencing factors of high-tech industry. Liu Wei adopts the three-stage DEA model to study the influence of environmental factors on the innovation efficiency of high-tech industry and obtains the positive correlation between environmental factors and innovation efficiency[1]. Using the SFA method to study the single factor to the high and new technology industry innovation efficiency influence, Li Xinchun extracts the labor and the fund two factors[2]. The other one is to study the factors affecting the development of high-tech industry from the ecological perspective. From the perspective of innovation ecosystem for empirical research on 53 national science and Technology Park, Chen Xiangdong and Liu Zhichun puts forward relevant countermeasures to improve the comprehensive level of science and Technology Park[3]. Using case analysis methods, Lv Yibo declassified the growth genes of iOS, Android and Symbian from the perspective of open innovation ecosystem[4]. The research point of validity is to improve the innovation technology and the research from the ecological point of view focuses on optimizing the innovation input input-output system. The existing research focuses on the impact factors of high and new technology industry, focusing on the development evaluation of a certain area[5],an industry[6] and the provinces and cities nationwide[7] high-tech industry. On the basis of previous studies, the 15 indicators are classified according to the innovation state, innovation potential and innovation flow in the innovation ecosystem[8][9]. The index system as shown in table 1 is obtained, such as number of enterprises, main business income and so on.

B. Sample Data Detection

The sample is derived from the 2015 statistics of China Science and Technology Statistics Yearbook. The data of 25 high-tech industries are measured by KMO and Bartlett sphericity. The results are shown in table 2. Test result shows that the observation of Bartlett ball detection statistics is 1198.125 and the probability of the corresponding P- close to 0. If the significance level is 0.05 and the probability of P- less than 0.05, it shows that the correlation coefficient matrix is significantly different from the unit matrix. The KMO value is 0.828. According to the KMO measurement standard, the original sample is more suitable for factor analysis.

TABLE II. KMO AND BARTLETT IDENTIFICATION

Take the sufficient degree of the Kaiser-Meyer-Olkin metric		0.828
Bartlett test of sphericity	***About chi square***	1198.125
	df	105
	Saliency	0.000

C. Extraction Factor

According to the correlation coefficient matrix of the original variable, the article specifies the extraction of three eigenvalues. The analysis results are shown in table 3. From the second column data, it can see that the common degree of all variables at this time is higher and the information loss of each variable is less. Therefore, the overall effect of this factor is ideal.

TABLE III. FACTOR COHERENCE IN ANALYSIS

	Start	**Capture**
X_5	1	0.995
X_{15}	1	0.982
X_8	1	0.984
X_{14}	1	0.965
X_9	1	0.992
X_3	1	0.984
X_1	1	0.986
X_{13}	1	0.968
X_2	1	0.976
X_{11}	1	0.955
X_4	1	0.984
X_6	1	0.976
X_{10}	1	0.963
X_7	1	0.983
X_{12}	1	0.982

According to the correlation coefficient matrix of the original variable, the eigenvalue and contribution rate shown in table 4 are obtained by factor analysis method. The second column to fourth column data item describes the initial solution of the factor analysis. The fifth column to seventh column data item describes the condition of the factor solution. The eighth column to the tenth column series describes the final factor solution.

TABLE IV. FACTORS EXPLAINING THE TOTAL VARIANCE OF ORIGINAL VARIABLES

element	**Initial eigenvalue**			**Extract sum of squares load**			**Cyclic sum of sum loading**		
1	12.874	85.829	85.829	12.874	85.829	85.829	7.055	47.031	47.031
2	1.406	9.371	95.2	1.406	9.371	95.2	3.876	25.842	72.873
3	0.395	2.63	97.831	0.395	2.63	97.831	3.744	24.958	97.831
4	0.158	1.051	98.882						
5	0.074	0.491	99.372						
6	0.059	0.39	99.762						
7	0.019	0.126	99.888						
8	0.008	0.052	99.94						
9	0.005	0.034	99.974						
10	0.003	0.02	99.994						
11	0	0.002	99.996						
12	0	0.002	99.998						
13	0	0.001	99.999						
14	5.43E-05	0	100						
15	4.53E-05	0	100						

D. Factor Nomenclature

TABLE V. COMPONENT SCORE COVARIANCE MATRIX

element	**1**	**2**	**3**
1	1	0	0
2	0	1	0
3	0	0	1

The table 5 component score covariance matrix shows that the correlation between the 3 factors has been lost, so it can be named and analyzed.

TABLE VI. ROTATION ELEMENT MATRIX

	element		
	1	*2*	*3*
X_9	0.931	0.239	0.261
X_8	0.903	0.278	0.302
X_3	0.888	0.287	0.338
X_7	0.878	0.275	0.369
X_6	0.87	0.292	0.366
X_2	0.867	0.316	0.351
X_{11}	0.745	0.446	0.447
X_{10}	0.58	0.576	0.543
X_{15}	0.272	0.926	0.226
X_{14}	0.291	0.837	0.424
X_{12}	0.355	0.699	0.606
X_1	0.493	0.464	0.727
X_4	0.484	0.471	0.727
X_{13}	0.54	0.438	0.696
X_5	0.599	0.44	0.665

In order to make the factor has the naming explanatory nature, orthogonal transform of the factor load matrix is carried out by using the variance method. The analysis results are shown in table 6. The first factor mainly explains the number of completed projects, the number of new product development projects, the number of new fixed assets, R & D institutions, the number of enterprises, the amount of investment, the total profit and the revenue of the main business. It can be named as innovation output of hi-tech industry(F_1). The second factor explains the purchase of domestic technology expenditure, technology introduction, expenditure and new product sales revenue. It can be named as high-tech industry innovation achievements transformation(F_2).

TABLE VII. FACTOR SCORE COEFFICIENT MATRIX

	element		
	1	*2*	*3*
X_5	-0.075	-0.168	0.414
X_{15}	-0.006	0.807	-0.653
X_8	0.262	0	-0.22
X_{14}	-0.1	0.514	-0.23
X_9	0.297	-0.004	-0.268
X_3	0.236	-0.025	-0.158
X_1	-0.157	-0.199	0.552
X_{13}	-0.119	-0.2	0.501
X_2	0.219	-0.004	-0.153
X_{11}	0.109	0.049	-0.049
X_4	-0.162	-0.192	0.55
X_6	0.212	-0.047	-0.104
X_{10}	-0.022	0.102	0.079
X_7	0.215	-0.069	-0.087
X_{12}	-0.163	0.183	0.185

The third factor mainly explains the research and experimental funds, internal expenditure, research and experimental projects, the number of patent applications and the equivalent time between the research and the experimental personnel. It can be named as high-tech industry innovation support(F_3). Simultaneously, estimation of Factor Score Coefficient was estimated by regression method. The specific results were shown in table 7.

III. HIGH-TECH INDUSTRY EVALUATION AND ANALYSIS

A. High and New Technology Industry Evaluation

According to the scoring function of the above factors, the F_1, F_2 and F_3 values of 25 industries were calculated by using EXCEL. Considering the quantity, the variance contribution rate of the 3 factors in table 4 is taken as the weighting factor to get the comprehensive score of the impact factor of the high-tech industry(F).

$$F=0.47031F_1+0.25842F_2+0.24958F_3 \quad (1)$$

The calculated results and factor rankings are shown in table 8.

TABLE VIII. COMPREHENSIVE EVALUATION OF INFLUENCING FACTORS OF HIGH AND NEW TECHNOLOGY INDUSTRY

Industry	Factor ranking			
	F_1	F_2	F_3	F
Electronic and communication equipment manufacturing industry	25	1	1	1
Communication equipment manufacturing	24	2	2	2
Communication terminal equipment manufacturing	23	3	3	3
Computer and office equipment manufacturing	21	4	6	4
Communication system equipment manufacturing	22	7	4	5
Pharmaceutical manufacturing	20	6	5	6
Electronic device manufacturing	19	8	7	7
Computer manufacturing	18	5	8	8
Electronic component manufacturing	17	10	9	9
Audiovisual equipment manufacturing	16	9	11	10
Chemical manufacturing	15	11	10	11
Medical instrument and instrument manufacturing industry	14	12	12	12
Instrument manufacturing	13	13	13	13
Aviation, spacecraft and equipment manufacturing	12	14	14	14
Aircraft manufacturing	11	16	15	15
Proprietary Chinese medicine production	10	15	16	16
Other electronic equipment manufacturing	9	17	17	17
Integrated circuit manufacturing	8	18	18	18
Biopharmaceutical manufacturing	7	19	19	19
Manufacture of medical instruments and apparatus	6	21	20	20
Manufacture of radio and television equipment	5	20	21	21
Computer parts manufacturing	4	22	22	22
Semiconductor discrete device fabrication	3	23	23	23
Spacecraft manufacturing	2	25	24	24
Manufacture of electronic vacuum devices	1	24	25	25

B. High and New Technology Industry Analysis

According to the weight coefficient of the 3 factors, the weight of F_1 is 0.47031, the weight of F_2 is 0.25842 and the weight of F_3 is 0.24958. F_1 has the greatest influence. F_2's influence is central. F_3's influence is minimal. According to the weight coefficient, the higher the F_1 score, the higher the overall ranking. But from the result of the comprehensive score ranking, the higher the F_1 score, the lower the overall ranking. The reason for this phenomenon is that the value of F_1 is negative. In general, the high-tech industry innovation output capacity is not enough. The support for innovation is not proportional to its support for innovation, which is not fully into innovation and not full of innovations into the innovation ability of income.

IV. CONCLUSIONS AND COUNTERMEASURES

The core of the above research is to achieve the innovation support and output effective outcome transformation of high-tech industry. This is not only the pursuit of innovation results, but also the control of the innovation process. In terms of innovation results, this is mainly due to the effective output of innovative products. From the point of view of innovation, it embodies the effective input of innovative capital. The key to ensure the effective output of innovative products is innovation technology and the key to ensure the effective input of innovation capital is the timeliness of capital investment. In view of the above two points, the author puts forward the following opinions. First, strengthen the continuous learning and research of innovative knowledge and technology. It should pay attention to the effective transformation of innovative knowledge and technology. Second, reserving excellent creative talents and giving full play to the value of creative talents. Third, changing the extensive capital input the economic growth mode of output. Fourth, importing more advanced innovative management concepts and improving the management system of high-tech industries.

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