Research on the Scientific and Technological Innovation of Jilin Pharmaceutical Manufacturing Industry

Zixuan Peng[1,a,*] and Jiwei Liu[1,b]

[1]Department of Economics, School of Changchun University of Technology, Changchun, Jilin, China

[a]pzx970216@163.com, [b]ljw1965715@163.com

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Abstract: In this paper, the pharmaceutical manufacturing industry in 26 provinces of China is taken as the research object, and the principal component analysis method is used to evaluate the ability of scientific and technological innovation. The results show that the balanced development of human input, capital input, industrial scale and scientific and technological output capacity is the decisive factor of scientific and technological innovation capacity. The reason for the weak scientific and technological innovation ability of Jilin Pharmaceutical manufacturing industry is the unbalanced development of human capital input, industrial scale, material capital and scientific and technological output.

1. Introduction

Pharmaceutical manufacturing industry is knowledge, technology, capital intensive high-tech industry, which is closely related to national health and economic stability and sustainable development. Scientific and technological innovation ability is an important indicator reflecting the development level and potential of pharmaceutical manufacturing industry. Chinese scholars have conducted in-depth research on the influencing factors, evaluation methods, innovation subject role and innovation resource allocation of scientific and technological innovation. Zhang Su thinks that there are problems of high input and low efficiency in the technological innovation of high-tech industry in China, and the transformation ability of technological output has a great influence on the technological innovation.[1] Wu Boyu, Peng benhong, etc. believe that China's technology activity funds have a negative impact on the innovation ability of labor-intensive industries, and the impact on the innovation ability of technology-intensive industries is uncertain[2].According to Li Yuchen, Chen Kaihua and Zhang Yi, the choice of indicators in different aspects and categories has different influences on the measurement of scientific and technological innovation ability[3].Jihong and liuyitong take Jilin Province as the research object and find that increasing R&D funds can promote the role of science and technology service industry in economic growth[4].Xiuguoyi thinks that the concentration of scientific and technological talents is directly proportional to the regional scientific and technological innovation ability, so the government should reasonably introduce talents and integrate human resources[5].Xu Tenan and Zhou Xiaoting used principal component analysis to study the technological innovation ability of Jilin Province. They believed that the regional independent innovation ability mainly lies in the innovation ability of enterprises. The independent innovation ability of enterprises in Jilin province belongs to the backward level in China[6].Xie Liyun believes that Chinese pharmaceutical manufacturing enterprises are small in scale, low in industrial concentration, unbalanced in regional development, and highly dependent on capital and human capital[7].Liang Xiaojuan and Xu Huaifu use the method of grey correlation analysis to study the influencing factors of technological innovation in China's pharmaceutical manufacturing industry. They think that the most critical factor is the expenditure for new product development[8].Jiang Yichen analyzed the innovation efficiency of the pharmaceutical manufacturing industry in Jilin Province, and thought that the innovation investment of the pharmaceutical manufacturing industry in Jilin Province is growing continuously, but there is still a big gap with the developed regions[9].It can be seen that the research results of Chinese scholars on regional and industrial scientific and technological innovation capacity are relatively rich. Using principal component analysis, this paper selects 26 provinces in China's pharmaceutical manufacturing industry to evaluate the change trend of technological innovation ability in 2009-2016.

2. Research Methods and Data

2.1 Research Method

In this paper, the principal component analysis method is used, considering the relationship between multiple indicators, using linear transformation, the independent indicators are transformed into a few uncorrelated principal components, and principal components are used to replace the original majority of indicators for analysis. It not only reduces the loss of original information, but also avoids the problem of collinearity among variables[10].The principle of principal component analysis is to standardize the data first, and stack all the annual cross-section data into a global data table according to the time sequence. Then calculate the KMO value of variables and Bartley spherical test. When the KMO value is greater than 0.6, it indicates that it is suitable for principal component analysis. Bartley spherical test rejects the original hypothesis, which indicates that there is correlation between variables and it is suitable for principal component analysis. Then, all principal components of the standardized variables are analyzed, and all covariance matrices, their eigenvalues and corresponding eigenvectors are calculated. The number of principal components is determined according to the principle that the eigenvalue is greater than 1 and the cumulative variance contribution rate is close to 85%. Calculate factor load matrix and principal component coefficient of basic index. Finally, the score function of comprehensive evaluation is constructed, and each principal component is used to classify or evaluate the samples.

2.2 Sample Data and Indicators

According to the sample and data requirements of principal component analysis, we selected 26 provinces in mainland China (2008-2016, the data of Tibet, Xinjiang, Ningxia, Qinghai and Gansu) as observation samples, identified data related indicators of technological innovation capability and set up an index evaluation system, which is related to China's high-tech industry year. China Industrial Statistics Yearbook and China Industrial Statistics Yearbook. The basic scale of the industry, the input of human capital, the input of funds and the output capacity of innovation are four primary indicators, and the innovation capacity of science and technology is reflected by 15 secondary indicators. See Table 1 for specific indicators and explanations.

2.3 Evaluation of scientific and technological innovation ability

2.3.1 Sample Data Test

The data were standardized to eliminate the influence of dimension. The KMO test and Bartley spherical test were carried out on the relevant sample data. The results of spss19.0 were shown in Table 2. The KMO statistical value was 0.538 greater than 0.5, indicating that the information contained in the original indicators had many common factors. The Bartlett spherical test approximate chi square distribution was significant at the level of 1%, and each variable was rejected to be unique Based on the original hypothesis, the test results show that the selected sample data is suitable for principal component analysis.

Table 1. Evaluation index of scientific and technological innovation ability of pharmaceutical manufacturing industry

First level indicators	Secondary index	code
Basic scale of industry	Number of enterprises	X1
	New fixed assets	X2
	Number of scientific research institutions	X3
	Number of new projects	X4
	Number of enterprises with R&D institutions	X5
	Industry scale = total assets / number of enterprises	X6
Investment in human capital	R&D personnel equivalent to full-time equivalent input growth rate	X7
	R&D personnel input growth rate	X8
Investment in material capital	Input intensity of foreign technology acquisition fund = (expenditure on domestic technology acquisition + expenditure on imported technology + expenditure on technological transformation) / number of enterprises	X9
	R&D institution expenditure input intensity = R&D institution expenditure / number of enterprises with R & D institutions	X10
	R&D investment intensity = R&D internal expenditure /enterprise average	X11
	Input intensity of enterprise expenditure	X12
	Input intensity of new product development funds = new product development funds / number of enterprises	X13
Innovation output capacity	Growth rate of new product sales revenue	X14
	Growth rate of effective invention patents	X15

2.3.2 Comprehensive evaluation

Table 2 KMO value and Bartlett spherical test

KMO and Bartlett spherical test		
KMO		0.538
Bartlett spherical test	Approximate chi square	581.093
	P value	0.000

According to the principle that the eigenvalue is greater than 1 and the cumulative variance contribution rate is close to 85%, the common factor and its number are determined. From table 3, it can be seen that the cumulative contribution rate of the eigenvalues of the first four factors reaches 83.01%, which indicates that the first four factors can well represent the explanation of 15 original indicators on the scientific and technological innovation ability of pharmaceutical manufacturing industry.

Table 3 Total Variance of Interpretation

Table of variance interpretation rate						
number	Characteristic root			Principal component extraction		
	Characteristic root	Variance interpretation rate %	Accumulate %	Characteristic root	Variance interpretation rate %	Accumulate %
1	5.716	38.107	38.107	5.716	38.107	38.107
2	3.664	24.427	62.534	3.664	24.427	62.534
3	1.964	13.096	75.63	1.964	13.096	75.63
4	1.252	8.348	83.978	1.252	8.348	83.978

As shown in Table 4, it can be seen that the first six indicators have a large factor load in the first common factor, including the number of enterprises, newly added fixed assets, number of scientific research institutions, number of newly started projects, number of enterprises with R&D institutions and industrial scale, which are the first principal components and named as basic scale input of industry. The second principal component is the full-time equivalent growth rate of R&D personnel and the growth rate of R&D personnel. In the third principal component, foreign technology introduction fee, R&D institution expenditure intensity, internal R&D expenditure input intensity, enterprise expenditure input intensity, new product development expenditure input intensity are in and larger, named as material capital input intensity. The growth rate of sales of new products and the growth rate of effective patents are heavily loaded in the fourth principal component, which is named as the output capacity of science and technology. The above four main components are based on scale input capability, human capital input capability, material capital input capability and technology output capability to measure the technological innovation capability of pharmaceutical manufacturing industry in each province.

Table 4 Factor Load Factors

Load factor table					
name	Load factor				Commonality (common factor variance)☐
	Principal component 1	Principal component 2	Principal component 3	Principal component 4	
1	0.613	0.673	0.076	0.081	0.841
2	0.525	0.639	0.007	0.157	0.709
3	0.779	0.569	0.045	-0.055	0.935
4	0.783	0.558	0.039	-0.052	0.929
5	0.789	0.547	0.022	-0.043	0.925
6	0.464	-0.757	-0.176	0.125	0.835
7	0.000	-0.152	0.937	0.029	0.901
8	-0.010	-0.096	0.926	0.107	0.878
9	0.684	-0.123	0.245	-0.406	0.708
10	0.652	-0.615	0.004	0.323	0.908
11	0.817	-0.538	-0.068	0.061	0.965
12	0.822	-0.529	-0.076	0.072	0.966
13	0.848	-0.429	-0.030	-0.011	0.904
14	-0.225	-0.016	0.279	0.562	0.445
15	0.030	0.341	-0.201	0.769	0.749

As shown in Table 5, the comprehensive scores of science and technology innovation ability of each province in China are calculated. It can be seen that from 2009 to 2016, Jiangsu, Shandong, Zhejiang and Guangdong are in the forefront, showing strong science and technology innovation ability. Combined with the comprehensive score table, the level of scientific and technological innovation ability of 26 provinces in China can be roughly divided into three groups. The first group is composed of ten provinces, namely Jiangsu, Shandong, Zhejiang, Guangdong, Hebei, Henan, Tianjin, Hubei, Sichuan and Shanghai. The characteristics of this group are that the scores are all above zero, indicating that these regions have strong scientific and technological innovation ability, and these provinces have strong scientific and technological innovation ability The scope of change of scientific and technological innovation capacity is not large, and it has been in the forefront. The second group consists of seven provinces, namely, Hunan, Beijing, Jilin, Anhui, Jiangxi, Chongqing and Hainan. Although the scores of these provinces are not as high as those of the first group, their scientific and technological innovation capabilities have great potential. The third group is composed of Inner Mongolia, Heilongjiang, Fujian, Guizhou, Shaanxi, Guangxi, Yunnan and Shaanxi. Due to the geographical and economic reasons, these provinces put the input of human capital and material capital in the back position. The output capacity of science and technology fluctuates greatly and the capacity is weak, so the comprehensive score is low and the position is in the back position.

Table 5 Comprehensive Score of Scientific and Technological Innovation Ability of Chinese Pharmaceutical Manufacturing Industry

2016		2014		2012		2010		average score	
province	score	province	score	province	score	province	score	province	score
Jiangsu	1.87	Jiangsu	1.66	Jiangsu	1.42	Shandong	1.3	Jiangsu	1.5
Shandong	1.07	Shandong	1.31	Shandong	1.37	Jiangsu	1.18	Shandong	1.19
Zhejiang	0.64	Zhejiang	0.45	Sichuan	0.67	Zhejiang	0.61	Zhejiang	0.63
Henan	0.53	Guangdong	0.4	Zhejiang	0.62	Guangdong	0.53	Guangdong	0.4
Guangdong	0.34	Hunan	0.33	Guangdong	0.47	Hebei	0.49	Hebei	0.2
Anhui	0.27	Sichuan	0.23	Hebei	0.34	Henan	0.41	Henan	0.19
Hebei	0.14	Henan	0.19	Hubei	0.27	Tianjin	0.22	Tianjin	0.11
Guizhou	0.11	Hebei	0.14	Jilin	0.26	Hubei	0.2	Hubei	0.08
Hunan	0.1	Hubei	0.1	Tianjin	0.14	Shanghai	0.15	Sichuan	0.07
Hubei	0.06	Tianjin	0.06	Shanghai	-0.03	Jilin	0.14	Shanghai	0.04
Jiangxi	-0.02	Shanghai	0.01	Jiangxi	-0.04	Jiangxi	0.14	Hunan	-0.03
Sichuan	-0.03	Liaoning	-0.01	Guangxi	-0.08	Heilongjiang	0.12	Beijing	-0.03
Beijing	-0.04	Shaanxi	-0.03	Henan	-0.1	Guizhou	0.11	Jilin	-0.03
Jilin	-0.11	Jilin	-0.05	Beijing	-0.12	Beijing	-0.09	Anhui	-0.08
Shanghai	-0.13	Shanxi	-0.06	Anhui	-0.13	Anhui	-0.14	Jiangxi	-0.11
Chongqin	-0.19	Beijing	-0.1	Yunnan	-0.23	Liaoning	-0.19	Chongqin	-0.19
Tianjin	-0.2	Jiangxi	-0.19	Hunan	-0.32	Chongqin	-0.25	Hainan	-0.26

3 Research Conclusions and Suggestions

3.1 Research Conclusion

Through the evaluation of scientific and technological innovation ability of Chinese pharmaceutical manufacturing industry, the basic conclusions can be drawn from four aspects. The first is to increase the basic investment in the industry, human capital investment, material capital investment and expand the industrial scale, which are the basic conditions for the stability of scientific and technological innovation capacity. Second, the number of scientific research institutions and the scale of enterprises have a great influence on the ability of scientific and technological innovation, that is to say, the ability of basic investment in scientific and technological innovation plays a decisive role. Third, the output capacity of science and technology has a certain impact on the ability of science and technology innovation, which is one of the important factors to promote science and technology innovation. Fourth, the weak scientific and technological innovation ability of Jilin Pharmaceutical manufacturing industry is caused by the imbalance of innovation capital input and basic input, the discomfort of human resources and industrial basic scale input, and the low level of scientific and technological output.

3.2 suggestions

In view of the main problems affecting the scientific and technological innovation ability of Jilin Pharmaceutical manufacturing industry, the following suggestions are put forward: first, balance the basic investment, increase the investment in human capital, combine the introduction and cultivation. The second is to expand the industrial scale, encourage scientific and technological research and development of enterprises, raise funds through large-scale mergers and acquisitions, issuance of stocks and bonds, etc. . The second is to coordinate the scale and quality, appropriately increase capital input, improve the output capacity of science and technology, attach importance to the technical content of products, and increase the added value of products.

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