Evaluation of Tech-innovation Performance: Evidence from Traditional Manufacturing Industries in China

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***Abstract*- In spite of huge contribution to more than sixty percent of GDP currently, traditional manufacturing industries in China fall into the trapes of poor tech-innovation performance, which leads to a great threat for the development and upgrading of traditional manufacturing industries. Through delimiting the scope of traditional manufacturing industries in China, this paper dissects its tech-innovation pattern, and selects the cross-section data of "China Statistical Yearbook on Science and Technology (2010)" to assess the tech-innovation performance of traditional manufacturing industries in China with the method of principal component analysis (PCA), and puts forward the ameliorating steps according to the measured outcomes at lost.**

Keywords- Traditional Manufacturing Industry; Technological Innovation; Performance Evaluation; PCA

I. INTRODUCTION

Traditional manufacturing industries in China are principally centered on labor-intensive industries and capital-intensive industries, which can be called traditional manufacturing industries. Since massive traditional manufacturing industries cluster is one of the basic actualites of Chinese economy, the development and upgrading of traditional industry in china is the primary focus in the evolution of manufacturing industries in China. Since the 1980s, technological introduction and transfer from the developed countries has been the principal technological resource of traditional manufacturing industries in China, and the poor tech-innovation performance has obstructed substainable development of traditional manufacturing industries in china. After delimiting the scope of traditional manufacturing industries in China, this paper expounds its tech-innovation pattern, adopts the cross-section data of "China Statistical Yearbook on Science and Technology (2010)" to estimate the tech-innovation performance of China traditional manufacturing industries with the way of PCA, and puts forward the improving steps on account of the final calculating results.

II. DEFINITIONS OF TRADITION MANUFACTURING INDUSTRIES IN CHINA

Traditional manufacturing industries in China means the industry with rough processed industry, which is ripe technology. There is no definite criterion of the high, and traditional technical industry so far. Organization for Economic Cooperation and Development (OECD) has classified the industries according to the content of research and development (R&D), namely the expenditure on R&D as a percentage of total revenue from the sale of products [1]. It belongs to the traditional-tech industry when R&D content is during 1～3%, and it belongs to the high-tech industry when R&D content is more than 3%. According to the definition of OECD, the characteristic of traditional industries of China's national economy is very obvious. On the basis of the cross-section data of "China Statistical Yearbook on Science and Technology (2010)", there are 23 manufacturing industries of 29 manufacturing industries in China that belong to the scope of tradition-tech manufacturing industries [2], as displayed in Table 1.

TABLE 1 RANGE OF TRADITIONAL MANUFACTURING INDUSTRIES IN CHINA

Code	Name of Manufacturing Industries	Code	Name of Manufacturing Industries
H_1	Processing of Food from Agricultural Products	H_{13}	Processing of Petroleum, Coking, Processing of Nucleus Fuel
H_2	Manufacture of Foods	H_{14}	Manufacture of Chemical Raw Material and Chemical Products
H_3	Manufacture of Beverage	H_{15}	Manufacture of Chemical Fiber
H_4	Manufacture of Tobacco	H_{16}	Manufacture of Rubber
H_5	Manufacture of Textile	H_{17}	Manufacture of Plastic
H_6	Manufacture of Textile Wearing Apparel, Footware and Caps	H_{18}	Manufacture of Non-metallic Mineral Products
H_7	Manufacture of Leather, Fur, Feather and Its Products	H_{19}	Manufacture and Processing of Ferrous Metals
H_8	Processing of Timbers, Manufacture of Wood, Bamboo, Rattan, Palm, Straw	H_{20}	Manufacture and Processing of Non-ferrous Metals
H_9	Manufacture of Furniture	H_{21}	Manufacture of Metal Products
H_{10}	Manufacture of Paper and Paper Products	H_{22}	Manufacture of General Purpose Machinery
H_{11}	Printing, Reproduction of Recording Media	H_{23}	Manufacture of Artwork, Other Manufacture
H_{12}	Manufacture of Articles for Culture, Education and Sport Activity		

The chief tech-innovation of traditional manufacturing industries in China is to import, apply and absorb the core and patented technologies, which are mainly rooted in the technological introduction and transfer of the developed countries [3]. Many traditional manufacturing enterprises in China often look down upon digesting and absorbing the technologies while throwing a lot of money into introducing foreign technologies blindly, so some companies are lost in the bad circle "introduce - backward - reintroduce" after developing for many years. They only own a spot of the patent about key technologies, and meet with a poor tech-innovation performance [4]. In view of this reason, this paper adopts the cross-section data of "China Statistical Yearbook on Science and Technology (2010)" to estimate the tech-innovation performance of tradition manufacturing industries in China with the way of PCA, and puts forward the improving steps on account of the final calculating results .

III. DATA AND METHODOLOGY

A. Index System and Original Data

The fundamental thought of performance estimation is a ratio of output and input, namely considered multifarious technological resources as the input while considered multifarious results as the output. When it estimates the tech-innovation performance of tradition manufacturing industries in China, this paper devises the input indexes and output indexes on account of data availability and the concerned research outcomes, as displayed in Table 2.

TABLE 2 INDEX SYSTEM OF MEASURING THE TECH-INNOVATION PERFORMANCE

Input index X	Intramural Expenditures on S&T Activities(ten thousands Yuan) X_1
	Total Expenditures on R&D(ten thousands Yuan) X_2
	Personnel Engaged in S&T Activities(person) X_3
	Personnel in S&T projects(person) X_4
Output index Y	Gross Industrial Output Value of New Products(ten thousands Yuan) Y_1
	Gross Revenue from the Sale of New Products(ten thousands Yuan) Y_2
	Projects for S&T Activities(item) Y_3
	Invention Patents(item) Y_4

On account of the cross-section data of "China Statistical Yearbook on Science and Technology (2010)", the original data of the above-mentioned output and input indexes of traditional manufacturing industries in China are displayed in Table 3.

TABLE 3 INDEX VALUE OF TRADITIONAL MANUFACTURING INDUSTRIES IN CHINA

Industry	X_1	X_2	X_3	X_4	Y_1	Y_2	Y_3	Y_4
H_1	872649	39975375	42438	32130	9303111	8001268	4087	629
H_2	627235	25357163	33278	23017	5197314	4826025	3766	745
H_3	781148	37051396	37771	28628	4880853	4645039	4236	253
H_4	286605	9448529	8691	6114	3464578	3422858	1443	277
H_5	1337249	60141019	95500	74776	13194058	12654835	8661	1023
H_6	310015	13545337	22454	17416	3388443	3225255	2313	259
H_7	176249	6273519	15623	13099	2835485	2733939	2246	95
H_8	189042	8290771	14051	9625	1906106	1866262	1108	230
H_9	112413	4486156	8164	5758	1262711	1158425	745	158
H_{10}	629175	28183310	28652	21591	6418951	5851966	1776	268
H_{11}	170774	7238639	12771	10177	1297344	1267542	1407	118
H_{12}	172214	7239067	12098	9673	1189407	1127151	2064	243
H_{13}	612626	29512280	28972	20116	9205564	9324010	2308	239
H_{14}	4609985	227846377	215482	159130	30821131	29900863	18188	4116
H_{15}	616971	32372156	24091	20074	6793393	6664587	1235	231
H_{16}	688667	34737058	30600	22807	5568531	5461351	4430	257
H_{17}	725623	36422319	46926	37956	6019819	6145504	4230	711
H_{18}	1461132	60843283	92476	67248	9147644	8893444	7155	1194
H_{19}	6585616	304563891	168087	119012	57079748	57735657	10397	1400
H_{20}	2057573	99034654	83225	62831	17888271	17384212	5643	1432
H_{21}	1080863	55246781	67034	52489	9352604	8754617	6145	1219
H_{22}	3932265	216760387	238392	175867	34879755	33455469	26778	3323
H_{23}	182218	9156839	16419	13515	1645507	1638801	1811	400

Resource: China Statistical Yearbook on Science and Technology (2010)

B. *Estimating Mould*

An appropriate model will be created to make a comprehensive comparison between input indexes and output indexes according to the above index system, and then the last performance of resource distribution will be analyzed. The basic expression formula of this mould is as follows:

$$R_i = \frac{K_i}{N_i} \tag{1}$$

Inside them, $K_i = \alpha_1 K_{i1} + \alpha_2 K_{i2} + \alpha_3 K_{i3} + \alpha_4 K_{i4}$, $N_i = \beta_1 K_{i1} + \beta_2 K_{i2} + \beta_3 K_{i3} + \beta_4 K_{i4}$

K_i means the comprehensive index value of technological output of *i* industry, K_{ij} is the value of each traditional output index of *i* industry, j =1,2,3,4; α_i is the weight of each output index; N_i means the comprehensive index value of technological input of *i* industry, N_{ij} is the value of each tech-innovation input index of *i* industry, β_j is the weight of each input index.

On the basis of the above model, after endowing the proper weight, we can estimate the comprehensive value of the output indexes and input indexes each, and then make comparison to obtain the tech-innovation performance value R_i of each industry. The bigger R_i often refers to the better resource allocation performance. Further, we can make a comparison to the distinction of tech-innovation performance of each industry.

But there are two problems to be solved such as non-dimensionalizing the index value and confirming weight of each index before real estimation. The non-dimensionalization makes the index value with different units add together, and the formula is as follows:

$$ratio_{index S} = 0.1 + 0.9[(S - S_{\min})/(S_{\max} - S_{\min})] \tag{2}$$

S_{max} and S_{min} mean that the maximum and minimum of this index value each during all Chinese traditional manufacturing industries, S means the real value of the index. PCA is chosen to settle the weight in this paper. The modulus of factor loading is considered as the weight to assess every factor, and then get a total estimating value after adding up the weighted average of every factor.

IV. RESULTS

On the basis of the above-mentioned mould, this paper non-dimensionalizes the concerned index value of traditional manufacturing industries in China. On the light of the above data, we dissect four input indexes and output indexes separately with PCA, in order to verify their own weights. The PCA outcome of tech-innovation input indexes is as follows: The value of KMO and Bartlett's Test (Table 4) is 0.728, the contribution rate of the first principal component is 95.246% (Table 6), and the component matrix is as follows (Table 5):

TABLE 4 KMO AND BARTLETT'S TEST

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.728
Bartlett's Test of Sphericity	Approx. Chi-Square	283.803
	df	6
	Sig.	.000

Extraction Method: Principal Component Analysis.

TABLE 5 COMPONENT MATRIX[a]

	Component
	1
X2	.969
X3	.982
X4	.979
X1	.974

a. 1 components extracted.

TABLE 6 TOTAL VARIANCE EXPLAINED

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	3.810	95.246	95.246	3.810	95.246	95.246
2	.188	4.693	99.939			
3	.002	.051	99.989			
4	.000	.011	100.000			

Extraction Method: Principal Component Analysis.

On account of only one principal component, their weights can be obtained only through making the load coefficient of input index divide by the sum of all the coefficients, the calculating result is: $\beta_1 = 0.2495$, $\beta_2 = 0.2482$, $\beta_3 = 0.2515$, $\beta_4 = 0.2508$.

Similarly, the value of KMO and Bartlett's Test of output indexes is 0.678, the contribution rate of the first principal component of output indexes is 84.764%, and the weights of output indexes including: $\alpha_1 = 0.2439, \alpha_2 = 0.2548, \alpha_3 = 0.2520, \alpha_4 = 0.2493$. Now we can figure out the value of tech-innovation performance R_i of every traditional manufacturing industry in China, and the outcome is displayed in Table 8:

TABLE 8 VALUE OF TECH-INNOVATION PERFORMANCE R_i OF TRADITIONAL MANUFACTURING INDUSTRIES IN CHINA

Industry	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8	H_9
E_i	0.9872	1.0680	0.8119	1.2141	0.8706	0.9777	1.0448	1.0006	1.0394
Industry	H_{10}	H_{11}	H_{12}	H_{13}	H_{14}	H_{15}	H_{16}	H_{17}	H_{18}
E_i	0.8957	0.9436	1.0578	1.0617	0.8550	0.9037	0.9398	0.9033	0.7925
Industry	H_{19}	H_{20}	H_{21}	H_{22}	H_{23}				
E_i	0.8250	0.9002	0.9366	0.9141	1.0472				

V. CONCLUSION

(1) As a whole, it is far away from satisfaction for the tech-innovation performance of traditional manufacturing industry in China. Only 8 of 23 traditional manufacturing industries in China have the tech-innovation performance beyond 1, and there are even six traditional manufacturing industries in China whose tech-innovation performance is beneath 0.9.

(2) There is great difference in innovative resource capacity and disposing performance during all kinds of traditional manufacturing industries in China. Further, there is a relationship of inverse proportion between innovative resource capacity and tech-innovation performance of traditional manufacturing industries in China, and the less innovative resource capacity often leads to higher tech-innovation performance while the more innovative resource capacity often brings poorer tech-innovation performance. As an example, some traditional manufacturing industries such as H_2, H_4, H_7, H_8, H_9, H_{12}, H_{13} and H_{23} own the least innovative resource but produce the highest tech-innovation performance, while other traditional manufacturing industries such as H_3, H_5, H_{10}, H_{14}, H_{18} and H_{19} hold the most innovative resource but get the poorest tech-innovation performance.

(3) Multifarious input for technological innovation should be added up so as to improve the competitiveness of traditional manufacturing industries in China. Improving the tech-innovation performance of traditional manufacturing industries in China does not rest with increasing innovation input, but it is the most important that we focus on providing good market environment for innovation output to contribute the industrialization of innovative fruit and the commercialization of innovative products.

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