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The evaluation and promotion countermeasures of innovation ability of manufacturing industry in Wuhan

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ABSTRACT

The development of manufacturing industry plays a vital role in promoting the development of Wuhan city. Explore the problems existing in the development of Wuhan manufacturing industry has important practical significance. On the basis of depth analysis of existing research results about evaluation of regional manufacturing industry innovation ability, together with the present situation of the development of the manufacturing industries in Wuhan, this paper set up an innovative factor analysis model consisted of manufacturing investment ability, manufacturing development ability and manufacturing production ability, which is more comprehensive than before; then for the first time used SPSS software to evaluate the innovation ability of manufacturing industry in Wuhan, concluding the industry rankings of manufacturing by their scores of innovation abilities; finally put forward the suggestions and countermeasures to improve the innovation ability of manufacturing industry in Wuhan, which can provide reference for Wuhan manufacturing related department to make decisions.

KEYWORDS

Manufacturing industry; Countermeasures; Wuhan; Innovation ability; Factor analysis.

INTRODUCTION

After Beijing, Shanghai, Tianjin, Chongqing, Guangzhou had become Chinese national central city, Wuhan also established to “renaissance” “big Wuhan”, built Wuhan into Chinese national central city, the national center for advanced manufacturing industry, to boost the rapid development of Chinese central region. The output value of manufacturing industrial enterprises in Wuhan above designated size in 2013 reached 920.64 billion Yuan, accounting for 88.57% of the gross value of industrial output of enterprises above designated size (1039.41 billion Yuan). The output value of manufacturing industrial enterprises in Wuhan reached 880.46 billion Yuan, accounting for 94.14% of the gross value of industrial output of enterprises (935.30 billion Yuan). The manufacturing industrial enterprises in Wuhan in 2012 was 37.25 billion Yuan, accounting for 96.36% of total profits in the total industrial enterprise (38.65 billion Yuan). In High-tech industries, manufacturing enterprise had an industrial added value of 118.07 billion Yuan in 2012, accounting for 99.89% of the gross industrial increase (118.20 billion Yuan), 30.51% of the added value of the second industry (386.96 billion Yuan), 14.75% of regional GDP (800.38 billion); The manufacturing industry in Wuhan was the important parts of its industry; its rapid development had a huge role in building Wuhan into national central city.

In the eighteenth national congress of the communist party of China, the policy was clearly proposed that "science and technology innovation was the strategic support to improve social productive forces and overall national strength, must be placed in the core position of the national development.” As important support strength of Wuhan industry, the manufacturing industry also faced a much-needed key issue to improve innovation ability.

The academies in domestic and overseas had done much research on innovation theory and evaluation of the innovational ability of manufacturing industry. As early as in 1912, Joseph Schumpeter for the first time put forward the ideas and concepts of technology innovation in the book "the theory of economic development”. Considering that innovation referred to the new combination of production factors finished by entrepreneurs, the purpose of innovation was to get the potential profits. He thought the invention was a kind of new concept or experiment, the technological innovation was to put the invention or scientific and technological achievements into production field, creating necessary commodity of market[1]. After that, the representative of American economist, Solow[2] held that technology like labor, capital, were the important factors of economic growth, technological innovation was the endogenous variable of economic growth. Followed by them, many scholars had also done a lot of empirical research on technology innovation. Such as Brown[3] (1957) published in the journal of economics in “the innovation of the machine tool industry”.

As for the study of the technology theory innovation, Fu Jiaji etc[4] had put forward the detailed definition of enterprise innovation from the aspects of factors of production and market of enterprise in as early as 1989. Yuan Deyu[5] (1992) put forward that technological innovation was the process of technical transformation, in the case that technology principle kept indeclinable. Huang Zhiqiang[6] (2001) argued that, innovation was a social action that enterprise combined new science & new technology and economic to make it produce economical and social benefit, which need a long socialization process. As for the evaluation of technology innovation, after questionnaire investigation and data analysis of 213 innovative manufacturing enterprises in the Beijing area. Sales force automation (SFA) method was applied to evaluate the efficiency of China's manufacturing industry innovation by Han Jing[7] (2010). She deeply discussed the influence factors of innovation efficiency, then gave policy suggestions to promote China manufacturing industries based on the evaluation to innovation efficiency of China manufacturing industry in the 2003-2007. Zhang Deyuan, Zhang Jiexi[8] (2013) built agricultural technological innovation ability evaluation index system consisted of the technology innovation environment, technological innovation input and output of technological innovation by selecting representative 14 original index in each city in Anhui province, then used the method of factor analysis and cluster analysis to evaluate and classify the municipal agricultural technological innovation ability, and put forward related countermeasure to improve the innovative ability of urban agriculture.

In the existing research results, the empirical analysis mainly had used the method of factor analysis, analytic hierarchy process (AHP), SFA method, and DEA method. And in the process of analysis, rigor and the rationality of index selection played an important role. Based on the analysis of the principle of index selection, this article established an evaluation model of manufacturing industry innovation ability in factor analysis method; put forward an empirical basis for targeted suggestions and countermeasures, through in-depth analysis and study of the factor evaluation of Wuhan manufacturing.

THE CONSTRUCTION OF EVALUATION INDEX SYSTEM OF INNOVATION ABILITY OF MANUFACTURING INDUSTRY IN WUHAN

The principles to evaluation innovation ability of manufacturing industry in Wuhan

Establishing an index system to evaluation the innovation ability of regional manufacturing industry, scientific and reasonable choice of evaluation index was the key. In the selection of index, three principles should be carried out:

(1) Scientific Principle: The setting of index system and the selection of indicators of regional manufacturing industry innovation ability must be consistent.

(2) Operability Principle: The setting of index system should be clearly defined; the indicators must have accessibility. Too little data will be enlarged before used.

(3) Comparability Principle. Quantitative data should be more applicable to make a comparison between regions.

The construction of evaluation index system of innovation ability of manufacturing industry in Wuhan

In addition, according to the psychological understanding of the word "ability", ability did not behave on knowledge or skills, but on how to master and apply the knowledge and skills dynamically. Ability was not referring to the existing achievements; it was the individual's potential and possibility. Combining these two points, this paper argued that the meaning of "ability" had three aspects: potential ability, application ability and ability to effect. We can call all kinds of resources input in manufacturing as innovation potential ability, their innovation ability was a kind of potential form, only when enterprises used these resources to research and developed (using skills) to realize the goal of innovation (ability to effort) was the ability of innovation ability in the true sense.

Based on the above principles and psychological perception of ability, evaluation index system of innovation ability of manufacturing industry in Wuhan should include investment capability of innovative resource inputs into manufacturing industry, research and development capabilities of manufacturing industry, innovative output ability of manufacturing industry. At this point, this paper got the evaluation index system of innovation ability of manufacturing industry in Wuhan.

TABLE 1 : Evaluation index system of innovation ability of manufacturing industry in Wuhan

Category	Index	Calculation Method
Investment Capability of Innovative Resource Inputs into Manufacturing Industry	R&D Input Intensity of Resources(X1)	Expenditure on R&D/ Sales Revenue of Products
	R&D Input Intensity of Human Capital(X2)	Full-time Equivalent of R&D Personnel/Average Staff and Workers
	R&D Input Intensity of Institutions(X3)	Percentage of Enterprises Having R&D Activities to Total Number of Enterprises
Research and Development Capabilities of Manufacturing Industry	The Number of Items Per One Thousand People(X4)	R&D Projects*1000/ Average Staff and Workers
	New Product Development Strength (X5)	Expenditure on New Products Development/ Expenditure on R&D
	The Number of Invention Patents Per One Thousand People(X6)	Inventions In Force*1000/ Average Staff and Workers
	Sales Ability of New Product(X7)	Sales Revenue of New Products/ Sales Revenue of Products
Innovative Output Ability of Manufacturing Industry	Expert Capability of New Product(X8)	Export of New Products / Sales Revenue of New Products
	Labor Productivity of New Product(X9)	Output of New Products/ Average Staff and Workers

RESEARCH ON INNOVATION OF MANUFACTURING INDUSTRY IN WUHAN BASED ON FACTOR ANALYSIS

The analyzed object of wuhan manufacturing industry innovation based on factor analysis

Based on the evaluation index system in the TABLE 1, this paper selected the 30 manufacturing industries in Wuhan in 2012 and 2011 as the research objects.

The procedure of problem analysis of wuhan manufacturing industry innovation based on factor analysis

TABLE 2 : Contribution of three principal component factors

Total Variance Explained							
Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Dimension0	1	3.394	37.712	37.712	3.394	37.712	37.712
	2	1.705	18.941	56.653	1.705	18.941	56.653
	3	1.174	13.046	69.699	1.174	13.046	69.699
	4	.911	10.122	79.821			
	5	.683	7.592	87.413			
	6	.458	5.088	92.501			
	7	.338	3.755	96.255			
	8	.223	2.473	98.728			
	9	.114	1.272	100.000			

Data sources: Obtained by SPSS software based on the relevant data of Wuhan science and technology statistical yearbook 2013.

Firstly, standardize data processing, in order to eliminate the interference of different dimensions.

Secondly, test the standardized data in Bartlett spherical inspection (Bartlett Test of Sphericity) and KMO (Kaiser - Meyer Olkin). Results showed that the thrust spherical approximate chi-square test value was 103.04, concomitant probability was less than the significance level of 0.05, KMO test value was close to 0.6, which illustrate that the data was suitable for factor analysis.

Thirdly, construct a factor model, and t set it as the following.

(1) Set analysis method of factor selection method as main component;

(2) Adopt the method of orthogonal rotation to makes the factor variable is more interpretability;

(3) Set those whose eigenvalue is greater than 1 as public factor.

By using SPSS18.0 statistical software to deal with those data in 30 Wuhan manufacturing industries, we calculated the TABLE 2. The accumulative contribution rate of three principal component factors was 69.70%, which mostly covered all information of the nine indicators express.

The rotating factor loading matrix in TABLE 3 showed that:

The first main factor had larger load factor on these four indicators, x2(R&D input intensity of human capital), x3, x4 and x6. Based on the characteristics of the four indicators, we can name the first principal component factor F1 as R&D input ability factor.

The second main factor had larger load factor on these three indicators, x1, x7 and x8. Based on the characteristics of the three indicators, we can name the second principal component factor F2 as R&D ability factor for New Products.

The third main factor had larger load factor on x9. Because the index was obtained through new product output value compared with the number of staff, comprehensively reflected the level of innovation aspects, Based on the characteristics of the indicator, we can name the first principal component factor F1 as R&D input ability factor.

In addition, by analyzing the accumulating contribution rate of the three main composition factors, we can know that the accumulating contribution rate of the first principal component factor F1 (R&D input ability factor) was 37.71%, which was the most important factors that affected the Wuhan manufacturing industry innovation ability. The accumulating contribution rate of the first principal component factor F2 (R&D input ability factor) was 18.94%. The accumulating contribution rate of the third principal component factor F3 (R&D input ability factor) was 13.05%.

TABLE 3 : Factor loading matrix

Component Matrix			
	Component		
	1	2	3
R&D Input Intensity of Resources(X1)	-0.171	0.691	-0.532
R&D Input Intensity of Human Capital(X2)	0.891	0.091	-0.055
R&D Input Intensity of Institutions(X3)	0.845	0.157	-0.268
The Number of Items Per One Thousand People(X4)	0.893	-0.019	-0.113
New Product Development Strength (X5)	-0.244	-0.320	0.131
The Number of Invention Patents Per One Thousand People(X6)	0.836	0.086	0.122
Sales Ability of New Product(X7)	-0.164	0.848	0.100
R&D Input Intensity of Resources(X1)	-0.105	0.602	0.647
R&D Input Intensity of Human Capital(X2)	0.510	-0.051	0.585

Fourthly, calculate the score of factors variables. Equation for the model scores was:

$$F = 0.3771F_1 + 0.18941F_2 + 0.13046F_3$$

Sorting innovation ability of manufacturing industry in Wuhan based on factor analysis method

(1) Sorting innovation ability of manufacturing industry in Wuhan in 2012

By calculate the factor scores of 30 Wuhan manufacturing industries in 2012, we got the ranking.

(2)Sorting Wuhan manufacturing industry in 2011 by their innovation ability

In the same way, we also had analyses the innovation ability of manufacturing industries in 2011 in Wuhan by using SPSS18.0 statistical analysis software, then got the ranking easily.

ANALYSIS OF INNOVATION ABILITY OF MANUFACTURING INDUSTRY IN WUHAN

Analysis of influence factors of innovation ability of manufacturing industry in Wuhan

In the evaluation index system of innovation ability of manufacturing industry in Wuhan in 2012, the accumulating contribution rate of R&D input factor reached 37.71%, forming the biggest influence. And this factor had larger load on these

four indicators, x2, x3, x4 and x6. This fully showed that, relative to the research and development capabilities and production capacity, innovation investment ability was the most important factors influencing the innovation ability of manufacturing industry in Wuhan. Therefore, manufacturing industries should increase R&D investment in human and institutions, at the same time pay attention to the research and development projects.

And those indicators of new products of manufacturing industry were also the important factors of enterprises should cause enough attention to. Enterprises should break through the traditional habit and management; fully use the existing R&D resources, focus on development, production, sales and export of new product.

Analysis of sorting result of innovation ability of manufacturing industry in Wuhan

From TABLE 4, we found that innovation ability in the fields of the iron and steel, electronics, machinery manufacturing, biochemical industry, had always been the top, and followed by the traditional labor-intensive industries. Investigate its reason, first of all, as a pillar industry in the field of industry, Wuhan government had paid great attention to the manpower, funds and investing institutions, as well as the development of the related preferential policies. As in 2012, Wuhan municipal government spent 3.636 billion Yuan on computer, communications, and other electronic equipment manufacturing, accounting for the entire manufacturing government spending (12.674 billion Yuan) of 28.69%, and investment of the last ten industries in innovation ability ranking the government spent is 044 million Yuan, the corresponding proportion was only 0.81%. And, how much attention enterprises pay to R&D activities and the development of new product in the industries will determine their innovation ability. As in the R&D activities of the enterprise, there were 270 companies going R&D in those ranking in top 10 in scores of innovation capability, while in those industries innovation ability ranks in the last ten in 2012, the number was only 19. In regard to the development of new products, industries ranking in the top 10 in scores of innovation capability had 2555 items of new product development project, accounting for 72.22% of the total items of new product development project (3538), while the corresponding proportion of the industries rank in the last 10 is less than 2%.

TABLE 4 : Comparison of score ranking of manufacturing industry

Ranking	2011	2012
1	Stationery, Education and Sports Goods	Ordinary Machinery Manufacturing
2	Medical and pharmaceutical Products	Medical and pharmaceutical Products
3	Manufacture of Rubber and Plastic	Tobacco Processing
4	Special Purpose Equipment Manufacturing	Telecommunication Equipment, Computer and Other Electronic Equipment Manufacturing
5	Manufacture of Motor Vehicles	Manufacture of Railway Equipment, Ships, Aerospace
6	Nonmetal Material Products	Special Purpose Equipment Manufacturing
7	Electric Machinery and Equipment	Instruments, Meters, Cultural and Official Machinery
8	Tobacco Processing	Textile, Garments, Shoes and Hats Products
9	Telecommunication Equipment, Computer and Other Electronic Equipment Manufacturing	Electric Machinery and Equipment
10	Instruments, Meters, Cultural and Official Machinery	Raw Chemical Material and Chemical Products

In addition, it was worth noting that Ordinary Machinery Manufacturing fared poorly in 2011, got the highest score in the whole manufacturing industry in 2012. By observing the index data values, we knew that there exists obvious increase in the index data values of Inventions in Force, output of new products, Sales Revenue of New Products, Export of New Products. Thus, we can get the conclusion that the rapid development of new products driving by Inventions in Force was the key to promote the innovative ability of industries.

Some advices to improve the innovation ability of Wuhan manufacturing

From the result of factor analysis, it's unbalanced on the innovation ability of Wuhan manufacturing industries: generally of knowledge- intensive industries had higher innovation ability while the traditional labor-intensive and capital-intensive industries got into the development bottleneck, need to change the traditional way of development. Based on these facts, this paper would put forward some advices to improve innovation ability of manufacturing industries in Wuhan.

Firstly, enterprises should focus on breaking through the key technology and eliminate the bottleneck in the improvement of competitiveness. Through the introduction of new technology, enterprises should actively transform and upgrade traditional industries; use advanced applicable technology; accelerate the technological transformation of traditional industries; continue to close down backward production facilities in accordance with the law; vigorously implement the brand strategy to make a group of enterprises have higher visibility and competitiveness of Wuhan brand in the international market. At the same time, enterprises should accelerate the cultivation of emerging industries according to characteristics and nature of different industries.

Secondly, enterprises should fully analyze development status of manufacturing, optimize resources of science and technology, and occupy the commanding heights of technological innovation. First of all, enterprises should promote Effective factors of agglomeration. On the one hand, enterprises should make full use of advantages in Wuhan; deepen the industry-university-institute cooperation development mode, providing a wider range of science and technology project resources for the development of Wuhan region. On the other hand, pool resources to overcome major S&T projects, and strive to form a group with independent intellectual property rights and larger market of emerging and high-tech industries. In addition, strengthen the organic connection between science and technology innovation platform; further strengthen the support of science and technology business incubators, accelerator and service, make it really go into a base for transformation of scientific and technological achievements, business enterprise growth, innovation, entrepreneurial talent training.

Finally, the government should increase R&D personnel, institutions and investment funds to provide enough power for promote manufacturing innovation ability. R&D factor is the potential basis for the development of manufacturing industry innovation ability. The government can take many measures to increase the R&D input in manufacturing enterprise. On the one hand, come up with some policies to provide institutional guarantee for enterprises setting up R&D institutions, and give R&D funds in terms of funding and support. On the other hand, mobilize some universities and academies in Wuhan to convey high-tech talents with research and development ability to the research and development institutions of enterprise to improve the overall strength of R&D institutions of manufacturing enterprises.

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