Evaluation on the Science & Technology Innovation Capability of Equipment Manufacturing Industry in China

Li Sui

School of Statistics and Applied Mathematics, Anhui University of Finance and Economics, Bengbu 233041, China

sui2007nuaa@163.com

Abstract

The science & technology innovation capability is the significant factor that insures sustainable S&T innovation of equipment manufacturing industry. By the method of factor analysis, the article summarizes three factors which make up the S&T innovation capability of equipment manufacturing industry. In which, the S&T innovation resource input of equipment manufacturing industry is the most important factor, the second is industrialization of innovation resources and diffusivity, the third is supporting environment that is propitious to innovation. According to the score, we find the S&T innovation capability of equipment manufacturing industry from 2005 to 2016 has been upgrading continuously.

Keywords

S&T innovation capability, equipment manufacturing industry, factor analysis.

1. Introduction

Currently, China is in the period of the accelerating progress in industrialiazation, the development of industries require more and more resources. But, in the long run, it is difficult that the limited resources ensure sustainable economic development. In order to solve conflict of the sustainable economic development and the limited resources, China needs high tech and advanced industries to overcome the restriction of resources and enhances capital technical constitution and improves the efficiency of using resources. Equipment manufacturing industry is the knowledge-intensive and technology-intensive industry and takes on the characters including high tempo and extensive spreading effect .by supplying machinery and equipment to other industries. Science & Technology innovation of equipment manufacturing industry not only boosts core competency of equipment manufacturing industry but also causes correlated industries innovate through spreading of new knowledge and new arts and crafts.

The S&T innovation capability of equipment manufacturing industry is the significant factor that insure sustainable S&T innovation. On the one hand it includes the realistic capability of transforming knowledge into new products and new arts and crafts, on the other hand it covers impact on correlated industries innovation. The S&T innovation capability of equipment manufacturing industry bears systematicness, foresightedness and dynamic characteristic, reflecting the ability of walking up to the future. Broadly speaking, there are three aspects which make up of the S&T innovation capability of equipment manufacturing industry: (1) technology innovation capability that reflects basic innovation strength; (2) transforming capability that reflects new knowledge is absorbed and transformed into realistic productivity; (3) supporting capability that help to exploit potential innovation capability of equipment manufacturing industry.

2. An Evaluation Index System of Science & Technology Innovation Capability of Equipment Manufacturing Industry in China

According to the primary constitutive factors of S&T innovation capability of equipment manufacturing industry, selecting and designing index will consider three aspects----the S&T innovation resource input of equipment manufacturing industry, industrialization of innovation

resources and diffusivity, supporting environment that is propitious to innovation. Thereinto, industrialization of innovation resources and diffusivity of equipment manufacturing industry covers two meanings: One is the ability of industrializing new technology and new arts and crafts in equipment manufacturing industry, which reflects how knowledge and technology will be translated into productivity. The other is the ability of transmitting the S&T innovation among correlated industries through spreading effect, which can affect the S&T innovation of the whole economy. The angle of view expands the whole economy that is based on the industrial dynamic technology relations. Supporting environment includes economic strength of equipment manufacturing industry and relational industry policy. Considering S&T innovation capability of equipment manufacturing industry take on the characters of durative and extensive correlation, we selected 19 original index to reflect them. They are listed in table 1.

Table 1. Original index reflecting the S&T innovation capability of equipment manufacturing industry

variable	original index	variable	original index
X1	R&D expenditure intensity	X11	contribution rate of technique progress of equipment manufacturing industry
X2	the ratio of S&T personnel to the employed in equipment manufacturing industry	X12	equipment manufacturing industrial technological induction
X3	the ratio of R&D personnel to the employed in equipment manufacturing industry	X13	equipment manufacturing industrial technological affection
X4	R&D institution density of equipment manufacturing enterprise	X14	the ratio of new product sales income to product sales income
X5	patent possession per person	X15	comparative advantage of equipment manufacturing industrial labour productivity
X6	the ratio of expenditure exploiting new product to S&T expenditure	X16	the ratio of R&D expenditure to GDP
X7	the ratio of engineering personnel to the employed	X17	the concentration of equipment manufacturing industry
X8	the ratio of micro-electronics equipment value to the fixed assets value	X18	equipment manufacturing industrial value added increase rate
X9	the ratio of assimilation expenditure in technology to the assimilation expenditure in technology	X19	comparative competitive advantage of equipment manufacturing industrial export
X10	the ratio of investment in the technical transformation to the investment in the fixed assets		

In which, R&D institution density of equipment manufacturing enterprise(X4)is the ratio of the number of equipment manufacturing enterprise possessing R&D institution to the number of equipment manufacturing enterprise. Calculating contribution rate of technique progress of equipment manufacturing industry uses Cobb-Douglas production function: $Y=AK\alpha L\beta$,Y is output, A is technological progress, K is capital, L is labour,$\alpha$is the output elasticity of capital,$\beta$is the output elasticity of labour. Contribution rate of technique progress of equipment manufacturing industry(X11)=y-αk-βl, y,k and l separately present the growth rate of output, capital and labour. Equipment manufacturing industrial technological induction(X12)= contribution rate of technique progress of high-tech industry×induction coefficient of equipment manufacturing industry. Equipment manufacturing industrial technological affection(X13)= contribution rate of technique

progress of equipment manufacturing industry×affection coefficient of equipment manufacturing industry. comparative advantage of equipment manufacturing industrial labour productivity (X15)= equipment manufacturing industrial labour productivity / regional labour productivity. The concentration of equipment manufacturing industry(X17)= the number of large and mediumsized h equipment manufacturing enterprise /the number of equipment manufacturing enterprise. comparative competitive advantage of equipment manufacturing industrial export(X19)=(equipment manufacturing industrial export figures /regional export figures)×(equipment manufacturing industrial GDP/regional GDP

3. Evaluation on the Science & Technology Innovation Capability of Equipment Manufacturing Industry in China

According to the datum from 2005 to 2016, we used factor analysis to evaluate the S&T innovation capability of equipment manufacturing industry in China. Original datum come from yearbooks and the ministry of S&T web.

We firstly test datum through KMO and Bartlett's test of sphericity to make sure they are fit for factor analysis. The result of KMO is 0.816, the Approx. Chi-square of Bartlett's test of sphericity is 876.952, andχ^2 marked probability is 0.0000,.The datum are relative and fit for factor analysis. We extracted common factors through principal component analysis and used varimax to get rotated component matrix. Judging from total variance explained (Table 2),we extracted 3 common factors. These 3 common factors retain the original information of 86.562 percent. By rotation converged in 6 iterations can gain rotated component matrix, thus we can find common factors with more clear meaning (Table 3).

According to the rotated component matrix, the index with large positive coefficient in common factor 1 includes R&D expenditure intensity(*X1*), the ratio of S&T personnel to the employed in equipment manufacturing industry(*X2*), the ratio of R&D personnel to the employed in equipment manufacturing industry(*X3*), R&D institution density of equipment manufacturing enterprise(*X4*), patent possession per person(*X5*), the ratio of expenditure exploiting new product to S&T expenditure(*X6*), the ratio of engineering personnel to the employed(*X7*), the ratio of micro-electronics equipment value to the fixed assets value(*X8*), the ratio of assimilation expenditure in technology to the assimilation expenditure in technology(*X9*), comparative advantage of equipment manufacturing industrial labour productivity(*X15*).These index show the intensity of innovation resource input production in the form of patent. So we named factor 1 the S&T innovation resource input of equipment manufacturing industry. The index with large positive coefficient in common factor 2 includes the ratio of investment in the technical transformation to the investment in the fixed ass(*X10)*, contribution rate of technique progress of equipment manufacturing industry(*X11*), equipment manufacturing industrial technological induction(*X12*), equipment manufacturing industrial technological affection(*X13*), the ratio of new product sales income to product sales income(*X14)*. These index show the ability of innovation production being transformed into production capacity and driving technological progress of correlated industries. So we named factor 2 industrialization of innovation resources and diffusivity. The index with large positive coefficient in common factor 3 includes the ratio of R&D expenditure to GDP(*X16*), the concentration of equipment manufacturing industry(*X17*), equipment manufacturing industrial value added increase rate(*X18*), comparative competitive advantage of equipment manufacturing industrial export (*X19*). These index show the factors that influence the S&T innovation of equipment manufacturing industry involved market structure, economic strength and regional innovation circumstances. So we named factor 3 supporting environment that is propitious to innovation.

According to the total variance explained, factor 1 is the most important factor, its contribution to the S&T innovation capability of equipment manufacturing industry reached 50.037 percent. The next is industrialization of innovation resources and diffusivity, its contribution to the S&T innovation capability of equipment manufacturing industry reached 24.953 percent. The contribution of supporting environment that is propitious to innovation reached 11.572 percent. According to the

component score coefficient matrix, we can compute the scores of the S&T innovation capability of equipment manufacturing industry in China from 2005 to 2016(Table 4). The expressions is

$$W_i = a_1F_1 + a_2F_2 + \cdots + a_pF_p \Big/ \sum_{i=1}^{p} a_i$$

In which $a_i = \lambda_i \Big/ \sum_{i=1}^{p} \lambda_i$, λ_i is the contribution of variance.

Table 2. Total Variance Explained

Extraction Sums of Squared Loadings		Rotation Sums of Squared Loadings	
% of Variance	Cumulative %	% of Variance	Cumulative %
61.246	51.246	50.037	50.037
16.758	68.004	24.953	74.990
8.558	86.562	11.572	86.562

Judging from the scores, the S&T innovation capability of equipment manufacturing industry fluctuated in some year, but its trend is advancing. In detail, the factor with the most contribution in these three factors is S&T innovation resource input of equipment manufacturing industry, which has been improving. Its average score was –0.3749 in the period of 2005—2010, which mounted up to 0.7103 in the period of 2011—2016. The same trend also appeared the other two factors. The score of industrialization of innovation resources and diffusivity reached 1.8471 in the year of 2016 from –1.4926 in the year of 2005. Supporting environment that is propitious to innovation also has been meliorating. The score in the year of 2005 was –1.1876, which continuously advanced and reached 1.8481 in the year of 2016. It is foreseeable that investment in research and development of equipment manufacturing industry continues to increase with government and the community attaching great importance to the S&T innovation. R&D investment will bring about the synchronous rapid growth in S&T innovation capacity. In order to achieve sustained improvement in S&T innovation capacity, besides increasing investment, it is more important to focus on enhancing the ability of industrialization of innovation resources and transmitting the advanced technology among industries.

Table 3. Rotated Component Matrix

variable	original index	Common component	Common component	Common component
		F1	F1	F1
X1	R&D expenditure intensity	0.9322	-0.2746	0.2199
X2	the ratio of S&T personnel to the employed in equipment manufacturing industry	0.9434	-0.2847	0.0172
X3	the ratio of R&D personnel to the employed in equipment manufacturing industry	0.8623	-0.2483	0.3344
X4	R&D institution density of equipment manufacturing enterprise	0.9322	-0.2746	0.2199
X5	patent possession per person	0.8025	-0.6049	-0.1003
X6	the ratio of expenditure exploiting new product to S&T expenditure	0.7671	-0.6465	0.0436
X7	the ratio of engineering personnel to the employed	0.9951	-0.0952	-0.0547

X8	the ratio of micro-electronics equipment value to the fixed assets value	0.7985	0.6211	-0.0537
X9	the ratio of assimilation expenditure in technology to the assimilation expenditure in technology	0.7812	0.2574	-0.2837
X10	the ratio of investment in the technical transformation to the investment in the fixed assets	-0.7488	0.6617	-0.0790
X11	contribution rate of technique progress of equipment manufacturing industry	-0.6556	0.6019	0.2108
X12	equipment manufacturing industrial technological induction	-0.1662	0.9667	-0.1591
X13	equipment manufacturing industrial technological affection	-0.5603	0.7367	-0.0811
X14	the ratio of new product sales income to product sales income	-0.7792	0.6191	-0.0527
X15	comparative advantage of equipment manufacturing industrial labour productivity	0.9069	0.4185	-0.0740
X16	the ratio of R&D expenditure to GDP	0.5522	-0.1885	0.6880
X17	the concentration of equipment manufacturing industry	0.1723	-0.5016	0.5664
X18	equipment manufacturing industrial value added increase rate	0.0973	-0.0578	0.8766
X19	comparative competitive advantage of equipment manufacturing industrial export	0.0973	-0.0578	0.8092

Table 4. Scores of the S&T innovation capability from 2005 to 2016

year	Score of factor 1	Score of factor 2	Score of factor 3	Score of the s & t innovation capability of equipment manufacturing industry
2005	-0.9160	-1.4926	-1.1876	-0.9682
2006	-0.3374	-0.5310	-0.3384	-0.3405
2007	-0.4063	-0.3405	-0.3395	-0.3276
2008	-0.7802	-0.4104	-0.3364	-0.5317
2009	0.5289	-0.3384	-0.5300	0.1189
2010	-0.3384	-0.3395	0.3688	-0.2114
2011	-0.4084	0.3678	0.4094	-0.0652
2012	0.3699	-0.4094	0.4073	0.1301
2013	0.3354	0.5300	0.5289	0.3613
2014	0.5279	1.4916	1.5868	0.8200
2015	1.5878	1.5858	1.4905	1.3627
2016	1.8491	1.8471	1.8481	1.6000

Table 5. Three Scheme comparing

Numble	Scheme 1	Scheme 2	Scheme 3
1	456	456	123
2	789	213	644
3	213	654	649

4. Conclusion

Equipment manufacturing industry is in the pivotal sectors in the industrial chain and has direct or indirect technological contact with other sections. Equipment manufacturing industry can bring along industrial formation and development. That is to say, the S&T innovation of equipment manufacturing industry can bring chain reaction among industries. To upgrade the S&T innovation capability, firstly equipment manufacturing enterprise depend on opening up the interior innovation resources, secondly equipment manufacturing enterprise depend on transforming innovation production by producing in large scale and devoting final product into market. At the same time, equipment manufacturing diffusion among industries can advance technological progress. Additionally, the scale of equipment manufacturing enterprise and competitive power will influence the S&T innovation capability.

References

[1] JIN Bei. The Position and Role of High-tech in China's Industrial Development [J]. China Industrial Economy ,2003,12:5-10(In Chinese).

[2] WANG Fang-sheng, JIANG Fu. Study on China's Capabilities of Industrial Technological Innovation [J]. Commercial Research ,2005,01:85-87(In Chinese).

[3] HUANG Tao-zhen, REN Shu-lin. Technology Innovation in China s Industry and Countermeasures [J]. Productivity Research, 2006,03:158-172(In Chinese).

[4] CHEN Ao. The Empirical Analysis on Influence of Technological Innovation Capacity s Difference in China s Industry [J]. Science of Science and Management of S.& T ,2007, 11:81-84 (In Chinese).

[5] WANG Zhangbao, LI Lei. The Gray Relevant Analysis of Technique Innovation Ability and Industry Competition Ability in Chinese Manufacturing Industry [J]. Science of Science and Management of S.& T ,2007,07:38-42(In Chinese).