# The Evaluation of the Innovation Capability of China's High-Tech Industries

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**Abstract**

This essay combines the factor analysis with the characteristics of high-tech industries, and makes comparison among China's 5 major categories of high-tech industrial innovation capacity. High-tech industrial innovation capability assessment model is built to evaluate the current development of China's high-tech industry innovation capability, analyze the innovation capacity of each high-tech industry in China, and provide suggestions to increase the innovation capability of high-tech industries.

**Keywords**: High-tech industries, Innovation capability, Factor Analysis

## 1. Introduction

Since 1960s, the rise of high-tech industry has had a profound impact on the structure of world economy, politics and military affairs. The development of high-tech industry has become one of the important indicators to measure a nation's comprehensive national strength. The rapid development of a national economy can not be separated from of the high-tech industries. Various sectors in traditional industries involve high technology. The rapid emergence of high-tech industry has become the world's most vibrant point of economic growth as well as the leading factor of growth of social wealth. The development of high-tech industry plays an essential role in the aspect of national security. Innovative is one of the most important characteristic of High-tech industry. Innovation capability directly determines the level of a country's comprehensive national strength.

The study of the evaluation of innovation capability in high-tech industries is relatively small both at home and abroad. Iuan-Yuan, Lu Chie-Bein, ChenChun-Hsien Wang (2007) used AHP method to determine the weight of the factors of innovation performance, and exerted fuzzy theory to evaluate the innovation capability of companies in high-tech industries. Wei Jiang (2002) holds the view that innovation capability is the integrated reflection of R&D, production preparation, marketing and management. Ding Weiguo (2002)took twelve indicators to evaluate innovation capability, including the proportion of R&D funding accounting for sales revenue, the proportion of R&D personnel accounting for technical personnel, the proportion of staff with bachelor degree or above, export revenue, the proportion of senior staff accounting for the total employees, the proportion of high-tech products sales, economic added value, the current asset turnover rate, and taxation generated by per capita, the ratio of return on equity, asset-liability ratio, total asset turnover rate and so on.

## 2. Factor Analysis Model of High-tech Industry Innovation Capability

Factor analysis method could guarantee the least missing of original information. k(k<j)main factors irrelative to each other are drawn from j original indexes according to appointed contribution rate. In this way we can represent their inner correlation, solve the problems of relativity and index weighing, and simplify the evaluation index (reduce dimension). What's more, by using factor analysis method, the variance's contribution rate of every factor been drawn can be regarded as the weight of the evaluation function, based on which the innovation capability of high-tech industries is evaluated. Therefore, this paper exerts factor analysis method and SPSS software to construct the complex evaluation model of the innovation capability of China's high-tech industries.

Construct factor analysis evaluation model. Factor score means the percentage of the information carried in every variable been extracted by main Factor ($F_j$) .Estimate the coefficient of factor score by using regression method, and write down the factor score function, that is, present the main factor in the form of the linear combination of the variables.

$$F_j = \beta_{j1} * X_1 + \beta_{j2} * X_2 + \beta_{j3} * X_3 + \beta_{j4} * X_4 + \beta_{j5} * X_5 + \beta_{j6} * X_6 + \beta_{j7} * X_7$$
$$+ \beta_{j8} * X_8 + \beta_{j9} * X_9 + \beta_{j10} * X_{10} \; (j = 1,2,3 \ldots \ldots k, k < j)$$

Construct the complex evaluation model by calculating the weighted total score of the factors. Weight ($W_j$) is replaced with the variance's contribution rate of every drawn factor. Here is the calculation formula:

$F = \sum W_j * F_j (j = 1,2,\ldots,\mathrm{k})$

## 3. The Analysis of Innovation Capability of High-tech Industries

### 3.1 The Instruction of Data Index

This paper selects industry data from the third to the seventh category derived from *China's high-tech industry statistical data in 2007.* Each main category includes first to third grade in order to analyze roundly. Select ten indexes to analyze the innovation capability of the five main categories industries, which are, Number of Enterprises($X_1$), Expenditure for Developing New Products($X_2$), Patent Applications Received($X_3$), Number of S&T Institutions($X_4$), Industrial Output Value of New Products($X_5$),general output($X_6$), Export delivering value($X_7$), Expenditure for Technological upgrading($X_8$), Value Added of Industry($X_9$), Personnel for S&T Activities($X_{10}$). Those ten indexes compose the index matrix of innovation capability of high-tech industry. The ten indexes are not mutual independent, but with certain correlation. By factor analysis, we can filter fewer meaningful factors to reflect the main structure of original data to achieve the goal of reducing dimension.

### 3.2 Find out Common Factor

Insert Table 1, Table 2 Here

According to Table 1 and Table 2, it could be told that the value of Bartlett is 731.290, and significance probability is 0.000, less than 1%. That is to say, the correlation matrix is not a unit matrix. Therefore, factor analysis is a good option. The value of KMO equals to 0.651, and the degree of cumulative explanation of the variables is 91.999. Those values mean the effect of exerting factor analysis method is good. The factor loading matrix is got after the orthogonal rotation. The correlation coefficient matrix among the indexes is got through SPSS. Two common factors are selected on the condition that their characteristic root is greater than one.

### 3.3 Factor Loading Analysis

Insert Table 3 Here

According to Table 3, it could be told that F1 mainly loads and explains the variables of Expenditure for Developing New Products ($X_2$), Patent Applications Received ($X_3$), Industrial Output Value of New Products ($X_5$), general output ($X_6$), Export delivering value ($X_7$), and Value Added of Industry ($X_9$).Those factors mainly reflect the innovation output capability of China's high-tech industry. F2 mainly loads and explains the variables of Number of Enterprises ($X_1$), Number of S&T Institutions ($X_4$), Expenditure for Technological upgrading($X_8$), and Personnel for S&T Activities ($X_{10}$). Those factors mainly reflect the innovation input capability of China's high-tech industry.

Use regression analysis method to estimate the factor score coefficient matrix. With the loading value, two score functions can be written as below:

$F_1=0.372* X_1 +0.830* X_2+0.799* X_3+0.332* X_4+0.940* X_5+0.880* X_6+0.935* X_7+0.232* X_8+0.776* X_9+0.663* X_{10}$

$F_2=0.867* X_1 +0.498* X_2+0.362* X_3+0.927* X_4+0.263* X_5+0.433* X_6+0.192* X_7+0.921* X_8+0.612* X_9+0.700* X_{10}$

Meanwhile, with the weight of variance's contribution rate of each factor, the evaluation model of innovation capability of China's high-tech industry is:

$F = 0.52054 * F_1 + 0.39946 * F_2$

### 3.4 Calculate Integrative Score

Insert Table 4 Here

## 4. Analysis of the Evaluation Result

According to Table 4, it could be told that manufacture of electronic equipment and communication equipment has the highest integrative score, what go next are the manufacture of computers and office equipments, manufacture of medicines, manufacture of medical equipment and measuring instrument and manufacture of aircrafts and spacecrafts. Among manufacture of electronic equipment and communication equipment, manufacture of communication equipment has the highest score. Except from manufacture of integrate circuit, manufacture of electronic components, manufacture of electronic appliances and manufacture of broadcasting and TV equipment have a comparatively high score in the aspects of both input and output innovation capability. The innovation capability of manufacture of Aircrafts and Spacecrafts is at a lower level.

Manufacture of electronic equipment and communication equipment has the highest integrative score, which is mainly due to the strong innovation output capability. Among manufacture of electronic equipment and communication equipment, manufacture of communication equipment stand at the forefront and has the higher score than other industries. However, manufacture of communication transmitting equipment is at a lower level. The innovation capability of manufacture of integrate circuit is comparatively weak, which imposes a great impact on China's high-tech industry and national strategy security. Integrate circuit is the foundation of other technology and it is necessary to improve the innovation ability of manufacture of integrate circuit.

In general, the innovation capability of manufacture of computers and office equipments is at higher level. Its innovation output capability is an advantage. However, the innovation input capability is a disadvantage. This situation is caused by the structure of manufacture of computers and office equipments, most of which focus on the mid-and low-products. From the point of view of industry chain, because of the lack of innovation input, many key technologies are still weak. China's manufacture of computers and office equipments is still an industry based on assembly and lack its own technology. Innovation input should be increased in manufacture of computers, and also the technological innovation capability. China should own its independent central technology to upgrade the industry level.

The innovation capability of manufacture of medicines is at a relatively high level. Among manufacture of medicines, manufacture of chemical medicine has certain advantage, but manufacture of finished traditional Chinese herbal medicine and manufacture of biological and biochemical chemical products are at a lower level. The existing innovation advantage in manufacture of chemical medicine should be greatly developed to enhance its innovation output capability. Accelerate the modern production and national sale of manufacture of finished traditional Chinese herbal medicine. Improve traditional Chinese herbal production method, plus make the process scaling and normalizing in order to accelerate the improvement of innovation capability of manufacture of finished traditional Chinese herbal medicine and manufacture of biological and biochemical chemical products.

The overall innovation capability of China's manufacture of aircrafts and spacecrafts is not high. Among that, the innovation input capability of manufacture and repairing of airplanes is relatively high. China's manufacture of aircrafts and spacecrafts should be market orientated, speed up reform, and improve independent innovation capability. Develop regional aircraft as the keystone. Push on the industrial process of utility aircraft and Light aircraft. Enlarge the production of alien spacecraft spare parts. Accelerate the R&D of new technology to improve the overall innovation capability of China's aviation industry.

## 5. Conclusion

As a whole, China's high-tech industry develops relatively fast, and its scale enlarges continuously. However, lacking of independent knowledge property and brand is very unfavorable to the sustained development of China's high-tech industry. Based on the current status of development and economic strength, China should aim at enhancing the position in high-tech industrial chain of the whole world. At the same time of developing competitive industry, give priority to the development of high-tech industries which are important to the national economy and politics. The development of High-tech industry will greatly accelerate the improvement of the whole national economy and make China upgrade from big high-tech industry country to strong high-tech industry country.

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Table 1. KMO and Bartlett's Test

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling | | .651 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 731.290 |
| | df | 45 |
| | SIg | .000 |

Table2. The Characteristic Root, Variance's Contribution Rate, Cumulative Contribution Rate of Correlation Coefficient Matrix

| Common Factor | Characteristic Root | Variance's Contribution rate(%) | Cumulative Contribution Rate (%) |
|---|---|---|---|
| F1 | 7.947 | 52.054 | 52.054 |
| F2 | 1.252 | 39.946 | 91.999 |

Table 3. Rotated Component Matrix

| | **Component** | |
|---|---|---|
| | F1 | F2 |
| $X_1$ | 0.372 | 0.867 |
| $X_2$ | 0.830 | 0.498 |
| $X_3$ | 0.799 | 0.362 |
| $X_4$ | 0.332 | 0.927 |
| $X_5$ | 0.940 | 0.263 |
| $X_6$ | 0.880 | 0.433 |
| $X_7$ | 0.935 | 0.192 |
| $X_8$ | 0.232 | 0.921 |
| $X_9$ | 0.776 | 0.612 |
| $X_{10}$ | 0.663 | 0.700 |

Table 4. Score of Innovation Capability of Each Sub-industry of China's High-tech Industry

| **Industry** | **$F_1$** | **$F_2$** | **F** |
|---|---|---|---|
| **Manufacture of Medicines** | -1.08323 | 2.83166 | 0.56727 |
| 1.Manufacture of Chemical Medicine | -0.7872 | 1.25706 | 0.092376 |
| 2.Manufacture of Finished Traditional Chinese Herbal Medicine | -0.64187 | 0.32585 | -0.20395 |
| 3.Manufacture of Biological and Biochemical Chemical Products | -0.46017 | -0.48088 | -0.43163 |
| **Manufacture of Aircrafts and Spacecrafts** | -0.65868 | 0.54202 | -0.12635 |
| 1.Manufacture and Repairing of Airplanes | -0.65833 | 0.48423 | -0.14926 |
| 2.Manufacture of Spacecrafts | -0.43933 | -0.63272 | -0.48144 |
| **Manufacture of Electronic Equipment and Communication Equipment** | 3.28748 | 2.75846 | 2.813159 |
| 1.Manufacture of Communication Equipment | 1.66111 | -0.44557 | 0.686687 |
| Manufacture of Communication Transmitting Equipment | -0.47467 | -0.41228 | -0.41177 |
| Manufacture of Communication Exchanging Equipment | 0.59087 | -0.73877 | 0.012462 |
| Manufacture of Communication Terminal Equipment | -0.30634 | -0.59002 | -0.39515 |
| 2.Manufacture of Radar and Its Fittings | -0.45035 | -0.56869 | -0.46159 |
| 3.Manufacture of Broadcasting and TV Equipment | -0.45428 | -0.52323 | -0.44548 |
| 4.Manufacture of Electronic Appliances | 0.02276 | 0.17877 | 0.083259 |
| Manufacture of Electronic Vacuum Appliances | -0.40161 | -0.47987 | -0.40074 |
| Manufacture of Semiconductor Discreting Appliances | -0.41919 | -0.55419 | -0.43958 |
| Manufacture of Integrate Circuit | -0.18806 | -0.40946 | -0.26146 |
| 5.Manufacture of Electronic Components | -0.11299 | 0.90002 | 0.300706 |
| 6.Manufacture of Domestic TV Set and Radio Receiver | 0.4139 | -0.41575 | 0.049376 |
| 7.Manufacture of Other Electronic Equipment | -0.4265 | -0.51017 | -0.4258 |
| **Manufacture of Computers and Office Equipments** | 2.31056 | -1.10426 | 0.761631 |
| 1.Manufacture of Entired Computer | 1.07044 | -1.05161 | 0.137131 |
| 2.Manufacture of Computer Peripheral Equipment | 0.69847 | -0.7643 | 0.058274 |
| 3.Manufacture of Office Equipment | -0.3363 | -0.66939 | -0.44245 |
| **Manufacture of Medical Equipment and Measuring Instrument** | -0.65876 | 0.88181 | 0.009337 |
| 1.Manufacture of Medical Equipment and Appliances | -0.45442 | -0.42066 | -0.40458 |
| 2.Manufacture of Measuring Instrument | -0.64331 | 0.61196 | -0.09042 |