Evaluation and Analysis of Innovation Ability of High-tech Enterprises based on Grey Correlation--Talking Shijiazhuang as an Example

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Abstract. On the basis of the definition of the concept of the high-tech enterprise innovation ability and the principle of designing the evaluation index system ,combined with the actual situation of Shijiazhuang high-tech enterprise innovation ability in recent years ,it has established an evaluation index system of Shijiazhuang high-tech enterprise innovation ability and then use gray correlation method to evaluate the technological innovation ability. Use comprehensive statistics and analysis of the innovation ability of high-tech enterprises registered in Shijiazhuang from 2013 to 2017 and find out the advantages and disadvantages of the innovation ability of Shijiazhuang high-tech enterprise and then give some corresponding suggestions.

Keywords: High-tech enterprise; Innovation ability; Grey correlation.

1. Introduction

The study of innovation was earlier abroad. The Austrian economist Joseph Schumpeter was the first to put forward the innovation theory explicitly. Schumpeter mentioned in his book " Theory of Economic Development" that innovation is that entrepreneurs recombine the factors of production and then introduce them into the new productive system, thus forming new productive forces. The research on technological innovation in China started relatively late compared with that in foreign countries. It was not until the middle and late 1980s that the research on technological innovation began to receive extensive attention from the academic circle.

In 21st century, science and technology are increasingly becoming the pillars to support economic development and social progress. Innovation provides power support for its development. As the basic unit of the national economy and the main body of technological innovation, enterprises are the main participants in market economic activities. An excellent enterprise needs to continuously improve its competitiveness through innovation and marketing, of which technological innovation ability is the foundation to ensure the core competitiveness of enterprises.

Therefore, based on the evaluation results of innovation capability of Shijiazhuang high-tech enterprises from 2013 to 2017, to find out the lack of innovation and development of Shijiazhuang high-tech enterprises, formulate development plans for relevant departments and enterprises, and provide impetus for social and economic development.

2. Build an Innovation Ability Index System for High-Tech Enterprise

2.1 The Influencing Factors of Innovation Ability of High-Tech Enterprises and Evaluation Index System

Innovation is a continuous process, therefore, the evaluation of the innovation ability of high-tech enterprises should focus on the whole process of its formation, including four aspects: innovation foundation, innovation input, innovation output and innovation impact.

Innovation foundation can be divided into internal and external levels. The internal factors include the number of scientific and technological personnel in the enterprise, the cooperative ability of production, teaching and research, and the number of research and development institutions. External factors include tax relief and financial support granted by the government.

Innovation input can be divided into two aspects, human and financial support, including the input intensity of scientific and technological personnel, the share of scientific and technological personnel, the input intensity of scientific and technological funds, the proportion of scientific and technological expenses.

Innovation output is described in two aspects: one is the innovation ability of the product, and the sales revenue of the new product reflects the technical effect quantity of the enterprise and reflects the innovation competitiveness.

Innovation impact. Evaluating the innovation ability of an enterprise can be seen from two aspects: innovation affects the development potential of the enterprise and innovation contributes to the development of the enterprise.

Table 1. The Evaluation index system of Innovation Ability of Shijiazhuang High Technology Enterprises

Primary indicator	Secondary indicator	Third indicator
Innovation Foundation (0.2)	R&D Foundation (0.7)	Technical Ability of Scientific and Technical Personnel
		Cooperation Ability of Production,Teaching and research
		Innovation Emphasis
	Government Support (0.3)	Income Tax Relief
		Government Expenditure on Scientific and Technological Activities
Innovation Input (0.3)	Human Input (0.5)	The Input Intensity of Scientific and Technological Personnel
		Share of Scientific and Technological Personnel
	Financial Input (0.5)	The Input Intensity of Scientific and Technological Funds
		Share of Expenditure on Scientific and Technological Activities
Innovation Output (0.2)	The Output of New Product (0.5)	The Proportion of New Product Sales Revenue to Product Sales Revenue
		Share of New Product Sales Revenue
	Innovation Output (0.5)	The Amout of Patent Applications
		The amount of registered trademarks
Innovation Impact (0.3)	Development Potential (0.4)	Sales Revenue of Income
		Full Labor Productivity
	Development Contribution (0.6)	Income Contribution of High-tech Products

3. Introduction of Grey Relational Degree Evaluation Method

Through comparative analysis of the collected data of high-tech enterprises in Shijiazhuang, it is found that the number of high-tech enterprises in each year will increase compared with the previous year, but the increase is unstable, and the evaluation of innovation ability contains certain subjective evaluation indexes, including fuzzy and uncertain information, so this study chooses to use gray correlation method to comprehensively evaluate the innovation ability of high-tech enterprises.

The basic idea of the gray correlation degree comprehensive evaluation method is to determine the most ideal sample from the evaluated objects, and take this as the reference sequence, through calculating the correlation degree between each sample sequence and the reference sequence, make comprehensive comparison and ranking of the evaluated objects.

4. Evaluation Results and Analysis of Innovation Ability of Shijiazhuang High-Tech Enterprises

According to statistics, among the high-tech enterprises registered in Shijiazhuang in 2013, 15 were excluded due to lack of relevant data. In 2014, there were 398 high-tech enterprises registered, of which two were excluded due to lack of relevant data. In 2015, 486 high-tech enterprises participated in the evaluation with complete data. In 2016, 621 high-tech enterprises participated in the evaluation with complete data. There were 806 enterprises registered in 2017, two of which were eliminated due to lack of relevant data.

4.1 Empirical Analysis

Judging from the scores of Shijiazhuang high-tech enterprises in the four aspects of innovation ability, during the past 5years, the innovation influence of Shijiazhuang high-tech enterprises has been continuously expanding, showing a stable upward trend, the innovation output is relatively stable, and the innovation foundation and innovation investment as a whole show a downward trend. As we can see in table 2, Shijiazhuang high-tech enterprises have the most prominent performance in innovation impact ability, with the highest average score, the weakest performance innovation foundation ability and the lowest average score. In the future, Shijiazhuang high-tech enterprises should pay attention to improving their innovation ability, consolidating innovation foundation and increasing investment in technological innovation.

Table 2. The Combined Evaluation Scoring about Innovation Ability of High Technology Industry in Shijiazhuang between 2013 and 2017

Year	Innovation Foundation	Innovation Input	Innovation Output	Innovation Impact
2013	61.19166	61.82433	63.63703	66.48130
2014	61.38893	61.52540	62.57641	66.95293
2015	60.47351	62.96230	62.22569	65.89690
2016	61.20033	61.33598	62.52836	66.29489
2017	60.92201	61.65446	62.70485	66.95215
Average	61.03529	61.86049	62.73447	66.51563

4.2 Comparative Analysis of Evaluation Results in Different Technical Fields

Among the top 100 enterprises in the nine high-tech fields in Shijiazhuang in 2017, the number of enterprises in the field of bio-pharmaceutical technology is the largest, and most of them are traditional pharmaceutical enterprises in Shijiazhuang, which shows that the high-tech enterprises in the field of bio-pharmaceutical in Shijiazhuang have a strong sense of innovation and have a good foundation after years of development.

Among Shijiazhuang's nine high-tech fields, the number of enterprises in the electronics and information fields has an absolute advantage in the list of top 100 investment in innovation. The number of enterprises entering the top 100 investment in innovation in 2017 is as high as 54, accounting for more than 50%, 16 more than in 2013, and the overall growth momentum is strong.

Among the nine major fields, the electronics and information field have the largest number of innovative top 100 enterprises, an increase of 14 enterprises compared with 2013, and the growth rate is increasing year by year. The second is biomedical technology. The number of enterprises that entered the top 100 in innovation output in 2017 ranked second. However, the advantage in this field has gradually lost since 2015, falling from the largest number to the second, and the downward trend is obvious.

From the perspective of innovation impact, the innovation impact of biomedical technology and new materials is on the rise. The two fields account for half of the top 100 list of innovation impact capabilities, with high-tech enterprises in the field of new materials showing the most prominent performance.

5. The Shortness of Innovation and Development in Shijiazhuang High-Tech Enterprise

1) The ability of innovation input and innovation foundation is relatively low.

Judging from the scores of innovation ability in the past five years, Shijiazhuang high-tech enterprises as a whole have relatively low levels of innovation foundation ability and innovation input ability.

2) The development in different technical fields is uneven.

Since 2013, the overall innovation ability of Shijiazhuang high-tech enterprises has been continuously improved, but the development of high-tech enterprises in various fields is uneven, and high-tech enterprises in each field have short boards in innovation ability.

6. Conclusion

Through the evaluation and analysis of the development status and innovation capability of Shijiazhuang high-tech enterprises, it can be seen that the overall scale of Shijiazhuang high-tech enterprises has been growing steadily and developing well since 2013. Among the nine major technological fields, the four major fields of advanced materials, biological and medical technology, electronics and information and optical mechanical and electrical integration have developed rapidly and become the pillar areas of Shijiazhuang high-tech enterprises. The innovation foundation also shows a declining trend, which makes the overall innovation output level of Shijiazhuang high-tech enterprises low. In view of these problems, combined with the actual development of high-tech enterprises in Shijiazhuang, this paper puts forward some countermeasures and suggestions to improve the innovation ability of high-tech enterprises in Shijiazhuang.

1)Strengthen the innovation consciousness and speed up the construction of enterprise R&D institutions.

2) Increase fund guidance and form a multi-channel fund input system.

3)Pay equal attention to the introduction and training, enrich the scientific and technological personnel team.

4) Enhance innovation ability in major fields.

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