Evaluation and Analysis of High-Tech Industry Based on Grey Correlation Evaluation Method——Taking Shijiazhuang as an Example

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Abstract: On the basis of clearly defining the concept and influencing factors of high-tech industry, this paper proposes a system of indicators for the development of high-tech industries consisting of four primary and 13 secondary indicators, and determines the grey correlation degree evaluation method. Based on the data from 2013 to 2017, compiled by Shijiazhuang Science, Technology and Intellectual Property Office, points out the impact of each index on industrial development, and draws conclusions, puts forward relevant suggestions, and provides scientific reference for relevant departments in Shijiazhuang to formulate development plans.

1. Intriduction

The high-tech industry is an important part of the development of new economies in the world.It has long been valued by all countries since its high added value and low energy consumption.Based on the economic development data of high-tech enterprises in Shijiazhuang from 2013 to 2017, this paper will build an evaluation index system and conduct a comprehensive systematic evaluation to explore the important influencing factors of the development of high-tech industry and propose the corresponding recommendations. In order to achieve industrial transformation and sustainable economic development provides a reference.

This paper will discuss and analyze the four aspects of industrial development, scientific and technological innovation, industrial agglomeration and management, and policy support.Establish an evaluation index system for high-tech industry development in Shijiazhuang City consisting of four first-level indicators and 13 second-level indicators (Table I).

2. Grey correlation evaluation method

The grey relational evaluation method is an evaluation method based on grey correlation analysis, which simplifies complex problems according to the model.The specific evaluation steps are as follows:

Table.1. Shijiazhuang High-tech Industry Development Index System

Primary indicators	Secondary indicators
Industrial development foundation (0.25)	Real GDP per capita(0.25)
	Per capita disposable annual income of urban households (0.15)
	Industrial added value above designated size (0.35)
	Total assets of industrial enterprises above designated size (0.25)
Technological innovation (0.35)	Expenditure on daily scientific and technological activities within the enterprise (0.25)
	Scientific and technological personnel (0.25)
	The number of patent applications accepted in the current year (0.2)
	High-tech product income (0.3)
Industrial agglomeration and management (0.25)	Number of high-tech enterprises (0.3)
	Total income from technology, industry and trade (0.4)
	Number of college or above (0.3)
Policy to industry support (0.15)	Income tax reduction (0.5)
	Government science and technology activities (0.5)

Step1: Determine the comparison and reference sequences.

$$X_i(k) = \{X_i(k) | k = 1,2,\cdots,n; i = 1,2,\cdots,n\} \quad Y = \{Y_k | k = 1,2\cdots,n\}$$

This paper takes the added value of high-tech industries above designated size as the reference sequence of the model.

Step2: Nondimensionalization of reference and comparison sequences.This paper chooses the standardization method (Z-Score).

$$x_i(k) = \frac{(X_i(k) - \bar{X})}{S}$$

Step3: Determine the weight. This paper selects the expert evaluation method, and the results are shown in Table1.

$$W = \{X_k | k = 1,2,\cdots,n\}$$

Step4: Calculate the grey correlation coefficient. Generally, it is more appropriate to take$\zeta \leq 0.5$.

$$P_i(k) = \frac{\min\limits_i \min\limits_k |Y(k) - X_i(k)| + \zeta \max\limits_i \max\limits_k |Y(k) - X_i(k)|}{|Y(k) - X_i(k)| + \zeta \max\limits_i \max\limits_k |Y(k) - X_i(k)|}$$

Step5: Introduce weights and calculate the proportion. The percentage calculation formula is:

$$r_i = \frac{1}{n}\sum_{k=1}^{n} W_k P_i(k) \qquad E_i = \frac{r_i}{\sum_{i=1}^{n} r_i} \times 100\%$$

Step6: Evaluation and analysis. Sort by percentage size, and the larger the percentage, the greater the influence on the reference sequence.

3. Analysis

According to the gray correlation evaluation method, using the Excel statistical function, the analysis of the development of high-tech industry in the city from 2013 to 2017 is carried out. The results are shown in Table II. In this paper, the secondary indicators are divided into three categories according to the percentage size (Table 3).

Table.2. Gray correlation degree of factors influencing high-tech industry

Primary indicators	Secondary indicators	Percentage E_i	Ranking
Industrial development foundation	Real GDP per capita	7.65%	8
	Per capita disposable annual income of urban households	4.11%	13
	Industrial added value above designated size	9.94%	2
	Total assets of industrial enterprises above designated size	6.26%	10
Leading by technological innovation	Expenditure on daily scientific and technological activities within the enterprise	10.08%	1
	Scientific and technological personnel	7.23%	9
	The number of patent applications accepted in the current year	6.06%	11
	High-tech product income	8.79%	5
Industrial agglomeration and management	Number of high-tech enterprises	9.27%	3
	Total income from technology, industry and trade	8.91%	4
	Number of college or above	8.25%	6
Policy to industry support	Income tax reduction	7.66%	7
	Government science and technology activities	5.79%	12

Table.3. Classification of indicators

Classification	Percentage	Index
Strong influence factors	[8%, 1)	Expenditure on daily scientific and technological activities within the enterprise; Industrial added value above designated size; Number of high-tech enterprises; Total income from technology, industry and trade; High-tech product income; Number of college or above
General influencing factors	[6%, 8%)	Income tax reduction; Real GDP per capita; Scientific and technological personnel; Total assets of industrial enterprises above designated size; The number of patent applications accepted in the current year
Weak influence factors	[0, 6%)	Government science and technology activities; Per capita disposable annual income of urban households

(1) Analysis of strong influence factors

The research status of science and technology activities in Shijiazhuang is in direct proportion to the industrial development, and the increase in the number of high-tech enterprises has accelerated the expansion of the scale of high-tech industries. Business activities such as technical services and technology transfer are also important modules of high-tech industries, and have positive effects on technological innovation and progress of the industry. The increase in income from high-tech products will boost the economic strength of the industry.The number of college graduates and above in Shijiazhuang has increased year by year, and the development of high-tech industries has added new impetus.

(2) Analysis of general influence factors

The income tax reduction and exemption of high-tech industry has increased year by year, providing a good policy environment for industrial development. Real GDP per capita of Shijiazhuang is comparable to the national average, laying a solid foundation for industrial development. In addition, the number of people participating in scientific and technological activities is also increasing year by year, but the increase in scientific and technological activities is not large.The industry in Shijiazhuang is dominated by traditional industries. Even if the scale of

high-tech industries is expanding every year, the assets of industrial enterprises will have certain restrictions on the development of high-tech industries.The number of patent applications accepted in Shijiazhuang increased year by year, but the average number of patent applications accepted by each company in the current year was decreasing, which had certain limitations on the promotion of industrial development.

(3) Analysis of weak influence factors

The government's science and technology activities in Shijiazhuang account for a small percentage and have limited driving effect. The increase in government science and technology activities has been small, and there has been a reduction in the middle. This has made the government's investment in research activities less effective in industrial development. During the five-year period from 2013 to 2017, although the urban Per capita disposable annual income of urban households in Shijiazhuang was higher than the provincial average, it was significantly lower than the national level. Most residents in Shijiazhuang still stay in some low-end traditional products. With the development of high-tech industries, the concept of consumption is gradually changing. However, in the early stage, consumer demand for the industry has not been much promoted.

4. Conclusions and recommendations

From the above analysis, it can be concluded that enterprise science and technology innovation, scientific research personnel training, industrial development foundation and government policy support have a major impact on the development of high-tech industries in Shijiazhuang.According to the above conclusions, and we can make corresponding suggestions for the development of high-tech industry in Shijiazhuang:

1) Increase investment and expenditure on research funding, and strengthen the introduction and training of high-end talents. Within the enterprise, we should increase investment in innovation, enhance the awareness of scientific and technological innovation, actively research and develop key core technologies, and enhance the level of scientific and technological strength. Actively introduce and train high-end technical talents, and give full play to the role of the main body of scientific and technological innovation.

2) Give play to the government's macro-control functions and achieve industrial transformation and upgrading. We should give full play to the government's macro-control functions, transform the economic development mode, optimize the industrial structure, promote industrial transformation and upgrading, and guide the high-quality development of the economy. The government should also stimulate the vitality of production and operation of enterprises, create a better business environment for enterprises, and reduce the economic costs of high-tech enterprises through measures such as tax reduction and fee reduction.

3) Improve the enterprise system and promote independent innovation of enterprises. Within the enterprise, the system of malpractice should be eliminated, a good internal management environment should be established, the management system should be improved, the enthusiasm of employees should be improved, and the core competitiveness of enterprises should be enhanced. Enhance its own independent innovation capabilities, break through barriers to research and development, master high-end core technologies, and develop cutting-edge high-end products.

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