Research on Industrial Structure Optimization of Hebei Province based on Innovation-driven Thought

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Abstract: Based on the industrial structure optimization theory, evaluation method and the impact of innovation on the industrial structure, this paper constructs a scientific and reasonable evaluation index system of supererogation and rationalization of industrial structure, and using principal component analysis on industrial structure of Hebei Province, fuzzy comprehensive evaluation method of industrial structure rationalization to conduct empirical evaluation and comprehensive analysis. Finally, aiming at the problems existing in the industrial structure of Hebei Province, some suggestions are put forward to speed up structural optimization to achieve sustainable industrial development.

1. Introduction

Innovation-driven is the strategic support for building a modern economic system. Under the background of innovation drive, industry as the main force of science and technology and economy is the main battlefield for transforming the development mode. Therefore, Hebei Province is a large industrial province in China. It has long formed an industrial system based on energy and raw material industries, resulting in not only the low quality of economic operations, but also a serious burden of resources and environment. At present, in order to completely get rid of the low-level industrial structure, Hebei Province must thoroughly implement the "innovation-driven" development strategy, and turn the development of industrial from resource-dependent to innovation-driven, thereby promoting the transformation of economic growth mode and realizing the economy of Hebei Province continuous and sTable development.

2. Theory and method of optimization

2.1 The meaning of industrial structure optimization

The optimization of industrial structure is constantly evolving. It is the process of the industry gradually moving from the low-end to the high-end and from the unreasonable low-level stage to the high-quality advanced stage.The same is true for industrial structure optimization..

The purpose of industrial structure optimization is to improve the utilization efficiency of industrial resource redistribution. The second is to optimize the redistribution process by adjusting the relevant industrial policies of the government, using the supply and demand structure to adjust the industrial structure, then promoting the rationalization of the industrial structure. It ultimately can achieve sustained and rapid development of the national economy.

2.2 Standard of measurement of industrial structure optimization

From the dynamic point of view, the optimization of industrial structure can be measured from the two dimensions of rationalization of industrial structure and high industrial structure.

Advanced industrial structure is the evolution process of the internal productivity of the

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industrial structure and the continuous improvement of the technical structure.It is also the process of industrial structure continuously entering high processing, high added value, technology intensification, knowledge and service. Rationalization of industrial structure is to measure the quality of polymerization between various industrial sectors. It is not only a reflection of the degree of coordination between industrial sub-sectors, but also a reflection of the degree of effective utilization of resources. It is a comprehensive measure of the degree of coordination between factor input structure and output structure.

2.3 The impact of innovation on the optimization of industrial structure

Innovation is the driving force for the optimization of industrial structure and the development of any country and region can be separated from innovation. Innovation has both direct and indirect effects on the industrial structure.By promoting the transformation of production factors among different industries, and thus causing the continuous expansion and contraction of relevant industrial sectors, the process of coordinated operation of various industries is a direct impact. The process of directly affecting the mutual benefits of production factors on the industrial structure and changing the industrial structure by affecting the external environmental conditions around the industry is a indirect impact.

3. Measurement index system and evaluation method

3.1 Industrial structure optimization measurement index system

According to the Industry relevance benchmark, location advantage benchmark, industry advantage benchmark, demand income elasticity benchmark and other industrial structure supererogation relevant criteria, combined with the actual industrial structure of Hebei Province, the industrial structure supererogation evaluation index system is constructed, as shown in Table 1.

The criterion for measuring the reasonable degree of the industrial structure is the intrinsic joint action between industries, and whether it is greater than the sum of the capabilities of various industries. According to the science and technology investment benchmark, resource utilization efficiency benchmark, economic benefit benchmark, investment balance benchmark and other relevant criteria, combined with the actual industrial structure of Hebei Province, the industrial industrial structure rationalization evaluation index system is constructed, as shown in Table 1.

Table1. Industrial structure supererogation and rationalization evaluation index system of Hebei

Supererogation index		Rationalization index	
Benchmark	Index	Benchmark	Index
Industry relevance benchmark	Induction coefficient, Influence coefficient	Science and technology investment benchmark	R&D intensity
Location advantage benchmark	Location quotient	resource utilization efficiency benchmark	Elasticity coefficient of energy consumption
Industry advantage benchmark	Industry scale	economic benefit benchmark	ratio of profits to cost
Demand income elasticity benchmark	Demand income elasticity coefficient	investment balance benchmark	Proportion of investment in fixed assets

3.2 Industrial structure optimization measurement method

3.2.1 Industrial structure supererogation measurement method

Measurement on industrial structure supererogation of Hebei Province uses principal component analysis. The specific calculation steps using SPSS software are:

(1) Variable normalization processing. The raw data is standardized by using SPSS.

(2) Variable KMO test. The KMO value of this study variable is 0.604, which is suiTable for principal component analysis.

(3) Extraction of common factors. The result of the industrial structure supererogation factorization of Hebei Province in 2016 is shown in Table 2.

Table 2 Industrial structure supererogation Factor Analysis Results of Hebei Province in 2016

Total variance of interpretation									
Ingredients	Initial eigenvalue Variance %			Extract square sum loading			Rotation square sum loading		
	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %	Total	Variance %	Cumulative %
1	2.396	47.929	47.929	2.396	47.929	47.929	2.200	44.007	44.007
2	1.550	30.995	78.924	1.550	30.995	78.924	1.746	34.917	78.924
3	.495	9.895	88.819	—	—	—	—	—	—
4	.346	6.918	95.737	—	—	—	—	—	—
5	.213	4.263	100.000	—	—	—	—	—	—

The final result of the factor analysis preserves all the factors whose eigenvalues are greater than 1, resulting in two principal components. In the total variance interpretation, the two principal components account for 78.924% of the total variance of the original variables.

(4) Calculating the eigenvector matrix. The component matrix of the analysis of industrial structure supererogation factor of Hebei Province in 2016 is shown in Table 3.

Table 3 The component matrix of the analysis of industrial structure supererogation factor of Hebei Province in 2016

Component matrix		
Index	First principal component	Second principal component
Induction coefficient	0.712	-0.584
Influence coefficient	0.598	0.667
Location quotient	0.777	-0.219
Industry scale	0.863	-0.193
Demand income elasticity coefficient	0.429	0.826

According to the component matrix of Table 4, the first factor mainly explains most of the information of the two variables about the output value scale and the location quotient.That is mainly the output strength index of the industrial industry in Hebei Province.The second factor mainly explains most of the information of the demand income elasticity coefficient and the influence coefficient, which can be summarized as the competitiveness index of the industrial industry in Hebei Province.

(5) Calculate the composite score of the principal component

The expressions of the two principal component functions are (1) and (2):

$$Z1 = F11 \times zX1 + F12 \times zX2 + F13 \times zX3 + F14 \times zX4 + F15 \times zX5 \quad (1)$$

$$Z2 = F21 \times zX1 + F22 \times zX2 + F23 \times zX3 + F24 \times zX4 + F25 \times zX5 \quad (2)$$

The calculation formula of the composite principal component score is (3):

$$Z = \mathrm{r}1 \times Z1 + \mathrm{r}2 \times Z2 \quad (3)$$

Among them, Xi represents the data obtained after standardization; Z represents the score of the integrated principal component; ri represents the principal component contribution rate; and Zi represents the score of the principal component i.

3.2.2 Industrial structure rationalization measurement methods

The industrial structure rationalization of Hebei Province is measured by fuzzy comprehensive evaluation method. The specific calculation steps are as follows:

(1)Determining the evaluation index and rank.

Determining the factor domain of the evaluation object,(4):

$$U = \{u_1, u_2, \cdots, u_{26}\} \quad (4)$$

The collection of comments consists of the final evaluation results which obtain 26 evaluation objects. It is usually expressed by V and the specific comment formula is (5):

$$V = \{\text{优，良，中，差}\} \tag{5}$$

Among them, u26 represents 26 evaluation objects and 26 is the total number of evaluation results. The benefits of the evaluation index are respectively excellent, good, medium and poor. The specific scores are respectively 10, 8, 6, and 4.

(2) Constructing a fuzzy comprehensive evaluation matrix and determining weights.

The fuzzy comprehensive evaluation matrix of the evaluation index of industrial structure rationalization is as follows (6):

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1m} \\ \cdots & \cdots & \cdots \\ r_{n1} & \cdots & r_{mn} \end{bmatrix} \tag{6}$$

According to the expert scoring method, the industrial structure rationalization index weights are 0.25, 0.25, 0.25, and 0.25.

(3) Performing fuzzy synthesis

The fuzzy comprehensive evaluation method is used to comprehensively evaluate 26 industrial industries in Hebei Province, and the calculation formula is (7).

$$B = A * R \tag{7}$$

4. Empirical measurement and analysis

According to the above-mentioned industrial structure supererogation and rationalization evaluation index system and evaluation method, 26 industries are determined according to the industry classification of Hebei Province input-output Table. The data comes from Hebei Economic Yearbook 2017 and Hebei Science and Technology Yearbook 2017,China Industrial Statistical Yearbook 2017 and China Statistical Yearbook 2017. The calculation results of the advanced and rationalized evaluation of 26 industrial structures in Hebei Province in 2016 are shown in Table 4. The meanings of the letters and numbers in Table 4 are shown below.

1. Mining of Coal 2.Extraction of Petroleum and Nature Gas 3.Mining and Processing of Metal Ores 4.Mining and Processing of Non-metal Ores and Other Ores 5.Manufacture of Foods and Tobacco 6.Manufacture of Textile 7.Manufacture of Textile, Wearing Apparel, Leather, Feather and Related Products 8.Processing of Wood and Furniture 9.Manufacture of Paper, Printing ,Articles for Culture, Education and Sports 10.Petroleum,Coking and Processing of Nuclear Fuel 11.Manufacture of Chemical Products 12.Manufacture of Non-metallic Mineral Products 13.Smelting and Pressing of Metals 14.Manufacture of Metal Products 15. Manufacture of General Purpose Machinery 16.Manufacture of Special Purpose Machinery 17.Manufacture of Transport Equipments 18.Manufacture of Electrical Machinery and Apparatus 19.Manufacture of Computers, Communication and Other Electronic Equipment 20.Manufacture of Measuring Instruments and Machinery 21.Other Manufacture 22.Utilization of Waste Resources 23.Repair Service of Metal Products, Machinery and Equipment 24.Production and Supply of Electric Power and Heat Power 25. Production and Supply of Gas 26. Production and Supply of Water

a. Induction coefficient b. Influence coefficient c. Location quotient d. Location quotient e. Demand income elasticity Coefficient f. Composite score (points) g. Ranking h. Technology intensity i. Elasticity coefficient of energy consumption j. Ratio of profits to cost(%) k. Proportion of investment in fixed assets(%) l. Composite score (points) m. Ranking

Table 4 Basic indexes and evaluation results of the industrial structure supererogation and rationalization of Hebei Province in 2016.

Industry	Supererogation basic indexes and evaluation scores							Rationalization basic indexes and evaluation scores					
	a	b	c	d	e	f	g	h	i	j	k	l	m
1	2.60	0.78	1.12	0.02	-0.96	-0.89	21	0.01	-0.10	0.01	0.00	5.475	22
2	1.08	0.71	0.43	0.00	-4.60	-2.60	25	0.03	-0.15	-0.35	0.00	6.325	14
3	2.13	1.20	3.37	0.04	-0.43	1.30	3	0.00	-1.68	0.17	0.02	7.187	5
4	0.67	1.01	0.40	0.00	-0.26	-0.95	26	0.00	-1.46	0.05	0.00	5.6	21
5	0.86	1.03	0.82	0.09	0.66	0.16	12	0.00	-0.88	0.07	0.08	7.075	8
6	0.58	0.95	1.06	0.04	0.75	-0.31	16	0.00	-1.62	0.07	0.03	6.45	13
7	0.46	1.06	1.14	0.04	0.52	-0.08	14	0.00	-1.22	0.09	0.03	6.525	11
8	0.69	1.08	0.60	0.01	0.81	-0.38	17	0.00	-1.74	0.08	0.03	7.125	6
9	1.38	1.19	0.78	0.03	1.21	0.33	10	0.00	-0.19	0.08	0.03	6.325	14
10	1.48	0.95	1.25	0.04	0.51	-0.13	15	0.00	-0.83	0.04	0.02	5.8	20
11	2.93	1.24	0.79	0.11	0.26	1.07	5	0.01	0.68	0.08	0.14	8.825	1
12	0.73	1.14	0.79	0.04	0.56	0.02	13	0.00	0.01	0.06	0.08	5.925	18
13	3.76	1.28	2.45	0.26	0.81	3.03	1	0.01	0.34	0.03	0.06	5.9	19
14	1.24	1.37	2.00	0.07	2.77	1.92	2	0.00	-0.82	0.05	0.08	6.125	17
15	0.67	1.33	0.78	0.03	2.20	0.77	7	0.01	3.13	0.07	0.08	6.3	16
16	0.52	1.28	0.98	0.03	0.26	0.27	11	0.01	0.68	0.08	0.06	6.6	10
17	0.51	1.31	0.77	0.07	2.68	1.09	4	0.02	-1.13	0.10	0.05	8.2	2
18	1.02	1.33	0.75	0.05	1.98	0.91	6	0.01	0.07	0.08	0.05	6.725	9
19	0.76	1.08	0.13	0.01	-0.72	-0.92	22	0.02	-0.54	0.07	0.02	6.5	12
20	0.39	1.16	0.28	0.00	0.71	-0.47	19	0.02	-1.27	0.12	0.00	7.2	4
21	0.41	1.24	0.67	0.00	3.38	0.51	8	0.01	47.19	0.07	0.01	5.075	23
22	1.26	1.48	0.53	0.00	0.40	0.50	9	0.00	1.14	0.02	0.01	4.95	24
23	0.49	0.79	0.32	0.00	-5.58	-2.78	26	0.08	-7.96	0.03	0.00	4.8	25
24	2.90	1.05	1.01	0.05	-2.67	-0.40	18	0.00	0.26	0.09	0.09	7.125	6
25	0.39	1.00	0.76	0.00	0.15	-0.78	20	0.00	-3.84	0.11	0.01	7.375	3
26	0.54	0.79	0.57	0.00	0.89	-1.18	24	0.00	3.07	0.04	0.01	4.8	25

4.1 Analysis of industrial structure supererogation of Hebei Province

Cluster analysis method is used to analyze the evaluation results of 26 industrial structure supererogation in Hebei Province, which are divided into five categories, namely:

The first category is Smelting and Pressing of Metals, which is the highest of industrial structure.

The second category is Mining of Coal; Production and Supply of Electric Power and Heat Power; the Manufacture of Chemical Products and Mining and Processing of Metal Ores .The industrial structure supererogation of these four industries is higher level.

The third category is the Manufacture of General Purpose Machinery; Manufacture of Electrical Machinery and Apparatus; Manufacture of Transport Equipments ; Other Manufacture ; Waste and Manufacture of Metal Products .The industrial structure supererogation of six industries is general.

The fourth category is Processing of Wood and Furniture ; Manufacture of Non-metallic Mineral Products; Manufacture of Paper, Printing ,Articles for Culture, Education and Sports; Manufacture of Special Purpose Machinery ;Manufacture of Textile ;Manufacture of Textile, Wearing Apparel, Leather, Feather and Related Products; Production and Supply of Gas ; Mining and Processing of Non-metal Ores and Other Ores; Manufacture of Computers, Communication and Other Electronic Equipment; Manufacture of Measuring Instruments and Machinery ; Manufacture of Foods and Tobacco; Petroleum, Coking and Processing of Nuclear Fuel and Production and Supply of Water . The industrial structure supererogation of these thirteen industries is lower level.

The fifth category is Extraction of Petroleum and Nature Gas ; Repair Service of Metal Products,

Machinery and Equipment. The industrial structure supererogation of two industries is the lowest.

4.2 Analysis of the rationalization of industrial structure of Hebei Province

Cluster analysis method is used to analyze the evaluation results of 26 industrial structure rationalization in Hebei Province, which are divided into 5 categories, namely:

The first category is the Manufacture of Chemical Products , which has the highest degree of industrial structure rationalization.

The second category is Manufacture of Non-metallic Mineral Products; Manufacture of Metal Products; Manufacture of Foods and Tobacco; Production and Supply of Electric Power and Heat Power; Communication Equipment; Manufacture of Special Purpose Machinery; Manufacture of Electrical Machinery and Apparatus; Smelting and Pressing of Metals ; Manufacture of Transport Equipments. The industrial structure rationalization of these nine industries is higher level.

The third category includes thirteen industries which are the rest of Manufacture of Textiles; Processing of Wood and Furniture; Manufacture of Textile, Wearing Apparel, Leather, Feather and Related Products; Manufacture of Paper, Printing ,Articles for Culture, Education and Sports; Mining and Processing of Metal Ores ; Production and Supply of Gas; Waste Resources; Production and Supply of Water; Petroleum, Coking and Processing of Nuclear Fuel; Mining and Processing of Non-metal Ores and Other Ores; Mining of Coal; Manufacture of Computers, Communication and Other Electronic Equipment; Manufacture of Measuring Instruments and Machinery. The industrial structure supererogation of these six industries is general level. The industrial structure rationalization of these industries is general level.

The fourth category is Other Manufacture, which has the lower degree of industrial structure rationalization.

The fifth category is Extraction of Petroleum and Nature Gas and Repair Service of Metal Products, Machinery and Equipment. The industrial structure rationalization of these two industries is the lowest level.

4.3 Comprehensive analysis of industrial structure optimization in Hebei Province

Cross-scoring and ranking the evaluation results of 26 industrial structures in Hebei Province, Mining and Processing of Metal Ores; Manufacture of Chemical Products; Manufacture of Transport Equipments; Manufacture of Electrical Machinery and Apparatus are both front in two evaluation results. Smelting and Pressing of Metals and Manufacture of Metal Products rank high in the supererogation but low in the rationalization . The Manufacture of Measuring Instruments and Machinery; Production and Supply of Gas; Production and Supply of Electric Power and Heat Power rank high in the rationalization but low in the supererogation . Mining of Coal, Mining and Processing of Non-metal Ores and Other Ores and Manufacture of Metal Products, Repair Service of Metal Products, Machinery and Equipment, and Production and Supply of Water rank lower in the evaluation results of industrial structure supererogation and rationalization.

The advantageous industries in Hebei's industrial structure supererogation ranking top ten are Smelting and Pressing of Metals, Manufacture of Metal Products, Mining and Processing of Metal Ores industry, Manufacture of Transport Equipments, Manufacture of Chemical Products, Manufacture of Electrical Machinery and Apparatus , Manufacture of General Purpose Machinery; Other Manufacture; Waste, Manufacture of Paper, Printing, Articles for Culture, Education and Sports,etc. These industries have a great positive impact on the industrial structure supererogation of Hebei Province, which will help to drive the optimization and upgrading of the overall industrial structure of Hebei Province.

The advantageous industries in the Hebei's rationalization of industrial structure ranking top ten are Manufacture of Chemical Products, Manufacture of Non-metallic Mineral Products, Manufacture of Metal Products, Manufacture of Foods and Tobacco, Production and Supply of Electric Power and Heat Power, Communication Equipment, Manufacture of Special Purpose Machinery, Manufacture of Electrical Machinery and Apparatus, Smelting and Pressing of Metals, and Manufacture of Transport Equipments. These industries have obvious industrial advantages over other industries in terms of technology investment benchmarks, resource utilization efficiency

benchmarks, economic benefit benchmarks, and investment balance benchmarks. They are in favor of the effective allocation of resources in Hebei Province and the main force driving the optimization and upgrading of the overall industrial structure of Hebei Province.

According to comprehensive analysis, the industries in Hebei Province mainly rely on the chemical industry, manufacturing industry and light industry, while the Manufacture of Computers, Communication and Other Electronic Equipment industries relying on innovation and technology are obviously weak.

The current development of Hebei Province also mostly relies on the previous superior resources and processing. It is seriously inadequate in terms of investment in science and technology. The ability to innovate very limited, and its own competitive strength is also poor.

5. Conclusion

According to the evaluation results of industrial structure supererogation and rationalization of Hebei Province, In the context of the "innovation-driven" era, Hebei Province needs to do the following five aspects to achieve the optimization and upgrading of industrial structure.

(1) Adjusting the industrial structure and promoting structural heightening. The optimization of industrial structure in Hebei Province needs to be linked to the current overall situation. The steel industry should be withdrawn orderly and accelerate the industrial clusters to move closer to the coastal areas, reduce the energy-intensive industry, drive the manufacturing industry to take the lead in development, accelerate the development of the Manufacture of Foods and Tobacco and build a unique foods and tobacco brand in Hebei Province. Finally, we should focus on helping the development of high-tech industries and promoting the optimization and upgrading of the industrial structure in essence.

(2) Accelerating the industrial industry to reduce production capacity and promoting structural rationalization. Through bankruptcy reorganization, insolvency liquidation, all zombie enterprises will be cleared out to ensure that the production capacity will really retreat and should be retired. We should encourage enterprises to go out and extend the industrial chain horizontally and vertically, to promote the high-quality improvement of equipment, Manufacture of Metal Products and steel production, and vigorously develop metallurgical raw materials, consumption reduction and emission reduction projects and related technical services, etc. Taking the productive service industry as the key development target, the logistics business will be separated from the steel enterprises. Based on the existing transportation resources and storage capacity, it will be integrated to create a group of modern specialized logistics enterprises that serve the steel enterprises.

(3) Improving the innovation ability of the industry and promoting structural upgrading. Actively introduce advanced and information-based industries, promote the complete transformation of the industry in terms of development concepts, and promote the optimization of industrial structure with new development models. At the same time, we must further implement special technical innovations such as new materials, actively form a joint project with major national science and technology projects, set up a group of industrial technology alliances with close integration of academic and research funding, and constantly accelerate the implementation of the national new intelligent development action plan, and strive to carry out pilot demonstrations of applications.

(4) Integrating industry characteristics and scientifically arranging development priorities. In order to cope with the fierce competition in the future, Hebei Province needs to develop some emerging industries from a strategic perspective. It can accurately target forward-looking information-based industries, combine information technology with traditional industrial industries, and cultivate a large-scale and technologically advanced industrial clusters. Eventually, a new highland for industrial development will be formed, and the height of industrial structure optimization will be enhanced to create greater scientific and technological achievements for Hebei Province.

References

[1] Dongshui Su, et al. Industrial Economics (Fourth Edition) [M]. Beijing: Higher Education Press, 2015

[2] Yuxi Wang. Research on industrial transformation and upgrading of Hebei Province under the coordinated development of Beijing, Tianjin and Hebei [D]. Baoding: Hebei University, 2017

[3] Chenhui Liu, Chao Tang. Quantitative research on industrial structure optimization--based on the concept of ecological civilization[J].Ecological Economy, 2017, 33(06): 260-262+266

[4] Jianping Zhu, Weinan Fang, Guijun Zhang, et al. SPSS statistical analysis and application [M]. Beijing: Capital University of Economics and Business Press, 2013

[5] Jiang Wei, Tuoyu Li, Yuqi Zhao. The overall pattern, realistic dilemma and policy trend of innovation-driven development [J]. China Soft Science, 2015(05): 21-30