Research on the Basic Ability of Manufacturing Industry in Liaoning Province Based on Model Testing and Data Analysis

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Abstract. In recent years, the state has supported and guided the development of the manufacturing industry from a strategic level, which has greatly promoted the manufacturing industry to move towards the information age. Based on the slow development of the manufacturing industry in Liaoning Province, this paper collects and monitors the operational data of the manufacturing industry, and uses big data analysis to construct an evaluation index system and evaluation model for industrial basic capabilities. This paper uses the entropy method to evaluate the basic capabilities of the manufacturing industry in Liaoning Province, constructs a multiple linear regression model, and uses empirical analysis methods to study the factors that affect the basic capabilities of the manufacturing industry in Liaoning Province. The empirical research results show that the economic level and industrial structure have a significant impact on the basic capabilities of the manufacturing industry in Liaoning Province. Finally, combined with the results of the empirical research, the countermeasures and suggestions for improving the basic capabilities of the manufacturing industry in Liaoning Province are put forward.

Keywords: Manufacturing · data analysis · entropy weight method

1 Introduction

Although China's manufacturing industry has developed rapidly in recent years, compared with developed countries, it is still at the global middle-to-lower level. As an important manufacturing industry base in China, Liaoning Province has a complete manufacturing system and 31 sub-sectors. However, in recent years, with the gradual deterioration of the resource environment and changes in market demand, the status of the manufacturing industry in the national economy of Liaoning Province has gradually declined [2].

The overall development level of the manufacturing industry in Liaoning Province is far lower than that of the same batch of advanced cities, mainly due to the weak technological innovation capability, excessive dependence on imports for some manufacturing, and failure to form a complete manufacturing industry chain. Moreover, the current academic research on improving the basic capabilities of the industry has

just started, and there is no clear proposal for improving the basic capabilities of the manufacturing industry. Therefore, this paper takes the basic capability of manufacturing industry in Liaoning Province as the research object, uses the quantitative analysis method combining qualitative and quantitative analysis to analyze the shortcomings of the basic capability of manufacturing industry in Liaoning Province, builds a multiple linear regression model, and uses Eviews software to study the impact Factors of the basic capacity of the manufacturing industry in Liaoning Province, and put forward corresponding policy suggestions.

2 Construction of the Evaluation Index System of Industrial Basic Capacity in Liaoning Province

Combining the existing theoretical foundations, this article defines basic industrial capabilities as the basic conditions and strengths that a country or region has to support industries. Which are specifically divided into: basic capabilities for technological innovation, basic capabilities for supporting and guaranteeing, basic capabilities for industrial competition, and sustainability develop basic capabilities [1].

Focusing on the connotation of basic industrial capabilities, combined with the design of the evaluation index system of relevant literature and the development of Liaoning Province's manufacturing industry, an evaluation index system consisting of 4 secondary evaluation indicators and 12 tertiary evaluation indicators has been constructed (Table 1).

In the industrial basic capability evaluation index system, the importance of each index is different, and the weight must be assigned reasonably. In this paper, the entropy weight method is used to determine the weight through the calculation of entropy. The calculation steps are simple and objectively effective.

Table 1. Evaluation Index System of Manufacturing Industry Basic Capability.

First level indicator	Secondary indicators	Three-level indicators	Index connotation	Indicator attributes
Industrial basic capabilities	Basic ability of technological innovation	Proportion of industry professional and technical personnel-X1	Industrial professionals/total employment in the secondary industry	Positive
		Advanced human capital-X2	Industrial enterprise R&D expenditure/total fiscal expenditure	Positive
		Number of patent applications-X3	Number of patent applications of industrial enterprises above designated size	Positive

(*continued*)

Table 1. (*continued*)

First level indicator	Secondary indicators	Three-level indicators	Index connotation	Indicator attributes
	Support and guarantee basic capabilities	Capital investment-X4	Total fiscal expenditure	Positive
		Purchase cost of equipment and tools-X5	Growth rate of purchase cost of manufacturing equipment and tools	Positive
		Energy saving and environmental protection investment-X6	Government energy conservation and environmental protection budget expenditure	Positive
	Basic ability for sustainable development	Total asset contribution rate-X7	Contribution rate of total assets of industrial enterprises above designated size	Positive
		Wastewater discharge per unit of industrial added value-X8	Wastewater discharge per unit of industrial added value	Negative
		Comprehensive utilization of solid waste per unit of industrial added value-X9	Comprehensive utilization of solid waste per unit of industrial added value	Positive
	Basic industrial competitiveness	Total profit-X10	Total profits of industrial enterprises above designated size	Positive
		Industrial added value-X11	Industrial added value	Positive
		Number of industrial enterprises-X12	Number of industrial enterprises above designated size	Positive

3   Prepameasurement Results and Evaluation Analysis of the Basic Capabilities of the Manufacturing Industry in Liaoning Province

3.1   Overall Analysis of the Basic Capabilities of the Manufacturing Industry in Liaoning Province

According to the evaluation index system constructed in this paper and the entropy value and weight of the specific index determined by the entropy method, the comprehensive score of the basic ability of manufacturing industry in Liaoning Province is calculated. From the perspective of the overall development trend, the comprehensive score of Liaoning Province's industrial basic capacity shows the development characteristics of repeated fluctuations, especially in the period of 2015–2016 (Table 2).

Table 2. Comprehensive scores of the basic capabilities of the manufacturing industry in Liaoning Province from 2010 to 2019.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Overall ratings	0.4811	0.5708	0.6402	0.6920	0.5440	0.2426	0.2240	0.4334	0.5624	0.5542

Table 3. Comprehensive scores of equipment manufacturing in various provinces and cities across the country.

Rank	Province	Score	Rank	Province	Score
1	Guangdong	0.8424	17	Tianjin	0.2729
2	Jiangsu	0.7199	18	Liaoning	0.2592
3	Zhejiang	0.4926	19	Shanxi	0.2503
4	Shandong	0.4547	20	Yunnan	0.2354
5	Shanghai	0.4026	21	Inner Mongolia	0.2303
6	Hubei	0.3972	22	Guizhou	0.2192
7	Fujian	0.3867	23	Guangxi	0.2040
8	Anhui	0.3830	24	Heilongjiang	0.1903
9	Henan	0.3787	25	Ningxia	0.1886
10	Hebei	0.3675	26	Xinjiang	0.1823
11	Hunan	0.3571	27	Gansu	0.1557
12	Jiangxi	0.3476	28	Qinghai	0.1394
13	Beijing	0.3321	29	Jilin	0.1303
14	Sichuan	0.3151	30	Tibet	0.1080
15	Shaanxi	0.3119	31	Hainan	0.0990
16	Chongqing	0.2935			

3.2 Comparative Analysis of the Basic Capabilities of Manufacturing Industries in Liaoning and Other Provinces

This paper selects the data of the basic capabilities of the manufacturing industry in 31 provinces in China for comparative analysis in 2019 (Table 3).

From the perspective of comprehensive evaluation, the comprehensive ranking of Liaoning Province's manufacturing industry's basic capabilities in 2019 is in the middle and lower positions [3]. As a leading industrial province in the country, Liaoning's industrial infrastructure capacity in recent years has fallen far behind other manufacturing provinces [5].

4 An Empirical Analysis of Factors Affecting the Basic Capacity of Manufacturing Industry in Liaoning Province

4.1 Influencing Factors of Industrial Basic Capacity

Based on the basis of the previous discussion, a total of five factors that affect the basic capabilities of Liaoning's manufacturing industry are selected: economic level, industrial structure, openness, industrial benefits, and education development level [4].

4.2 Model Construction

The comprehensive scores of the basic capabilities of the manufacturing industry in Liaoning Province obtained above are used as the explained variables, and the indicators in Table 4 are used as the explanatory variables. Taking the logarithm of the variable to reduce the scale of the variable to alleviate the impact on the empirical analysis, the following model was established:

$$Y = \alpha + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 + \alpha_4 \ln X_4 + X_5 + \mu \qquad (1)$$

4.3 Empirical Research and Result Analysis

4.3.1 Data Stationarity Test

In this paper, the unit root test method is used to test the stationarity of the data. The test results show that all variables other than the independent variable industrial structure are not stable, but after the first-order difference, each index has passed the stationarity test.

4.3.2 Regression Analysis Results

The regression results in Table 5 show that the P values of economic level, industrial structure, degree of openness, and industrial efficiency are all less than 0.05, indicating

Table 4. Selection of indicator variables for the influencing factors of the basic capabilities of manufacturing industries in Liaoning Province.

Variable	Index selection
Economic level (X1)	Gross Regional Product of Liaoning Province
Industrial structure (X2)	GDP of the secondary industry/Gross industry of the total industry
Openness (X3)	Manufacturing Utilization Foreign Investment Project Contract Amount
Industry benefit (X4)	Industrial cost utilization rate
Educational development level (X5)	Number of graduate students that year

Table 5. Least squares regression results.

Variable	Regression coefficients	Standard error	t statistic	P value
LNX1	0.936263	0.324378	2.886331	0.0447
LNX2	0.773088	0.245353	3.150925	0.0345
LNX3	0.127156	0.030183	4.212793	0.0136
LNX4	0.215568	0.045292	4.759529	0.0089
X5	−0.0000126	0.0000119	−1.056942	0.3501
C	−13.35035	3.504150	−3.809869	0.0189
AdjR2 = 0.989487; Log L = 27.73365; F statistics = 75.29810;				
AIC = −4.346730; SC = −4.165179; DW = 2.221557				

Table 6 Residual ADF test results

Variable	ADF value	Critical value			Statistics	Conclusion
		1%	5%	10%		
Y1	−3.4545	−2.8473	−1.9882	−1.6001	0.0033	Stable

that these four variables have a significant impact on the basic capabilities of manufacturing industries in Liaoning Province. However, the level of education development ($P < 0.05$) has no significant impact on the basic capabilities of the manufacturing industry in Liaoning Province, and the regression coefficient is negative. This shows that the level of education development has a restraining effect on the industrial basic capacity of the manufacturing industry.

Cointegration test. The results of the cointegration test show that the ADF value of the residual Y1 of the regression model is −3.4545, which is less than its critical value of 1%, 5%, and 10%, indicating that the data is stable and there is no pseudo-regression. There is a long-term cointegration relationship between independent variable and dependent variable (Table 6).

4.4 Discussion of Empirical Results

At present, the main factors affecting the basic capabilities of the manufacturing industry in Liaoning Province are economic level, industrial structure, degree of openness, and industrial benefits. Among them, the economic level and industrial structure have a significant impact on the basic capabilities of the manufacturing industry in Liaoning Province. The regression coefficients of the openness index and the industrial benefit index are 0.13 and 0.22, respectively. These two factors have a relatively small impact on the basic capabilities of the industry. To improve the basic capabilities of Liaoning's manufacturing industry, we must focus on developing the overall economic level of Liaoning Province and increasing the proportion of the secondary industry in the total

industry, and expand the level of opening up in Liaoning Province and improve industrial efficiency.

5 Countermeasures and Suggestions for Improving the Basic Capabilities of the Manufacturing Industry in Liaoning Province

5.1 Adjust the Innovation Mechanism and Improve the Industrial Development Environment

From the previous analysis, it can be concluded that although Liaoning's innovation capital investment has been increasing in recent years, the output of innovative products has not increased proportionally. Therefore, focusing on improving the conversion rate of industrial technological innovation achievements is a key point that Liaoning Province needs to solve at present.

It is necessary to establish a benign interaction platform between scientific research institutions and enterprises. Raise funds for research institutions through the establishment and participation of scientific research projects by enterprises, and at the same time promote the transformation of scientific research results.

5.2 Encourage Foreign Investment and Enhance Industrial Capital Strength

Enterprises should seize the opportunity of transferring manufacturing from developed countries to developing countries, actively attract capital investment from advanced regions, and improve their economic strength.

5.3 Strengthen the Role of the Government and Guide the Efficient Development of the Industry

The government should provide directional subsidies and policy guidance based on the development status of the manufacturing industry in Liaoning Province. Regarding the problem of brain drain in Liaoning Province, the government must improve the talent introduction and training mechanism.

6 Conclusion

Manufacturing is the fundamental industry for all countries to enhance their national competitiveness. In view of the slow development of the manufacturing industry in Liaoning Province, this article takes the basic capabilities of the manufacturing industry in Liaoning Province as the research objective, constructs an evaluation index system for the basic capabilities of the manufacturing industry, and builds a multiple regression model to explore its influencing factors.

From a comprehensive evaluation point of view, the industrial infrastructure capacity of Liaoning Province in recent years has lagged far behind other strong manufacturing provinces. The empirical results show that the economic level and industrial structure

have a significant impact on the basic capabilities of the manufacturing industry in Liaoning Province. Based on the above analysis, Liaoning Province can start with the industrial environment and establish a platform for benign interaction between scientific research institutions and enterprises; secondly, encourage foreign investment and enhance the strength of industrial capital; and finally, strengthen the role of the government to guide the efficient development of the industry.

In future research, we will continue to pay attention to related issues and further enrich the research on the mechanism and path of the influence of industrial basic capabilities in Liaoning Province.

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