Comprehensive Measurement and Analysis of Advanced Manufacturing Industry Development Level in China

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Abstract. China is in the process of the fourth industrial revolution, and advanced manufacturing industry, as its key, has attracted great attention from scholars. This article constructs a comprehensive evaluation index system for the development level of China's advanced manufacturing industry from the four dimensions of development scale, factor input, quality and efficiency, and innovation level to evaluate the development level of China's regional manufacturing industry. This study is based on the manufacturing data of 30 provinces in China from 2017 to 2021, and uses the entropy method to calculate and analyze the development level of advanced manufacturing in each province in China. Research shows that China's advanced manufacturing industry as a whole shows a layout of low in the west and high in the east. The development level of each region shows a steady growth trend, but the gap has continued to widen in the past five years.

Keywords: advanced manufacturing industry; development level; entropy method.

1 Introduction

The world is currently undergoing the fourth industrial revolution, where advanced manufacturing plays a crucial role in the industry. It drives high-quality economic development and enhances national security[1]. However, China's manufacturing industry is still in the process of industrialization and lags behind developed countries, particularly in advanced manufacturing. Challenges include large scale but weak strength, low level of informatization, limited independent innovation in high-end technology, and heavy reliance on foreign countries for core technologies and equipment. In this context, establishing an infrastructure support system compatible with advanced manufacturing is essential for China to become a manufacturing power and encourage active participation in international competition[2]. Therefore, quantitative measurement of advanced manufacturing development is crucial to identify existing problems and facilitate targeted improvements.

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2 Construction and Measurement Methods of Indicators

Two primary approaches have been proposed for studying the level of development in the advanced manufacturing industry. One approach is to represent the development of advanced manufacturing in a single dimension. For example, Obi[3] et al. contend that advanced manufacturing technology, from a technological standpoint, transcends the traditional boundaries of manufacturing technology. Jiang Li[4] investigates the spatio-temporal evolution characteristics of advanced manufacturing layout at the regional, city, and district levels in the Pearl River Delta region from 2004 to 2018, using employed persons data. Chen Hong[5] et al. examine the international competitiveness of the advanced manufacturing industry by analyzing the import and export of advanced manufacturing products.

The alternative approach involves constructing an indicator system, selecting various indicators from multiple dimensions, and conducting a comprehensive assessment of the development level of the advanced manufacturing industry through objective weighting. Wang[6] et al. constructed an indicator system including four dimensions: production factors, development scale, organizational structure, and innovation capabilities. Jiang[7] and colleagues constructed a set of 12 indicators to evaluate the level of high-quality development in the manufacturing industry.

2.1 Construction of Measurement Index System

This article starts from four dimensions to construct an evaluation index system for the development level of advanced manufacturing. The specific indicators are shown in Table 1.

Table 1. Advanced Manufacturing Development Evaluation Indicator System

dimension	sub-indicators	unit	weight	peoperty
development scale	Number of R&D organizations	unit	12.06	+
	Number of employees at the end of the year	person	5.91	+
	Gross industrial output as a percentage of GDP	percent	2.58	+
factor inputs	Full-time equivalent of R&D personnel	man-year	9.11	+
	Internal Expenditure on R&D	10^4 yuan	8.98	+
	Expenditure on new product development	10^4 yuan	10.49	+
	Expenditures on technological transformation	10^4 yuan	4.23	+
quality and efficiency	Operating income	10^4 yuan	5.56	+
	Gross industrial output	10^4 yuan	5.87	+
	Net profit	10^4 yuan	2.89	+
	Total exports	10^4 yuan	9.98	+
level of innovation	Number of new product development projects	item	8.20	+
	Publication of scientific and technological papers	10^4 piece	2.94	+
	Number of Patent Applications	piece	3.48	+
	Technology market turnover	10^4 yuan	7.73	+

2.2 Data

The data utilized in this paper are sourced from reliable publications such as the China Statistical Yearbook, China Torch Statistical Yearbook, and China Science and Technology Statistical Yearbook. To ensure the availability and consistency of data, this paper used panel data from 2017 to 2021, covering 30 provinces (excluding Tibet, Hong Kong, Macau, and Taiwan) in China.

2.3 Measurement Method

In this paper, the entropy value method is employed to determine the weight of each subdivided indicator. The specific steps for calculating the weights are as follows:

$$X_{ij}^{*} = \frac{X - \min(X)}{\max(X) - \min(X)} \tag{1}$$

$$P_{ij} = \frac{X_{ij}^{*}}{\sum_{i=1}^{n} X_{ij}^{*}} \tag{2}$$

$$e_j = -k \sum_{i=1}^{n} \left(P_{ij} * \ln P_{ij} \right) \tag{3}$$

$$d_j = 1 - e_j \tag{4}$$

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{5}$$

$$s_i = \sum_{j=1}^{n} \left(w_j * X_{ij}^{*} \right) \tag{6}$$

3 Results and Analysis

Based on the application of the entropy value method to measure the weight of each index in the advanced manufacturing industry, the comprehensive development level of the industry in each province from 2017 to 2021 have been determined.

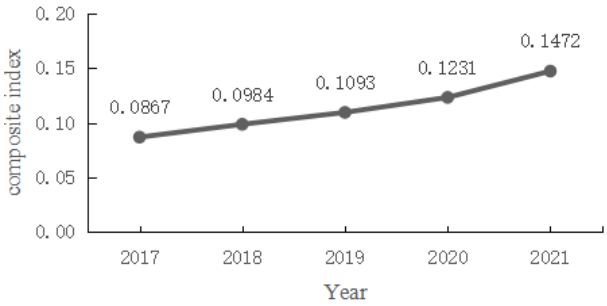

Fig. 1. Trends in Comprehensive Index of Advanced Manufacturing from 2017 to 2021

As depicted in Figure 1, the development level of China's advanced manufacturing industry exhibits a consistent upward trend over the years. The average value of the advanced manufacturing industry's development index across all provinces in the country has increased from 0.0867 in 2017 to 0.1472 in 2021, indicating a noticeable growth pattern. This trend suggests that advanced manufacturing technologies have been widely adopted in recent years, leading to fruitful advancements in the development of advanced manufacturing across all regions of the country.

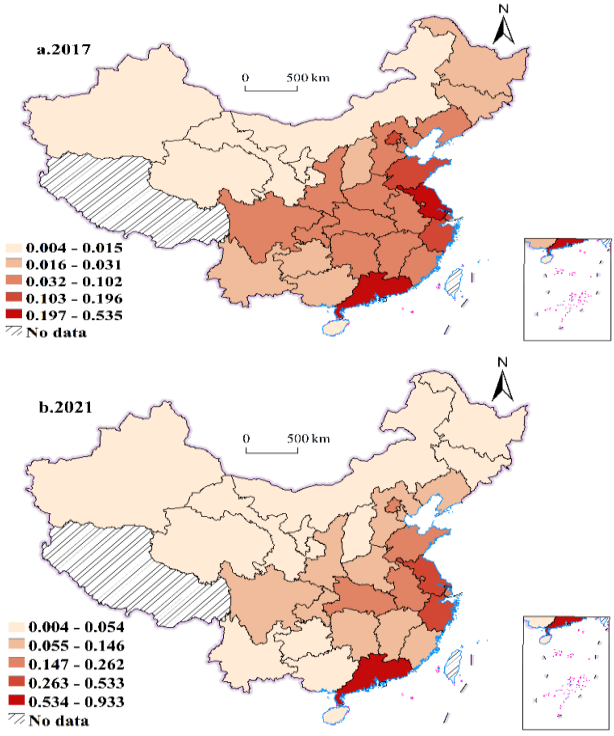

Fig. 2. The Development Pattern of Advanced Manufacturing in China

Figure 2 reveals that the overall level of advanced manufacturing development in the eastern region surpasses that in the central and western regions. Additionally, there is a significant issue of polarization in the development level of the advanced manufacturing sector, which can be attributed to differences in geographic location. The development level of advanced manufacturing shows an obvious distribution pattern of low in the west and high in the east. Among them, Guangdong and Jiangsu have always been at the highest level, with the best development of advanced manufacturing industries; while Xinjiang, Qinghai and Gansu have always been at the fifth gradient, with low levels of advanced manufacturing development.

Table 2. Regional Average Comprehensive Index of Advanced Manufacturing.

region	Beijing	Tianjin	Hebei	Shanxi	Inner Mongolia	Liaoning	Jilin	Heilongjiang
mean value	0.2060	0.0680	0.0898	0.0331	0.0237	0.0708	0.0388	0.0299
region	Shanghai	Jiangsu	Zhejiang	Anhui	Fujian	Jiangxi	Shandong	Henan
mean value	0.1617	0.4278	0.2775	0.1195	0.0913	0.0894	0.1912	0.0808
region	Hubei	Hunan	Guangdong	Guangxi	Hainan	Chongqing	Sichuan	Guizhou
mean value	0.1347	0.1062	0.7334	0.0411	0.0065	0.0675	0.1090	0.0249
region	Yunnan	Shaanxi	Gansu	Qinghai	Ningxia	Xinjiang		
mean value	0.0256	0.0918	0.0186	0.0051	0.0098	0.0147		

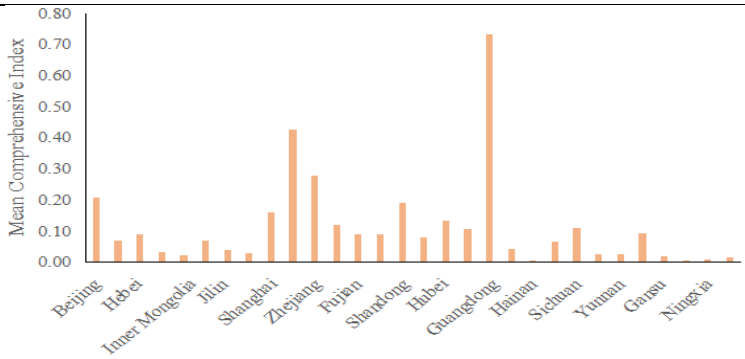

Fig. 3. Regional average of the advanced manufacturing composite index

Given the need to account for the diversity and comprehensiveness of the composite index of the development level of the advanced manufacturing industry, this paper utilizes a comprehensive evaluation model. This model calculates the weighted average

of the composite index for each indicator across the 30 provinces, cities, and districts. The resulting mean value represents the composite index of the development level of the advanced manufacturing industry for each province from 2017 to 2021. By analyzing these mean values, differences in the development level of the advanced manufacturing industry among regions can be examined. Table 2 provides a visual representation of these variations.

As observed comprehensively from Table 2 and Figure 3, there is a clear trend of polarization in the development level of the advanced manufacturing industry. This trend is characterized by a higher level of development in economically developed regions and a lower level of development in less developed regions.

4 Conclusions

Through the analysis of the development level of the national advanced manufacturing industry based on the results calculated by the entropy method, it can be found that: from the perspective of the advanced manufacturing comprehensive index, the overall development of China's advanced manufacturing industry shows a growth trend and is developing for the better; advanced manufacturing industries in various regions There are significant differences in development conditions, showing a trend of polarization, and the differences are gradually widening. Specifically, the distribution pattern is that the east is best, the center is second, and the west is relatively backward.

References

1. Tang X, Zhang X, Li Y. Dynamic coordination development in China’s manufacturing and manufacturing-related service industries[J]. Econ. Res. J, 2018, 53(3): 79-93.
2. Li Jinhua. Comparison of Germany's "Industry 4.0" and "Made in China 2025" and its inspiration [J]. Journal of China University of Geosciences (Social Sciences Edition),2015,15(05):71-79.
3. Obi C N, Leggett C, Harris H. National culture, employee empowerment and advanced manufacturing technology utilisation: A study of Nigeria and New Zealand[J]. Journal of Management & Organization, 2020, 26(4): 460-482.
4. Jiang Li. Spatial-Temporal Patterns of Advanced Manufacturing Distribution and lts Influence Factors in the Pearl River Delta [J]. Tropical Geography,2023,43(10):1973-1985.
5. Chen Hong, Li Zengquan. Empirical Analysis of the International Competitiveness of China's Advanced Manufacturing Industry [J]. Statistics & Decision,2019,35(07):154-157.
6. WANG Xiao-chuan, SUN Qiu-yu. The Dynamic Evolution of lndustry Matching and its lmpact on the High-quality Economic Development in the Yellow River Basin-Based on High-class Service Industry and Advanced Manufacturing Industry[J]. On Economic Problems,2023, (06):120-129.
7. Jiang X G, He J B, Fang L. Measure, Regional Difference and Promotion Path of High-Quality Development Level of Manufacturing[J]. Shanghai Economic Review, 2019, 7: 70-8.