Research on Financing Efficiency of Manufacturing Enterprises in Hebei Province

—— Based on DEA Efficiency Measurement Mode

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Abstract—With the rapid development of the national economy, measurement models play an increasingly important role in studying economic problems. The paper takes A-share listed manufacturing enterprises in Hebei Province from 2018-2020 as the sample, using DEA-BCC and DEA-Malmquist models to analyze the financing efficiency from a static and dynamic perspective. The results show the financing efficiency of manufacturing enterprises in Hebei Province is low, mainly caused by the low technical level, which shows most enterprises do not pay attention to technological innovation. Pure technical efficiency and scale efficiency do not reach the best at the same time. It shows that the financing efficiency of manufacturing enterprises in Hebei Province has a certain room for improvement, which needs to be improved from the technical level and scale degree.

Keywords-Financing efficiency; manufacturing enterprises; DEA model

1 INTRODUCTION

The report on the 19th National Congress of the Communist Party of China calls for "accelerating the development of advanced manufacturing". Therefore, as the pillar industry of the national economic development, the development of the manufacturing industry is not only an important part of deepening the supply-side structural reform and promoting high-quality economic development but also an objective requirement of building a modern socialist country in an all-round way. As the cradle of modern industry in China, the healthy development of Hebei province cannot be separated from the improvement of financing efficiency. Therefore, the paper measures the efficiency of manufacturing enterprises in Hebei province from the perspective of financing efficiency, it is conducive to identifying the difficult problems in the development of manufacturing enterprises in Hebei Province, which is of important reference significance for its transformation and upgrading.

2 LITERATURE REVIEW

Compared with foreign countries, the domestic research on financing efficiency started late, Zeng Kanglin [1] (1993) first proposed the concept of financing efficiency, but he did not

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specifically define it. In recent years, with the continuous research of financing efficiency, the academic definition of financing efficiency was mainly divided into two categories. The first view was proposed by Song Guanghui [2] (2017), based on the previous research, he defined financing efficiency as the efficiency of the integration of funds and the reasonable use of funds. The second view was proposed by Wu Yangfang [3] (2019), who believed that the financing efficiency includes the cost of capital integration and the integration risk. At present, the first view is agreed on the financing efficiency of manufacturing enterprises, and the reasonable use of funds is generally regarded as the main perspective of studying the financing efficiency.

In the process of studying the financing efficiency, we use the Data Envelopment Analysis method, which is called the DEA model, the gray correlation method, the fuzzy comprehensive evaluation method, etc. In recent years, Chinese scholars have achieved fruitful results when using the DEA model to study financing efficiency. Xiong Zhengde (2014) used the two-stage DEA model to study the debt financing efficiency of 20 listed enterprises in 2010-2012 from a static perspective. The research results showed that the financing efficiency was low [4]. Shen Chen (2017) used the three-stage DEA model to analyze the financing efficiency of small and medium-sized enterprises in the New Third Board market from a static perspective. The results showed that the relatively low scale efficiency was the main reason for the low financing efficiency [5]. Geng Chengxuan (2017) used the DEA-Malmquist model to dynamically analyze the financing efficiency of 11 listed machinery manufacturing companies in Jiangsu Province from 2009 to 2014. The results showed that the technological progress made the financing efficiency of the industry increase year after year, and pointed that there were certain differences in the factors affecting the financing efficiency of each company [6]. Zhai Bin (2020) used the DEA-Malmquist model, taking 63 manufacturing enterprises in southern Jiangsu Province as the sample, the dynamic analysis found the number of enterprises that achieved effective DEA was small. Most enterprises were relatively low and lacked innovation ability due to relatively backward technology, the overall financing efficiency was low [7].

According to the existing literature, the research perspective of financing efficiency covers a wide range, laying a solid foundation for the subsequent research. However, most studies analyze the financing efficiency from a static or dynamic perspective alone, rarely combine the two perspectives jointly, so that the analysis results are not objective enough. Hebei Province has formed a relatively complete industrial system in recent years. Studying the financing efficiency of the manufacturing industry in Hebei Province can fully understand the advanced degree and shortcomings of productivity. In addition, the measures of financing efficiency are varied. Based on the previous studies, this paper measures the financing efficiency of manufacturing enterprises in Hebei Province from 2018-2020, from static and dynamic perspectives by using the DEA model, and putting forward relevant suggestions according to the analysis results. The paper not only broadens the method research on financing efficiency in the academic circles but also provides a thinking space for the future transformation and upgrading of manufacturing enterprises in Hebei Province.

3 DATA SOURCE AND RESEARCH DESIGN

3.1 Model introduction

In the DEA model, the evaluated unit is known as the decision-making unit (DMU). The DEA model selects multiple input and output indicators of the decision-making unit, it uses the method of linear planning to construct the optimal input and output as the production frontier. Where the effective point is located on the leading edge, the efficiency value is set to 1, the invalid point is located outside the leading edge, and is given a relative efficiency value index more than 0 and less than 1. The closer the efficiency value of the decision-making unit is to 1, the more effective the efficiency of the decision-making unit. Assuming there are n manufacturing enterprises, and there are n decision units, each with x input elements and y output elements, we can establish the formula:

$$\begin{cases} \min\theta=V_0 \\ s.t.\sum X_j\lambda_j+s_j^-=\theta X_0, i=1,2,\ldots,m \\ \sum Y_j\lambda_j-s_r^+=Y_0, r=1,2,\ldots,s \\ \sum\lambda_j=1, \lambda_j\geq 0, j=1,2,\ldots,n \\ s_r^+\geq 0, s_j^-\geq 0 \end{cases} \quad (1)$$

The above method uses the DEA-BCC model to measure the efficiency of the sample, which is a static measure of different period panel data, but it can't observe the dynamic changes during the sample, so it is difficult to measure whether the efficiency level improves or not. The DEA-Malmquist model can depict the dynamic trend. According to the Malmquist index (total factor productivity index) calculated by this model, it can reflect the efficiency value of multiple periods to study the factors affecting the efficiency changes. The specific formula is:

$$M(y_{t+1},x_{t+1},y_t,x_t)=\left(\frac{D^t(x_{t+1},y_{t+1})}{D^t(x_t,y_t)}\times\frac{D^{t+1}(x_{t+1},y_{t+1})}{D^{t+1}(x_t,y_t)}\right)^{\frac{1}{2}} \quad (2)$$

According to the research of scholars, the Malmquist index can be further decomposed:

$$M(y_{t+1},x_{t+1},y_t,x_t)=\left[\frac{D^{t+1}(x_{t+1},y_{t+1})}{D^t(x_t,y_t)}\times\left(\frac{D^t(x_{t+1},y_{t+1})}{D^{t+1}(x_{t+1},y_{t+1})}\times\frac{D^t(x_t,y_t)}{D^{t+1}(x_{t+1},y_{t+1})}\right)^{\frac{1}{2}}\right] \quad (3)$$

If the Malmquist index is more than 1, the efficiency level increases relative to the previous issue; if the index is equal to 1, the level is the same as the previous; if the index is less than 1, the level decreases relative to the previous.

3.2 Data source

In this paper, the manufacturing enterprises in Hebei Province listed in A-shares from 2018 to 2020 are selected, and there are 39 enterprises after ST enterprises and some financial indicators are excluded as samples, the relevant financial data come from the CSMAR. When using the DEA model, the sum of the input and output indicators should be more than twice of the decision-making units. In this paper, there are 39 manufacturing enterprises, which meets the requirements of the model measurement. In addition, the DEA model requires the data of the decision-making unit must be non-negative. The input and output indicators selected in

this paper have negative values. Therefore, we use the specific method to ensure the selected values are between 0 and 1:

$$Y_{ij} = 0.1 + \frac{x_{ij}-a_i}{b_i-a_i} \times 0.9 \quad (4)$$

$$b_i = max(X_{i1}, X_{i2}, \dots, X_{ij}), a_i = min(X_{i1}, X_{i2}, \dots, X_{ij}), i = 1,2 \dots i$$

3.3 Index establishment

Drawing on the previous definition of "financing efficiency", this paper takes the use efficiency of capital as the main perspective of studying financing efficiency, first of all, we need to consider the investment cost of manufacturing enterprises, and then determine the financing efficiency of manufacturing enterprises according to the effectiveness of the resource allocation. Therefore, the investment index adopted in this paper considers the enterprise capital ability, reflecting the enterprise financing structure, capital utilization ability, and the operation ability of the enterprise. This paper selects three input indicators: asset-liability ratio, operating cost, and inventory turnover ratio.

The output index of the enterprise financing efficiency should be considered from the ability of the enterprise to obtain profitability, reflecting the two aspects of the enterprise profitability and income efficiency. This paper selects two output indicators: the operating income and the net interest rate of total assets. The specific source and representative significance of specific input and output indicators are shown in Table 1 below.

TABLE 1. SELECTION OF INDICATORS AND RELEVANT INSTRUCTIONS

Type	Name of the index (X_1)	Relevant instructions
Investment index	Asset-liability ratio (X_2)	The financing structure
	Operating cost (X_3)	The use of funds
	Inventory turnover ratio (X_4)	The operating ability
Output indicators	The operating income (Y_1)	The profitability
	The net interest rate of total assets (Y_2)	The enterprises' utilization of assets

4 REGRESSION AND OUTCOME ANALYSIS

4.1 Static analysis of financing efficiency

The level of financing efficiency θ is divided into five levels. When θ=0, the financing is minimally inefficient and invalid; when $0<\theta\leq0.5$: relatively invalid state; when $0.5<\theta\leq0.8$: in an inefficient state; when $0.8<\theta\leq1$: in a relatively active state; when θ=1: in an effective state, the financing efficiency has reached the best.

The technical efficiency for each year is shown in Table 2:

TABLE 2. TECHNICAL EFFICIENCY VALUES FOR EACH YEAR

Level	2018		2019		2020	
	Amount	Percent	Amount	Percent	Amount	Percent
0	0	0	0	0	0	0
0-0.5	18	46.15%	15	38.46%	16	41.03%
0.5-0.8	9	23.08%	12	30.77%	13	33.33%
0.8-1	5	12.82%	5	12.82%	3	7.69%
1	7	17.95%	7	17.95%	7	17.95%

The table shows that the vast majority of the technical efficiency in three years within the range of 0-0.5, which are in a relatively ineffective state, the number of the relatively ineffective and inefficient enterprises accounts for about 70% in three years, reflecting the financing efficiency is not optimistic. There are only 7 enterprises achieve the optimal financing efficiency.

The pure technical efficiency is shown in Table 3:

In terms of pure technical efficiency, the value of 0-0.5 in the sample enterprises has not changed much in three years, about 20% of the total; the value of 0.5-0.8 in the sample enterprises was increasing, which from 20.51% in 2018 to 28.21% in 2019, and reached 33.33% in 2020. The value of 0.8-1 in the sample enterprises was close in 2018 and 2020, all accounted for about 20% of the overall sample. In contrast to 2018, a significant downward trend occurred in 2019, the decline was approximately 44%. the value of 1 in the sample enterprises fluctuated within three years, most available in 2019. But the decline was significant in 2020. On the whole, the restricted financing efficiency of enterprises is mainly caused by the low efficiency of pure technology.

Annual scale efficiencies are shown in Table 4:

In terms of scale efficiency, the average has exceeded 0.8 in three years, indicating that the scale efficiency of most enterprises has reached a relatively effective state. But a few enterprises still have relatively low scale efficiency, probably due to insufficient investment or redundancy.

4.2 Dynamic analysis of financing efficiency

The dynamic changes are shown in Table 5:

Within 3 years, the Malmquist index of 39 sample enterprises fluctuated at the level of 1.0 with a decreasing trend. The Malmquist index from 2018 to 2019 was 1.006, indicating the financing efficiency in this period has improved; 0.906 from 2019 to 2020, indicating the financing efficiency has decreased significantly. The average is 0.956 less than 1, indicating most of the listed manufacturing enterprises in Hebei Province are in the development stage, and they are greatly affected by many uncertain factors such as technological innovation, financial environment, and financing scale.

The Technical Efficiency Index (Effch) is used to reflect the increased financing output from sample enterprises due to technological advances or reduced financing costs, which is influenced jointly by the pure technical efficiency index (Pech) and the scale efficiency index

(Sech), the mathematical model can be expressed as Effch=Pech×Sech. According to Table 5, the scale efficiency index for 2018-2020 is more than 1, which shows the scale efficiency of the sample enterprises has been improving within 3 years. In terms of the range of changes in the scale efficiency index and the pure technical efficiency index from 2018 to 2020, the decline of the pure technical efficiency index decreased greatly, the effect on the technical efficiency index is relatively obvious, it is one of the declines in the Malmquist index.

The Technology Progress Index is used to reflect the level of technological progress, namely the advancement of production technology, which can be regarded as the core competitiveness of the enterprise. If the Tech is greater than 1, the core technology of the enterprise has improved; otherwise, the core technology of the enterprise has decreased. It can be seen that the Tech of the sample enterprises is less than 1 within 3 years, and it is in a state of the declining year after year, indicating that the technical level of the enterprise shows a backward state, and there is a certain room for improvement in the core technology and management of the enterprise.

5 CONCLUSION AND SUGGESTIONS

5.1 Conclusion

From what we analyze above, we can conclude:

The financing efficiency of most manufacturing enterprises in Hebei Province is less than 1 from 2018 to 2020, the sample enterprises are in fluctuations. Most of the financing efficiency is relatively ineffective and inefficient.

From the perspective of the specific indicators of financing efficiency, the scale efficiency of the decision-making unit is higher than the technical efficiency's. The factor is mainly caused by the low efficiency of pure technology. Therefore, enterprises should constantly expand the technology to match the effective financing scale to improve the financing efficiency.

5.2 Suggestions

According to the research of this paper, the financing efficiency of manufacturing enterprises in Hebei province is not ideal, the backward of the pure technology efficiency is the main factor of the limited. Therefore, enterprises need to improve the situation through the effective allocation of technology, talents, and other factors of production:

In terms of technology, technical level and technological innovation are the important embodiment of the core competitiveness of enterprises. By reducing repetitive labor, technological innovation improves the production efficiency of enterprises. This requires enterprises, on the one hand, to update the existing technical level and equipment. On the other hand, while retaining the existing business, they can open up pilot small-scale technological innovation and strengthen scientific research.

In terms of talents, enterprises can try to build a cooperation platform with universities, accelerating the transformation of scientific and technological knowledge to technological achievements. Making full use of the talent to improve the pure technical efficiency.

In terms of management, the development of enterprises cannot only focus on the technical level; management mode should keep pace with the times. Therefore, enterprises need to develop strategic planning, not only staying in the production workshop but led by the decision layer through all levels of the company. Through the effective agglomeration and allocation of these resources, the technological progress of enterprises can be promoted. It is also an inevitable choice for manufacturing enterprises to improve financing efficiency.

According to the analysis of scale efficiency, it can be seen that most enterprises have reached a relatively effective state. However, there are still some enterprises with deficiencies, they need to combine their actual situation to choose the appropriate financing scale. For the insufficient investment, they can expand the business scale and business outlets to adapt to the demand in the future. However, with the expansion of the enterprise-scale, enterprises may obtain financial support through debt, which is likely to increase the business risk and financial risks. At this time, through the way to expand the scale of the enterprise has no longer adapted to the market competition, therefore, they should reasonably control the scale and development speed of enterprises, to avoid the adverse use of funds, and improve the use efficiency of funds.

TABLE 3. PURE TECHNICAL EFFICIENCY VALUES FOR EACH YEAR

Level	2018		2019		2020	
	Amount	Percent	Amount	Percent	Amount	Percent
0	0	0	0	0	0	0
0-0.5	9	23.08%	9	23.08%	8	20.51%
0.5-0.8	8	20.51%	11	28.21%	13	33.33%
0.8-1	9	23.08%	5	12.82%	8	20.51%
1	13	33.33%	14	35.89%	10	25.65%

TABLE 4. SCALE EFFICIENCY VALUES FOR EACH YEAR

Level	2018		2019		2020	
	Amount	Percent	Amount	Percent	Amount	Percent
0	0	0	0	0	0	0
0-0.5	4	10.26%	2	5.13%	3	7.69%
0.5-0.8	9	23.08%	7	17.95%	7	17.95%
0.8-1	19	48.71%	23	58.97%	22	56.41%
1	7	17.95%	7	17.95%	7	17.95%

TABLE 5. DYNAMIC CHANGES FROM 2018 TO 2020

Year	Effch	Techch	Pech	Sech	Tfpch
2018-2019	1.027	0.980	0.991	1.035	1.006
2019-2020	0.973	0.931	0.956	1.018	0.906
Mean value	1	0.956	0.974	1.027	0.956

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