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Research on Financing Efficiency of Automobile Manufacturing Enterprises Based on AHP-DEA Model

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Abstract

With the beginning of reform and opening up, the automotive industry has continued to develop. China's auto industry has become a large capital and technology investment industry. With the opening of national policy, foreign auto industry giants have entered the Chinese market one after another, and they want to gain a share in this growing market. Compared with domestic enterprises, these foreign-funded enterprises have huge international markets and rich technical background. These advantages pose a huge threat to China's automobile industry. In order to reduce this gap, the blind expansion of China's automobile manufacturing industry exists. Therefore, China's automobile manufacturing industry currently has a certain problem of overcapacity, and technical bottlenecks are difficult to break through. New technology research and development requires a large amount of capital investment and market recognition, so a large amount of capital investment is needed to promote the development of the industry. However, the financing mode of the industry itself is restricted by national policies, it is difficult to invest in foreign funds, and the industry has only a single financing channel. Therefore, under this background, the data envelope method is used to study the financing efficiency of the automobile industry, analyze the problems existing in the financing efficiency of enterprises, and provide some suggestions and methods for improving the financing efficiency of enterprises.

Keywords

Financing efficiency; data envelopment analysis; automobile manufacturing.

1. Introduction

During the 13th Five-Year Plan period, the CPC Central Committee put forward new requirements for the development of China's auto industry, and demanded that the domestic auto industry be optimized. The main lies in strengthening independent innovation capabilities, strengthening profitability, improving service quality, enhancing corporate competitiveness, and reducing dependence on state financial subsidies. In the current context of financing difficulties for auto companies, auto companies need to reduce capital use costs, increase financing efficiency, and use corporate funds for research and development of core technologies and improve corporate management efficiency to ensure rapid development of the company.

2. Research Methods

(1)The data envelopment analysis method is a quantitative analysis method that evaluates comparable units based on multiple input and output indicators. It was proposed by American operations researcher Charnes and W.W. Cooper in 1978. It is an evaluation method that can

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be applied to different departments and has multiple input and output indicators. In the evaluation, the method has small error, simple calculation steps, and can reduce the influence of subjective factors. The data envelopment analysis method is mainly divided into the following steps: determining the decision unit; constructing the evaluation index; data processing, selecting the DEA model, calculating the relative efficiency of the sample, and analyzing the result.

(2)Analytic Hierarchy Process (AHP) was proposed by T. L. Saaty, a professor of mathematics at the University of Pittsburgh in the United States in 1973. It is a multi-program, multi-objective decision-making method that can be used to deal with complex social, political, economic, and technical decision-making issues. First, layering complex decision-making issues. Second, it uses a series of pairwise comparisons to determine the relative importance of each plan or measure under a certain criterion. These criteria themselves are a measure of higher-level The relative importance of each element is weighted. This process can be continued through a hierarchical relationship until the total ranking of the highest goal for each decision-making scheme or measure is calculated. The analytic hierarchy process is essentially a decision-making thinking mode, which has the characteristics of analysis, judgment and synthesis of human thinking. As a decision-making tool, AHP has the advantages of simplicity, ease of use, effectiveness, strong adaptability, and wide application range.

3. Construction of DEa Indicator System

3.1. Index Selection Principle

The accuracy of the financing efficiency evaluation index selection seriously affects the validity of the evaluation results, so in order to ensure the evaluation results and rationality, accuracy and reliability. When constructing an evaluation index system for financing efficiency of automobile manufacturing enterprises, the following indicators are selected as the pre-selected indicators, and then scored by experts.

Table 1. Pre-selection table for input indicators

Index classification	Indicator name
B1 Enterprise size	C1 Number of employees
	C2 Total assets
B2 Financing costs	C3 Financial expenses
	C4 Cash out of financing activities
B3 Revenue level	C5 Total operating income
	C6 Roe
B4 Operating capacity	C7 Operating profit
	C8 Total asset turnover
	C9 Turnover ratio of current assets
B5 debt-paying ability	C10 Equity ratio
	C11 Asset-liability ratio

3.2. Construction of Judgment Matrix

3.2.1 Building the hierarchy

Based on the summary of the analysis of the construction of the evaluation index system for financing efficiency, the evaluation model is divided into three levels: the target level, the criterion level and the plan level.

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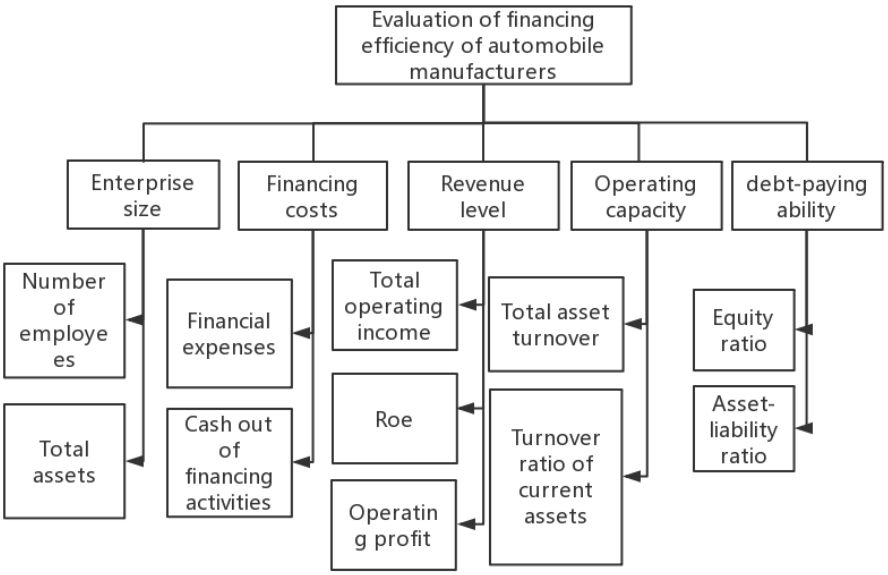

Figure 1. Decision-making diagram of financing efficiency of automobile manufacturers

3.2.2 Alculate the judgment matrix

Based on the survey and calculation of yaahp software, the following results were obtained:

Table 2. Judgment matrix and weighting of financing efficiency of automobile manufacturing enterprises

Project	Enterprise size	Financing costs	Revenue level	Operating capacity	debt-paying ability
Enterprise size	1.000	1.000	4.000	2.000	2.000
Financing costs	1.000	1.000	3.000	1.500	1.500
Revenue level	0.250	0.333	1.000	0.333	0.500
Operating capacity	0.500	0.667	3.000	1.000	1.000
debt-paying ability	0.500	0.667	2.000	1.000	1.000

Among them, the judgment matrix of Table 2 λmax = 5.0298, CR = 0.0067

Table 3. Judgment Matrix and Weight of Revenue Level

Project	Operating profit	Roe	Total operating income	Weight (W)
Operating profit	1.000	0.500	0.500	0.199
Roe	2.000	1.000	1.500	0.454
Total operating income	2.000	0.667	1.000	0.347

Among them, the judgment matrix in Table 3 λmax = 3.0183, CR = 0.0176

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Table 4. Financing cost judgment matrix and weight

Project	Financial expenses	Cash out of financing activities	Weight (W)
Financial expenses	1.000	1.500	0.600
Cash out of financing activities	0.667	1.000	0.400

Among them, the judgment matrix in Table 4 is λmax = 2; CR = 0

Table 5. Enterprise size judgment matrix and weight

Project	Total assets	Number of employees	Weight (W)
Total assets	1.000	3.000	0.750
Number of employees	0.333	1.000	0.250

Among them, the judgment matrix of Table 5 λmax = 2; CR = 0

Table 6. Operation capacity judgment matrix and weights

Project	Turnover ratio of current assets	Total asset turnover	Weight (W)
Turnover ratio of current assets	1	0.3333	0.25
Total asset turnover	3	1	0.75

Among them, the judgment matrix of Table 6 λmax = 2; CR = 0

Table 7. Solvency judgment matrix and weight

Project	Equity ratio	Assets and liabilities	Weight (W)
Equity ratio	1.000	0.500	0.333
Assets and liabilities	2.000	1.000	0.667

Among them, the judgment matrix in Table 7 is λmax = 2; CR = 0

3.2.3 Determination of final indicators

It can be seen from the above table that the weights obtained by the analytic hierarchy process are considered and finally selected.

Input indicators: 1. Total assets 2. Financial expenses 3. Asset-liability ratio

Output indicators: 1. Return on net assets 2. Total operating income 3. Total asset-liability ratio

3.3. Determination of Effective Standards for Financing Efficiency

This article adopts the classification method and refers to the previous research literature on the division of efficiency evaluation. For details, see Table 9 below.

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Table 8. Weight calculation results of analytic hierarchy process

Main target	Sub-goal	W1	Project	W2	Final weight
Financing efficiency	Enterprise size	0.313	Operating profit	0.062	0.0195
			Roe	0.142	0.0444
			Total operating income	0.109	0.0340
	Financing costs	0.264	Financial expenses	0.158	0.0417
			Cash out of financing activities	0.106	0.0278
	Revenue level	0.077	Total assets	0.058	0.0045
			Number of employees	0.019	0.0015
	Operating capacity	0.181	Turnover ratio of current assets	0.045	0.0082
			Total asset turnover	0.136	0.0245
	debt-paying ability	0.166	Equity ratio	0.055	0.0091
			Assets and liabilities	0.110	0.0183

Table 9. Gradient classification criteria for financing efficiency

	Non-DEA effective			DEA effective
Efficiency distribution	(0, 0.5)	[0.5, 0.8)	[0.8, 1)	1
Efficiency standard	Low efficiency	Lower efficiency	Higher efficiency y	Optimal efficiency

According to the classification of financing efficiency, when the efficiency is 1, it is considered that the DEA of the financing efficiency of the enterprise is effective, and the scale efficiency is optimal. When the efficiency value is less than 1, non-DEA financing efficiency is effective, which is divided into three gears. When the lowest level is 0 <X <0.5, the financing efficiency of the enterprise is in the low efficiency stage. Under the financing efficiency, it is difficult to effectively use the funds. An analysis of the reasons leading to the low efficiency of the enterprise is required. When the middle gear is 0.5≤X <0.8, the financing efficiency of the enterprise is in the inefficient intermediate stage. The capital utilization situation has increased compared with the lowest gear, but there is still room for improvement; when the highest gear is 0.8≤X <1, the enterprise's Financing efficiency is at a high level of non-efficiency, which indicates that the efficiency of capital utilization by enterprises is quickly reaching an optimal state.

4. DEA Calculation Results

According to the evaluation index system established above, collect data from 2014-2018 of listed companies in China's automobile manufacturing companies for analysis, solve it with MyDEA software, use the CCR model and BCC model to analyze the financing efficiency of the company, and calculate the technical efficiency (TE), Pure technical efficiency (PE), scale efficiency (SE). The specific calculation results are shown in the following table

4.1. Technical Efficiency

Comprehensive technical efficiency is a comprehensive evaluation of the ability of an enterprise to allocate and utilize resources under its control. This article is used to evaluate the technical

efficiency of 20 auto manufacturing listed companies in 2014-2018. The specific efficiency is shown in Table 10 below.

Table 10. Distribution of technical efficiency of sample enterprises from 2014 to 2018

Efficiency value	2014	2015	2016	2017	2018
(0,0.5)	7	6	7	3	5
[0.5,0.8)	4	6	5	7	6
[0.8,1)	3	1	1	3	1
1	6	7	7	7	8
Mean efficiency	0.682	0.670	0.672	0.734	0.710

According to the above table 10, the efficiency distribution of the sample companies can be observed. The number of companies with effective technical efficiency during the sample period has maintained an increase from 2014 to 2016. Six companies in 2014 (30%), 2015, 2016, 2017 The annual average is 7 (35%) and 2018 (8% (40%)). Two of these companies have always had a technical efficiency of 1 during the sample period. They are SAIC Group and Jiangling Motors (10%). %). Although the average technical efficiency and the number of effective companies have improved during the sample period, the average technical efficiency of the industry is less than 1, so it can be seen that the inefficient financing of some companies in the automotive manufacturing industry affects the overall financing efficiency of the industry. In addition, because technical efficiency is affected by both pure technical efficiency and scale efficiency, it is necessary to dismantle technical efficiency and understand the degree of impact on corporate efficiency in terms of corporate governance, management capabilities, and enterprise scale. The following section will analyze the technical efficiency.

4.2. Analysis of Pure Technical Efficiency

Pure technical efficiency is an indicator of the internal management capacity and technical level of an enterprise. The following table 11shows the pure technical efficiency of the 20 automobile manufacturing listed companies during the sample period.

Table 11. Distribution of pure technology efficiency of sample companies from 2014 to 2018

Efficiency value	2014	2015	2016	2017	2018
(0,0.5)	0	0	1	0	0
[0.5,0.8)	8	8	8	7	6
[0.8,1)	3	2	2	2	2
1	9	10	9	11	12
Mean efficiency	0.836	0.850	0.825	0.876	0.890

According to the above tables 11, it can be concluded that the number of companies with pure technical efficiency is basically unchanged from 2014 to 2018. The number of companies with effective efficiency during the sample period was 9 in 2014 (45%) and 10 in 2015. (50%), 9 in 2016 (45%), 11 in 2017 (55%), and 12 in 2018 (60%). From the efficiency distribution, it can be seen that nearly half of the companies in the automotive manufacturing industry are effective in pure technical efficiency, and the number of effective companies with pure technical efficiency is higher than the number of technically efficient companies. Pure technical efficiency is the technical efficiency that excludes the impact of scale efficiency. In the high efficiency range

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and the average industry financing efficiency in the sample period maintained an increasing trend, the average pure technology efficiency average reached 0.8 in the sample period, indicating that the industry as a whole has a management level higher than the technical efficiency level and a reasonable corporate governance structure, but the average pure technology efficiency It is still below 1, and if the enterprise wants to develop further, it still needs to improve the management ability of the enterprise while absorbing funds for development, improve the corporate governance structure, and ultimately improve the production efficiency of the enterprise.

4.3. Statistical Analysis of Scale Efficiency

Scale efficiency is a measure of the change in output when the company's input factors change in the same proportion while the technological level and factor prices remain unchanged. The scale efficiency distribution of auto manufacturers in 2014-2018 is shown in Table 12 below.

Table 12. Scale efficiency distribution of sample companies from 2014 to 2018

Efficiency value	2014	2015	2016	2017	2018
(0,0.5)	4	2	4	2	4
[0.5,0.8)	4	7	3	5	4
[0.8,1)	6	4	6	6	4
1	6	7	7	7	8
Mean efficiency	0.793	0.779	0.799	0.827	0.782

From 2014 to 2018, the average scale efficiency showed an “M” -shaped fluctuation, and the overall average showed volatile growth. Among them, the number of effective scale efficiency companies was 6 in 2014 (30%) and 7 in 2015 (35%), 7 in 2016 (35%), 7 in 2017 (35%), and 8 in 2018 (40%). According to the statistical results, it can be seen that the average scale efficiency during the sample period is higher than the technical efficiency, but lower than the pure technical efficiency. It shows that the overall scale efficiency of the industry has a greater impact on technological efficiency. The average scale efficiency of the industry as a whole during the sample period is 0.796. The overall scale of the industry is about to enter a more reasonable range. It still needs to be improved. In order to further help enterprises to improve the efficiency of scale. Understand whether enterprises reduce investment, reduce the scale of the enterprise to increase scale efficiency or increase investment, and expand the scale of the enterprise to increase scale efficiency. The following section will analyze the changes in scale efficiency.

5. Conclusion

5.1. The Technical Efficiency Level of the Industry Is At A Relatively Low Level, but There Is A Growing Trend

The technical efficiency in the CCR model is mainly used to measure the ability of an enterprise to achieve the maximum output under the given input factors. Technical efficiency is a comprehensive reflection of pure technical efficiency and scale efficiency. During the sample period, the average technical efficiency of listed companies in China ’s automobile manufacturing industry were 0.682, 0.670, 0672, 0.734, and 0.710, respectively. They are at lower efficiency in the financing gradient division. However, by observing the trend of the overall technical efficiency of the industry, it can be seen that the average value of the technical efficiency of listed companies in China's automobile manufacturing industry is on the rise, increasing by 4.1% in 2018 compared to 2016. It is a steady increase in pure technical efficiency.

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It can be seen from the calculation conclusions that most of China's listed automobile manufacturing companies have low levels of technical efficiency and their ability to convert financing into their own output is still low.

5.2. The Industry's Resource Utilization Rate Is High, and It Continues to Increase

The pure technical efficiency in the BCC model is mainly used to measure the ability of an enterprise to use existing resources and to express the technical level of enterprise management. According to the calculation results, it can be known that the average values of the pure technical efficiency of China's automobile manufacturing industry during the sample period were 0.836, 0.850, 0.825, 0.876, and 0.890, respectively. A higher level of efficiency in the financing gradient division. From the perspective of changes, the industry as a whole is showing an increasing trend. During the sample period, it increased from 0.836 in 2014 to 0.890 in 2018, an increase of 6.46%. According to the calculation conclusions, it can be seen that the investment of most listed companies in China's automobile manufacturing industry is at a reasonable level, and the funds incorporated by the enterprises can be used reasonably.

5.3. The Scale Efficiency Is At A Low Level, but the Overall Growth Is Gradually Increasing

Modular efficiency is mainly used to measure the ability of a company to increase output by expanding its scale. The higher the scale efficiency, the closer the company's scale is to the optimal output scale. According to the calculation results, it can be seen that the average scale efficiency of listed companies in China's automobile manufacturing industry is 0.793, 0.779, 0.799, 0.827, 0.782, which is a relatively low level of efficiency in the financing gradient division. However, it can be seen from the overall data change trend that scale efficiency has approached a higher level in the financing gradient division, and scale efficiency has gradually increased. However, compared with the level corresponding to the pure technical efficiency of the automobile manufacturing industry, there is still a certain gap.

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