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`Chinese Automotive Industry Performance Evaluation of Each Month in 2014 via DEA

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Abstract

Treating our above-scale industrial enterprises in the automotive industry production efficiency as the research object, each month in 2014 industrial enterprises above designated size car manufacturing efficiency of the main indicators for the sample data, DEA CCR model is based on the use of DEAP software, its production efficiency comprehensive evaluation, objective evaluation of the 2014 cars each month of above-scale industrial enterprises in the manufacturing sector overall production efficiency, has been effective in January China's automobile industry in industrial production and non-active month, it has been benchmarking and performance gaps, so as to provide basis for decision making to improve production efficiency.

Keywords*: DEA method, Automotive Manufacturing, Performance Evaluation*

1. Introduction

Automobile industry is the pillar industry of the national economy and the industry chain is long. The influence factors are also complex. Therefore, it has been a hot research topic for the domestic and foreign scholars to evaluate the overall development level of the automobile industry by using the index and method. There are a lot of methods to evaluate the efficiency of the existing methods, such as the financial evaluation, economic growth, the balanced score card, and some other mathematical methods, such as analytic hierarchy process, factor analysis, fuzzy comprehensive evaluation and data envelopment analysis (Envelopment Analysis: DEA Data) [1]. Various efficiency evaluation methods have their own advantages and disadvantages. In comparison, the DEA is a non-parametric and it has its own unique advantages compared with other methods, which is a kind of measurement economic method to evaluate the relative efficiency of multi input multi output decision making units. DEA method is suitable for the evaluation of various systems, which are not affected by measurement units and the weight coefficients or explicit expressions are not given in advance, which can not only determine that decision units are invalid, but it also give the target value [2]. Therefore, in recent years, DEA method has been widely used in the evaluation of public sector, non-profit organizations, the efficiency of production enterprises and many other areas [3-6].

2. Domestic and Foreign Research Present Situation

As a world subject, the theory of corporate performance evaluation and evolution of the western economy is in the development. Early attention to a single financial indicator, by 1990s, it is generally realized that over a certain local evaluation will

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lead to the weakening of the overall results, which began to pay attention to the multi-dimensional evaluation index system. On the basis of the concept of "relative efficiency evaluation", the operational research scientist Clearness proposed the data envelopment analysis (DEA), which is based on the mathematical programming of DEA, especially suitable for the complex system with multi input and multi output that has many unique advantages, so it is widely used.

Such as: Berger (1993), using the DEA Method Research on frontier efficiency in Norway, Sweden and Finland and other countries of the bank, there are two kinds of variable and constant returns to scale, the Swedish National Bank, Norway State Bank of Finland between the two countries with higher efficiency; Cummins (1996) and other people use DEA method to investigate the life insurance in Italy the company and non-life companies and the technical efficiency, technical efficiency and operating efficiency of life insurance and property insurance company as a life insurance or property insurance company franchise franchise the conclusion; Jeng (2001) was analyzed by using DEA method in America Japan and Taiwan region, the efficiency of financial institutions, the structure of property rights and agency cost the non-life insurance industry efficiency in Japan also count; Banker *et al* (2006) the efficiency of using the DEA method and the logarithmic cost function to evaluate the North Carolina hospital, and Wiley (2006) DEA () Samoilenko, S. (2008) proposed the research on the performance of the Turkey Stock Exchange listed on the Istanbul stock exchange.

In China, the evaluation of the problem has been one of the hot spots, especially in recent years and especially in the field of economic production by using DEA method. Such as: Xu Jianzhong, *et al.*. (2007) using the DEA method, with the integration of higher education resources in Heilongjiang Province as an example, the effect of the integration of higher education resources is evaluated. And put forward the integration of higher education resources in Heilongjiang Province countermeasures and suggestions; Lin Ji Keng, (2007) the ranking evaluation based on DEA / AHP model is applied to the power system after the blackout of the whole of the black start scheme to avoid the artificially set the AHP judgment matrix of subjectivity and arbitrariness, so as to overcome the DEA method can in a scale of all sort of shortcomings. And for Tianjin power grid, this method is used to evaluate the candidate black start scheme and the optimal solution is obtained by Zhang Bing *et al.*. (2008) using DEA method to evaluate the eco efficiency of Hangzhou Bay Fine Chemical Industrial Park. The results show that overall the park within 43 enterprises have 26 enterprises ecological efficiency is relatively effective and another 17 homes enterprises ecological efficiency invalid and invalid scale. Meanwhile, the park further development circular economy, improving the ecological efficiency and achieving the park's sustainable development which put forward some valuable suggestions; Xiao Jian (2008) executed by using DEA method, combined with the characteristics of the depot storage, to a group of warehouses evaluation and utilization evaluation results to the warehouse performance grading, and finally draws a conclusion of the performance benchmark.

Through the analysis, it is found that the bar code management and implementation of distribution system are of these two best practices. They are simultaneously applied to lower the efficiency of two warehouses and the supporting process improvement, re-use the same DEA model to evaluate the group of warehouses and finding the two library performance has indeed been significantly improved; Shuai Ying *etc.* (2009) it use DEA method of as before under the environment of electricity market a year in power generation enterprises of the monthly production efficiency rating, it is concluded that the production efficiency is relatively effective quantitative results. In order to realize the evaluation of the efficiency in the DEA method, the DEA method is used to evaluate the efficiency of

the proposed model. The CCR method is used to evaluate the efficiency of the proposed model. The two evaluation is carried out by using the DEA model.

In 2008 , 9annual as decision making units, to the Inner Mongolia area 9 years of highway construction were overall with effectiveness, validity and technical measure projection analysis, and it put forward the corresponding improvement measures; I wish Lingxi *etc*. (2011) uses DEA method for railway emergency plan compilation performance comprehensive evaluation. At the same time, according to the limitation of the traditional DEA method, the improved DEA method is proposed and the important degree of the evaluation index of the emergency plan is given to different weights, which improves the reliability and accuracy of the evaluation results. Finally, taking the Qinghai Tibet Railway Company as an example, the comprehensive evaluation of the performance of the plan is carried out.

The DEA model is introduced into the evaluation of the automobile manufacturing industry. In this paper, the sub category of the automobile manufacturing industry in China, the vehicle manufacturing industry is the research object. Through the introduction of DEA model, we can complete the measurement of the production efficiency of the automobile manufacturing industry. In this paper, the definition of automobile manufacturing industry is based on the "national economic industry classification" (GB / T4754 - 2002) standard, the research object is 1998 - 2010 13 year of China automobile manufacturing industry enterprises which are the main benefit index, all the samples from the network industry, according to the auto parts of the automobile manufacturing industry, it is the main benefit index data [7-10].

3. DEA Model

Data envelopment analysis (DEA) is an effective method to evaluate the relative efficiency of decision making units (DEA), which is based on the concept of A.Chug and W. Cooper, and the relative efficiency of decision making units (CCR) is emerging, and the related research has been formed, and has been widely used in Management Science, system engineering, decision analysis and so on. The prominent advantage of DEA is that it has a high sensitivity and reliability and it can be used in the original appearance without unified unit, which can guarantee the integrity of the original information.

3.1. CCR Evaluation and Solution

The model assumes that there are DMU n. Each DMU has a m input, s output. Xij is DMUj (j=1, 2,... (n) I (i=1, 2),... (N1) input; YRJ is DMUj (j=l, 2,... (n) r (r=1, 2),... S) an output; the efficiency index of the DMUi can be expressed as:

$$h_j = \frac{u^T y_i}{v^T x_j} = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{mn} v_i x_{ij}}, j = 1,2,\ldots,n \quad (1)$$

xj is the m dimension input vector of DMUj, yj is s, DMUj,, V, m, u, s,, and CCR model:

$$\max h_{j_o} = \frac{\sum_{r=1}^{s} u_r y_{rj_o}}{\sum_{i=1}^{m} v_i x_{ij_o}}$$

$$s.t. \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1,\ j = 1,2,\ldots n \qquad (2)$$

$$u \ge 0, v \ge 0$$

The optimization objective of the model is to select the most favorable weight, which makes the maximum efficiency index. In practical application, it is generally through the establishment of dual model in order to more easily from the theoretical and economic significance for in-depth analysis. The dual form of linear programming (2) is:

$$\min \theta$$

$$s.t. \sum_{j=1}^{n} \lambda_j x_j + s^+ = \theta x_0$$

$$\sum_{j=1}^{n} \lambda_j y_j - s^- = \theta y_0 \qquad (3)$$

$$\lambda_j \ge 0,\ j = 1,2,\ldots n$$

θUnconstrained， $s^+ \ge 0, s^- \le 0$

The effective value of the DMUo for the decision unit (referring to the effective use of the input relative to the output); XJ is a collection of inputs to the DMUj, which can be made by (XJ2, xjl,... (XJM) YJ DMUj of the output elements of the collection, by (YJ2, yjl,... Yjr) indicates that the combination of DMUj and s- in the J DMUo decision making unit is DMUj, and the s+ is a slack variable.

(1) when θ=1, and slack variable s-=0, s+=0, then called DEA is DMUo effective, that is, the N decision making unit of the economic system in the original input XO output Yo has reached the optimal.

(2) when θ= 1, and slack variables s = 0 or + = 0 is called DMUo is weak DEA efficient. That is to say the 11 decision unit is composed of economic system in the original input XO can reduce the s-process and maintain native yo, or unchanged in input XO can be output Y0 to improve its.

(3) when $\theta \neq$ 1, it is said DMUo DEA invalid, that is to say the decision making unit DMUo can be through the combination which will put down to the proportion of the original XO and maintain native out yo unchanged. If the linear programming (2) of the CCR model is added, the BCC model is the DEA model.

3.2. Selection of Input and Output Indicators

The input and output indexes of DEA requirements must be more objective and comprehensive and the production characteristics of DMU are fully reflected. On the scale of industrial enterprise data, the main benefit of the automobile manufacturing industry is to provide a total of 15 kinds of index data, but the DEA method as a non-parametric evaluation tool, the selection of its index has its special requirements, such as the index to reflect the production characteristics, the non-correlation is between the input index and output index. The index selection not only take into account the comprehensive and concise, but also take into account the index data acquisition feasibility and automobile manufacturing industry production and management features, in the industrial network database it provides the original

15 indicators, Lin choose one of the following three kinds of input and output indicators, as specified in Table 1 shows:

Table 1. Input and Output Indicators

Input indicators	Output indicators	
X1 Fixed investment	Y1 Y2	income profit

4. Empirical Analysis

According to Table 1 of the index. From the network industry database in the collection of China's auto enterprises are the main input output indicators, the database provides a monthly index data from 12 to 2 in February, but in 2014 due to the Spring Festival, the company's inventory marketing environment is not the same, it will be in February data out. Therefore, only selected the data from March 2014 to December count, see Table 2.

Table 2. 2014 Above Scale Industrial Enterprises of Auto Manufacturing Industry in China

month	Fixed investment (billion)X1	income(billion)Y1	profit(billion)Y2
201403	869.28	5869.3	495.5
201404	804.77	5490.9	518
201405	1019.74	5520.9	566.5
201406	1142.48	5653.4	566.4
201407	987.82	5119.9	407.9
201408	955.76	5088.5	389.8
201409	1046.43	5728.1	472.7
201410	933.15	5814.6	474.5
201411	835.92	5943.2	509.5
201412	832.61	6991.1	754.6

Table 3. 2014 Evaluation Results of the Main Indicators of the Auto Industry in China

month	DMU	CCR	BCC	Economies of scale	Economies of scale
201403	1	0.804	0.934	0.861	Decreasing
201404	2	0.813	1.000	0.813	Decreasing
201405	3	0.645	0.795	0.811	Decreasing
201406	4	0.589	0.709	0.831	Decreasing
201407	5	0.617	0.815	0.758	Decreasing
201408	6	0.634	0.842	0.753	Decreasing
201409	7	0.652	0.773	0.843	Decreasing
201410	8	0.742	0.869	0.854	Decreasing
201411	9	0.847	0.973	0.870	Decreasing
201412	10	1.000	1.000	1.000	

Deap2.1 software selection and by using formula (3) to solve the model, substituting the data in Table 1, it calculated the pure technical efficiency (BC2) and efficiency (C2R) evaluation results (see Table 3), which also can get C2R model of slack variables s a, S + results (see Table 4).

Table 4. 2014 Above Scale Industrial Enterprises in China's Auto Manufacturing Industry

month	DMU	Output indicators slack variable		Input indicators slack variable
		S_1^+	S_2^+	S_1^-
201403	1	0.000	82.178	0
201404	2	0.000	0.000	0
201405	3	277.522	0.000	0
201406	4	144.388	0.000	0
201407	5	371.000	110.100	0
201408	6	402.400	128.200	0
201409	7	0.000	82.709	0
201410	8	0.000	94.551	0
201411	9	0.000	79.833	0
201412	10	0.000	0.000	0

Table 3 shows that the relative efficiency of DEA in December 2014 is 4, and that of the corresponding row in Table 1 is 4, s+ is 0, therefore, the DMU is relatively effective in December, and the DEA value of s+ is calculated in the rest of the DMU model. For those <1 months, you can reduce the amount of investment, while maintaining the original output, or to take measures to increase output in the same situation. By relaxing variable s-, s+ can be calculated by the target value of the input or output.

From Table 3 it can be seen that in 2014 the scale of China's auto manufacturing industry enterprises to invest CCR which is relatively effective and BCC is relatively effective (CCR and BCC are valid) only in December.

5. Conclusions and Policy

DEA CCR model and BCC model are used in this paper. The fixed investment in most of the month of 2014 is invalid, and the BCC and CCR in December are valid and effective.

The analysis results reveal some problems in the automobile manufacturing industry in China:

(1) A waste of resources, which includes: scientific and technological input, waste of human resources, waste of production data and other issues.

(2) It is seen that the scale of the automobile manufacturing industry in China is still in high cost.

(3) By comparing the input and output of the imported brand automobile enterprises, the scale of China's auto production system is more efficient. Manufacturing enterprises in the product added value is very low, which cannot create a high profit and it is one of the problems.

Several problems are caused by the analysis result, we can put forward the following suggestions:

(1) Optimize the structure of investment resources to avoid blindly expand the scale, it should increase investment in science and technology;

(2) The effect of strict examination on scientific and technological input, such as the assessment of the results of various vertical and horizontal issues;

(3) Optimize the industrial chain to improve the utilization efficiency of funds.

(4) Expand the market, the two tier cities, three cities, and the distribution of risk.

(5) On the lower reaches of the industrial chain in the Internet industry, exerting common resistance and sharing of financial risks.

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