

Research on Corporate Governance and Efficiency Evaluation Based on DEA Model

-- Take Chang'an Group as an example

Yuan Zhang

Chongqing University of Technology, Chongqing 400000, China

Abstract: Based on the DEA model, this paper constructs a mathematical model representing the process of corporate governance from the perspective of input-output, from the point of view of exploring the essence of corporate governance and improving the efficiency of corporate governance, taking Chang'an group from 2016 to 2020 as the research sample, this paper calculates the value of Chang'an company's governance efficiency, evaluates the level of Chang'an company's governance and gives some relevant suggestions. The empirical results show that from 2016 to 2020, the corporate governance efficiency of Chang'an company shows a trend of decreasing first and then increasing, and there are still some problems. Finally, the paper puts forward some optimization suggestions to provide reference for other enterprises to improve corporate governance efficiency, at the same time, it provides a new idea for the state-owned enterprises how to evaluate the efficiency of corporate governance objectively.

Keywords: Corporate Governance; Corporate Governance Efficiency Evaluation; Dea Model.

1. Introduction

1.1. Background

Recently, Corporate governance has received extensive attention from both practical and theoretical circles around the world. First, corporate governance issues are getting worse: there are issues such as high compensation of corporate executives that have caused dissatisfaction among shareholders and other stakeholders, increasing regulatory awareness among institutional investors, and more stakeholders getting involved in corporate governance. Second, good corporate governance can promote the rationalization of the equity structure of the enterprise, strengthen the internal control of the enterprise, reduce the agency cost of the enterprise, enhance the core competitiveness of the enterprise, improve the operating performance, and achieve the sustainable development of the enterprise. Third, corporate governance is the governance of the corporate system. However, due to the continuous evolution of the corporate system, the corporate governance process is not once and for all, so enterprises need to establish different corporate governance mechanisms based on their own characteristics and the process of assigning shareholders' rights and responsibilities. Therefore, the evaluation of corporate governance has gradually become an important research direction, and practice shows that scientific and reasonable evaluation methods can help to form reputation constraints, improve the level of corporate governance, and then promote corporate development. Therefore, this paper takes the exploration of the essence of corporate governance and the improvement of corporate governance efficiency as the starting point, constructs a mathematical model representing the corporate governance process from the perspective of input and output based on the DEA model, and uses the data envelopment analysis (DEA) method to evaluate corporate governance and its efficiency.

1.2. Research implications

Practice shows that scientific and reasonable evaluation methods can help to form reputation constraints, improve the level of corporate governance, and then promote the development of the company. Based on this, this paper constructs a mathematical model representing the corporate governance process from the perspective of input and output, and tries to calculate the governance efficiency value of Chang'an by using the DEA method to understand the level of corporate governance in Chang'an. At present, there is no unified method for evaluating the corporate governance efficiency of state-owned enterprises. Based on the particularity of the corporate governance of state-owned enterprises, this paper scientifically selects the corresponding indicators, tries to evaluate the corporate governance efficiency of state-owned enterprises with the help of the DEA model, and selects Chang'an Group as an application case to find the problems existing in its corporate governance, evaluates its corporate governance and efficiency, and puts forward optimization suggestions, hoping to provide reference opinions for Chang'an Group to improve the efficiency of corporate governance.

1.3. Research Methodology

Data envelopment analysis is a new interdisciplinary field of mathematics, operations research, mathematical economics and management science, and it is a method that uses mathematical programming models to evaluate the relative effectiveness of multiple input and multiple output "units". The two main evaluation models in the DEA method (CCR and BCC model) are radial, that is, the evaluation indicators of input and output change in proportion to each other, and there is a problem of index selection in the existing literature of DEA model, the DEA model assumes that the less input is better when the output is fixed, or the output increases as much as possible when the input is increased, so some of the variables representing the capital structure or equity

structure (such as equity concentration, board size, asset-liability ratio, etc.) It does not conform to the assumptions of the DEA model, which have been taken into account in the construction of the corporate governance model in this paper. There can be many different forms of DEA models according to different evaluation purposes, but the corporate governance efficiency is mainly to evaluate the company's ability to maximize output when the input is fixed or the ability to minimize the input when the output is fixed after corporate governance behavior, so it is more in line with the connotation of corporate governance to choose the input-oriented BCC model and the corresponding corporate governance efficiency value as the efficiency evaluation index. In this paper, the most basic DEA model, the BCC model, is used to evaluate the efficiency of corporate governance.

2. Literature Review and Theoretical Analysis

At present, the research on the evaluation system of corporate governance can be roughly divided into two categories: comprehensive index evaluation method and data envelopment analysis method. In the composite index evaluation method, Gompers et al. (2003) and Bebchuk et al. (2009) divide the 24 elements of governance into five dimensions—hostile takeover mitigation tactics, voting rights, director and officer protections, other takeover defenses, and national laws—and constructs a G-index or trench index of corporate governance. Bai et al. (2005) evaluated corporate governance from three aspects: internal, external and governance mechanisms with Chinese characteristics, and Li Hanjun and Zhang Junxi (2006) evaluated corporate governance from four aspects: independence and effectiveness of board of directors, shareholding structure, management and information disclosure, and constructed an IG index of corporate governance level by principal component analysis. The Corporate Governance Evaluation Research Group of the Corporate Governance Research Center of Nankai University (2004, 2006) constructed a corporate governance index evaluation model from six dimensions: shareholders' equity and controlling shareholders, directors and boards of directors, managers, supervisors and boards of supervisors, information disclosure, and stakeholders. Hao Chen (2009) used the factor analysis method to extract corporate governance factors such as equity concentration, salary, long-term incentive mechanism of directors, supervisors and senior executives, and the number of meetings of the "three sessions", and then weighted the factor variance contribution rate to calculate the corporate governance composite index. Wang Fusheng and Liu Shiyu (2010) used the Ohlson model to separate the value of corporate governance factors from enterprise value (stock price), and used it as an evaluation index of corporate governance. In addition, many scholars regard corporate governance as similar to the production process, borrowing the concept of efficiency, and using data envelopment analysis (DEA) to evaluate the level of corporate governance. Lauterbach and Vaninsky (1999) construct a C2GS2 model with total assets, shareholder equity ratio, and executive compensation as input variables and net income as output variables to calculate the efficiency index of corporate governance level.

Lehmann et al. (2004) used the BC2 model with equity concentration, owner nature and capital structure as input

variables, and fixed asset investment ratio, operating income and return on total assets as output variables, to evaluate the efficiency of corporate governance of German enterprises. Fan Linbang et al. (2008) evaluated the governance efficiency of China's listed power companies by using the C2R model and C2GS2 model with the size of the board of directors, the proportion of independent directors in all directors, the proportion of shares of the largest shareholder, and the proportion of the shares of the top five shareholders as input variables, and Tobin's Q value and return on net assets as output variables. Lu Yuan (2009) used the C2R model and C2R cross-evaluation model with total assets and operating expenses as input variables, premium income and owner's equity as output variables to evaluate the governance level of major insurance companies in China. Wang Huaiming and Shi Xiaoming (2010) used the BC2 model with the shareholding ratio of the largest shareholder, the balance of equity, the proportion of independent directors, the size of the board of directors, the integration of the two positions, the audit committee and the shareholding ratio of senior executives as input variables, and the asset-liability ratio, the growth rate of tangible assets and the growth of the company as the output variables, to explore the governance efficiency of agricultural listed companies. Since corporate governance is a dynamic concept from multiple perspectives and levels, the comprehensive index evaluation method is susceptible to the problems of researchers according to different research purposes and different understandings of the connotation of corporate governance, there are great differences in the construction method and the selection of variable indicators, and there is a large subjectivity in the weighting of variables, which leads to inconsistent research results and hinders the application of corporate governance evaluation index in practice. Although the efficiency-based DEA evaluation method is not widely used, it has relative advantages: firstly, DEA treats the production process as a black box and does not require the functional relationship between input and output variables to be known, secondly, the method is especially suitable for the efficiency evaluation of multi-input and multi-output production processes, and thirdly, the method can evaluate different dimensional indicators and does not require much sample size (Manzoni and Islam, 2009). The existing research literature on the evaluation of corporate governance efficiency based on the DEA method varies greatly in the selection of input and output variables, mainly because the dimensions of corporate governance research change with the evolution of corporate governance theory, that is, the corporate governance theory has developed from the initial "shareholder-first unilateral governance theory" to the "stakeholder co-governance theory"¹ (Blair, 1995).

Xu Xiangyi and Xu Ning (2012) argue that the reconstruction of the scope of the client and related goal-oriented problems make the theory fall into the "pan-stakeholder" dilemma, which leads to the contradiction between the corporate decision-making mechanism and the essence of the economic subject of the enterprise, and affects the evaluation of corporate governance efficiency to a certain extent. In order to improve the above shortcomings, Liu Shiyu and Wang Fusheng (2011) proposed a research method to define corporate governance from the perspective of "cost and benefit", regard corporate governance as a quasi-production function, and use the DEA method to evaluate the level of governance. Based on the input-output perspective, this paper uses the DEA method to evaluate the corporate governance

level of Chang'an Company.

3. Introduction to Chang'an Group and Its Corporate Governance Status

3.1. Introduction of Changan Group

China Changan Automobile Group Co., Ltd. (hereinafter referred to as "China Changan"), founded on December 26, 2005, formerly known as China Southern Industrial Automobile Co., Ltd., changed its name to China Changan Automobile Group Co., Ltd. on July 1, 2009, and changed its current name to April 2019. China Changan adheres to the guidance of the five major development concepts and three major changes, and takes the leading development strategy of Southern Group as the guide, and coordinates the development of business sectors such as vehicles, auto parts, sales and service, and logistics, forming a relatively complete industrial chain.

3.2. Current status of corporate governance

Since its listing on the Shenzhen Stock Exchange in October 1996, the company has continuously improved the corporate governance structure and standardized the company's operation in strict accordance with the requirements of laws and regulations such as the Company Law, the Securities Law, the Code of Governance for Listed Companies, the Several Provisions on Strengthening the Protection of the Rights and Interests of Public Shareholders, the Administrative Measures for Information Disclosure of Listed Companies, the Rules for the Listing of Stocks on the Shenzhen Stock Exchange, and the Internal Control Guidelines for Listed Companies on the Shenzhen Stock Exchange. However, in terms of corporate governance, there are still many problems that need to be improved: 1. The special committees under the board of directors are not perfect, and the operating mechanism of the company's remuneration and appraisal committee needs to be improved; 2. The company has not adopted the cumulative voting system in the election of directors and supervisors; 3. The construction of the company's internal control system needs to be further strengthened, and some management systems need to be revised and improved; 4. The company's information disclosure management needs to be further strengthened. Therefore, based on the current situation of Chang'an Group's corporate governance, this paper evaluates and studies the corporate governance efficiency of Chang'an Group based on the DEA model method, in order to improve the corporate governance efficiency.

4. Model Building

4.1. Data Sources

In this paper, the official corporate annual report of Changan Group is selected as a sample for efficiency analysis. The data used mainly include the total assets and net assets of Changan Group, total liabilities and debt-to-asset ratio, operating income and operating costs, main business income and costs, management expenses, the remuneration of the top three executives and the number of managers receiving compensation. The study period is from 2016 to 2021, and the purpose of this study is to further investigate the dynamic changes of Chang'an's corporate governance efficiency on the basis of horizontal comparison of Chang'an's corporate

governance efficiency.

4.2. Selection of input-output indicators

Based on the production function $Y=F(K,L)$, combined with the theory of corporate governance, this paper satisfies the assumptions of the DEA research method and considers the availability of data, which is the main basis for selecting input and output indicators. Based on this, this paper selects three input variables: management expenses, top three executive compensation, and the number of paid managers. The selected input indicators are:

- $x1j$ = management expenses for year j
- $x2j$ = top three executive salaries on the j th level
- $x3j$ = number of managers receiving remuneration in the j th year $j=1,2,3,4,5,6$

For the output indicators, this paper selects return on equity, total asset turnover and operating income growth rate as the output variables of the DEA model. ROE represents the management's ability to use net assets to create profits, and is the most direct output of state-owned enterprises. The total asset turnover ratio reflects the efficiency with which management uses assets, and measures the degree of agency conflict from management's perspective. The revenue growth rate reflects the growth of the company and is used to illustrate the future development capabilities and trends of state-owned enterprises. The selected output indicators are:

- $Y1j$ = Return on equity in the j th year
- $Y2j$ = Growth rate of operating income in the j th year
- $Y3j$ = total asset turnover in year j

Table 1 lists the model variables and their definitions.

Table 1. DEA model variables and their definitions

	The name of the variable	Variable definitions
Input variables	Management fees	Administrative expenses/operating income
	Top three executive compensation	Top 3 Executive Compensation/Ln(Total Owner's Equity)
	Number of remunerated management	Number of Managers Receiving Remuneration/Ln (Total Owners' Equity)
Output variables	Return on equity	Net Profit $\times 2 /$ (Total Owners' Equity at the beginning of the year + Total Owners' Equity at the end of the year) $\times 100\%$
	Growth rate of operating income	Operating income $\times 2 /$ (total assets at the beginning of the year + total assets at the end of the year) $\times 100\%$
	Total Asset Turnover	(Main business income of the current period - main business income of the previous period)/Main business income of the previous period $\times 100\%$

4.3. Construction of DEA system model

The BCC model takes into account that in the case of variable scale benefit (VRS), that is, when some decision-making units are not operating at optimal scale, the measure of technology efficiency (TE) is affected by scale efficiency

(SE). When building the BCC model, we need to assume that the return to scale is variable:

$$\begin{aligned} & \text{Max } Y_j \sum_{r=1}^2 u_r y_{rj} - \mu_j & j = 1, 2, \dots, 6 \\ & \text{s.t. } \sum_{i=1}^3 v_i x_{ij} = 1 & j = 1, 2, \dots, 6 \\ & \sum_{i=1}^2 u_r y_{rj} - \sum_{i=1}^3 v_i x_{ij} - \mu_j \leq 0 & j = 1, 2, \dots, 6 \end{aligned}$$

$U_r, v_i \geq 0 \quad r = 1, 2; i = 1, 2, 3$, where μ_j is the scale reward indicator for year j

Based on μ_j , you can judge the scale remuneration. When $\mu_j > 0$ indicates a decreasing return to scale in year j , when $\mu_j = 0$, it means that the return to scale remains unchanged in year j , and when $\mu_j < 0$, it means that the return to scale increases in year j . The scale efficiency (SE) value in the BCC model compares the technical efficiency of a particular decision unit under a constant scale reward (CRS) with the technical efficiency under a variable scale reward (VRS). If there is no difference between the two, it means that the inefficiency of the decision-making unit is due to the technical inefficiency,

and if there is a difference between the two, it means that the inefficiency of the decision-making unit is due to the inefficiency of scale. The relationship between them can be expressed as: $TE_{CRS} = TE_{VRS} \times SE = PTE \times SE$

In the formula, TE_{CRS} represents the technical efficiency value under the fixed scale remuneration, TE_{VRS} represents the technical efficiency value under the variable scale remuneration, i.e., the pure technical efficiency (PTE), and SE represents the scale efficiency value. Through the BCC model, it can be clearly seen to what extent Changan Group's inefficiency is due to pure technical inefficiency (redundancy of factor inputs) and to what extent it is due to scale inefficiency (not reaching the optimal scale)

5. Analysis of Empirical Results

Deap2.1 software was used to calculate the comprehensive technical efficiency (TE), pure technical efficiency (PTE), scale efficiency (SE) and scale benefit status of Changan Group from 2016 to 2021, and the results are shown in Table 2.

Table 2. Efficiency values of Changan Group from 2016 to 2021

DMU												
	TE	PTE	SE	Gains at scale	TE	PTE	SE	Gains at scale	TE	PTE	SE	Gains at scale
2016	0.472	0.599	0.788	drs	0.460	0.549	0.838	drs	0.402	0.492	0.816	drs
2017	0.362	0.393	0.921	drs	0.252	0.267	0.945	drs	0.255	0.262	0.972	irs
2018	0.819	1.000	0.819	drs	0.765	0.854	0.895	drs	0.583	0.698	0.831	drs
2019	0.266	0.274	0.974	drs	0.200	0.223	0.897	irs	0.267	0.283	0.941	drs
2020	0.288	0.325	0.887	drs	0.143	0.177	0.812	irs	0.246	0.272	0.893	irs
2021	0.300	0.381	0.787	drs	0.265	0.279	0.950	irs	0.313	0.346	0.909	irs

As can be seen from Table 2, before considering environmental variables and random interferences, Chang'an Group's innovation efficiency generally has the following characteristics: the overall average comprehensive technical efficiency is 0.361, which does not reach the DEA effect, the total average pure technical efficiency is 0.399, indicating that Chang'an Group's input-output transformation technology level is relatively low, and the total average scale efficiency is 0.894, indicating that Changan Group has a significant scale effect. According to the calculation results of the traditional DEA model, the overall scale efficiency is greater than the pure technical efficiency, indicating that the scale factor plays an important role in the development of Chang'an Group's innovative technology, and the technical factor is in a secondary position.

6. Conclusion

Changan Group's overall innovation capability is insufficient. The results show that from 2016 to 2021, the average innovation efficiency of Chang'an Group is low, indicating that the overall innovation ability of Chang'an Group is insufficient, which seriously affects the development of Chang'an Group. The reason for the low level of innovation efficiency of Changan Group is mainly caused by the combination of pure technical efficiency and low scale efficiency, and the scale efficiency has a greater impact. This shows that the scale of Chang'an Group is not perfect, and the system and mechanism are not perfect, which affects the company's innovation and development.

References

- [1] Ni Boo. Research on financing efficiency of listed companies in China based on AHP-DEA[D]. Hangzhou University, 2020. (32):6-12.
- [2] Huang Xiaoshan. Research on the technical efficiency of listed companies in China's manufacturing industry[D]. Normal University, 2016. (55): 31-43.
- [3] Liu Wenhui. Research on corporate governance and efficiency evaluation based on data envelopment analysis method[J]. Securities Market Herald, 2012(11):62-67.
- [4] Diez-Vial, A. Montoro-Sanchez. How knowledge links with universities may foster innovation: the case of a science park Tech-innovation, 2016. pp.41-52.
- [5] Ma Dan. Research on corporate governance efficiency of listed companies in China's retail industry based on DEA[D]. Shenyang University of Technology, 2010. (6):66-67.
- [6] Wu J, An Q. X, Xiong B. B. Etal. Congestion Measurement for Regional Industries in China: A Data Envelopment Analysis Approach with Undesirable Outputs [J]. Energy Policy, 2013, 57(7):7-13
- [7] Pannu H. S. Dinesh K. U. Farooque J. A. Efficiency and Productivity Analysis of Indian Pharmaceutica Industry Using Data Envelopment Analysis [J]. International Journal of Operational Research, 2011, 10(1):121-136
- [8] Chen Y. Du J. Sherman H. D. Etal. DEA Model with Shared Resources and Efficiency Decompositio [J]. European Journal of Operational Research, 2010, 207(1):339-349

- [9] Fan Linbang, Liang Dongzhen, Nie Rui. Application of DEA in Performance Analysis of Listed Companies in Electric Power Industry[J]. Enterprise Economics, 2008, (2): 102-104.
- [10] H Chen. Research on the Value Correlation of Corporate Governance: Panel Data from Shanghai and She Stock Exchanges 2002~2005[J]. Securities Market Herald, 2009, (3): 40-46.
- [11] Li Hanjun, Zhang Junxi. The Degree between Governance and Performance of Listed Enterprises[J]. Management World, 2006, (5): 121-127.