The Business Performance Evaluation of Securities Listed Companies Based on DEA Model

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Abstract. Under the macro background of rapid economic development, the market competition is increasingly fierce. As the main body of market competition, it is the first important issue for enterprises to improve their own economic efficiency in the face of increasingly fierce competition. DEA is a relatively effective tool to study the same type of departments’ revenue (or units), and it is also a very complete method to deal with a class of multi-objective decision-making problems in theory. In this paper, data envelopment analysis (DEA) and lingo software are used to effectively measure the performance of 8 listed companies through DEA analysis and scale return analysis.

Introduction

To evaluate the operating performance of listed companies is a way to measure the management ability of senior management, through which we can effectively analyze the operating performance and the operation of the company. At the same time, in the stock market, investors and company owners also hope to evaluate the situation of the company through marketing performance, which is of great significance to investors, managers and government departments: (1) it is conducive to the effective investment of investors; (2) it can effectively restrain and motivate operators; (3) it can help the management of listed companies improve its management level (4) it is conducive to the standardization and development of capital market (5) it is conducive to the development of government supervision and national economy. Therefore, how to scientifically reasonably and effectively evaluate the operating performance of listed companies has become a common concern of securities management institutions, listed company operators and investors. DEA analysis is increasingly used in the field of performance evaluation. In this paper, the listed companies of securities are taken as the research object. Data envelopment analysis is used to analyze the company's operating performance, making full use of the advantages of this method to find the best way to improve operating efficiency.

DEA Model for Evaluating the Performance of Listed Companies

Data envelopment analysis [1], or DEA for short, is one of the most effective methods for performance evaluation of multi output organizations. It was founded by A. Charnes and W. W. Cooper in 1978. Based on the idea of mathematical programming, the DEA method compares the relative efficiency among the decision-making units by establishing a linear programming model. The evaluation is based on the input data and output data of the decision-making unit. Input data refers to some resources that the decision-making unit needs to consume in a certain activity, such as the input capital, labor, plant and equipment, etc. Output data refers to the amount of information that the input is transformed into some output results of the decision-making unit through a certain production process, such as the quantity, quality, profit, etc. DEA is especially suitable for complex organizations with multiple inputs and outputs, so it has a wide range of application values in different fields such as society, science and technology, economy, education and so on. At present, the application of DEA has gradually expanded from the original evaluation field to the fields of prediction, early warning and estimation technology progress.
Variable Scale Model Revenue Model (VRS Model, Also Known as $C^2G^2$ Model)

The dual problem of linear programming is considered:

\[
(P) \max \; vp = \mu Y_0 + u_0 \tag{1}
\]

\[
\text{s.t.} \begin{cases}
\omega^T X_j - \mu^T Y_j - u_0 \geq 0, j = 1, 2, \ldots, n \\
\omega^T X_0 = 1, \omega \geq 0, \mu \geq 0
\end{cases} \tag{2}
\]

\[
(D) \min V_p = \sigma \tag{3}
\]

\[
\text{s.t.} \begin{cases}
\sum_{j=1}^{n} X_j \lambda_j + S^- = \sigma X_0 \\
\sum_{j=1}^{n} Y_j \lambda_j + S^+ = Y_0 \\
\sum_{j=1}^{n} \lambda_j = 1 \\
\lambda_j \geq 0, j = 1, 2, \ldots, n \\
S^+ \geq 0 \\
S^- \geq 0
\end{cases} \tag{4}
\]

The pure technical efficiency of each company is calculated by the model, reflecting the pure technical efficiency of each company [2]. Let the optimal solution of the problem be $\lambda^*, s^-*, s^*, \sigma$, the conclusion is as follows:

If $\sigma^* = 1$, it is weak DEA is effective ($C^2G^2$ pure technology);

If $\sigma^* = 1$, $s^-* = 0$ and $s^* = 0$, DEA is effective ($C^2G^2$ pure technology).

The economic explanation of $C^2G^2$ model is as follows: in the production possibility set $T$, when the output $Y_0$ remains unchanged, we try to reduce the input $X_0$ by the same proportion of $\sigma$, that is, the optimal value of linear programming $\sigma = 1$, in the case of single input and single output, the decision-making unit $j_0$ is technically effective. On the contrary, if the input quantity $X_0$ cannot be reduced in the same proportion of $\sigma$, that is, the optimal value of linear programming $\sigma < 1$; in the case of single input and single output, the decision-making unit $j_0$ is not technically effective.

The reason why it is different from $C^2R$ model is that the composition of production possible set $T$ does not satisfy the axiomatic hypothesis of conicity, that is, for any $(X, Y)$ belongs to $T$, $k \geq 0$, and there is $K(X, Y) = (kX, kY)$ belongs to $T$, that is to say, if the input quantity $X$ is $k$ times input, then the output quantity $Y$ has also been $k$ times of the original output.

The Basic Idea of DEA Method to Analyze the Stock Efficiency of a Company

First of all, we should determine the evaluation index of company stock efficiency. The basic function of DEA is to evaluate the "relative effectiveness" of multiple similar samples. In order to select DEA method correctly and get scientific evaluation conclusion and useful decision information, it is necessary to establish corresponding input-output index system and select appropriate DEA model for different operation objectives of securities companies. For a securities company, its high efficiency means that the same amount of input gets a larger output.

Secondly, the decision-making unit (DMU) is selected. Selecting DMU is to determine the evaluation reference set. Generally speaking, because the effectiveness of DEA depends on the homogeneity of decision-making units to a great extent, the higher the homogeneity of decision-making units, and the more accurate the evaluation results [3]. Based on this, this paper selects the stocks of 8 listed companies as decision-making units, which not only meets the requirements of DEA method for the number of decision-making units, but also meets the requirements of DEA method for the quality of decision-making units. Then, establish the input and output index system. The first principle of selecting the input and output index system is that it can truly and objectively reflect the evaluation objectives and contents; secondly, it is necessary to avoid the strong linear relationship between the internal indexes of the input (output) set in terms of technology and make screening before selecting. Then, DEA model is selected and DEA evaluation analysis is carried out. In the process of evaluation, first of all, the efficiency of securities companies is tentatively analyzed by DEA. According to the scientific nature and rationality of the
conclusions, we decide whether to adjust the index system and reselect the model is decided. Finally, the conclusion of comprehensive evaluation is given. Through DEA to evaluate the efficiency of securities companies, we can get the following information: DEA effectiveness of each decision-making unit and the relative scale return of each decision-making unit. According to these information, combined with the current situation of securities companies in China, the evaluation result report can provide useful information for decision-making.

Data Analysis

Sample Selection

In this paper, the stocks of 8 listed companies are selected. According to the requirements of DEA on indicators, the purpose of evaluation and the availability of data. Select earnings of per share (yuan) as the indicator, the four representative operating income indicators of operating revenue (10,000 yuan), the same period last year (10,000 yuan), year-on-year growth (%), quarter on quarter growth (%) are selected; And net profit indicators of net profit (10,000 yuan), the same period last year (10,000 yuan), year-on-year growth (%), quarter on quarter growth (%) are selected.

Model for Evaluating Scale Effectiveness and Technical Effectiveness

DEA Model (R) Solution. According to the $C^2GS^2$ model formula algorithm of technical effectiveness, the $C2GS2$ model is established by using the original data. The calculated data through Lingo is brought into the above linear programming, we use Lingo and Excel to solve it and get the evaluation results of DEA effectiveness, as shown in Table 1:

| Stock Abbreviation       | Valid Value of DEA | Slack Variable of Input Index | Slack Variable of Output Index |
|--------------------------|--------------------|-------------------------------|-------------------------------|
|                          | $\theta$ | $S_1^-$ | $S_2^-$ | $S_3^-$ | $S_1^+$ | $S_2^+$ | $S_3^+$ |
| KATE TECHNOLOGY          | 0.7800  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  |
| TOLY BREAD               | 1.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  |
| LONGCIN                  | 0.9935  | 0.0000  | 20531780| 0.0000  | 0.0895  | 0.3508  | 0.0000  |
| SHANGHAI HUGONG          | 1.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  |
| *ST XINJI                | 0.7241  | 0.0000  | 7591126 | 0.0000  | 0.0659  | 0.0000  | 0.0000  |
| CNEC CORPORATION         | 1.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  |
| SHENZHAN GAS             | 0.5379  | 54790240| 26459020| 0.0000  | 0.0000  | 0.0000  | 0.0000  |
| FUCHENG GROUP            | 1.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  |

DEA Effectiveness Analysis. According to the effective value of DEA, it can be seen that the DEA values of TOLY BREAD, SHANGHAI HUGONG, CNEC CORPORATION and FUCHENG GROUP are all equal to 1, so DEA is weak effective at least, and because the slack variables of the four securities companies are all 0, it is proved that DEA is an effective decision-making unit, which indicates that the production and operation activities of these four securities companies are relatively efficient; while the effective value of DEA of other listed companies is less than 1, that is not weak effective of DEA. The less effective DEA is, the lower the efficiency of stock input-output is.

Scale Income Analysis. While analyzing the effectiveness of the shares of listed companies, it is also easy to use the value obtained in DEA model to judge the scale return of DMU, as shown in Table 2.
Table 2. Scale Income of Listed Companies.

| Stock Abbreviation     | Constant Returns on Scale $\sum_{j=1}^{n} \lambda_j = 1$ | Increasing Returns on Scale $\sum_{j=1}^{n} \lambda_j < 1$ | Diminishing Returns on Scale $\sum_{j=1}^{n} \lambda_j > 1$ |
|------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| KATE TECHNOLOGY        | 1.0000                                                      |                                                             |                                                             |
| TOLY BREAD             | 1.0000                                                      |                                                             |                                                             |
| LONGCIN                | 1.0000                                                      | 0.9301                                                      |                                                             |
| SHANGHAI HUGONG        | 1.0000                                                      | 0.6271                                                      |                                                             |
| *ST XINJI              | 1.0000                                                      |                                                             |                                                             |
| CNEC CORPORATION       | 1.0000                                                      |                                                             |                                                             |
| SHENZHAN GAS           | 1.0000                                                      |                                                             | 0.4874                                                      |
| FUCHENG GROUP          | 1.0000                                                      |                                                             |                                                             |

From the above analysis, we can see that the effective decision-making units of DEA are all scale efficient, the scale returns of KATE TECHNOLOGY, TOLY BREAD, SHANGHAI HUGONG, CNEC CORPORATION and FUCHENG GROUP are all unchanged. From Table 2, it can be seen that the scale returns of LONGCIN, *ST XINJI and SHENZHAN GAS are increasing, so these companies can expand their capital by issuing additional A shares or allotting shares, so as to increase their output. In this paper, there are no companies with decreasing returns on scale. Such companies should consider reducing the scale of assets, improving the rate of return on assets, and making the scale returns effective.

Conclusion

The input and output indexes of 8 listed companies are used as DMU ($j = 1, 2 \ldots 20$) in the horizontal evaluation of company scale and technical effectiveness. DEA method was used in this process. Among them, the shares of TOLY BREAD, SHANGHAI HUGONG, CNEC CORPORATION and FUCHENG GROUP are all DEA effective, and each non effective DMU can be adjusted through its projection on the effective operation surface of DEA.

The relative efficiency of securities companies is closely related to the level of internal management and the external environmental factors. External environmental factors (including national macro policy factors and market factors) affect the economic benefits of the company through the input and output factors that affect its production and operation.

Through the above analysis, we can see that the economic benefits of the company are the result of the comprehensive effect of internal and external factors. This requires the company to grasp the macro policy dynamics and market changes on the basis of constantly improving its management level. It is necessary to constantly improve the level of holding shares in order to increase the company's efficiency. Through the comprehensive evaluation of the economic benefits of the company by DEA model, we can get the valid and invalid companies of DEA, and get the gap in the efficiency of their respective operation and management, find out the deficiencies and improve them. Similarly, this method can also be used in the vertical comparison of different years of the same company to obtain the projection of invalid decision-making units of DEA effective operation, reflecting the change of economic benefits of the company in a period of time.

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