Analysis of financing efficiency of big data industry in Guizhou province based on DEA models

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Abstract. Taking 20 listed enterprises of big data industry in Guizhou province as samples, this paper uses DEA method to evaluate the financing efficiency of big data industry in Guizhou province. The results show that the pure technical efficiency of big data enterprise in Guizhou province is high, whose mean value reaches to 0.925. The mean value of scale efficiency reaches to 0.749. The average value of comprehensive efficiency reaches 0.693. The comprehensive financing efficiency is low. According to the results of the study, this paper puts forward some policy and recommendations to improve the financing efficiency of the big data industry in Guizhou.

1. Introduction
In recent years, big data industry in China develops rapidly. The government formulates many policies to promote its development. The situation is the same in Guizhou province. The government of Guizhou province takes big data industry as the pillar industry. However, the development of big data industry needs a lot of fund. The financing difficulties and financing efficiency have restricted big data industry development in Guizhou province. This is one of the "bottleneck". Only effectively solving the problem of financing difficulties and financing efficiency, the big data industry can be injected funds continually and develop healthily and continuously. At present, the big data industry in Guizhou province is at a stage of rapid development. Therefore, based on the current situation of financing development of big data industry in Guizhou province, DEA analysis method is used to evaluate the financing efficiency of big data industry analysis in Guizhou province. This paper aims to solve the financing difficulties of big data industry in Guizhou province and improve its financing efficiency, put forward the corresponding policy recommendations for the big data industry in Guizhou province to provide theoretical support and policy recommendations.

2. Literature review
Mayes and Majluf (1984) [1] introduce the theory of information asymmetry into the study of capital structure, and put forward the pecking order hypothesis. Shouguo Zhao et al (2011) [2] define the financing efficiency from the microscopic view and use DEA method to analysis financing efficiency of listed companies in Shaanxi. The results show that the financing efficiency of listed companies in...
Shaanxi province is low, but the scale efficiency is high, the low technical efficiency is the problem listed companies generally facing in Shaanxi. Xiaoning Wang (2016) [3] take 461 small and medium-sized enterprises as the sample to evaluate the financing efficiency of the industrial enterprises. The study finds that the rise of pure technical efficiency shows that the management financing level of small and medium enterprises is higher, and the traditional DEA method overestimates the losses caused by the invalid management of financing efficiency. External business environment has inhibitory effect on the financing efficiency. Qiong Wang (2016) [4] statically and dynamically evaluates the financing efficiency of 29 listed companies in Jiangsu Province from 2009 to 2014, and find that the financing efficiency growth is mainly dependent on technological progress, the efficiency improvement of the enterprises is affected by technical efficiency. Based on panel data of China’s big data industry listed companies, Xianfeng Han (2016) [6] uses DEA method to measure the technical efficiency and analyzes its changing trend. The results show that the technical efficiency of big data industry in China is relatively low, and the main reason is that the pure technical efficiency growth is low; technical efficiency and pure technical efficiency on the eastern region is higher than that of the central and western regions, but the level of scale efficiency is lower than the central and western regions.

From the above research, we can see that most scholars analyze the financing efficiency by DEA method. DEA analysis is very mature in the financing efficiency measurement. In this paper, taking the big data industry in Guizhou province as an example, this paper uses DEA method to evaluate the financing efficiency of big data industry enterprises in Guizhou. This paper does comparative analysis from the perspective of empirical analysis, and provides targeted policy and recommendations for the development of big data industry enterprises in Guizhou province.

3. Research design

(1) Research methods

In 1978, A. Charnes & W.W. Cooper and other scholars created the first DEA analysis model. DEA model can use nonparametric planning method to evaluate the relative effectiveness of multi-input and multi-output system. BCC assumes the CCR model constant returns to scale production function, and adds a constant variables, to ensure that the variable returns to scale. With the support of strategic emerging industrial finance, the BCC model has the characteristics of multiple input and output, and adds convexity constraint condition on the CCR model. This makes the BCC model scale returns vary and distinguish between TE, PTD and SE. The TE obtained under CCR mode can better reflect the management level of DMU, in which technical efficiency refers to the ability to achieve the effect of scale economy compared with the scale efficient point. Pure technical efficiency refers to the efficiency of eliminating scale factors. The relationship between the three variables is as follows:

$$\begin{align*}
\min_{\theta, \lambda} & \quad \theta - \varepsilon \left( \sum_{i=1}^{n} \lambda_i s_i - s^* \right) \\
\text{s.t.} & \quad \sum_{j=1}^{m} \lambda_j x_{ij} - s^* = y_{ir} \\
& \quad \sum_{j=1}^{m} \lambda_j x_{ij} + s^* = \theta y_{ir} \\
& \quad \sum_{i=1}^{n} \lambda_i = 1, \quad \lambda_i \geq 0, \quad s^* \geq 0, \quad s^* \geq 0 
\end{align*}$$

$$i = 1,2,...,n; j = 1,2,...,m; r = 1,2,...,s \quad i$$ is the number of DMU. \( m \) and \( s \) are the number of input and output variables, respectively. \( x_{ij} (j = 1,2,...,m) \) is an input factor. \( y_{ir} (r = 1,2,...,s) \) is the output element. \( \theta \) is a valid value for the DMU.
(2) Selection and processing of sample data
This paper selects 20 listed companies of big data industry in Guizhou province in 2016. The sample data are from the RESSET database. The financial revenue \( Y_1 \) is output variable; the total assets \( X_1 \), total equity \( X_2 \), total asset turnover ratio \( X_3 \), asset-liability ratio \( X_4 \) are input variables. The explain of indicators are shown in Table 1.

| Index                | Name                               | Description                                                                 |
|----------------------|------------------------------------|-----------------------------------------------------------------------------|
| Output variables     | The financial revenue \( Y_1 \)   | Reflect the business results of the enterprise                              |
| Input variables      | The total assets \( X_1 \)         | Reflect the scale of enterprise                                              |
|                      | Total equity \( X_2 \)             | Reflect the total value of the assets of an enterprise                      |
|                      | Total asset turnover ratio \( X_3 \) | Comprehensive evaluation of the operating quality and efficiency of all the assets of an enterprise |
|                      | Asset-liability ratio \( X_4 \)    | Reflect the solvency of enterprise                                          |

4. Empirical analysis
Using software DEAP2.1 to efficiency measurement, the calculation results are shown in Table 2. The average value of comprehensive efficiency of big data industry enterprises in Guizhou province is 0.693, and the efficiency level is not high. The average value of pure technical efficiency and scale efficiency are 0.925 and 0.749, respectively. 85% of enterprises are increasing returns to scale. The scale efficiency of most enterprises is low. Most enterprises have a big gap in scale efficiency, which leads to the low average value efficiency of the enterprises. The funding gap makes the enterprise scale effect cannot reach economies of scale through investment expansion.

There have 3 enterprises reaching the financing DEA efficiency, accounting for 15% of the samples, which proves that the DEA financing efficiency enterprises are neither redundant input (input reaching minimum) nor redundant output (output reaching maximum). The remaining 17 enterprises are non-effective financing. Their financing efficiency is less than 1. The pure technology efficiency value of some enterprise is equal to 1, but the scale efficiency is less than 1. This leads to financing efficiency invalid. There are redundancy or insufficient in output. The pure technical efficiency of two companies QIAN YUAN POWER and Guiyang Longmaster was 1, but the scale efficiency is at a very low level (respectively 0.311,0.147), leading to the pure technical waste. Therefore, the financing efficiency of big data enterprises in Guizhou province is poor, the scale of operation do not achieve the optimal level. It leads to that financing efficiency is not optimal.
### Table 2 DEA analysis results

| Name                          | Total efficiency | Pure technology efficiency | Scale efficiency | Scale compensation status |
|-------------------------------|------------------|----------------------------|------------------|---------------------------|
| ZHONGTIA FINANCE              | 0.742            | 0.851                      | 0.872            | increase progressively    |
| GUIZHOU TYRE                  | 0.815            | 0.913                      | 0.893            | increase progressively    |
| CHINA ZHENHUA                 | 0.876            | 0.962                      | 0.911            | increase progressively    |
| GOHIGH                        | 1                | 1                          | 1                | invariant                 |
| SOUTH HUITON                  | 1                | 1                          | 1                | invariant                 |
| GUIZHOU AEROSPACE ELECTRONIC  | 0.505            | 1                          | 0.505            | increase progressively    |
| GUIZHOU JIULIAN               | 0.789            | 0.942                      | 0.838            | increase progressively    |
| QIAN YUAN POWER               | 0.311            | 1                          | 0.311            | increase progressively    |
| GUIZHOU XIN BANG              | 0.515            | 0.634                      | 0.813            | increase progressively    |
| GUIZHOU BAI LING              | 0.513            | 0.793                      | 0.647            | increase progressively    |
| Guiyang Longmaster            | 0.147            | 1                          | 0.147            | increase progressively    |
| CHANG ZHENG TIANCHENG         | 0.353            | 0.76                       | 0.465            | increase progressively    |
| CHI TIAN HUA                  | 0.764            | 0.906                      | 0.843            | increase progressively    |
| GUIZHOU RED STAR              | 0.501            | 0.958                      | 0.523            | increase progressively    |
| GUIZHOU PANJIANG              | 0.778            | 0.897                      | 0.867            | increase progressively    |
| MOUTAI                        | 1                | 1                          | 1                | invariant                 |
| GUIZHOU GUIHANG               | 0.847            | 1                          | 0.847            | increase progressively    |
| GUIZHOU YIBAI PHARMACEUTICAL  | 0.758            | 0.917                      | 0.827            | increase progressively    |
| AVIC HEAVY MACHINER           | 0.887            | 0.967                      | 0.918            | increase progressively    |
| GUIZHOU STEEL ROPE            | 0.757            | 1                          | 0.757            | increase progressively    |
| MEAN                          | 0.693            | 0.925                      | 0.749            |                           |

5. Conclusions and policy recommendations

(1) Conclusions

This paper selects big data industry enterprises in Guizhou province in 2016 as the samples, and uses the DEA method to calculate the comprehensive efficiency, pure technical efficiency and scale efficiency of big data enterprises. This paper draws a conclusion through the measurement results:
Firstly, DEA results indicate that the average value of comprehensive efficiency of big data industry enterprises in Guizhou province is 0.693, the average value of pure technical efficiency and scale efficiency are 0.925 and 0.749 respectively, so the financing efficiency invalid is mainly due to the invalid scale efficiency.

Secondly, The results of DEA financing efficiency analysis show that, among the big data enterprise in Guizhou province, there are 17 enterprise at the stage of increasing returns to scale, accounting for 85% of the enterprises, and their financing efficiency is non-effective. Because the non-effective scale efficiency leads to non-effective of financial efficiency, this kind of the enterprises should expand the scale of operation.

(2) Recommendations
Firstly, Optimize financing decisions to enhance the scale efficiency. Big data enterprises in Guizhou province should pay attention to the scale efficiency, and improve the comprehensive efficiency. Most enterprises in Guizhou province has not reached the optimal scale, so the enterprises should optimize their financing decision-making process, implement the sustainable dividend policy, reduce the cost of financing in the equity market. In the financing gap situation, expand financing channels, make full use of funds to improve enterprise scale efficiency.

Secondly, Focus on technology innovation, and meet the policy orientation. With the sustainable operation of enterprises, and the use of funds and management technology, the average value of pure technical efficiency is high. For the enterprises whose pure technical efficiency is low should adjust industrial restructuring and technological upgrading quickly, to meet the national policy guidance and hold the potential demand of the market, improve the production performance and profitability, expand financing channels, strengthen the collection and allocation of funds.

Lastly, Formulate reasonable policies to promote the development of big data industry. The government should provide easy access for big data enterprise financing, lead the industrial cluster to play synergistic effect, establish and improve the financial support system that provides the safeguard for the development of big data enterprise in Guizhou Province, reduce the financing cost of big data enterprise and promote the financing efficiency.

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