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Research on financing efficiency of big data industry based on three stage DEA

- Taking Guizhou Province as an example

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Abstract. Using 20 listed companies of big data industry in Guizhou Province as samples, this paper uses three stage DEA method to evaluate the financing efficiency of big data industry in Guizhou Province. The evaluation results based on three stage DEA show that the average of pure technology efficiency is 0.92, the average of scale efficiency is 0.703, and the average of comprehensive efficiency is 0.648. This indicates that the financing efficiency big data industry in Guizhou Province is low. Differential test shows that the difference of comprehensive efficiency is mainly caused by the difference of scale efficiency.

Introduction

There are many problems waiting to solve in big data as the basic strategic resources. Such as the difficult data sharing, "Data noise" caused by the vast amounts of data, the imperfect of policy and regulation systems, the imperfect of investment and financing policies and fiscal and taxation mechanism to support the big data industry. The financing efficiency is one of the obstacle for the development of the big data industry in Guizhou province. Only the problem of financing efficiency be solved effectively can the big data industry enterprises use the funds effectively and the big data industry be developed healthily and sustainably. At present, the big data industry in Guizhou province is in a stage of rapid development. So this paper uses the three-stage DEA analysis method to evaluate the financing efficiency of big data industry in Guizhou. In view of the operating condition and environment of company of big data industry, this paper compares the financing efficiency differences after eliminating the environmental impact and random error factors. Big data businesses in Guizhou are classified into three types and compared two by two, so the difference between them can be found. This paper puts forward corresponding policies or Suggestions for the improving of the financing efficiency of big data industry in Guizhou province.

Literature Review

The influence of factors such as external environment and random error on the calculation of financing efficiency can be adjusted simultaneously, the three-stage DEA model raised by Fried(2002)[1] had been widely used. Dengyue Luo(2013)[3] gave the use of inefficient management formula in the right way and the calculate formula of inefficient management in three-stage DEA model raised by Shuangjie Li(2007)[2]. Weiwei Chen(2014)[4] analyzed the principle and application of the three-stage DEA model and put forward some differences and problems in the application of the second stage, then, evaluate the effectiveness of information construction of colleges and universities after adjusting the environment variables reasonably. Xiaoning Wang(2016)[5]evaluated the financing efficiency of 461 small industrial enterprises. The study found that pure technical efficiency rising showed that small and medium-sized enterprises' financing management level is higher; the traditional DEA methods overestimated the loss of financing efficiency caused by the management inefficiency; The external operating environment had a restraining effect on the financing efficiency; The efficiency value increased with the increasing number of years. Mengni Yao(2016)[6] analyzed the financing efficiency of 14 large commercial Banks in 2009 to 2014. The empirical results showed that there were differences between the first and the third stage and the first stage efficiency was generally lower than the third . Xianfeng Han(2016)[7] used DEA method to analyze the technical efficiency big data industry listed companies in China and the trend of the decomposition index change.The results showed that the technical efficiency of big data industry in China at low level, which is mainly due to the low growth of pure technology efficiency. The technical efficiency and pure technical efficiency of the eastern region are higher than

those in the central and western regions, but the scale efficiency is lower than that in the central and western regions, and the pure technical efficiency changes in different regions are different.

To sum up, the domestic and overseas scholars have been deeply involved in the research of the three-stage DEA method, and the three-stage DEA method has been used more in all walks of life. Most scholars built the reasonable index system by collecting the annual financial data of companies, and then conduct the three-stage DEA analysis on the financing efficiency of enterprises. But, at present, most researches only focus on the enterprise financing efficiency, but less on comparison about financing efficiency that eliminate environment variables and random error before and after or on comparison about company of difference financing efficiency. Therefore, this paper uses the three-stage DEA method to evaluate the financing efficiency of big data industry in Guizhou province. According to the clustering results，this paper makes a diversity test on different kinds of company and analyzes difference of financing efficiency of big data industry from the demonstration point of view to provide scientific policies and recommendations to the development of big data industry in Guizhou province.

Model and Method

Three-stage DEA Model

The three-stage DEA model eliminates the influence of the external operating environment and the random errors on the efficiency value, so that the efficiency is closer to the real financing efficiency of the company. At the first stage, this paper choices VRS model by multistage-oriented to analyze variables of input and output. At the second stage, this paper uses SFA method to analyze input redundancy value (slack values between original input variable and target input variable). In the third stage, the first step is repeated with adjusted input and output variables.

Data Source and Index Selection

This paper selects the 2016 financial data from 20 listed companies of the big data industry in Guizhou province. The sample data is from the RESSET financial database. The indicators are shown in Table 1.

Table 1, index description

Index	Name	Explain
output variables	gross revenue（Y_1）	Reflect the business results of enterprises
input variable	general assets（X_1）	Reflect the scale of enterprise
	general capital（X_2）	Reflecting the total value of the assets of an enterprise
	turnover of total capital（X_3）	Comprehensive evaluation of the operating quality and efficiency of all assets in an enterprise
	asset-liability ratio（X_4）	Reflect the solvency of enterprises
environment variable	Establishment years（Z_1）	Reflecting the ability of enterprises to operate continuously
	property right structure（Z_2）	dummy variable, State owned enterprises take 1, Private enterprises take 0
	listage（Z_3）	Reflecting the financing ability of enterprises

Empirical analysis

First stage DEA analysis

The results of the first stage of the efficiency measure results are shown in Table 2. 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 is 0.925 and 0.749 respectively, and 85% of enterprises are increasing in scale. The enterprise scale efficiency is low and the gap is large, which leads to the low average enterprise comprehensive technical efficiency.

Table 2, Results of first-stage DEA analysis

Name	CE	PTE	SE	RS	Name	CE	PTE	SE	RS
ZHONGTIAN FINANCE	0.742	0.851	0.872	increase	GUIYANG LANGMA	0.147	1	0.147	increase
Guizhou TYRE	0.815	0.913	0.893	increase	CHANG ZHENG TIANCHENG	0.353	0.76	0.465	increase
CHINA ZHENHUA	0.876	0.962	0.911	increase	CHI TIAN HUA	0.764	0.906	0.843	increase
GOHIGH	1	1	1	invariant	Guizhou RED STAR	0.501	0.958	0.523	increase
SOUTH HUITON	1	1	1	invariant	Guizhou PJ	0.778	0.897	0.867	increase
SACO	0.505	1	0.505	increase	KWEICHOW MOUTAI	1	1	1	invariant
Guizhou JL	0.789	0.942	0.838	increase	Guizhou AEROSPACE	0.847	1	0.847	increase
QIANYUAN POWER	0.311	1	0.311	increase	Guizhou YIBAI PHARMA CEUTICAL	0.758	0.917	0.827	increase
Guizhou XIN BANG	0.515	0.634	0.813	increase	AVIC	0.887	0.967	0.918	increase
Guizhou BAI LING	0.513	0.793	0.647	increase	Guizhou WIRE CABLE	0.757	1	0.757	increase
MEAN VALUE	0.693	0.925	0.749						

Note: CE: comprehensive efficiency; PTE:Pure Technology Efficiency; SE:Scale Efficiency;RS: Return to Scale.

Second stage analysis

In the second stage, the SFA regression analysis was conducted with software Frontier 4.1, and the regression analysis of SFA model was shown in table 3. In this paper, the property right structure is the virtual variable, and the smaller the parameter value, the less input relaxation of the environment variate is, which is conducive to the improvement of financing efficiency. On the contrary, the more investment the variable produces, it is not conducive to the improvement of financing efficiency.

Slack value of total assets: the duration of establishment has no significant impact on the total slack value of the asset; The property right structure and the length of the listed years have significant influence on the total slack value of the asset. The coefficients of the three environmental variables are 1.827, -141.899, 18.518. Among them, there is a negative relationship between the property right structure and the total value of the assets. The two environmental variables, the number of years and the number of years of listing, are positively related to the total assets.

Slack value of total equity: the duration of the establishment has no significant impact on total equity slack value; The structure of property rights and the number of years of listing , have a significant impact on the total equity slack value at 1% level.

Slack value of total asset turnover: the two environmental variables of the fixed number of years and the listed years have no significant impact on the total equity slack value; The property right structure has a significant influence on the relaxation value of total asset turnover at 10% level. The external environmental factors have little influence on the total asset turnover slack value.

Slack value of asset-liability ratio: the duration of establishment has no significant impact on the total equity slack value; The structure of property right and the number of years listed in the market have significant impact on the total equity slack value.

Table 3, Regression result of SFA

	General Assets	General Capital	Turnover of Total Capital	Asset-Liability Ratio
Constant Term	-321.992***	-160.431***	-0.027	-23.664***
Establishment Year	1.827	0.260	-0.0005	0.128
Property Right Structure	-141.899***	-44.092***	-0.093*	-6.822***
Listage	18.518***	9.914***	0.007	1.329***
s^2	65386.759***	12951.449***	0.004**	430.995***
g	1.000***	1.000***	1.000***	1.000***
L	-124.912	-108.008	37.1906	-76.8
LR	10.128	11.555	8.594	5.9

Note: L is log likelihood，LR is single sided likelihood ratio test statistics. * shows significant at the significant level of 10%, ** shows significant at the significant level of 5%, *** shows significant at the significant level of 1% 。

Third stage DEA analysis

In the third stage of DEA, according to SFA model, statistical noise and environmental factors were eliminated to measure the financing efficiency of the big data industry enterprises in Guizhou province. Calculation results as shown in Table 4. It is can be seen that the average comprehensive financing efficiency of big data industry in Guizhou is 0.648, the average pure technical efficiency is 0.92, and average scale efficiency is 0.703. The drop of average comprehensive efficiency shows that the first stage DEA results overestimate the pure technical efficiency.

Table 4, Results of third-stage DEA analysis

Name	CE	PTE	SE	RS	Name	CE	PTE	SE	RS
ZHONGTIAN FINANCE	0.756	1	0.757	increase	GUIYANG LANGMA	0.076	1	0.076	increase
Guizhou TYRE	0.842	1	0.842	increase	CHANG ZHENG TIANCHENG	0.306	1	0.306	increase
CHINA ZHENHUA	1	1	1	invariant	CHI TIAN HUA	0.713	0.946	0.753	increase
GOHIGH	1	1	1	invariant	Guizhou RED STAR	0.59	1	0.59	increase
SOUTH HUITON	1	1	1	invariant	Guizhou PJ	0.709	0.914	0.776	increase
SACO	0.395	0.796	0.496	increase	KWEICHOW MOUTAI	1	1	1	invariant
Guizhou JL	0.688	0.848	0.811	increase	Guizhou AEROSPACE	0.65	0.817	0.796	increase
QIANYUAN POWER	0.273	1	0.273	increase	Guizhou YIBAI PHARMA CEUTICAL	0.667	0.868	0.768	increase
Guizhou XIN BANG	0.494	0.713	0.692	increase	AVIC HEAVY MACHINER	0.891	1	0.891	increase
Guizhou BAI LING	0.443	0.835	0.531	increase	Guizhou WIRE CABLE	0.476	0.674	0.706	increase
MEAN VALUE	0.648	0.920	0.703						

Differential analysis

The result of differential test for efficiency values of first and third stage DEA are shown in Table 5. The test results shows that there are significant differences in the CE and SE between first and third stage DEA at the level of 5%, and the difference of CE is mainly caused by the difference of SE. comprehensive efficiency

Table 5, Efficiency Value Difference Test of First and Third stage

		T	df	Significant（test of two-tailed）
Group1	CE1-CE3	2.205	19	0.04
Group2	PTE1-PTE3	0.160	19	0.875
Group3	SE1-SE3	3.333	19	0.003

Note: CE1: comprehensive efficiency of first stage of DEA; CE3: comprehensive efficiency of third stage of DEA.

Conclusions and policy recommendations

This paper selects the operating data of big data industry enterprises in 2016 in Guizhou as samples, uses the three-stage DEA analysis method to calculate the comprehensive efficiency of big data industry enterprises, the pure technical efficiency and scale efficiency, and accurately evaluates the financing efficiency of the big data industry enterprises in Guizhou. We get the following conclusions: The financing efficiency of big data industry enterprises in Guizhou province is low. The results of the three-stage DEA efficiency measurement show that the average value of the comprehensive efficiency of the financing of the big data industry enterprises in Guizhou province is 0.648, the average pure technical efficiency is 0.92, and the average scale efficiency is 0.703. Differential test shows that the difference of comprehensive efficiency is mainly caused by the difference of scale efficiency.

According to the conclusion of this paper, the following policy suggestions are proposed:

(1) Optimize investment and financing decisions and improve scale efficiency. The longer the big data companies list, the higher the comprehensive efficiency. Because of the rich market experience, the stable equity financing, the scale efficiency increases and the comprehensive efficiency is improved, but the big data business did not achieve the optimal scale. So the big data enterprise should optimize the investment and financing decision-making process, implement the sustainable dividend policy, and reduce the financing cost of the equity market. Under the present situation of the financing gap is bigger, they should expand the financing channels, make full use of the funds, and improve enterprise scale efficiency.

(2) Improve the turnover rate of total assets. This paper analyzes the big data 1 enterprises (low financing efficiency enterprises) in Guizhou province, and finds that the enterprises have significant difference in total asset turnover rate with high financing efficiency. Therefore, such big data enterprises with low financing efficiency should adopt more flexible and marketable marketing methods to improve their earnings, and achieve the scale economy of financing efficiency.

(3) Launch reasonable policies to promote the development of big data industries. To improve the efficiency of the big data industry enterprises financing efficiency in Guizhou, government should appropriately guide industrial clusters, play the cluster synergy effect, establish and perfect the corresponding financial support system, form the stable relations between banks and enterprises, capital markets and enterprise, reduce the large data industry enterprises financing cost, and promote to increase the financing efficiency.

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