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Study on the Performance Evaluation of Tertiary Industry in China

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Abstract
In this paper, we collected the statistical data describing the development of tertiary industry for each province of China. The statistical section data from above data set, Data Envelopment Analysis Model is used for the performance evaluation of China's tertiary industry. The result figures out the provinces of China which are DEA efficient and which are not in tertiary industry by 2009. Meanwhile, the result gives advice on the direction adjustment and range for each province, that the development of technology-intensive industry should be the key factor of tertiary industry.

Key words: Tertiary industry; DEA; Scale efficiency; Performance evaluation

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INTRODUCTION
The tertiary industry is one of three industry types in a developed economy. It consists of the soft parts of economy, and involves the provision of services to other businesses as well as final consumers, provides services to the general population and to businesses and the basic characteristic of this sector is the production of services instead of end products. According to the provision of National Bureau of Statistics, Chinese tertiary industry is split into two main categories, the distribution and service, four levels: first, the circulation departments, such as transportation industry, post and communication, catering industry, wholesale and retail industry and warehousing; second, the departments serving the producing and life, such as financial industry, insurance industry, information consulting service, etc.; third, the departments serving for education, such as broadcast, television, physical, social welfare, etc.; forth, such as state organs, government agency, social organizations, police, military, etc., but it does not count as the factor in the third industrial output value or GDP (Wu, 2000). In the national economic statistic, the tertiary industrial output value includes transport, storage and post, wholesale and retail trades, hotels and catering services, financial intermediation, real estate, leasing and business services, scientific research, technical services and geologic prospecting, management of water conservancy, environment and public facilities, services to households and other services, education, health, social security and social welfare, culture, sports and entertainment, public management and social organizations.

The level of tertiary industry is an important indicator of modernization and civilization of state or region. The development of tertiary industry can promote the growth of national economy, satisfy the increasing needs for material and cultural fulfillments and improve the level of social and professional service, but also be good for the development of market economy, the optimization of allocation resources and the enhancement of national economy efficiency and operating quality (Ma & Wang, 2009; Li, 2011; Si & Li, 2011). Therefore, the investigation for the development status of tertiary industry is an important subject.

In this paper, the performance of tertiary industry is evaluated by DEA Model Method, using the statistical section data from each province of China in 2009.

1. METHODOLOGY

Data Envelopment Analysis was proposed by famous operational researcher A. Charnes, W. W. Cooper and E. Rhodes, and used for evaluating the relative efficiency of some department of same calibre. The first version is C^2R. As a non-parameter evaluation method, it is widely used in mathematics, operational research, mathematical economics, management and various crossing field.

Data Envelopment Analysis is a new research field. It is an optimization approach, which takes advantage of mathematical programming model and sampling technology, for evaluating the performance of a set of peer entities called Decision Making Units (DMUs) which convert multiple inputs into multiple outputs. The definition of a DMU is generic and flexible, such as hospitals, cities, courts, countries, etc. (Wei, 2004; Wu, 2002; Ma, 2010). Every DMU is viewed as an evaluation unit, and all DMUs consist of the population. Formally, DEA is a methodology directed to frontiers rather than central tendencies. According to the relative position of DMU and frontiers, we can learn whether the DMU is efficient. If the DMU is efficient, it means the DMU is in the ideal state, that is, the output of science & technology matches economic input well. If not, we can analyze the reasons for inefficient or weak efficient, and figure out the direction and extent of improvement.

The main advantage to this method is its ability to accommodate a multiplicity of inputs and outputs, and no need to explicitly specify a mathematical form for the production function. It is also useful because it takes into consideration returns to scale in calculating efficiency, allowing for the concept of increasing or decreasing efficiency based on size and output levels. A drawback of this technique is that the model specification and inclusion/exclusion of variables can affect the result, and the inefficient units can be analyzed and quantified. However, there are some disadvantages of DEA. For example, the result is sensitive to the selection of inputs and outputs, cannot test for the best specification, and the number of efficient firms on the frontier tends to increase the number of inputs and output variables.

The C^2R is given by

$$(C^2R)\begin{cases} \max \dfrac{u^T Y_0}{V^T X_0} \\ \dfrac{u^T Y_j}{V^T X_j} \le 1 \ , \ \ j = 1,2,...,n \\ u \ge 0, v \ge 0 \end{cases} \tag{1}$$

It is the classical one in so many DEA models (Tang, Kong, & Hui, 2011). This model is established directly based on these input and output indicators, and the calculation output shows the DEA efficiency of each DMU using the linear duality theory.

2. ANALYSIS FOR PERFORMANCE EVALUATION OF TERTIARY INDUSTRY

2.1 The Selection for Input and Output Variables

The tertiary industry is a great industrial group, including a wide range of businesses. There are so many factors to its performance, and its efficiency also expresses in so many aspects. Therefore, the input and output variable should be selected. After principal component analysis (Li & Si, 2010), three variables are selected.

Table 1
Input and Output Variables

Input indicators	Output indicators
X_1- the number of the tertiary industry corporation body	Y_1- the amount of the added value of the tertiary industry
X_2 – the number of the tertiary industry practitioners	
X_3 – the fixed investment of the tertiary industry	Y_2- the amount of technology market trading

2.2 The Analysis of Performance Evaluation of Input-Output Efficiency

The 31 provinces of China, that is, 31 DMUs participate in the DEA analysis. The raw data is from the statistical yearbook and statistics bulletin (2009).

2.2.1 Efficiency Analysis

In Table 2, ***crste***, comprehensive efficiency, the technological efficiency regardless of returns to scale; ***vrste***, pure technical efficiency, the technological efficiency considering returns to scale; ***scale***, scale efficiency, the scale efficiency considering the returns to scale; irs, increasing returns to scale; crs, constant returns to scale; drs, decreasing returns to scale.

Table 2 shows that the average of the pure technical efficiency of input-output in 31 provinces is 0.768, and the average of scale efficiency is 0.904, at upper-middle level in general. Among the 31 provinces, there are four DEA effective DUMs (Beijing, Shanghai, Jiangsu, and Guangdong), about 12.9% in total, and their scale efficiency index is 1. It means that these four DUMs have reached the best output level in the existing investment. Four provinces, whose scale efficiency index is less than 1 and pure technical efficiency index is 1, are weak DEA efficiency, about 12.9% in total. They are Tianjin, Inner Mongolia, Hainan and Tibet. The computation suggests that they are rich in ethnic

cultural resources, however, the size of tertiary industry is small, and there will be a large promotion space. 27 provinces, whose scale efficiency index is less than 1, are inefficient, about 87.1% in total. These weak DEA efficient cities do not have the optimized relationship of input-output. Increasing output or reducing invesmentt can adjust the allocation of technical resources, to realize the optimal combination of input and output. Table 2 also shows that the 27 provinces are increasing returns to scale, and they can increase the output to reach the balance. In general, most provinces do not have the reasonable and optimal configuration, and there is great adjusting space in the optimization and utilization of the tertiary industry.

Table 2
The Performance Evaluation Index of 31 Provinces

Firm	Crste	Vrste	Scale	Tendency	Firm	Crste	Vrste	Scale	Tendency
DMU1	1.000	1.000	1.000	crs	DMU17	0.551	0.575	0.959	irs
DMU2	0.988	1.000	0.988	irs	DMU18	0.707	0.732	0.966	irs
DMU3	0.722	0.740	0.976	irs	DMU19	1.000	1.000	1.000	Crs
DMU4	0.559	0.605	0.924	irs	DMU20	0.504	0.548	0.918	irs
DMU5	0.989	1.000	0.989	irs	DMU21	0.738	1.000	0.738	irs
DMU6	0.685	0.705	0.972	irs	DMU22	0.591	0.650	0.908	irs
DMU7	0.744	0.798	0.933	irs	DMU23	0.517	0.538	0.961	irs
DMU8	0.719	0.770	0.934	irs	DMU24	0.600	0.686	0.875	irs
DMU9	1.000	1.000	1.000	crs	DMU25	0.558	0.611	0.914	irs
DMU10	0.924	0.924	1.000	crs	DMU26	0.442	1.000	0.442	irs
DMU11	0.790	0.799	0.989	irs	DMU27	0.534	0.572	0.934	irs
DMU12	0.619	0.659	0.939	irs	DMU28	0.590	0.707	0.834	irs
DMU13	0.740	0.762	0.971	irs	DMU29	0.510	0.900	0.566	irs
DMU14	0.593	0.646	0.918	irs	DMU30	0.589	0.598	0.656	irs
DMU15	0.707	0.708	0.999	Irs	DMU31	0.561	0.654	0.858	irs
DMU16	0.600	0.619	0.969	irs	Average	0.689	0.768	0.904	

2.2.2 Projection

According to the result of the software DEAP 2.1, we record the redundant input and the lack of output for every DMU.

In Table 3, among the inefficient cities, for example, DMU 3, the scale efficiency index is 0.976, this is, 97.6% of investment can support current output level. So, the waste of resource and ineffective utilization exist in this province. This DMU will achieve relative optimum of input-output ratio under the following condition that decreasing investment by 2012.32 thousands employees or reducing 35.346 billion fixed investment of tertiary industry, or augmenting 23.32 billion technology market trading. The others are similar.

This result also suggests that, most provinces make big investment owing to the recognition of the tertiary industry's importance to national economy growth, and the scale efficiency is almost 1. However, the average of pure technical efficiency is 0.768. This figure means that there is 23.2% for expanding. In general, some provinces invest too many manpower input, and waster them a lot. The turnover of sci-tech is not large enough. This condition will be ameliorated if improving the technological content. Therefore, the development of technology is tertiary industry's direction. We should constantly develop and improve the conventional industries of tertiary industry, such as real estate; and speed up the burgeoning industry, like finical and insurance industry; also be active in expanding the technical service, electronic industry, internet digital industry, especially pay attention on the industrialization, commercialization and export-orientation of skill and knowledge intensive industry, to promote a rapid development of tertiary industry.

Table 3
Input and Output

DMU	Scale	Input redundancy (s^-)			Output gap (s^+)	
		The number of the tertiary industry practitioners	The fixed investment of tertiary industry	The number of the tertiary industry corporation body	Increment of tertiary industry	Turnover of sci-tech
DMU1	1.000	0	0	0	0	0
DMU2	0.988	0	0	0	0	0
DMU3	0.976	201.232	35.346	0	0	233620.664
DMU4	0.924	0	0	0	0	284649.342
DMU5	0.989	0	0	0	0	0
DMU6	0.972	0	536.082	0	0	0
DMU7	0.933	0	0	0	0	0
DMU8	0.934	0	0	0	0	0
DMU9	1.000	0	0	0	0	0
DMU10	1.000	0	1175.161	0	0	1177641.604
DMU11	0.989	0	0	0	0	1092276.992

To be continued

Continued

DMU	Scale	Input redundancy (s^-)			Output gap (s^+)	
		The number of the tertiary industry practitioners	The fixed investment of tertiary industry	The number of the tertiary industry corporation body	Increment of tertiary industry	Turnover of sci-tech
DMU12	0.939	207.384	931.515	0	0	0
DMU13	0.971	0	0	0	0	342577.843
DMU14	0.918	95.714	0	0	0	88147.548
DMU15	0.999	0	451.992	0	0	1633721.141
DMU16	0.969	219.408	0	0	0	201570.654
DMU17	0.959	47.649	0	0	0	0
DMU18	0.966	205.990	122.390	0	0	0
DMU19	1.000	0	0	0	0	0
DMU20	0.918	0	0	0	0	218236.606
DMU21	0.738	0	0	0	0	0
DMU22	0.908	102.895	501.359	0	0	0
DMU23	0.961	227.215	366.846	0	0	0
DMU24	0.875	360.480	0	0	0	290951.284
DMU25	0.914	73.366	0	0	0	6822.704
DMU26	0.442	0	0	0	0	0
DMU27	0.934	0	0	0	0	0
DMU28	0.834	207.039	0	12167.708	0	0
DMU29	0.566	13.770	0	0	0	208760.690
DMU30	0.656	16.878	0	0	0	104911.241
DMU31	0.858	33.275	0	0	0	526230.219
Average		64.913	132.926	392.507	0	208751.219

CONCLUSION

As can be seen from the above analysis, Beijing, Shanghai, Jiangsu and Guangdong are DEA efficiency, with the optimal match of the input and output. Among them, the technology efficiency of Jiangsu is 0.924. The weak DEA provinces are Tianjin, Inner Mongolia, Hainan and Tibet, whose technical efficiency is 1 but scale efficiency is less than one, and they can achieve relative optimum of input-output ratio by decreasing input or increasing output. The rankings of performance evaluation for tertiary industry are as follows: Beijing, Shanghai, Guangdong, Jiangsu, Shandong, Inner Mongolia, Zhejiang, Tianjin, Hebei, Liaoning, Fujian, Henan, Hunan, Sichuan, Hubei, Anhui, Heilongjiang, Shaanxi, Jilin, Shanxi, Jiangxi, Guangxi, Yunnan, Chongqing, Guizhou, Xinjiang, Gansu, Hainan, Ningxia, Qinghai, Tibet. In general, the benefits of tertiary industry greatly increased, with a high output efficiency ratio. The average scale efficiency index is 0.904, however, the average technology efficiency index is 0.689, which means a low level. The pure technical efficiency is 0.768, which means there are 23.2% upside.

Nonetheless, there are some shortcoming. Imbalance is still a hinder between regions, for example, the big gap in the absolute amount of input, a waste of resources, insufficient output. Therefore, we should carry forward the advantage, make up the deficiency to enhance the proportion of tertiary industry accounted for national economic development further.

REFERENCES

Li, C. H.(2011). Correlation analysis between scientific and technological progress and economic development. *Management Science and Engineering, 5*(4).

Li, C. J., & Si, F. J.(2010). Generalized inferences on the common mean vector of several multivariate normal populations. *Aussino Academic Publishing House Sydney Australia*, (8).

Ma, H. Y., & Wang, L. Y.(2009). Research on effects of cycle stability and employment absorption of China's tertiary industry. *Soft Science of China,* 144-150.

Ma, Z. X. (2010). *Data envelopment analysis models and methods* (pp.144-149). Beijing: Science Press.

Si, F. J., & Li, C. J.(2011). *Application of canonical correlation analysis in science&technology and economic development research* (p.10). The Invitation of First (2011) International Academic Seminar of Soft power.

Tang, W., Kong, H. Z., & Hui, H. Q.(2011). Analysis on scientific and technical resource allocation efficiency based on data envelopment model. *Science and Technology Management Research, 13,* 187-191.

Wei, Q. L.(2004). *Data envelopment analysis* (pp.23-55). Beijing: Science Press.

Wu, W. J.(2002). *Data envelopment analysis and application* (pp.33-49). Beijing: China Statistical Press.

Wu, Y. M.(2000). Newly assessment of synthetical development levels of tertiary industry of 31 provinces regions of China. *Soft Science of China*, (10), 52-56.