

Research on China's Regional Cultural Industries' Efficiency Based on Factor Analysis and BCC & Super Efficiency Model

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Abstract

Cultural industries are becoming important drivers for global economic growth. Competitiveness of cultural industries lies in its performance. This paper takes deep research on the cultural industries' performance of 31 regions in China by the methods of factor analysis and super BCC efficiency model, using the whole statement data of 2010 from cultural industries. As the study shows, there are only 7 provinces which are efficient DMUS in DEA, and inefficiency in scale is one of the most important factors for cultural industries' efficiency in China, and the short of output is more widespread and serious than redundancy of input. Some proposals are put forward. Firstly, output should be expanded based on completely digging and utilizing the present resources. Second, blind development and input should be avoided. Third, the northeast and central region should work hard to improve pure technical efficiency, and northeast and northwest region should improve scale efficiency.

Keywords: cultural industries, input-output, factor analysis, model of BCC, model of super efficiency

1. Introduction

As the most potential industry in the 21st century, the position of cultural industry has been gradually revealing in the economic and social development of China. In the year of 2012, the Chinese government proposed the "cultural industry doubling plan" in the 12th five-year period, which aims to improve the cultural industry innovation capability and core competitiveness and promote cultural industry to be a pillar industry of the national economy. Therefore, it is important for improving the overall strength of China's cultural industry to understand objectively the current performance in different regions and find the development gap and improvement direction.

At present, some scholars study the performance of the cultural industries by the method of Data Envelopment Analysis (DEA). Hou Yan-Hong (2008) used the CCR super efficiency model to analyze the investment performance of cultural industry of 24 provinces in 2006, and then analyzed the cause and solution of the investment underperformance of Tianjin's cultural industries. Guo Guo-feng and Zheng Zhao-feng (2009) evaluated the input & output indexes of the six central provinces' cultural industries by method of factor analysis, and studied the cultural industry performance and input and output path of the six central provinces by the DEA model and structural equation. Wang Jia-ting and Zhang Rong (2009) studied the culture industries' efficiency of 31 provinces in China in 2004 by using the three stage DEA model, concluding that the efficiencies of cultural industries were obviously different in various regions. Ma Xuan and Zheng Shi-lin (2010) used the CCR, BCC and SE model to study the efficiency of China's cultural industries from 1996 to 2006 and concluded that regional cultural industries efficiency gap between eastern and western was shrinking, and the ascension space of the pure technical efficiency was large. Jiang Ping and Wang Yong (2011) used the three-stage DEA and super efficiency DEA model to analyze the input-output efficiency of cultural industries in 2008 by the second economic census data, believing that the provincial cultural industry efficiency was greatly influenced by the environment. Zhang Ren-shou, Huang Xiao-jun (2011) analyzed the cultural industry input and output performance of 13 provinces in 2007, using the CCR model and DEA super efficiency model and concluded that the comprehensive performance of cultural industries in Guangdong province was the first and still improvable. Wang Jia-ting and Gao Shan-shan (2012) evaluated the efficiency of rural cultural industries in China and found that the cultural industry efficiency was higher in rural areas of central China.

The literatures above have made a meaningful exploration to the efficiency of Chinese cultural industries, but there are still some disadvantages. Firstly, the selection of input and output indexes was subjective, and most of them are value indexes. Presently, except for Guo Guo-feng and Zheng Zhao-feng (2009), others did not use the method of factor analysis, just selecting 2 to 4 input and output indexes by subjective judgment. However, it is easy to miss important information if just a limited number of value indexes are selected, because there are various categories of cultural industries and plenty of cultural investments cannot be measured in terms of value. Improper indexes may also affect the accuracy of evaluation results. Secondly, the selected industries and data can't reflect the full picture of cultural industries in former researches. Many industries were not included, such as "related culture products manufacturing industry", "cultural tourism industry" and "wholesale and retail industry". Thirdly, some literatures analyzed the performance of cultural industries by the CCR model. But the assumption of this model is constant returns to scale, which does not match with cultural industries' character of "increasing returns with endogenous development mechanism". Fourthly, most of the researches used the input-oriented DEA model. But the cultural industries' fixed investment is large and relatively stable, which determines it is more suitable to use output-oriented method. Presently, no one has used output-oriented BCC model to study the regional culture industries performance. Fifthly, few literatures calculated the input redundancy ratio and output inefficiency ratio for relatively invalid DMUS, which mean the improvement direction. Given the above considerations, this paper collects all the cultural industry data of 31 provinces in 2010 and combines the factor analysis method and output-oriented BCC super efficiency model to analyze the regional cultural industries' performance, reflecting accurately the state and future orientation of Chinese regional cultural industries.

2. Research Methods and Data Specified

2.1 Theoretical Model and Research Method

2.1.1 Output-Oriented BCC Model

Data envelopment analysis (DEA) model is a kind of efficiency evaluation method, which is developed based on the concept of relative efficiency by A. Charnes and W. W. Cooper, famous operations researchers in America. Currently, DEA model has become an important method of efficiency evaluation for multiple input and multiple output system. The BCC model takes "variable return to scale (VRS)" as a premise, and divides technical efficiency (TE) of each decision making unit into pure technical efficiency (PTE) and scale efficiency (SE). DEA model can be divided into input-oriented and output-oriented in terms of measurement difference. Input-oriented DEA model is an efficiency evaluation model when input reaches the smallest under the condition of constant output; output-oriented DEA model is an efficiency evaluation model when output reaches the largest under the condition of constant input. For CCR model, the results of input-oriented and output-oriented analysis are the same, but for BCC model the results have differences. Considering the fixed investment of cultural industry is large and relatively stable, the output-oriented BCC model is better.

Assume that there are n decision making units (DMU), and each DMU has m kinds of inputs and s kinds of outputs. Input set is $X = \{x_i, i = 1, 2, \dots, m\}$; output set is $Y = \{y_k, k = 1, 2, \dots, s\}$. x_j and y_j mean the input and output variables of j -th DMU. Under the output-oriented condition, the dual form of BCC model can be expressed as:

$$\begin{cases} \max_{\theta, \lambda} \theta \\ s.t. \sum_{j=1}^n \lambda_j x_j + s^+ = x_0 \\ \sum_{j=1}^n \lambda_j y_j - s^- = \theta y_0 \\ s^+ \geq 0, s^- \geq 0 \\ \sum_{j=1}^n \lambda_j = 1, \lambda_j \geq 0 \end{cases} \quad (1)$$

in Model (1), θ means effective value of DMU, s^+ and s^- mean slack variable. Their economic meaning is: when $\theta=1$, $s^+=0$ and $s^-=0$, the DMUs are DEA efficient, and the technology and scale are all efficient; when $\theta=1$ and one of s^+ and s^- is not 0, the DMUs are weak DEA efficient and at least one of technology

and scale is not the best; when $\theta < 1$, the DMUS are DEA inefficient and both of technology and scale are not the best.

As shown in Figure 1, we explain output-oriented BCC model (as Figure 1(a)) and input-oriented CCR model (as Figure 1(b)) with a simple example of single input and single output. P means DEA inefficient decision making units. Technical efficiency is equal to CP/CD under the output-oriented condition; while technology efficiency is equal to AB/AP under the input-oriented condition. The technical efficiency of input-oriented and output-oriented are the same under the condition of CCR, as shown in Figure 1 (b): $AB/AP = CP/CD$, while they are not equal under the condition of VRS, as shown in Figure 1 (a): $AB/AP \neq CP/CD$.

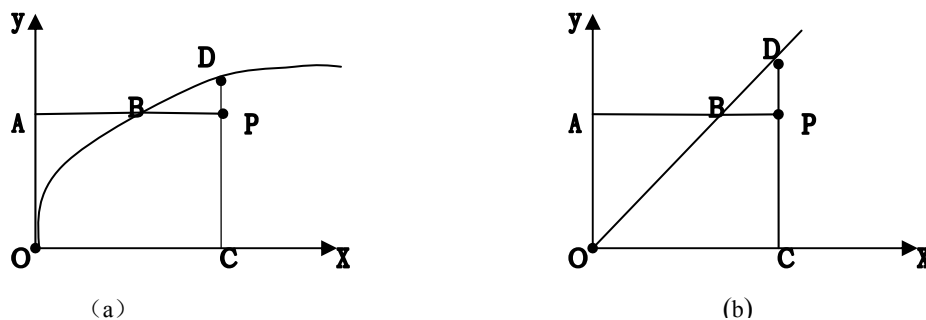


Figure 1. Comparison of output-oriented BCC model and input-oriented CCR model

Figure 2 shows the principle of the BCC model and the calculation of the slack variable under the output-oriented condition of one input and two outputs. The piecewise linear curve is the frontier production function. By radial extension, point P is projected into the point P'. However, P is not on the efficient frontier, because output y_1 can increase AP' under the condition of no increase of the input which is the slack variable of output.

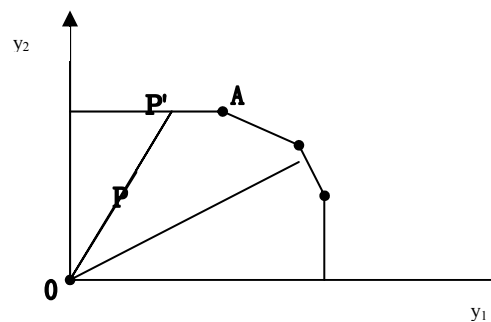


Figure 2. Output-oriented BCC model

2.1.2 Factor Analysis Method

In order to do efficiency evaluation with DEA model, the required number of DMUs must be at least twice than the input and output indexes. Choosing a large number of indexes will appear information overlap problems between indexes and affect the accuracy of DEA evaluation as well. However, because the cultural industry is a complicated system of multiple input and multiple output, it is not enough to reflect the whole cultural industry situation to select just a small amount of indexes by subjective judgment. The factor analysis method can solve this problem very well. Factor analysis is a statistical analysis method which is able to change multiple complex variables to a few the overall explainable but unrelated factors. This paper establishes a cultural industry input and output index system and uses factor analysis method to extract the main factors, and then naming the factors according to the information provided by the orthogonal rotating load matrix. In the end, the factor scores are applied to the DEA performance analysis of cultural industry.

2.1.3 Super-Efficiency Model

The BCC model will get many effective production units with the efficiency value of 1, but their production efficiency must be different. Traditional BCC model is unable to carry on further order for them. Super efficiency DEA analysis method can take further discriminating and contrasting to the decision making units on

the production frontier. The basic idea is: when evaluating decision making units, taking the evaluation decision-making unit itself out of sets. As shown in Figure 3, assuming each decision-making unit has two inputs and one output. SS' is the production frontier of BCC model. Efficiency values of A, B and C are all 1. When measuring the super efficiency value, the evaluation decision-making unit will be excluded. The super efficiency value may be less than 1. When we evaluate the super efficiency value of point B, it is no longer on the frontier and frontier just includes A and C. B' is the projection of B. Super efficiency value of B' is equal to OB'/OB (assumptions of 0.7), which indicates that if the output is synchronously decreases by 30%, the decision making unit is still effective.

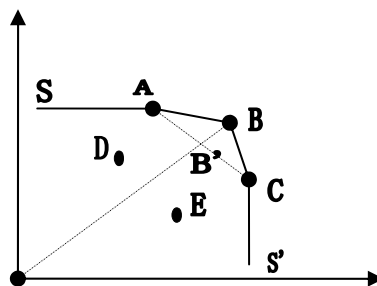


Figure 3. Super efficiency DEA model of output

2.2 Input and Output Evaluation Index System of Cultural Industries

As shown in Table 1, this paper takes existing researches' results as references, and then builds 11 indexes of the cultural industry input evaluation from three angles---the basic elements input, capital investment and cultural resources input. Besides, from two angles of economic output and social production, we build 16 indexes to evaluate the cultural industries output:

Table 1. Input and output evaluation index system of cultural industries

Cultural industries input index	
Basic elements input	Employed persons X_1
	Enterprise number X_2
Capital investment	The number of social humanities and test researchers X_3
	New fixed assets of Cultural relics construction investment X_4
	Internal R&D expenditure X_5
	Financial allocation of cultural relics X_6
Cultural resources input	New books X_7
	State Protected Historic site X_8
	State-level non-material cultural heritage X_9
	Collection of cultural relics X_{10}
	State-level scenic area X_{11}
Cultural industries output index	
Economic output	The added value of cultural industries Y_1
	Tourism income Y_2
	Culture and related products wholesale and retail sales Y_3
	Cultural manufacturing sales Y_4
	Entertainment places sales Y_5
	Performing arts venues show income Y_6
Social production	Annual production of radio and television time Y_7
	Radio and television cable subscribers Y_8
	Internet penetration rate Y_9
	Books, newspaper and magazine printing Y_{10}
	Public libraries in general circulation Y_{11}
	Library information construction computers Y_{12}
	Original debut drama performing arts groups Y_{13}
	Performing arts venues Y_{14}
	Organization activities in public arts cultural center township Y_{15}
	Number of tourists Y_{16}

2.3 Indexes and Data Explanation

In 2004, according to the *classification of national economy industry* (GB/T4754 2002), Chinese National Bureau of Statistics makes the *classification of cultural and related industries*, in which the cultural industries are divided into nine industries, including news services, publishing and copyright services, radio, television and film service, culture and art services, network culture services, cultural services of leisure and entertainment, other cultural services, cultural goods equipment and related cultural products production, cultural goods equipment and related cultural products sales. The index system of this paper covers the cultural industries above as much as possible. The indexes X_1 and X_2 are data of the whole industry, which are aggregated by the number of different industries. The two indexes represent the basic elements of cultural industries investment and reflect the overall scale of the regional cultural industries. The indexes $X_3 \sim X_6$ reflect the regional capital investment of cultural industries. The indexes $X_7 \sim X_{11}$ represent the resources input of regional cultural industries, reflecting the resources endowment of regional cultural industries.

The indexes $Y_1 \sim Y_6$ represent the economic output scale of cultural industries. The added value of cultural industries (Y_1) is a comprehensive index of the whole industry. The other indexes respectively represent cultural services, retail industry and manufacturing industry and so on. In addition to using these economic indexes to measure the output of cultural industries, the other outputs are hard to be measured by economic indexes. Therefore, we use real object to represent the output, like $Y_7 \sim Y_{17}$ in Table 1, which is a necessary complement to economic output. The original data of this paper are all from *China's Cultural Relics Statistical Yearbook*, *China's Tourism Statistical Yearbook and Copy*, *China's Press and Publication Data Assembly*, *DRCNET Statistical Database System* and *China Info Bank*.

3. Factor Analysis of Input and Output Indexes

In order to ensure the comparability and consistency of the data, we do standardization processing to eliminate the dimension and the magnitude difference of original data by SPSS17.0 software. Test results show that KMO test values are 0.731 and 0.785. The p values of Bartlett's sphericity test are 0, which shows that the indexes are suitable for factor analysis.

The Table 2 shows that the cumulative variance contribution rate of the first four factors of input indexes reaches 85.99%, and that of the first three factors of output indexes reaches 81.439%. Thus, we can say it's enough for these factors to represent the most information of the index system. In order to grasp accurately the economic meaning of the selected factors and explore their potential information, we do varimax orthogonal rotation to the factor loading matrix. As a result, the first factor of the input indexes has larger load on the five indexes X_1, X_2, X_5, X_6 and X_7 , which are the elements needed by all industries. So the first factor is named as "the basic element inputs". The second factor has larger load on the X_3 and X_{10} , named as "the scientific research inputs to the cultural industries". The third factor has larger load on the X_4, X_8 and X_9 . Of them, X_8 and X_9 are the special resources of cultural industries and X_4 can be seen as the new investment of each year. So the third factor is named as "the special resource inputs". The fourth factor has larger load on the X_{11} , which is the state-level scenic area. Thus the fourth factor is named as "the tourism resource inputs".

Table 2. Variance, eigenvalue and contribution rate

Total Variance Explained						
Input Component	Initial Eigenvalues			Extraction Sum of Squared Loadings		
	Total	of Variance %	Cumulative %	Total	of Variance %	Cumulative %
1	5.219	47.444	47.444	4.250	38.635	38.635
2	1.730	15.724	63.168	2.134	19.400	58.035
3	1.483	13.486	76.654	1.885	17.135	75.170
4	1.027	9.336	85.990	1.190	10.820	85.990
Output Component	Initial Eigenvalues			Extraction Sum of Squared Loadings		
	Total	of Variance %	Cumulative %	Total	of Variance %	Cumulative %
1	9.086	56.790	56.790	7.327	45.796	45.796
2	2.881	18.006	74.796	4.078	25.487	71.282
3	1.063	6.643	81.439	1.625	10.157	81.439

The first factor of output indexes has larger load on $Y_1, Y_4, Y_5, Y_7, Y_8, Y_{11}, Y_{12}, Y_{13}, Y_{14}$ and Y_{15} , which represent the products or services outputs of cultural enterprises. So factor one is named as “the output of cultural enterprises”. The second factor has larger load on Y_2, Y_3, Y_6, Y_9 and Y_{10} , which are associated with direct consumption. Thus the second factor is named as “the cultural consumption income”. The third factor has more loads on Y_{16} , which is named as “tourist trips”.

Table 3. Score of extracted input and output factors

Region	basic element inputs	scientific research inputs	special resources inputs	tourism resource inputs	comprehensive score of Input factor	output of cultural Enterprise and institution	cultural consumption income	tourist trips	comprehensive score of Output factor
Beijing	0.10	4.41	-0.55	-0.54	0.72	-1.51	4.89	0.49	0.74
Tianjin	-0.20	0.02	-1.12	-0.73	-0.36	-0.59	0.27	-1.01	-0.38
Hebei	-0.27	-0.57	1.64	-0.06	0.00	-0.17	-0.30	0.42	-0.14
Shanxi	-0.99	0.39	1.82	-0.91	-0.29	-0.29	-0.31	-0.27	-0.29
Neimenggu	-0.60	0.08	0.18	0.05	-0.28	-0.36	-0.46	-0.35	-0.39
Liaoning	0.66	-0.22	-0.79	-0.18	0.18	0.17	-0.02	1.14	0.23
Jilin	-0.29	-0.22	-0.82	-0.47	-0.38	-0.37	-0.36	-0.36	-0.37
Heilongjiang	-0.25	-0.33	-0.93	0.18	-0.33	-0.50	-0.35	0.24	-0.36
Shanghai	1.00	0.58	-1.34	-0.75	0.37	1.37	1.29	-1.93	0.94
Jiangsu	1.70	0.67	0.16	-0.36	1.05	2.34	0.19	0.39	1.42
Zhejiang	2.26	-0.51	1.29	0.76	1.44	2.31	0.41	-0.49	1.37
Anhui	-0.04	-0.46	-0.21	-0.09	-0.15	-0.10	-0.41	-0.04	-0.19
Fujian	0.11	-0.64	0.65	-0.39	0.00	0.86	-0.35	-1.48	0.19
Jiangxi	-0.30	-0.42	-0.24	0.14	-0.27	0.00	-0.67	-0.22	-0.24
Shandong	1.12	0.17	1.02	0.01	0.81	0.80	0.04	1.66	0.67
Henan	-0.33	0.22	2.53	-0.88	0.16	0.12	-0.25	0.94	0.11
Hubei	-0.31	0.58	1.32	1.04	0.25	0.39	-0.35	0.15	0.13
Hunan	0.02	-0.33	0.35	0.20	0.03	0.22	-0.39	-0.04	-0.01
Guangdong	3.50	-0.83	-0.78	-0.93	1.56	2.30	0.99	0.86	1.71
Guangxi	-0.42	0.25	-1.01	1.03	-0.23	-0.19	-0.42	0.15	-0.22
Hainan	-0.80	-0.51	-0.86	-0.69	-0.74	-0.98	-0.09	-0.86	-0.69
Chongqing	-0.39	0.09	-0.90	0.07	-0.33	-0.40	-0.03	-0.34	-0.28
Sichuan	0.29	0.66	0.07	4.20	0.75	0.83	-0.52	0.33	0.35
Guizhou	-0.57	-0.90	-0.07	-0.18	-0.51	-0.81	-0.40	0.04	-0.58
Yunnan	-0.40	-0.84	1.07	-0.46	-0.26	-0.93	-0.49	3.62	-0.22
Tibet	-0.92	-0.71	-0.63	-0.43	-0.79	-1.10	-0.34	-0.81	-0.82
Shaanxi	-0.86	1.63	0.24	-0.59	-0.20	-0.36	-0.28	-0.16	-0.31
Gansu	-0.72	-0.37	0.07	-0.66	-0.53	-0.67	-0.40	-0.34	-0.54
Qinghai	-0.77	-0.69	-1.10	1.28	-0.59	-0.98	-0.24	-0.82	-0.73
Ningxia	-0.79	-0.57	-0.94	-0.79	-0.77	-0.87	-0.34	-0.75	-0.69
Sinkiang	-0.52	-0.66	-0.11	1.12	-0.30	-0.52	-0.34	-0.16	-0.42

The input-output factor scores of each province are shown in Table 3. The five provinces with the maximum or minimum comprehensive scores (Note 1 & 2) are marked out with shading. The five provinces with minimum output comprehensive factor scores are: Tibet, Ningxia, Hainan, Qinghai and Gansu, and the five provinces with a maximum output factor scores are: Guangdong, Jiangsu, Zhejiang, Shanghai and Beijing. Furthermore, the five provinces with a maximum input comprehensive factor scores are: Guangdong, Zhejiang, Jiangsu, Shandong and Sichuan, and the five provinces with a minimum output factor scores are: Tibet, Ningxia, Hainan, Qinghai and Guizhou. By contrast we can only infer that the performance of cultural industries in Shanghai and Beijing may be relatively higher, because output of the two provinces ranks top five but the input is not. Similarly we can conclude that the performance of cultural industries in Shandong and Sichuan are not very high. However, more accurate relative performance cannot be reflected in Table 3. So it is necessary to do further research with BCC method.

4. Cultural Industry Input-Output Efficiency Analysis

Taking the above extracted input and output factors as indexes of BCC model, we analyze the performance of regional cultural industries. These indexes, extracted by factor analysis, can fully reflect the input and output condition of the regional cultural industries. There are 31 decision making units and 7 extracted factors, which meets the requirements of BCC model. However, BCC model requires that the indexes should not be negative. So we make indexation to all scores in Table 3. This process changes the negative factors to positive one, not affecting the comparison results of relative efficiency.

Many inputs of cultural industry, especially cultural resources, are the results of historical and cultural accumulation, which are relatively fixed in a period of time. Improving the performance of cultural industries depends on the output. So it is necessary to study cultural industries performance of each province from the perspective of output and find a way to improve the performance of cultural industries for each province. In this paper, we use DEAP 2.1 software, and adopt the output-oriented BCC model to calculate the regional performance of industries in China. For the DEA ineffective units, we calculate the input redundancy ratio and output inefficiency ratio and give the best improvement path for them.

4.1 The Results Analysis of BCC Model

Table 4. Cultural industries efficiency value of 31 provinces in China

firm	crste	vrste	scale	scale benefit	Ranking of crste	firm	crste	vrste	scale	scale benefit	Ranking of crste
Beijing	1	1	1	-	1	Shanxi	0.988	1	0.988	irs	2
Tianjin	0.698	1	0.698	irs	13	Hunan	0.624	0.656	0.952	irs	18
Hebei	0.71	0.814	0.872	irs	12	Hubei	0.968	0.978	0.99	irs	3
Shanghai	1	1	1	-	1	Anhui	0.575	0.695	0.828	irs	21
Jiangsu	1	1	1	-	1	Jiangxi	0.685	0.879	0.78	irs	16
Fujian	1	1	1	-	1	Henan	0.796	1	0.796	irs	9
Shandong	0.506	0.521	0.971	drs	25	Central area	0.773	0.868	0.889		
Guangdong	1	1	1	-	1	Liaoning	0.676	1	0.676	irs	17
Zhejiang	1	1	1	-	1	Jilin	0.546	0.716	0.762	irs	23
Hainan	0.839	1	0.839	irs	6	Heilongjiang	0.527	1	0.527	irs	24
East area	0.875	0.934	0.938			Northeast area	0.583	0.905	0.655		
Guangxi	0.68	1	0.68	irs	14	Chongqing	0.571	0.8	0.713	irs	22
Shaanxi	0.818	1	0.818	irs	8	Sichuan	0.876	0.949	0.923	irs	4
Gansu	0.592	0.859	0.69	irs	20	Guizhou	0.832	1	0.832	irs	7
Qinghai	0.852	1	0.852	irs	5	Yunnan	1	1	1	-	1
Neimenggu	0.619	0.861	0.719	irs	19	Tibet	0.794	1	0.794	irs	10
Ningxia	0.686	1	0.686	irs	15	West area	0.753	0.944	0.795		
Xinjiang	0.715	0.86	0.831	irs	11	China	0.78	0.922	0.846		

Notes: “-” means constant returns to scale; “irs” means increasing returns to scale; “drs” means decreasing returns to scale. Shaded area is the average of area.

4.1.1 Total Analysis

The results show that the three efficiency scores (crste, vrste and scale) of Beijing, Shanghai, Zhejiang, Jiangsu, Fujian, Guangdong and Yunnan are all 1, being effective DMUs in DEA. In contrast, the pure technical efficiencies of some provinces are high (vrste=1) while the scales of them are inefficient, such as Tianjin, Hainan, Guangxi, Shaanxi, Qinghai, Ningxia, Shanxi, Henan, Liaoning, Heilongjiang, Guizhou and Tibet, named DEA weak efficient DMUs. The rest of the 12 provinces belong to DEA no-efficiency DMUs.

4.1.2 Evaluation of Comprehensive Efficiency (Crste)

The average comprehensive efficiency score of Chinese cultural industries is 0.78. The efficiency value of Beijing, Shanghai, Zhejiang, Jiangsu, Fujian, Guangdong and Yunnan is 1, which shows that the cultural industries structure of these provinces is reasonable and the allocation of resources is appropriate. The cultural industries of these provinces achieve stable and efficient scale returns and they belong to the DEA efficient production frontier. According to the comprehensive efficiency ranking, except for the 7 provinces above, some provinces such as Shanxi, Hubei, Sichuan, Qinghai, Hainan, Guizhou, Shaanxi, Henan and Tibet come out top, while the other provinces not mentioned are below the national average. In terms of regional comparison, the production frontier

is mainly concentrated in the eastern area, while the low efficiencies are mainly located Northeast and West area. Sorting of regional comprehensive efficiency is: East area Φ national average Φ Central area Φ West area Φ Northeast area. (Symbol “ Φ ” means the former is superior to the latter). It’s worth noting that Shandong province has long been regarded as the developed provinces of cultural industries, while the result by output-oriented BCC model shows that the cultural industries efficiency of Shandong province is the lowest. That is to say, Shandong province is far from achieving the maximum output under the existing input. And we also noticed that the comprehensive efficiency of Yunnan province have a only beautiful preponderance in West area.

4.1.3 Evaluation of Pure Technical Efficiency (Vrste)

The national average score of pure technical efficiency is 0.922. Pure technical effective provinces include the 7 DEA efficient DMUs and 12 DEA weak efficient ones mentioned above. The rest 12 provinces of China are pure technologies invalid, most of which are lower than the national average. Sorting of regional pure technical efficiency is: West area Φ East area Φ national average Φ Northeast area Φ Central area.

4.1.4 Evaluation of Scale Efficiency (Scale)

The average score of scale efficiency is 0.846. Except for the 7 DEA efficient provinces, the rest 24 provinces are all scale inefficiency, seven of which are higher than the national average, such as Hebei, Shanxi, Shandong, Hubei, Hunan, Sichuan and Qinghai. Shandong province is in the stage of diminishing returns to scale, which shows that Shandong should consider narrowing the scale of cultural industries. The rest 23 provinces are in the stage of increasing return to scale, which shows that the cultural industries of these areas has the space of further expanding the size. The average scale efficiency is lower than the average pure technical efficiency. That is to say the scale inefficiency is the most important factor that affects China’s cultural industries performance. Sorting of regional scale efficiency is: East area Φ Central area Φ national average Φ West area Φ Northeast area.

4.1.5 The Input Redundancy Ratio and Output Inefficiency Ratio of Non-Efficiency DMUs

In order to study the gap of the DEA non-efficiency provinces to the production frontier, this paper adopts the DEA projection principle to calculate the input redundancy ratio and output inefficiency ratio. The two ratios are respectively the differences between actual scale and target scale. Because this paper focuses on the output-oriented relative efficiency, the output inefficiency ratio is an important part to consider. The calculation results are shown in Table 5.

Table 5. The input redundancy ratio and output inefficiency ratio of DEA non-efficiency DMUs (Note 3)

Region	Score	Input redundancy ratio				Output inefficiency ratio		
		Basic element inputs	Scientific research inputs	Special resources inputs	Tourism resource inputs	Output of cultural Enterprise	Cultural consumption income	Tourist trips
Hebei	0.71	0.0%	0.0%	-81.4%	0.0%	22.9%	22.8%	22.8%
Neimenggu	0.619	0.0%	0.0%	0.0%	-39.8%	16.1%	16.0%	16.1%
Jilin	0.546	0.0%	0.0%	0.0%	0.0%	39.6%	39.6%	39.6%
Anhui	0.575	0.0%	0.0%	0.0%	0.0%	44.0%	43.9%	44.0%
Jiangxi	0.685	0.0%	0.0%	0.0%	-35.7%	13.8%	13.7%	13.8%
Shandong	0.506	0.0%	0.0%	-41.8%	-26.7%	91.9%	91.8%	91.9%
Hubei	0.968	0.0%	-29.0%	0.0%	-80.6%	2.2%	2.3%	2.3%
Hunan	0.624	0.0%	0.0%	0.0%	0.0%	52.3%	52.4%	52.4%
Chongqing	0.571	0.0%	-0.7%	0.0%	0.0%	24.9%	24.9%	24.9%
Sichuan	0.876	0.0%	-45.3%	0.0%	-97.4%	5.4%	5.3%	5.4%
Gansu	0.592	0.0%	0.0%	0.0%	0.0%	16.5%	16.4%	16.5%
Xinjiang	0.715	0.0%	0.0%	-31.1%	-7.3%	16.3%	16.3%	16.2%

Table 5 shows that the 12 DEA non-efficiency provinces are all output deficient. Among them, Shandong, Anhui, Hunan and Jilin provinces are suffering from serious output deficiency. Their output inefficiency ratios of cultural enterprise, cultural consumption income and tourist trips are all over 35%. The key to improving the cultural industry performance is to improve the output level. The basic element inputs of all provinces don’t exist redundancy; the scientific research inputs of Sichuan and Hubei is redundant; the special resources inputs

redundancy rates of Hebei, Shandong and Xinjiang are higher; the tourism resources redundancy rates of Sichuan, Shandong, Hubei, Jiangxi, Xinjiang and Neimenggu are higher. As the results show that the resources have not been fully utilized in the cultural industries. We should focus on digging the characteristics and value of the existing cultural resources thoroughly, improve the efficiency of production and avoid people, capital and material resources being invested on the new resources and blind development. As for the unexplored potential culture resources, we should leave them to the future generations.

4.2 The Result Analysis of Super-Efficiency Model

In order to do further comparison to DEA effective DMUs, this paper analyzes the DMUs of production frontier ($crste=1$) by super efficiency DEA model. We get the super efficiency value of the seven DEA effective provinces by EMS1.3 software.

Table 6. Super efficiency value of DEA efficient provinces (Note 4)

Region	Beijing	Yunnan	Guangdong	Zhejiang	Jiangsu	Shanghai	Fujian
Super efficiency score α	0.0133	0.037	0.229	0.502	0.53	0.645	0.849
Reducible output ($1-\alpha$)	98.67%	97.3%	77.1%	49.8%	47%	35.5%	15.1%
Benchmarking values (Note 5)	22	24	1	1	8	16	16

According to the super efficiency DEA principle, output-oriented super efficiency value is less than 1. And the smaller the super efficiency value (α), the larger the reducible output ($1-\alpha$), meaning the DEA efficiency is higher. For example, it is still effective when the current cultural industries of Beijing reduces by 98.67%. In the seven DEA provinces, the efficiency ranking is Beijing, Yunnan, Guangdong, Zhejiang, Jiangsu, Shanghai and Fujian. Beijing is the national political, economic and cultural center, which has a unique advantage to develop the cultural industries. The output efficiency of Yunnan is higher in the cultural industry, owing to the development of tourism industry by the unique local natural and cultural resources. The cultural industries output efficiency of Guangdong is higher than other places, which mainly originates from the cultural consumption brought by comprehensive economic strength.

5. Conclusions and Suggestions

Firstly, performance of the cultural industries is not optimistic in China. There are only seven DEA effective provinces in this country, and most of them concentrate in the eastern region. Central and western regions are lower in the comprehensive efficiency, and the Northeast region are the lowest.

Second, the average value of pure technical efficiency is larger than that of scale efficiency. 19 provinces are pure technology effective. Pure technical efficiency is the highest in the west of China and the lowest in the central region.

Third, the scale non-efficiency is the most important factors that affect China's cultural industries performance. Shandong province is in the stage of diminishing returns to scale and the rest provinces are in the stage of increasing return to scale. Scale efficiency is best in the east region and worst in the northeast area.

Fourth, DEA non-efficiency provinces all have output deficiency in the cultural enterprise, cultural consumption income and tourist trips. That shows the public output and the enterprise output are all deficient under the present resource condition.

Fifth, input redundancy mainly reflects in the scientific research inputs, tourism resource inputs and special resources inputs, which means the resources of cultural industries have not been fully utilized in the development.

Sixth, even among the DEA efficient provinces, the cultural industry performances are quite different as well. The top three of super DEA efficiency are Beijing Yunnan and Guangdong.

In view of the situation in China, the provinces should take corresponding measures according to their own situation to improve their input-output efficiency of cultural industries. Firstly, the provinces which are in the stage of increasing return to scale should try to expand the scale of the industry and improve the efficiency of scale. Secondly, the DEA non-efficiency provinces should pay more attention to expanding the output on the base of completely digging and utilizing the present resources rather than the blind investment and development. Thirdly, the northeast and central regions of China should expedite technological innovation and scientific transformation of cultural industries, and improve the efficiency of industrial technology, while the northeast and west regions should expand the scale of cultural industries.

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Notes

Note 1. According to the basic principles of production performance, for the purpose of improving the production efficiency, we should obtain the largest output with the smallest input as much as possible. The province with high efficiency in cultural industry has smaller input while larger output, and vice versa. Therefore, it is convenient to contrast to mark out the minimum input and maximum output of each province.

Note 2. We take each extraction factor variance of cumulative variance proportion as weights, and weight the factor scores. Thus we get the comprehensive scores.

Note 3. Table 5 only lists pure technical inefficiency provinces. The rest 19 provinces are not on the list. Because their pure technology are effective, and the input redundancy ratio and output inefficiency ratio are 0.

Note 4. As for the DEA non-efficiency provinces, the value of super efficiency scores is the same with that under the BCC model. Thus they are not on the list.

Note 5. Benchmarking value means the number of other provinces taken this province as a benchmark. Such as 22 in table means there are 22 provinces if taking Beijing as the benchmark.

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