CSCanada
Management Science and Engineering
Vol. 6, No. 3, 2012, pp. 22-25
DOI:10.3968/j.mse.1913035X20120603.1893

ISSN 1913-0341 [Print]
ISSN 1913-035X [Online]
www.cscanada.net
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Research on the Operating Efficiency of Listed Companies in the Crafts Industries -- Based on DEA

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Received 25 May 2012; accepted 9 September 2012

Abstract
Using DEA method, this paper mainly researches on the operating efficiency of the 18 Chinese crafts listed companies which are as decision making units (DMU). The net profit, gross income, total assets, the total cost, current assets, the number of employees are thought to input and output variables. Combining with the data results, this essay analyzes currently enterprises' operating efficiency of Chinese crafts industries, which provide references for their development.

Key words: The crafts industries; Listed companies; DEA; Operating efficiency

LI Qingdong, CUI Zhixin (2012). Research on the Operating Efficiency of Listed Companies in the Crafts Industries -- Based on DEA. *Management Science and Engineering*, *6*(3), 22-25. Available from http://www.cscanada.net/index.php/mse/article/view/j.mse.1913035X20120603.1893 DOI: http://dx.doi.org/10.3968/j.mse.1913035X20120603.1893

In recent years, with the rapid development of economy, China has made a lot of progress in the crafts industries, which has became one of the world's largest countries about producing and exporting crafts. However, the market demand changes rapidly in the crafts industries. It is a personalized industry, meanwhile, the product life cycle is short. Those characteristics cause the risk of the Chinese craft industries to increase. How to promote operational efficiency of Chinese crafts enterprises and long-term development of the enterprise, which are worth the focus of attention.

In Chinese craft industries, the listed companies accounted for larger proportion of the whole industries, therefore, this article selects data of the crafts industries listed company by June 30, 2012. Using the DEA method, it analyzes the operating efficiency of crafts listed companies.

1. THE BASIC PRINCIPLE AND MODEL SELECTION OF DEA

Data Envelopment Analysis (DEA for short) was brought up in 1978 by A. Charnes and W.W.Cooper *et al.*, the famous operations researchers, which is an evaluation method for efficiency of multiple inputs and multiple outputs based on the concept of relative efficiency (WEI, 2004). Specifically, by using the mathematical programming models, it gets data results about relative efficiency comparisons among Decision Making Units (DMU for short). It can construct data frontier: on the frontier of DMU values to 1 is a valid; in the frontier of DMU values between 0 and 1 is invalid. This paper uses the C^2R model to evaluate the technological efficiency and scale efficiency of the DMU.

Suppose there are n DMU; each DMU has m kinds of input (consuming resources) and s kinds of output (the effectiveness of the work); $X_{ij} = (x_{1j}, x_{2j}, \ldots, x_{mj})^T$ represents jth (j = 1, 2, ..., n) DMU comparison against ith (i = 1, 2, ..., m) kinds of inputs, meanwhile, $Y_{rj} = (y_{1j}, y_{2j}, \ldots, y_s)^T$ represents jth (j = 1, 2, ..., n) DMU comparison against rth (r = 1, 2, ..., s) kinds of outputs (YANG, 2001). On the premise of keeping at least DMU output, it devotes minimal resources. Its concrete model as follows:

$$\min[\theta - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)]$$

$$s.t.\begin{cases}\sum_{j=1}^{n} x_{ij}\lambda_j + S_i^- = \theta x_{ij}, i = (1,2,...,m)\\ \sum_{j=1}^{n} y_{rj}\lambda_j - S_r^+ = \theta y_{rj}, r = (1,2,...,s)\\ \theta, \lambda_j, S_i^-, S_r^+ \geq 0\\ j = (1,2,...,n)\end{cases}$$

Among them, θ represents relative efficiency; S_i^- and S_r^+ represent slack variables; ε represents non-Archimedean infinitesimal. Using this model, we can tell whether effective DMU. Suppose θ^*, λ^*, S^{-*}, S^{+*} are the optimal solution in C^2R model, it can be as follows: If meet $\theta^* = 1$, then DMU is weak DEA efficient; If $\theta^* = 1$, $S^{-*} = 0$, $S^{+*} = 0$, then DMU is DEA efficient; If $\theta^* < 1$, $S^{-*} \neq 0$, $S^{+*} \neq 0$, then DMU is non-DEA effective (CHENG & Quan, 2010).

Using the optimal solution of C^2R model, it can judge the changing conditions of return to scale of DMU:

If $\frac{1}{\theta}\sum_{j=1}^{n}\lambda_j = 1$, then it is constant returns to scale;

If $\frac{1}{\theta}\sum_{j=1}^{n}\lambda_j > 1$, then it is decreasing return to scale;

If $\frac{1}{\theta}\sum_{j=1}^{n}\lambda_j < 1$, then it is increasing returns to scale (Charnes, Cooper, & Rhodes, 1978).

2. EMPIRICAL RESEARCHES

2.1 Selection of DMU and Index

This paper researches on the operating efficiency of 18 Chinese listed companies in the crafts industries which are as DMU (see Table 1). Considering situation of Chinese crafts industries and the acquired possibility of data, it selects the concrete input indexes which include total assets, the total cost, current assets and the number of employees, and output indexes which include the net profit and gross income.

Table 1
The Crafts Companies' Original Data of Input and Output

Company	Net profit	Gross income	Total assets	Total cost	Current assets	The number of employees
MEI HUA SAN	212	2.00	6.20	1.98	2.83	1654.00
LAO FENG XIANG	21900	72.10	79.00	69.90	68.00	2510.00
GAO LE WAN JU	1629	0.83	12.20	0.67	8.19	898.00
HA ER SI	2343	2.31	6.34	2.08	5.04	1302.00
DONG FANG JIN YU	10171	16.73	30.30	15.70	26.20	392.00
ZHU JIANG GANG QIN	8653	6.22	20.60	5.39	15.50	1728.00
QING DAO JIN WANG	2065	5.60	12.20	5.39	9.60	1019.00
XIONG MAO YAN HUA	1525	1.05	5.15	0.89	3.02	254.00
RUI BEI KA	10300	11.30	39.80	10.30	31.80	11659.00
MING PAI ZHU BAO	4660	37.70	41.40	37.20	40.30	1065.00
XING HUI CHE MO	1613	1.09	9.55	0.93	4.11	1452.00
HUA WEI GU FEN	636.00	0.70	8.66	0.63	7.34	1272.00
FEI YA DA	3507.00	7.39	31.80	7.04	23.60	4400.00
XIN HAI GU FEN	4007.00	2.32	10.40	1.92	5.30	4698.00
HAI LUN GANG QIN	741.00	0.72	3.89	0.64	2.44	931.00
CHAO HONG JI	8260.00	8.30	17.90	7.47	14.80	3573.00
GUANG BO GU FEN	424.00	2.12	11.50	2.08	6.13	3487.00
QUN XIN WAN JU	1395.00	1.09	8.90	0.96	7.32	1262.00

Note: Net profit's monetary unit is million Yuan; Gross income, total cost, current assets, the number of employees' monetary units are one hundred million Yuan; the number of employees' unit is people.
Source: data.eastmoney.com

2.2 Solving and Analysis the Model

Using Deap 2.1 software, it processes sample data base on DEA model (see Table 2).

Table 2
The Companies' DEA Evaluation Results

DMU	CRSTE	VRSTE	SCALE	SE
MEI HUA SAN	0.938	1.000	0.938	irs
LAO FENG XIANG	1.000	1.000	1.000	-
GAO LE WAN JU	1.000	1.000	1.000	-
HA ER SI	0.982	1.000	0.982	irs
DONG FANG JIN YU	1.000	1.000	1.000	-
ZHU JIANG GANG QIN	1.000	1.000	1.000	-
QING DAO JIN WANG	0.957	0.961	0.996	irs

To be continued

Continued

DMU	CRSTE	VRSTE	SCALE	SE
XIONG MAO YAN HUA	1.000	1.000	1.000	-
RUI BEI KA	0.948	1.000	0.948	drs
MING PAI ZHU BAO	1.000	1.000	1.000	-
XING HUI CHE MO	0.974	0.984	0.989	irs
HUA WEI GU FEN	0.905	1.000	0.905	irs
FEI YA DA	0.899	0.926	0.970	drs
XIN HAI GU FEN	1.000	1.000	1.000	-
HAI LUN GANG QIN	0.940	1.000	0.940	irs
CHAO HONG JI	1.000	1.000	1.000	-
GUANG BO GU FEN	0.852	0.854	0.998	drs
QUN XIN WAN JU	0.941	0.944	0.997	irs

Note: CRSTE signifies comprehensive technical efficiency; VRSTE signifies pure technical efficiency; SCALE signifies scale efficiency; SE signifies changing conditions of economical scale; irs signifies increasing returns to scale; drs signifies decreasing return to scale; - signifies constant returns to scale.

2.2.1 Analysis on Comprehensive Technical Efficiency (CRSTE)

According to the calculated results of Table 2, we can see that there is eight companies' comprehensive technical efficiency to reach the DEA efficient in 18 listed companies. Thereinto, eight companies include LAO FENG XIANG, GAO LE WAN JU, DONG FANG JIN YU, ZHU JIANG GANG QIN, XIONG MAO YAN HUA, MING PAI ZHU BAO, XIN HAI GU FEN and CHAO HONG JI, which reach the ideal state in the crafts industries, that is to say, enterprises get the maximum output with a minimum of input. Those companies account for 44.44% of the 18 listed companies in the aspect of efficient frontier of the comprehensive technical efficiency. In conclusion, we can see that the whole crafts industries are not efficient, because of short developing time, low level of the technological innovation and small scale.

2.2.2 Analysis on Pure Technical Efficiency (VRSTE)

Pure technical efficiency refers to the enterprises' production efficiency due to the factors of management and technical. In Table 2, in addition to the above 8 companies, there are 5 listed companies to reach 1 in pure technical efficiency, which include MEI HUA SAN, BEI RUI KA, HUA WEI GU FEN and HAI LUN GANG QIN. In terms of pure technical efficiency, 13 companies account for 72.22% of the total amount, which indicate that relative input of crafts industries is more excellent in pure technical efficiency. That is, these listed companies' potential get better exertion in aspect of internal management and technique efficiency.

2.2.3 Analysis on Scale Efficiency (SCALE)

Scale efficiency refers to the enterprises' production efficiency due to the factors of scale. As seen from the Table 2, 8 companies' efficiency value falls on efficient production front surface, which are LAO FENG XIANG, GAO LE WAN JU, DONG FANG JIN YU, ZHU JIANG GANG QIN, XIONG MAO YAN HUA, MING PAI ZHU BAO, XIN HAI GU FEN, and CHAO HONG JI. Meanwhile, these enterprises' scale efficiency reaches to maximize, keeping existing investment scale.

Because the production scale input of enterprises which are RUI BEI KA, FEI YA DA and GUANG BO GU FEN is very big, they do not achieve ideal output. RUI BEI KA Company does not attain on the superior in scale efficiency, however, it achieves ideal in the technique efficiency. So it just to reduce the scale of enterprise invests. However, FEI YA DA and GUANG BO GU FEN companies are not fall on the efficient production front surface in scale and technical benefits. If they want to improve this question, enterprises have to reduce the production scale and to improve level of technical.

MEI HUA SAN, HA ER SI, HUA WEI GU FEN and HAI LUN GANG QIN companies do not get the most optimum in scale benefits, but its technical efficiency can be given full play. If enterprises want to improve scale efficiency, they only need to expand the scale of input. However, QING DAO JIN WANG, XING HUI CHE MO and QUN XING WAN JU companies do not have a good development in aspect of scale efficiency and technique efficiency. Thus, enterprises should seek increase of investment and the developmental way of technical innovation.

2.2.4 Target Improvement Analysis

According to the C^2R model, it seeks "cast shadow" of efficient production front surface for non-DEA efficient listed companies. Those enterprises can achieve effective adjustment from non-DEA to effective DEA through the data sample point (Charnes, Cooper, & Golary, 1985). Taking GUANG BO GU FEN Company for example, its analysis is as follows. Hereinto, its relative efficiency value is 0.852. From the side of input, $S_1^- = 0.487$ indicates input of resources too many, so it needs to reduce investment in the original basis. Based on DEA projection analysis, we can adjust the original input value: namely, the total assets reduces to 9.335; the total cost reduces to 1.776; current assets reduces to 5.235; employs cutting to 2978.005. From the side of output, $S_1^+ = 3014.146$ indicates that the output is not enough. Net profit of company adds to 3438.146 (see Table 3).

Table 3
The Results of DEA Projection of GUANG BO GU FEN Company

Name	Net profit	Gross income	Total assets	Total cost	Current assets	The number of employees
Original data	424.00	2.12	11.50	2.08	6.13	3487.00
Projection data	3438.146	2.12	9.335	1.776	5.235	2978.005

We can get the adjustment range about input and output from Table 3 as follow: Adjustment range of Net profit is 710.88%; Adjustment range of Gross income is 0.00%; Adjustment range of Total assets is -18.83%; Adjustment range of Total cost is -14.62; Adjustment range of Current assets is -14.6; Adjustment range of the number of employees is -14.597%.

According to the above, QING DAO JIN WANG, XING HUI CHE MO, FEI YA DA and QUN XIN WAN JU companies, in addition to GUANG BO GU FEN Company, will also refer to this method to adjust, and the concrete value such as shown in Table 4.

Table 4
Target Improvement Value of Non-DEA Efficient Listed Companies

DMU	Adjusted output		Adjusted input			
	Net profit	Gross income	Total assets	Total cost	Current assets	The number of employees
QING DAO JIN WANG	4133.408	5.600	11.723	5.179	9.011	979.167
XING HUI CHE MO	1694.642	1.090	6.679	0.915	4.045	636.165
FEI YA DA	9032.329	7.390	25.022	6.521	19.254	4015.258
GUANG BO GU FEN	3438.146	2.120	9.335	1.776	5.235	2978.005
QUN XIN WAN JU	1810.259	1.090	8.402	0.906	5.250	942.301

CONCLUSIONS

The crafts industries have high demand for individuation and vogue. Currently, these problems we are facing are innovation and counterfeiting of products. Through empirical study of the Chinese crafts listed companies' operating management efficiency, the following conclusions can be drawn:

(1) Using C^2R model, we analyze the 18 crafts companies' efficiency to get the following conclusions: LAO FENG XIANG, GAO LE WAN JU, DONG FANG JIN YU, ZHU JIANG GANG QIN, XIONG MAO YAN HUA, MING PAI ZHU BAO, XIN HAI GU FEN and CHAO HONG JI companies are the most ideal state of input and output; RUI BEI KA, FEI YA DA and GUANG BO GU FEN *et al.* lie in the interval decreasing return to scale; The rest of the seven companies lie in interval of increasing returns to scale. If investment scale of companies is increasing, its performance will also increase.

(2) Crafts market is generally the low efficiency and unbalanced development. If they want to make the enterprise to keep steady development in the market, we need to constantly adapt to changes of market macroscopic environment. More important, enterprises require its internal potential to obtain the very good development. And they improve management and technical efficiency continuously. The main reasons for the lower operating efficiency are the imperfect mechanism, loose management, idle assets, the excessive costs and other issues. For projection analysis of non-DEA listed companies, those provide references for improvement of operational efficiency and management efficiency.

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