DEA-Based Operational Efficiency Empirical Study for China's Listed Construction Firms with the Belt and Road Initiative

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Abstract

The "Belt and Road Initiative" is and will continue to be an overall strategy of China's all round open-ing-up for a long time into the future. It is the way China reaches out to the world, brings the new challenges to the listed construction enterprises which are becoming more aware of the significance to improve the operational efficiency and management style. Aiming at the problems, with the characteristics of the listed construction enterprises into consideration, through the enterprises management knowledge and DEA method, the appropriate decision- making unit (DMU) is screened, and also acorresponding input and output indicator is established. Then the aggressive cross-evaluation C^2R-DEAmodel avoiding the faults of traditional DEA is used to evaluate DEA for operational efficiency of the listed construction firms chosen the samples in China during 2012 to 2014 years in order to provide relevant decisions and references. Analyzing the differences among the listed construction firms and ranking, it is concluded that the efficiency of a few is low relatively level. It is more accuracy and objective that domestic listed construction firms to evaluate their operational efficiency and relative competitiveness through comparing the variations in value. It is concluded the influence of the "Belt and Road Initiative".

Keywords: LISTED CONSTRUCTION FIRMS, DEA, OPERATIONAL EFFICIENCY, EMPIRICAL STUDY, THE BELT AND ROAD INITIATIVE

Introduction

According to development plan of transportation "Twelfth Five Year Plan", at the end of "twelfth five-year plan", the total mileage of the traffic engineering construction in china will reach 108000 kilometers, that will cover 90% of the cities with more than 200000 population. The cost of fixed-asset completed investment in term of transportation construction projects saw a considerable increase, rising form 1.451249 trillion in 2012 to about 2.5 trillion in 2014. It reflects that construction field plays an important role in China. On the other hand, the building of the "Belt and Road" has become a long term national strategy for China, which will have great impacts on the China's construction field development. With the layout of "Belt and Road Initiative", the construction field is still the prime driver of national economic and social development. The research of the operational efficiency is beneficial to evaluate themselves and relative competitiveness more accuracy and objective for domestic listed construction firms and promote the healthy development of the construction field.

In the late 1960s, with the construction projects being drawn the attention gradually, operating efficiency of the construction companies also has become the research focus in the theoretical and practical circles at the same time. Although there are a variety of literatures discussing the different models to be used to evaluate operational efficiency of the construction companies, the gap between the actual data and the evaluation results is significant. Constant scale return of CCR model (Chames[1], et al 1978) cannot effectively distinguish between the pros and cons of the decision units. Goal programming model

(Athanassopoulos[2] 1995) use the expected value instead of the approximate value. There are Bootstrap model (Simar and Wilson[3] 1998), improved DEA model (Barros and Peypoch[4] 2009) and so on.

Evaluation model

A.Charnel and W. W.Cooper first introduced the concept of DEA (Data Envelopment Analysis), based on "relative efficiency evaluation". A basic evaluation process main consists of the following steps[5]:

1. The decision- making unit isexpressed as (j=1,2,…, n), traditionalCCR modelis obtained as follows:

$$\max\ y_i^T u = E_{ii}$$

$$\text{s.t. } y_i^T u \le x_j^T v\ (1 \le j \le n),\ x_i^T v = 1,\quad u \ge 0,\ v \ge 0 \qquad (1)$$

where X_j=input, Y_i=output, E_{ii}=self – evaluation value of DMU_j. If E_{ii}=1, DMUi is effective, while if the E_{jj}< 1,DMU_jwill be called not effective.

2. Using the Eq.(1), let us calculate the linear programming optimal solution su_i* and v_j * . Based on the cross-evaluationidea,cross-evaluationvalue (E_{ik}) can be calculated as.

$$E_{ik} = \frac{y_k^T u_i^*}{x_k^T v_i^*} \qquad (2)$$

According to the Eq.(2), with E_{ik} increasing, DMU_k is moreoptimal but DMU_j is reverse.

3. Using the Eq.(2), the cross-evaluationvalue E_{ik} be calculated, then the cross-evaluationmatrix format can be written as:

$$E=\begin{bmatrix} E_{11} & E_{12} & \cdots & E_{1n} \\ E_{21} & E_{22} & & E_{2n} \\ \vdots & & \ddots & \vdots \\ E_{n1} & E_{n2} & \cdots & E_{nn} \end{bmatrix}$$

In this paper, average of each line ofthe cross-evaluationmatrixis used to represent every decision-making units' evaluations. Let aaverage number be parameterized bye, given by thefollowing equation:

$$e=\frac{1}{n}\sum_{k=1}^{n} E_{ki} \qquad (3)$$

According to the Eq.(3), with e_i increasing, DMU_i is moreoptimal.

The Empirical Analysis

Based on the aggressive cross-evaluation idea, to establish acorresponding input and output indicator system[6] that can objectively reflect he quantitative change of operating efficiency, the principle of scientific and operability is followed in this paper. Then the cross-evaluation C^2R-DEAmodelcombining the characteristics of the evaluation method (DEA)is used to analysis empirical operational efficiency of the listed construction firms chosen the samples in China during 2012 to 2014 years .Input and output indicators and relevant data are shown in Table. 1

The Results Analysis

Analyzing the differences amongthe listed construction firms and ranking, it is concluded that the efficiency of a few is lowrelatively level. According to thecross-evaluation C^2R-DEAmodel then the cross-evaluationmatrix (E_{2014})in 2014 can be written as:

$$E_{2014}\ [:::]$$

According to the matrix $E_{2014}$the self – evaluation vectors $\overline{E_{2014ii}}$ is obtained as follows:

$$\overline{E_{2014ii}} = (E_{11}\ E_{22}\ E_{33}\ E_{44}\ E_{55}\ E_{66}\ E_{77}\ E_{88}\ E_{99}\ E_{10}) =$$

=(1.00 1.000.99 1.00 0.94 0.870.980.97 1.00 1.00)

Using the Eq.(3), for averaging as explained in the previous section, aaverageself – evaluation vector $\bar{e}$ can generally be represented as:

$$\bar{e} = (e_1\ e_2\ e_3\ e_4\ e_5\ e_6\ e_7\ e_8\ e_9\ e_{10}) =$$

=(0.4661 0.6090 0.5246 0.5708 0.4855 0.4815 0.4995 0.46510.6003 0.6844)

As e_i (i=1,2…10) is used to evaluate theoperationalefficiency, the listed construction firms chosen the samples can be ranked according to e_i from big to small.

Similarly, the the cross-evaluationmatrix in 2013 (E_{2013}) and in 2012 (E_{2012}) be calculated.

Table 2 shows the listed construction firms with their corresponding self – evaluation value and average self – evaluation valuecalculated by the model to be used for the operational efficiencyevaluation of the listed construction firms from 2012 to 2014.

Fig. 1 shows a comparison of tenlisted construction firms having different average self – evaluation value during three years. Analysisingthe data in table 2 and the trends in figure 1, the results can be found that:

(1). Luqiao Chongqing, Yunnan City Investment, Luqiao Chengdu, Longjian shares and Tianjian group have kept self-evaluation value (E_{ii}) reach the maximum. It explains that enterprise competitiveness of the formers is more than that of others and theoperation of themost listed company is stable and in the best station. However self-evaluation valueof some construction firms including Hongrun construction, Xinjiang urban construction and Beixin Luqiaostill

Table 1.indicators and relevant data of the listed construction firms

			Input indictor (Billion yuan)				Output indictor		
		year	total assets	fixed assets	Cash flow from operating activities	Operating costs	Operating income (Billion yuan)	Basic earning per share (yuan/ shares)	Weighted average return on equity (%)
1	Luqiao, Chongqing	2012	53.7	3.96	2.29	0.4	3.2	0.26	11.82
		2013	63.5	3.54	2.54	0.4	3.4	0.30	12.74
		2014	63.0	3.40	2.81	0.3	3.4	0.27	8.76
2	Yunnan City Investment	2012	222.0	0.23	-18.00	2.6	3.5	0.27	6.27
		2013	242.0	2.97	-17.30	19.9	29.6	0.39	8.64
		2014	335.0	3.31	-25.7	23.7	39.5	0.54	11.12
3	Hongrun construction	2012	113.0	5.44	-3.25	61.4	68.2	0.23	6.80
		2013	125.0	6.03	0.35	69.7	78.6	0.32	8.98
		2014	139.0	11.70	-2.93	70.1	79.7	0.26	9.51
4	Luqiao, Chengdu	2012	52.3	1.21	-7.02	33.6	39.4	0.78	17.46
		2013	79.1	1.01	-4.24	36.3	42.7	0.48	15.53
		2014	63.0	0.82	-0.18	12.6	15.0	0.19	5.33
5	Tengda construction	2012	47.6	3.44	-3.20	11.7	13.7	0.03	1.91
		2013	55.4	1.41	-0.36	15.8	18.5	0.20	13.51
		2014	56.6	1.34	0.07	26.0	29.1	0.03	2.06
6	Pudong construction	2012	151.0	3.18	0.14	6.22	12.1	0.72	13.11
		2013	159.0	2.70	2.38	27.3	38.3	0.75	11.73
		2014	149.0	2.53	2.48	32.7	37.7	0.51	7.30
7	Xinjiang urban construction	2012	70.7	7.46	-1.21	22.1	25.9	0.23	8.29
		2013	84.3	5.54	0.23	39.8	44.4	0.26	8.83
		2014	95.8	4.70	2.41	49.7	56.7	0.14	4.65
8	Beixin Luqiao	2012	64.4	6.52	-5.62	30.5	34.9	0.09	3.16
		2013	85.4	7.11	-3.59	43.8	50.1	0.06	1.93
		2014	100.0	6.82	3.31	51.6	58.1	0.05	2.32
9	Longjian shares	2012	61.1	3.38	-14.9	60.1	65.0	0.03	2.33
		2013	70.2	3.00	0.14	52.1	56.5	0.03	2.21
		2014	68.4	2.90	-4.05	51.2	55.7	0.03	2.29
10	Tianjian group	2012	85.8	1.47	6.51	23.9	30.8	0.50	7.88
		2013	97.9	2.39	5.53	34.4	45.1	0.68	10.76
		2014	110.0	1.91	3.51	42.3	53.0	0.76	11.87

Table 2. Evaluation for operational efficiency of the listed construction firms

		2012			2013			2014		
		rank	self – evaluation value (E_{ii})	average self–evaluation value (e_i)	rank	self – evaluation value (E_{ii})	average self– evaluation value (e_i)	rank	self– evaluation value (E_{ii})	average self– evaluation value (e_i)
1	Luqiao, Chongqing	3	1.00	0.55	10	1.00	0.32	9	1.00	0.47
2	Yunnan City Investment	10	1.00	0.41	7	1.00	0.40	2	1.00	0.61
3	Hongrun construction	7	0.93	0.44	5	0.99	0.43	5	0.99	0.52
4	Luqiao, Chengdu	1	1.00	0.62	1	1.00	0.68	4	1.00	0.57
5	Tengda construction	9	0.95	0.42	3	1.00	0.51	7	0.94	0.49
6	Pudong construction	4	1.00	0.52	4	1.00	0.47	8	0.87	0.48
7	Xinjiang urban construction	8	0.93	0.43	8	0.94	0.40	6	0.98	0.50
8	Beixin Luqiao	6	0.95	0.47	9	0.99	0.36	10	0.97	0.47
9	Longjian shares	2	1.00	0.56	6	1.00	0.41	3	1.00	0.60
10	Tianjian group	5	1.00	0.51	2	1.00	0.55	1	1.00	0.68

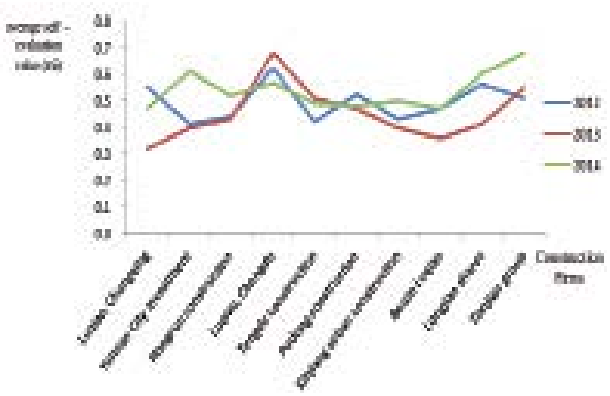

Figure 1. Comparison chart of operational efficiency of the listed construction firms

have been less than 1 during three years. It shows that their operations are not at their best and need to improve.

(2).Due to"Belt and Road Initiative", there have been rising trends of the rank for the listed construction emprises which are located on the west area such as Yunnan City Investment, Xinjiang urban construction, while rank of the eastern construction firms is decreasing since 2013 . With the strategic layout of "Belt and Road Initiative", it is possiblethat the resources of the construction field can be reallocated transferring from coastal regions to inland. What is more,the "Belt and Road Initiative" will provide more economichinterland for the coastal areas' industrial structure upgrading and economic development, which will strengthenthe coastal areas' international competitiveness[7].

Conclusion

This paper uses the aggressive cross-evaluation C^2R-DEA model to evaluate operationalefficiency-of10 listed construction firms chosen the samples in China during 2012 to 2014 years, verifying this evaluation method is more accurately than the traditional DEA method in terms of measuring the operational efficiency.With the background of "Belt and Road Initiative", the level of operating efficiency in overall construction industry is climbingwith strong market competitiveness, especially the firms located on the influencing direction of the former policy.At the same time, some companies have reached the optimal scale benefit, so there is no need to expend the scale avoiding waste.

However, this paper just researches from the prespective of operational efficiency, while the technical efficiency, cost efficiency etc should be further studied. In addition, this paper did not remove uncontrolled factors in the study process such as the environmental impact on the efficiency.

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