Analysis of Competitive Advantage of Construction Firms

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Abstract

This paper is aimed to investigate the operational efficiency of 16 listed/marketed construction companies in Taiwan during 2012-2016 after the Asian economic crisis in 2008. We discover the determinant of competitive advantage of construction companies in Taiwan in that period. Data envelopment analysis (DEA) is adopted to evaluate the productivity efficiency of construction companies in Taiwan. 170 decision making units (DMU) of 16 companies in 5 years are considered. DEA is a model with multiple inputs and outputs in calculating the technical efficiency of construction companies in Taiwan. The average of technical efficiency is 0.726. The average of pure technical efficiency is 0.883. The average of scale efficiency is 0.828. All these numbers imply the companies in construction industry are in good operation conditions after economic crisis in 2008. A further analysis with Du-Pond analysis and Tobin Q is used to investigate short term and long-term competitive advantage of construction companies with best technical efficiency in the industry. This analysis enables the analyst to understand the source of superior (or inferior) return by comparison with companies in similar industries. In the Tobin Q analysis, we discover that financial leverage is the critical determinant of competitive advantage of construction firms in construction industry in Taiwan after the Asian economic crisis in 2008.

Keywords: Tobin Q analysis, data envelopment analysis, Asian economic crisis, Du-Pond analysis.

INTRODUCTION

A fundamental requirement in applying operations research models is the identification of a "utility function" which combines all variables relevant to a decision problem into a single variable which is to be optimized. Underlying the concept of a utility function is the view that it should represent the decision-maker's perceptions of the relative importance of the variables involved rather than being regarded as uniform across all decision-makers or externally imposed. The problem, of course, is that the resulting utility functions may bear no relationship to each other and it is therefore difficult to make comparisons from one decision context to another. Indeed, not only may it not be possible to compare two different decision-makers but it may not be possible to compare the utility functions of a single decision-maker from one context to another.

A traditional way to combine variables in a utility function is to use a cost/effectiveness ratio, called an "efficiency" measure. It measures utility by the "cost per unit produced". On the surface, that would appear to make comparison between two contexts possible by comparing the two cost/effectiveness ratios. The problem, though, is that two different decision-makers may place different emphases on the two variables. It also must be recognized that effectiveness will usually entail consideration of a number of products and services and costs a number of sources of costs. Cost/effectiveness measurement requires combining the

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sources of cost into a single measure of cost and the products and services into a single measure of effectiveness.

Again, the problem of different emphases of importance must be recognized. This is especially the case for the several measures of effectiveness. But it may also be the case with the several measures of costs, since some costs may be regarded as more important than others even though they may all be measured in dollars. When some costs cannot be measured in dollars, the problem is compounded. More generally, instead of costs and effectiveness, the variables may be identified as "input" and "output". The efficiency ratio is then no long characterized as cost/effectiveness but as "output/input", but the issues identified above are the same. Data Envelopment Analysis (DEA) measures the relative efficiencies of organizations with multiple inputs and multiple outputs. The organizations are called the decision-making units, or DMUs.

DEA assigns weights to the inputs and outputs of a DMU that give it the best possible efficiency. It thus arrives at a weighting of the relative importance of the input and output variables that reflects the emphasis that appears to have been placed on them for that particular DMU. At the same time, though, DEA then gives all the other DMUs the same weights and compares the resulting efficiencies with that for the DMU of focus.

If the focus DMU looks at least as good as any other DMU, it receives a maximum efficiency score. But if some other DMU looks better than the focus DMU, the weights having been calculated to be most favorable to the focus DMU, then it will receive an efficiency score less than maximum. Thus, there are two possible definitions of efficiency depending on the purpose of the evaluation. One might be interested in possible reduction of inputs (in DEA this is called the input orientation) or augmentation of outputs (the output orientation) in achieving technical efficiency. Depending on the purpose of the evaluation, the analysis provides different sets of peer groups to which to compare.

MODELING

Assume that each DMU has values for a set of inputs and a set of outputs. Choose non-negative weights to be applied to the inputs and outputs for a focus DMU so as to maximize the ratio of weighted outputs divided by weighted inputs But do so subject to the condition that, if the same weights are applied to each of the DMUs (including the focus DMU), the corresponding ratios are not greater than 1Do that for each DMU. The resulting value of the ratio for each DMU is its EDA efficiency. It is 1 if the DMU is efficient and less than 1 if it is not.

Consider the revised form of the input-oriented model:

$$\min \quad \tilde{\theta} = \theta - \varepsilon\,(s_1^+ + s_2^+ + s_1^- + s_2^-)$$

$$\text{s.t.} \sum_{j=1}^{N} \mu_j\, y_{1j} - s_1^+ = y_{1t};$$

$$\sum_{j=1}^{N} \mu_j\, y_{2j} - s_2^+ = y_{2t};$$

$$\sum_{j=1}^{N} \mu_j\, x_{1j} + s_1^- = \theta\, x_{1t};$$

$$\sum_{j=1}^{N} \mu_j\, x_{2j} + s_2^- = \theta\, x_{2t};$$

$$\mu_j \geq 0\,(j = 1, 2, \ldots, N);\, s_1^+, s_2^+, s_1^-, s_2^- \geq 0;\, \phi \text{ free}.$$

The dual of this LP problem is

$$\max \quad p_{1t}\, y_{1t} + p_{2t}\, y_{2t}$$

$$\text{s.t. } p_{it}\, y_{1j} + p_{2t}\, y_{2j} - w_{1t}\, x_{1j} - w_{2t}\, x_{2j} \leq 0;\ (j = 1, 2, \ldots, N);$$

$$w_{1t}\, x_{1t} + w_{2t}\, x_{2t} = 1;$$

$$p_{1t} \geq \varepsilon;\, p_{2t} \geq \varepsilon;\, w_{1t} \geq \varepsilon;\, w_{2t} \geq \varepsilon.$$

The only difference between this problem and its earlier specification is that now we have a lower bound on the shadow prices.

The Du Pont identity breaks down Return on Equity (that is, the returns that investors receive from the firm) into three distinct elements. This analysis enables the analyst to understand the source of superior (or inferior) return by comparison with companies in similar industries (or between industries). The Du Pont identity, however, is less useful for some industries, such as investment banking, that do not use certain concepts or for which the concepts are less meaningful. Variations may be used in certain industries, as long as they also respect the underlying structure of the Du Pont identity. DuPont System of Analysis Objective: Find out why a company's profitability, as measured by ROA and ROE, is higher or lower than the industry average ROA or ROE or last year's company ROA or ROE.

The DuPont system of analysis merges the income statement and balance sheet into two summary measures of profitability: Return on Total Assets (ROA) and Return on Equity (ROE).

The DuPont Equation

ROA = Net Profit Margin on Sales x Total Assets Turnover
ROA = Net Income/Sales x Sales/Total Assets

Extended DuPont Equation

ROE = Net Profit Margin x Total Assets Turnover x Equity Multiplier
ROE = N. I./Sales x Sales/Total Assets x Total Assets/Common Equity

<u>Tobin Q Equation</u>

Q = firm' market value/ firm's replacement value

EMPIRICAL STUDY

16 listed/marketed construction companies in Taiwan during 2012-2016. 170 decision making units (DMU) of 16 companies in 5 years are considered. DEA is a model with multiple inputs and outputs in calculating the technical efficiency of construction companies in Taiwan.

Three inputs are selected, which are total asset, equities, and staff number. Two outputs are considered, which are net revenue and net profit before tax and interest. The ratio of firm net worth over capital is shown in Figure 1.

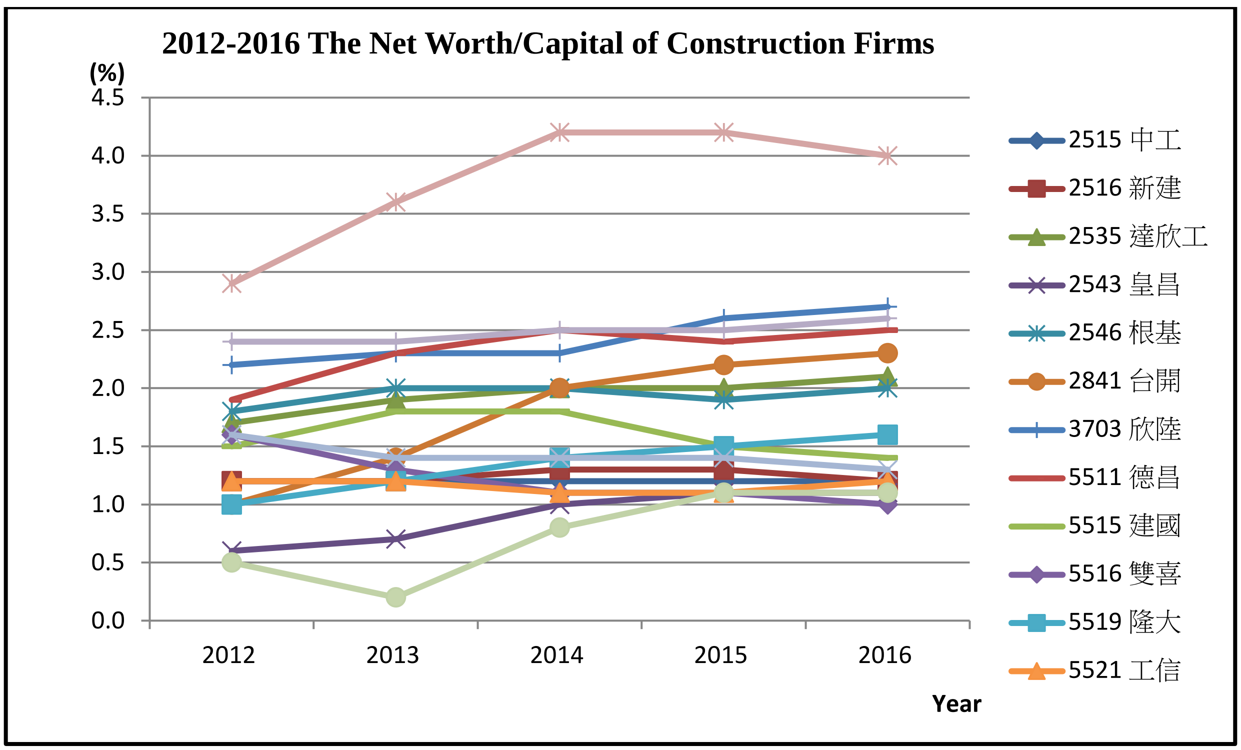

Figure 1 The ratio of Net Worth/Capital of Construction Firms in 2012-2016

Table 1 shows results of DEA analysis.

Table 1 Technical efficiency of DEA analysis

No.	DMU	TE	PTE	SE	RTS		
					IRS	CRS	DRS
1	2515 中工	0.264	0.29	0.91		1	4

2	2516 新建	0.86	0.866	0.993	1	3	1
3	2535 達欣工	0.886	0.965	0.921		3	2
4	2543 皇昌	0.705	0.734	0.96	3	2	
5	2546 根基	0.998	1	0.998	1	4	
6	2597 潤弘	0.748	0.899	0.845	1	2	2
7	2841 台開	0.732	0.862	0.823	1	3	1
8	3703 欣陸	0.812	1	0.812		1	4
9	5511 德昌	0.744	0.874	0.853	2	1	2
10	5515 建國	0.541	0.589	0.927	2	1	2
11	5516 雙喜	0.696	1	0.696	5		
12	5519 隆大	0.907	0.973	0.931		3	2
13	5521 工信	0.45	0.486	0.939	3	2	
14	6122 擎邦	0.584	0.704	0.826	5		
15	6179 亞通	0.771	1	0.771	3	2	
16	9933 中鼎	0.916	1	0.916		1	4
	Average	0.726	0.828	0.883			
	Sum of RTS				27	29	24
	RTS/Total %				33.75%	36.25%	30.00%

The results of Tobin Q analysis is shown in Table 2.

Table 2 Tobin Q of benchmark firms

NO.	Firm	2012	2013	2014	2015	2016	Average
1	2515 中工	0.53	0.55	0.52	0.46	0.47	0.51
2	2516 新建	0.32	0.38	0.39	0.41	0.44	0.39
3	2535 達欣工	0.55	0.68	0.65	0.53	0.54	0.59
4	2543 皇昌	0.41	0.49	0.63	0.44	0.51	0.5
5	2546 根基	0.32	0.39	0.38	0.32	0.33	0.35
6	2841 台開	0.78	0.66	0.56	0.55	0.59	0.63
7	3703 欣陸	0.59	0.58	0.55	0.51	0.53	0.55
8	5511 德昌	0.71	0.49	0.64	0.63	0.51	0.6
9	5515 建國	0.71	0.6	0.54	0.48	0.47	0.56
10	5516 雙喜	0.61	0.62	0.67	0.59	0.48	0.59
11	5519 隆大	1.19	1.2	0.99	0.8	0.7	0.98
12	5521 工信	0.63	0.79	0.75	0.68	0.67	0.7
13	6122 擎邦	0.53	0.54	0.71	0.47	0.63	0.58
14	2597 潤弘	0.76	0.85	0.86	0.62	0.63	0.74
15	6179 亞通	0.88	3.46	2.33	1.86	1.8	2.07
16	9933 中鼎	0.89	0.84	0.73	0.57	0.63	0.73
	Average	0.65	0.82	0.74	0.62	0.62	0.69

CONCLUSIONS

This study is based on the construction of 16 listed companies who TPEX-listed from 2012 to 2016, and analyzes the firms scale. After the DEA analysis, we analyze the construction firms with financial and profitability index to find the competitive advantage of the best firms, which can be the example to follower to learn.

The first section is to apply the data-envelop-analysis (DEA) method to analyze the construction industry technical efficiency and scale efficiency in construction industry. The results showed that the average total efficiency of the five years was 0.726, the pure technical efficiency was 0.828, and the scale efficiency was 0.883.

The second stage is to use the financial ratio analysis by their own capital rate, liquidity ratio, net capital ratio and debt ratio to measure the short-term debt service capacity. The results show that there are 62.5% of the construction industry, in the financial response capacity can meet the construction industry evaluation criteria “level one ".

The third stage uses ROE and Tobin's Q as a measure of long-term competitive advantage indicators. In ROE's study to show there are 37.5%, the five-year average annual salary can reach 8%, indicating that these companies have a long-term competitive advantage.

This study is based on the DEA analysis model and then use the Du-Pond analysis of the short-term solvency of enterprises and Tobin Q long-term competitive advantage. These two analysis is used for listing of Taiwan's construction industry OTC business. The results of the study can be used for other firms in construction industry to study, or for business managers to adjust the business strategy with a view to enhance the competitive advantage of enterprises.

DEA model could provide us an approach to identify the most efficient firm in the construction industry in Taiwan. We find that the operation efficiency of the firms does not have significant relationship with the profitability and size of firms. The construction firm have the tendency to increase their capital from 2012 to 2016.

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