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FORECASTING FINANCIAL INDICATORS AND PROVIDING AN EFFECTIVE SELECTION METHOD FOR SUPPLIERS

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ABSTRACT

The backlight module industry is the upstream of the thin-film-transistor liquid-crystal-display (TFT-LCD) manufacturing. The industry in Taiwan is currently facing a tough competition. This study tries to provide an effective selection method for suppliers by combining the grey prediction, data envelopment analysis (DEA) and heuristic technique. The model starts from DEA concept to find inputs and outputs, and then employs the grey prediction to predict the inputs and outputs which are based on the historic data. The analysis includes DEA to measure the operation efficiency. One of the backlight module companies is chosen to be the target company A. Eight major listed TFT-LCD companies in Taiwan were selected as alternatives for partner selection. The empirical results show that some of eight companies who have better operation efficiency may result in poor efficiency afterwards. Contrarily, some companies with poor operation efficiency have chance to get better. The proposed method can provide good advices for partners' selection.

Keywords: Grey prediction, data envelopment analysis, alliance, supply chain.

INTRODUCTION

The thin-film-transistor liquid-crystal-display (TFT-LCD) is one of Taiwan's main industries for which the government is trying to help to increase the productivity and enhance the competitiveness. According to ITRI (Industrial Technology Research Institute in Taiwan), the revenue of large sized TFT-LCD in Taiwan has reached new Taiwan dollar (NTD) 1,087,300,000 (ITRI, 2014) [1]. Besides, among the large sized TFT-LCD products, Table 1 (Display Search, 2014) shows that the LCD television (TV) has highest growth rate, and the note book personal computer (PC) follows.

The backlight module is one of the key components to provide illumination for the TFT-LCD panel because the liquid crystals used in LCDs are not light-emitting. Besides, comparing with other components, the backlight module is the most expensive one, demand, specification; quality and size are strongly dependent upon the type of TFT-LCD. The backlight module manufacturers are experiencing the difficulties of making profits due to the fact that the material cost of backlight module accounts for 84% of the total cost. Therefore, how to adjust their operational strategies properly has become a very essential subject.

Alliance has been an important research topic since decades ago. Mottner and Smith (2009) argue that relative market power existing between retailers and suppliers [2]. Lin and Yang (2003) apply the grey prediction model to forecast accurately the output value of Taiwan's optoelectronics industry [3]. Wang and Li (2011) use DEA (Tone, 2001) to deal with alliances issues [4, 5]. The results demonstrate that DEA can effectively help to select Partners selection for alliances. However, none of above can solve the issue of finding the proper supplier partners.

The objective of this study is to provide an effective method by combining the grey prediction, DEA and heuristic technique to find proper partners. The contributions of this research are conspicuous. This is a new studying method on both academic and industry. Hence, through the proposed method, this research not only can evaluate the present situation of industry, but also provide suggestions for decision makers to find better suppliers.

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The remainder of this paper is organized as follows. Section 2 proposes the approach of this study. Experimental designs and result analysis based on realistic data are in Section 3. Finally, conclusions are in Section 4 with future research directions.

RESEARCH DESIGN AND METHOD

This study develops an approach to assist Taiwan's TFT-LCD industry to evaluate the operation efficiency under the DEA (Tone, 2001) through GM (1, 1) (Deng, 1989) model and find the candidate priority of alliance within supply chain under several different inputs and outputs [6]. Alliance is a cooperative agreement between the companies. The purpose is to reach the competitive advantages. The GM (1, 1) model is an effective predictive tool for forecasting. This paper, uses 5 periods of data analysis (2010-2014) to forecast the input and output factors in the third quarter of 2015 through the GM(1,1) model. The SBM model can revise the CCR model's problem to make more accurate results. Therefore, this paper is based on the methodology of GM (1, 1) model and the SBM model for alliance calculation. This study designs several steps for this application. See Figure 1.

Step 1. Collect the DMU

This study selects one backlight module company as the target company to simulate the efficiency if this company allies with TFT-LCD companies and selects the best partner.

Step 2. Select Inputs/Output

How to choose the input and output factors when using DEA model is an argument issue in the academic literature. The choice of input and output factors will influence the efficiency under evaluation, so the selection of the factors is vital. In previous sections, the authors have investigated quite some literature and list the key factors important to TFT-LCD industry. This study finds the input factors to be asset, R&D expense and operation cost, and output factor to be profit.

Step 3. Grey prediction

Grey prediction has based on grey model (GM) with three basic operations which are the accumulated generation operation (AGO), inverse accumulated generation operation (IAGO) and grey modeling to predict the performance in the third quarter of 2015.

Step 4. Forecast accuracy

Forecasting always has risk of error. This study uses the mean absolute percent error (MAPE) (Lewis, 1982) to measure the prediction accuracy. If the forecasting error is too high, then the re-selection of inputs and output factors is necessary.

Step 5. Pearson correlation

The formulation of DEA is to measure the efficiency of each DMU by constructing a relative efficiency score via the transformation of the multiple inputs and outputs into a ratio of a single virtual output to a single virtual input. Therefore testing a positive correlation between the selected input and output is important.

Step 6. Choose the DEA model

The SBM model deals with the input and output slacks directly which can correct the overestimation of CCR model.

Step 7. Analysis before alliance

According to the SBM-Input model, this study calculates the efficiency ranking of each DMU before alliance. The purpose is to understand the performances of each DMU before alliance.

Step 8. Factor modification

Since changes would always happen after alliance, here this study sets up 2 parameters to modify the changes of inputs and output. The parameter "k" is for modification of sum of input variables and parameter "m" is for the modification of sum of output factors. These two parameters could change according to the author's assumption. Regarding the input aspect, this paper assumes that companies will decrease their inputs after alliance. k=0.8 is moderate to express that the decrease is significant. As for the output aspect, assuming that additional integration effect will increase the operation revenue. m=1.2 is moderate to express that improvement is efficient and m=0.8 is inefficient. Based on these assumptions, there are 24 scenarios. See Table 2.

Step 9. Analysis after alliance

The factor results for all virtual companies of alliance are multiplied by the parameters for all the combinations. Then, use the SBM model to analyze all the combinations for each virtual company, summarize all the virtual companies' production frontier numbers and compare the efficiencies of the decision making units before and after alliance, and finally provide the overall suggestion.

Step 10. Summary

If a company is inefficient before alliance, but efficient after alliance, the firm reaches the production frontier, and then this specific alliance is a better choice. Contrarily, if the firm does not reach the production frontier after alliance, then the alliance is not preferable.

EMPIRICAL ANALYSIS AND RESULTS

In order to implement the model proposals, this study selects the basic information of one back light module

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company and eight TFT-LCD companies. These major companies of published stock market for TFT-LCD industry in Taiwan. All data are selected from Market Observation Post System of Taiwan Stock Exchange (2014) [7].

After reviewing the DEA literature, three input factors are appropriate (step 2 mentioned before); the asset, R&D expense and operation cost which are important to TFT-LCD industry. In the output side, the profit is the most important index to measure a firm's performance. The paper uses GM (1, 1) model to predict the input and output values for each DMU for the future.

This research uses five period data (2010-2014) to forecast the values of input and output variables in 2015. The results of all factors are shown in Table 3.

This paper uses the MAPE (Lewis, 1982) to measure the prediction accuracy [8]. All variables are calculated in the same way; see Table 4. The MAPE ranges from 0.12% to 20%, which confirms that GM (1, 1) model indeed provides high accuracy.

This study adopts the SBM model to measure the efficiency of each decision making unit. The efficiency of SBM is between 0 and 1. If a company's efficiency is 1, this implies that the company has reached the production frontiers and has better efficiency, compared with other companies. This research calculates the companies' efficiency ranking by using SBM-Input model; see Table 5.

Before alliance, there are four companies in DEA frontier, which means they have good operation efficiency by either using less input resource or creating more output results. This research assumes that the inputs decrease 20% while the output may increase 20% or decrease 20% after alliance. There are total 24 scenarios;

see Table 2. According to Table 2, the study applies the SBM-Input model and list all the combinations in Table 6.

This study uses the predicted value to evaluate all the DMUs through SBM model. Only four out of eight companies reach the production frontiers, which proves that these companies still have lot of space for improvement. From the view of resource perspective, among the 24 combinations, some of them have indeed improved their efficiency; however some of the combinations' efficiency decrease which indicates that this alliance indeed has risks. Firms who have better performance may result in inefficiency after alliance. On the other hand, firms who do not reach production frontier may have chances to improve their efficiency after alliance. Therefore, the firms can analyze their own strengths and weaknesses before alliance, and then find partners that are good for them and hence get better alliance results. This provides the targeted company with valuable information for partner selection.

Before alliances, companies C, D, E and I are in DEA frontier (score=1) which means they have good operation efficiency (100% of score=1) by using less input resources or having more output results (see Table 5). But after alliances with company A, the combinations of C (92% of score=1), D (82% of score=1), E (92% of score=1) and I (58% of score=1) do not reach the DEA frontier completely, which means alliances with company A have some potential risks (see Table 6). Therefore C, D, E and I may be less incentive to ally with A. Before alliances, the efficiency of companies B, F, G and H did not reach the production frontier (score<1; see Table 6); however, after alliance, all have reached the frontiers (B: 58%, F: 50%, G: 50%, H: 58%) which means they have the opportunity to improve their operation efficiency to reach the best efficiency (score=1). Therefore, B, F, G and H could be more willing to ally with company A.

Table 1. The large sized TFT-LCD products

Products	2013	2014	Growth
LCD Monitor	140.1	184.1	31%
Note PC	79.8	114.3	43%
LCD TV	54.4	86	58%
Others	10.1	12.9	28%
Total	284.4	397.4	40%

Unit: million United States dollars (USD)

Table2. Scenarios of input and output setting

Scenarios	Sum of total assets*k	Sum of R&D expense*k	Sum of operation costs*k	Sum of profits*k
1	1	1	1	1
2	1	1	1	0.8
3	1	1	1	1.2
4	1	1	0.8	1
5	1	1	0.8	0.8
6	1	1	0.8	1.2

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7	1	0.8	0.8	1
8	1	0.8	0.8	0.8
9	1	0.8	0.8	1.2
10	0.8	0.8	0.8	1
11	0.8	0.8	0.8	0.8
12	0.8	0.8	0.8	1.2
13	1	0.8	1	1
14	1	0.8	1	0.8
15	1	0.8	1	1.2
16	0.8	0.8	1	1
17	0.8	0.8	1	0.8
18	0.8	0.8	1	1.2
19	0.8	1	1	1
20	0.8	1	1	0.8
21	0.8	1	1	1.2
22	0.8	1	0.8	1
23	0.8	1	0.8	0.8
24	0.8	1	0.8	1.2

Table 3. Forecasted input and output data of all DMUs in 2015

DMU	(I)Total Assets	(I)R&D expenditure	(I)Operation costs	(O)Profit
A	6433603	110519	3832699	4007522
B	10485534	239884	6351957	6764894
C	740629367	3785290	399238955	430184288
D	614761721	6585389	228440187	257784719
E	97153939	1411490	60266095	67349452
F	47148385	614784	22605204	24730680
G	6033626	62997	3282902	3538036
H	222438804	4100286	114266869	117817048
I	2984816	6717	1285942	1321220

Unit：NTD thousand

Table 4. Summary the MAPE of all DMUs

DMU	(I)Total Assets	(I)R&D expenditure	(I)Operation costs	(O)Profit
A	7.4%	0.2%	4.4%	5.1%
B	1.5%	0.7%	5.7%	1.4%
C	3.6%	2.2%	3.7%	6.6%
D	13%	5.2%	6.1%	6.5%
E	6.6%	5.8%	2.8%	10.9%
F	2.7%	2.3%	3.9%	3.3%
G	4.1%	9.9%	14.7%	4.7%
H	0.1%	19.4%	6.1%	3.8%
I	5.4%	3.8%	22.5%	22.2%

Table 5. Efficiencies and ranking before strategic alliance

DMU	Score	Ranking
A	0.8195481	6
B	0.8085482	7
C	1	1
D	1	1
E	1	1
F	0.8004878	8
G	0.8440476	5

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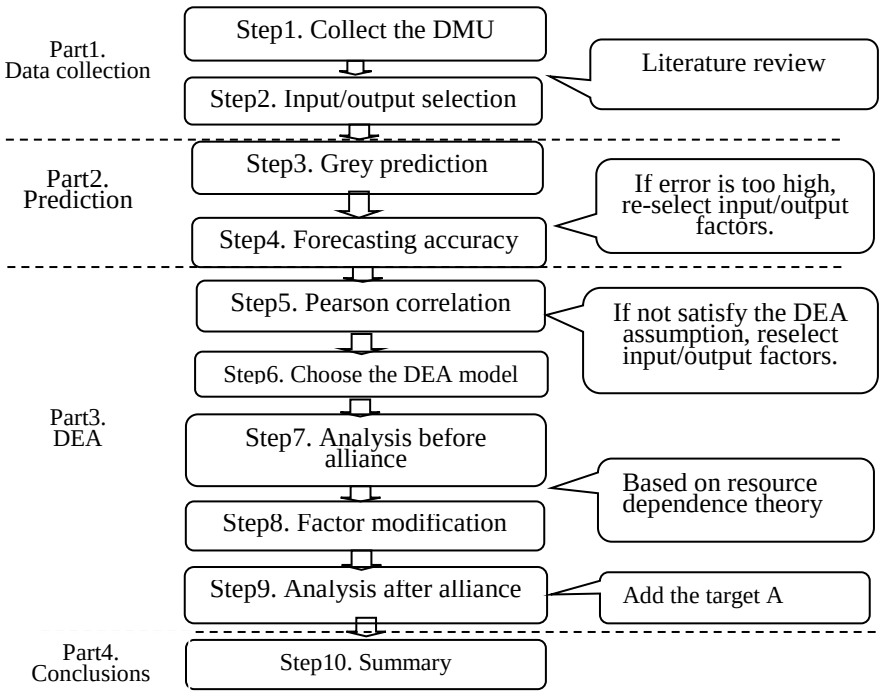
H	0.7072094	9
I	1	1

Table 6. Efficiencies after strategic alliance

DMU	Frontier numbers	Percentage	Ranking
A+B	14	14/24=58%	4
A+C	22	22/24=92%	1
A+D	20	20/24=82%	3
A+E	22	22/24=92%	1
A+F	12	12/24=50%	6
A+G	12	12/24=50%	6
A+H	12	12/24=50%	6
A+I	14	14/24=58%	4

Figure 1. Research development



Conclusions

Facing intensive competition, huge investments and easily affected by the market demand are part of the features in TFT-LCD industry. Considering these features, many companies would like to enhance their competitiveness through alliance. This research, proposes a new methodology which combines the GM (1, 1) model and DEA model under several inputs and output strategies.

This research uses Company A - one of the backlight module companies, to test whether the alliance advantages exist if company A has alliance with TFT-LCD companies. In section 4, this study finds out that companies B, F, G, and H are the best candidates for company A to have alliance. Among the 24 strategies, some strategies' efficiency improved; however, some of them decrease, which indicates that alliances indeed have risks. Firms who have better efficiency may result in poor efficiency when the partners of alliance failed. In contrary, firms who originally have poor efficiency may have chance to increase their efficiency once they have chosen the right supplier partners. Therefore, this study can summarize that alliance not always can help firms increase their efficiency and performance. Blindly proceeding alliance may cause the company losing their overall competitiveness.

For future research, more inputs and outputs

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variables can be alternatives and more different industries can be targets for this proposed model.

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