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Indicator Circuit with Incremental Clustering to Measure Operators' Efficiency in Telecommunications Industry

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ABSTRACT

The indicator circuit with incremental clustering (ICIC) can aggregate many indicators into a composite index using the process of incremental clustering in the score assignment. This study applies the ICIC to compose the scores of firms' efficiency from 6 indicators of 1,000 top firms in Thailand in 2003. Then it selects 17 firms in the telecommunications industry to measure the performance of ICIC and compares to that of the indicator circuits with reference points (ICRP) introduced by Suriya (2015). The results reveal that the ICIC solves many problems occurred in ICRP. First, it differentiates the efficiency of the firms better. Second, it ranks the firms in a more reasonable way. Third, it is more flexible to adjust the range of the scores by the incremental distances from the highest score.

JEL Classification: C43, C45, L96.

Keywords: Indicator circuit; incremental clustering; composite index; efficiency index; telecommunications industry.

1. INTRODUCTION

Indicator circuit (IC) mimics electronic circuit such that electricity flows from the input gate to several nodes inside the circuit and produce the output signal at the end. Each node in the circuit transforms the input signal into an intermediate signal to feed other nodes in the next layer. Then, all the intermediate signals flow into the last layer to produce the final output of the circuit.

Suriya (2015) introduces the indicator circuit with reference points (ICRP) and indicator circuit with self-organizing map (ICSOM) that aggregate many indicators into a composite index. In that study, the index measures the efficiency of 1,000 top companies in terms of total revenue in 2003 in Thailand. Then

it shows the ranking of the efficiency of 17 companies in telecommunications industry. It also compare the performance between ICRP and ICSOM, and discovers that ICRP is better than ICSOM in terms of the relevance to financial ratios and the distribution of scores of the index.

A problem occurs in the ICRP. The scores of the index are extremely close to one another. It is hard to see which company is better than another one when their scores are quite similar. This little difference of the scores make it almost impossible to separate the companies into the category of high and low efficiency.

In this study, the indicator circuit comes with the incremental clustering. It aims at breaking the scores into more details. The idea is to create more clusters than that appears in the ICRP. The incremental clustering seems to serve this purpose well. Therefore, the study employs the incremental clustering into making an indicator circuit. At the end, it compares the performance of the indicator circuit with incremental clustering (ICIC) and the ICRP.

2. INDICATOR CIRCUIT WITH INCREMENTAL CLUSTERING (ICIC)

The construction of ICIC follows these steps. From step 1 to 6, they are similar to the construction of ICRP in the work of Suriya (2015). The difference is at step 7 when the ICRP assign four different points but the ICIC assigns many more points due to increment of the distance to the first point. Another difference is at step 12 – 14. The ICRP adjusts the centroid of each cluster by the mean of the cluster. The number of the adjustment is n times. After the complete adjustment, the ICRP reset its weights and start over again m times. However, the ICIC does not adjust the centroid. It resets the weights m times right after the clustering in each repeat is done.

Step 1: Selection of indicators

This study selects 6 financial indicators which are Current ratio, debt-equity ratio, return on asset, return on equity, net profit margin and return on investment.

Step 2: Unit of measurement

ICIC does not normalize the unit of measurement. It separates the units into 5 groups; times, per cent, days, rounds and dollars. The advantage of this method is at the intertemporal comparability. While the normalized unit depends heavily on the maximum value of each indicator of the leading company in each year (normalized to be one), it is hard to compare the composite index over time. The unnormalized unit still keeps the meaning of each financial indicator and does not depend on the leading company in each year, thus the composite index can be compared over time. However, the disadvantage of this method should be noted that the composite index may place heavier weight to an indicator with higher value. Therefore, this trade-off is at the choice of the modeler.

Step 3: Number of layers

There are 3 layers consisting of input layer, latent layer and output layer. Number of outputs is two (Y and Z) whereas number of nodes in the latent layer is 5 that accounts for five different units of measurement assigned in step 2.

Step 4: Initial weights

The initial weights range from zero to one. All the linkages between the input to latent nodes, and between the latent to output nodes are assigned the initial weights.

Step 5: Calculation of the latent variable (L) and the outputs (Y and Z)

The latent variable (L) and the outputs (Y and Z) can be calculated as

$$L_j = \sum_{i=1}^{K} w_{ji} x_i;\ j = 1, 2, ..., 5$$

$$Y = \sum_{j=1}^{5} w_{6j} L_j$$

and

$$Z = \sum_{j=1}^{5} w_{7j} L_j$$

Step 6: Plot Y and Z on the Euclidean space. The space limits to the area bounded by (Y, Z) = (0, 0) until (Y, Z) = (1, 1).

Step 7: Set the first point at $(Y_1, Z_1) = (1, 1)$. Then set the increment of the distance, d. The second point will be located at $(Y_2, Z_2) = (1 - d, 1 - d)$. The third point will be also located at $(Y_3, Z_3) = (Y_2 - d, Y_2 - d)$. In general, each point $(Y_k, Z_k) = (Y_{k-1} - d, Z_{k-1} - d)$. The number of the points are determined by $k = (1/d) + 1$ to ensure that the points are bounded in the area Y = [0, 1] and Z = [0, 1].

Step 8: Measure the Euclidean distance between a coordinate (Y_j, Z_j) of a firm j and each reference point k by this following formula.

$$d_j = \sqrt{\left(Y_j - Y_k\right)^2 + \left(Z_j - Z_k\right)^2}$$

where, d_i distance between a coordinate (Y_j, Z_j) of a firm j and each reference point k when $j = 1, 2, \ldots, n$ firms and $k = 1, 2, \ldots, k$ groups.

Y_j and Z_j is the coordinate of Y and Z for a firm j.

Y_k and Z_k is the coordinate of Y and Z at a point k.

Step 9: Compare the Euclidean distance between those calculated in step 8. Choose the point with the shortest distance to represent a group of that firm.

Step 10: Assign a score of 100 to the first cluster (Y_1, Z_1). The second lower cluster will get the score of $100 - (10d)$. The third lower cluster will get the score of $100 - (20d)$. In general, the score of the cluster k is $100 - [(k - 1)(10d)]$. For example, when the increment is set to be 0.01, the last cluster is $k = (1/d) + 1 = 101$. Then the least score is 90. Finally, measure the score of each firm by the cluster where it belongs. Collect these scores.

Step 11: Adjust the weights (in step 4) with randomized numbers with a randomized sign of positivity or negativity. This is called Δw.

Step 12: Reset the initial weights in step 4. Repeat step 5 to 10. Iterate this step for m rounds. Collect all the scores of all rounds.

Step 13: Calculate the grand mean of the scores from all the m rounds.

Step 14: Rank the grand mean from the highest to the lowest value.

3. RESULTS FROM ICIC

The settings of ICIC model are shown in Table 1.

Table 1
The settings and results of the ICIC model

The settings of ICIC model			
Round of clustering	1	Unit of measurement	Unnormalized
Rounds of reweights	3	Number of indicators	6

Source: ICIC model.

The production of Y and Z signals by different weights differentiate the firms into many different locations in the Euclidean space. A point in the scatter plot in Figure 1 represents a firm. Each firm will be assigned to be a member of cluster. It can be imagined that these clusters are located by the diagonal line linking (0,0) and (1,1).

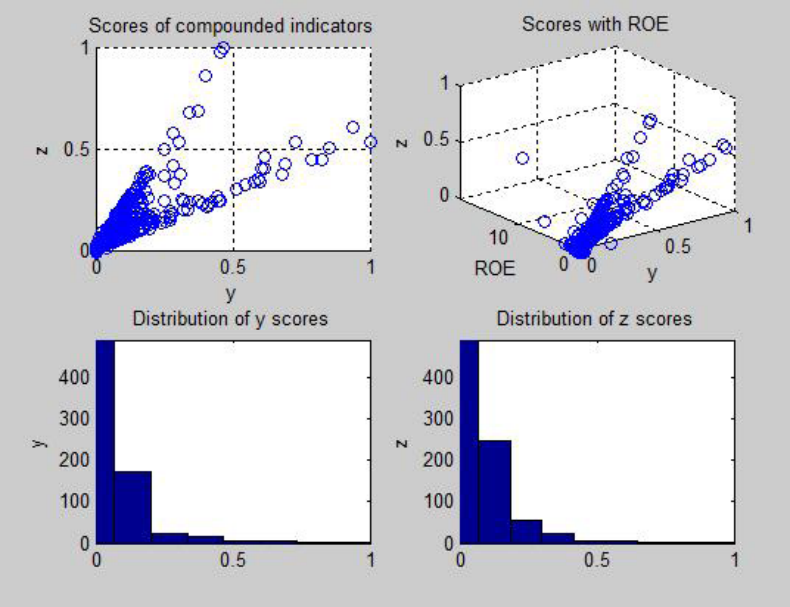

Figure 1: Scatter plots on the Euclidean space of (Y,Z) and (Y,Z,ROE) with the bar charts showing the distribution of Y and Z.

The following figure (Figure 2) shows the distribution of the final efficiency score of 1,000 firms that top Thailand's chart of largest revenue in 2013. The left-hand-side of the figure locates the firm with the largest revenue and vice versa.

It can be seen that the scores are bounded between 90 and 100. Most of the firms stick together at the bottom line near 90. It can be imagined that if the least score is set to be 0 rather than 90, these companies should have their score also close to the bottom line of 0.

A reason why the study set the least score at 90 because these 1,000 companies are the top companies of the country. Their efficiencies should not be marked by low scores. When the owners or shareholders of the companies look at such the very low score and ask why, the researchers just reply that it only reflects the rank of the efficiently in the relative term, not an absolute term. This answer seems not to be satisfying to

them. They need something that shows the high efficiency of the firms as well as reflects the rank among other firms in the country. Therefore, the most compromised range of the score begins from 90.

By this range, the top score shown in Table 2 is 98.40 and the mean of the scores is just 90.80 with the standard deviation of 0.99. These numbers reveal again that most of the firms are located near the bottom line.

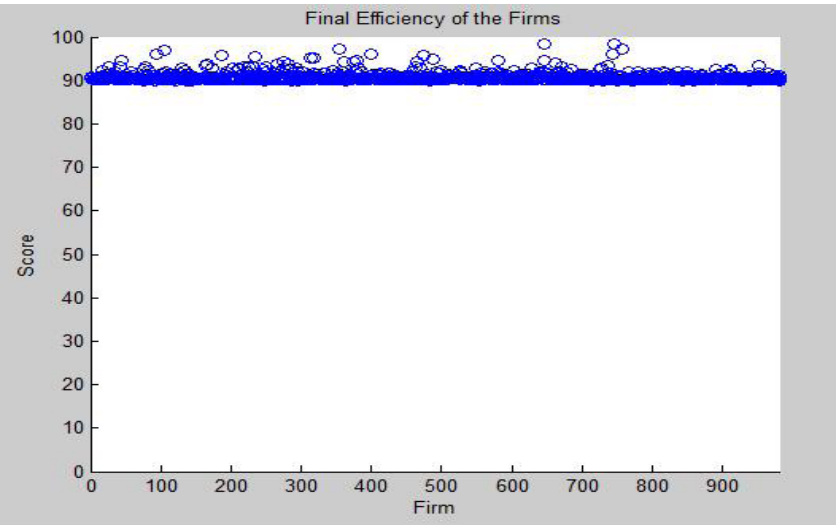

Figure 2: The distribution of final efficiency score of 1,000 firms

Table 2
The results of the ICIC model

The results from ICIC model			
Mean score	90.80	Maximum score	98.40
Standard deviation	0.99	Minimum score	90.00

Source: ICIC model.

To compare the performance between ICIC and ICRP, the study ranks the efficiency of 17 companies in the telecommunications industry. There are several reasons why it selects only these companies. First, the telecommunications companies are at the focus of the further analysis of their efficiencies. This study is a part of a project funded by the regulator of the industry. Second, it may make a long list of companies when the study compares the rank of all the 1,000 companies. If so, it cannot give a clear picture of the ranking results in details.

The results in Table 3 shows some remarkable differences between the performance of ICIC and ICRP. First, the ranks of companies are not the same. Second, the number of companies that share the same rank are different in favor of ICIC (Table 4).

It can be noticed that ICIC places more importance to the current ratio over the profits. Firm G which is in the 5th rank of ICRP moves upward to the 4th place. The ICIC differentiates between firm B and C which are indifferent in ICRP such that now firm B dominates firm C in terms of 5 indicators apart of only the Return on Equity, ROE. It should be noted that the smaller Debt/Equity ratio (D/E ratio) is better than the larger one. This seems to be reasonable.

At the bottom of Table 3, the ICIC also differentiates firm Q and P which share the same rank in ICRP, the 16th place. Now firm Q is at the 13th place while firm P is at the last place. Both firms have 3 indicators that dominates each other. It is hard to judge from the number of better indicators in this case. The largest different is at the D/E ratio. Firm Q has a lower D/E ratio, 3.5579, compared to that of firm P which is 59.5518. It can be seen that the ICIC ranks the 13th to 17th places mainly by the D/E ratio and also the current ratio.

Table 3
The ranking of the efficiency of telecommunications operators

Rank by ICIC	*Rank by ICRP*	*Firms*	*Final efficiency score from ICIC model (Out of 100 points)*	*Current ratio*	*D/E ratio*	*ROA*	*ROE*	*Net profit margin*	*ROI*
1	1	Firm A	92.83	1.0663	15.0796	0.1848	2.9720	0.0400	38.2953
2	2	Firm B	90.97	2.0143	0.9859	0.4215	0.8371	0.3269	7.3333
2	2	Firm D	90.97	3.5049	0.3992	0.5031	0.7040	0.7280	0.3938
4	5	Firm G	90.87	3.7947	0.3578	–0.2147	–0.2916	–0.2539	–0.4169
5	2	Firm C	90.73	1.0324	30.8830	0.1015	3.2370	0.2563	6.1348
6	5	Firm E	90.60	2.5541	0.6435	0.0219	0.0359	0.0500	0.7257
7	5	Firm F	90.50	1.6245	1.6012	0.2153	0.5601	0.3421	1.9732
7	8	Firm K	90.50	2.1985	0.8344	0.0324	0.0595	0.1253	0.1416
9	8	Firm I	90.40	1.7380	1.3550	0.1989	0.4684	0.3457	0.6554
10	8	Firm H	90.33	1.0624	16.0345	0.0735	1.2516	0.1221	2.0515
11	10	Firm J	90.23	1.3671	2.7237	0.0168	0.0625	0.1417	0.0071
12	12	Firm L	90.17	1.2236	4.4723	–0.0011	–0.0061	–0.0010	–0.0008
13	14	Firm N	90.07	1.2489	4.0183	–0.0980	–0.4918	–0.0771	–1.5032
13	16	Firm Q	90.07	1.2811	3.5579	–0.3754	–1.7111	–0.6691	–0.2650
13	13	Firm M	90.07	1.0438	22.8336	–0.0277	–0.6600	–0.0190	–0.2916
16	14	Firm O	90.03	1.0230	43.5517	–0.0177	–0.7877	–0.0492	–0.5039
17	16	Firm P	90.00	1.0168	59.5518	–0.0455	–2.7538	–0.0552	–0.1912

Source: ICIC model from this study and the results of ICRP from Suriya (2015).

Table 4
The number of firms that share the same rank

Types of Indicator Circuit	*Total number of firms*	*Number of firms that share the same rank*	*Ratio of the number of firms that share the same rank (%)*
ICIC	17	7	41.2
ICRP	17	14	82.4

Source: ICIC model from this study and the results of ICRP from Suriya (2015).

4. CONCLUSIONS

This study constructs an indicator circuit with incremental clustering (ICIC) which composes a composite index of telecommunications operators' efficiency. It uses the idea of electrical circuit to build this model. It solves the problem that occurs in the previous version of the indicator circuit with reference points

(ICRP) made by Suriya (2015) such that the ICIC differentiates the efficiency indices among the firms better. The number of firms that shares the same rank decreases from 82.4 per cent in ICRP to 41.2 per cent in ICIC. Moreover, the ICIC seems to rank the firms in a more reasonable way. However, it may still be argued when it places more importance in the ranking to the current ratio and debt-equity ratio than the profit-related ratio.

References

Suriya, Komsan. 2015. "Indicator Circuit with Reference Points and the Comparison with Indicator Circuit with Self-organizing Map," *International Journal of Intelligent Technologies and Applied Statistics 8*, 2 (June 2015): pp. 103-112.