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Assessing the Performance of Agricultural Cooperatives Using the Context-Dependent Data Envelopment Analysis: The Case of Dong Thap Province in Vietnam

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Abstract: The common results of standard Data Envelopment Analysis (DEA) are efficiency scores of firms, however, in terms of fully efficient firms, this approach cannot identify which one is the better performer. This study applied DEA to estimate technical and scale efficiency; and further adopted the context–dependent DEA to assess attractiveness and progress scores for 64 agricultural cooperatives in Dong Thap province of Vietnam. The findings show that the average technical efficiency is fairly low, 0.58 under constant returns to scale and 0.72 under variable returns to scale showing that there is a high prospect of improving technical efficiency. Only eight cooperatives (12.5%) achieve the technical efficiency score of one indicating that they are operating at optimal scales. Although they are all efficient, they largely differ in attractiveness scores obtained from the context-dependent DEA. This would be the appropriate technique because it allows the cooperative's officials to evaluate and facilitate the development of agricultural cooperatives and its outcomes would be also useful for farmers to select the best option for their investigation and may lead to follow-up participation based upon the attractiveness scores.

Key words: Technical Efficiency・Context–Dependent DEA・Attractiveness・Agricultural Cooperatives

INTRODUCTION

The Mekong Delta of Vietnam is a famous agricultural region where produces over half of national rice production and hence it is referred to as the rice bowl of the country since 1985 the Delta experienced the highest growth ratio of rice production [1]. There are three predominantly export products namely rice, fruit and pangasius fish, produced in Mekong Delta, providing the main income resource for over 13 million rural people. In common with most farmers in developing countries work independently on small farms, individual farmers in the Mekong Delta produce small quantities of agricultural products with unstable quality, high input costs and high production costs as well. As a result, the products are uncompetitive in the marketplace and low incomes are generated along the line.

Although the government has encouraged individual farmers to join cooperatives, however, it has not been successful. As reported by [2] that cooperatives in the Mekong Delta have taken a vital role in improving production efficiency and raise agricultural production. Notwithstanding cooperatives' services were good in general, they were not specifically good enough to suit the need of the members. Moreover, these cooperatives are facing to major challenges such as lacking economy of scale due to the small scale of operation, shortage of capital, low level of education and management capacity on the board of directors.

In addition, Thanh [3] reported that the development of cooperatives in the region was limited in terms of both quantity and quality. In 2008, the Delta had 1, 623 cooperatives which accounted for 8.93% of the total number of cooperatives in the country. Of this, 48.6% was agricultural cooperatives. According to Hai [4] only 21.9% farmers in the Mekong Delta participated in agricultural cooperatives in 2010, while 68.3% farmers were members of cooperatives in the Red River Delta, a smaller delta of Vietnam. This could be attributed to the severe influence from the old type of agricultural cooperatives. During 1975-1986, the government had promoted the expansion of cooperative throughout the country. At that time, all

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properties owned by individual farmers including land and capital assets were integrated to form the local agricultural cooperatives. Then the profits would be equally distributed to each farmer. However, these cooperatives did not perform well to provide members the expected satisfaction and many of them collapsed as the result. To be more specific, Hai [4] also found that some old farmers in An Giang province in the Mekong Delta were still afraid of joining the cooperatives from the bad experience in the past, i.e., they lost all their means of living (Operation capitals for farming) after the collapse of cooperatives.

Generally, the development of agricultural cooperatives in the Mekong Delta now is still far limited and most farmers are poor. The pervasively low economic efficiency of most agricultural cooperatives deters farmers from joining. Simmons and Birchall [5] stated that attempts to organize farmers into cooperatives have often failed in developing countries, however, these failures do not specify weaknesses in the cooperative model.

Therefore, there is a need to analyze the current status of agricultural cooperatives for proposing appropriate adjustments to foster developments. This study aims to measure technical efficiency and performance of agricultural cooperatives. The findings may assist cooperatives to improve their efficiency and further to attract farmers' participation; moreover, farmers can base on the measured attractiveness scores to choose the cooperative to join.

The present study applied original Data Envelopment Analysis (DEA) to measure the relative efficiency and further employed the context-dependent DEA methodology to assess the performance of agricultural cooperatives. DEA is known as a non-parametric approach and it was first presented by Charnes *et al.* [6]. It is commonly used for efficiency measurements of decision-making units (DMUs) which often produce multiple outputs. This approach is a dominant method for performance measurement of firms and organizations, it has been applied largely and by a growing number of studies in various fields such as banking, service, heath care and education and engineering and science; as well as of country and region. According to Zhu [7] in the traditional DEA method, each DMU is compared to a set of frontier DMUs, then based on the performance of inefficient DMUs, they will be ranked by comparison with the best-practice frontier. Nonetheless, when DMUs have the same score efficiency, DEA cannot identify which one is the better performer. Due to these limitations, the original DEA was adjusted by Seiford and Zhu [8] such that the relative performance of DMUs can be addressed, which is referred to as the context-dependent DEA methodology. Several studies have adopted the context-dependent DEA. For example, Chen *et al.* [9] employed this method for estimating the efficiency of public libraries in Tokyo and also identified their relative attractiveness scores; another case study isfor a power company situated in Osaka of Japan, Morita *et al.* [10] measured the performance for fourteen sales branches and Ulucan and Atıcı [11] also applied this approach to estimate the performance of a project which is supported by the World Bank in Turkey and the authors suggested that context-dependent DEA approach can serve as an efficient method for performance evaluation. Another study is in a commercial bank in Iran where the performance of its 20 branches was examined by Lotfi *et al.* [12].

MATERIALS AND METHODS

Context-Dependent Data Envelopment Analysis: The context-dependent DEA comprises two main steps. In the first step, the DMUs are classified into performance levels called efficient frontiers. The second step is followed by the first step of classifying the DMUs to calculate the attractiveness and progress scores for every DMU which are then used for ranking the performance of DMUs. In this study, the model formulation of context-dependent DEA was based on Seiford and Zhu [8].

Stratification DEA Method: Assume that DMU_j (j = 1,2,...,n) manufactures s outputs (y_j) by using m inputs (x_j), $x_j = (x_{1j},...,y_{mj}$ and $y_j = (uy_{ij},...y_{sj})$.

All n DMUs are set as $J^l = \{DMU_j\, j = 1,...,n\}$, $J^{l+1} = J^l - E^l$ in which $E^l = \{DMU_k \in J^l \mid \Phi\,(l, k) = 1\}$ and $\Phi^*\,(l, k)$ represents the optimal value in the linear model and specified as follows;

$$\begin{aligned} &\Phi^*(l,k) = \max_{\lambda_j,\Phi(l,k)} \Phi(l,k) \\ &\text{subject to} \sum_{j\in F(J^l)} \lambda_j y_j \geq \Phi(l,k) y_k; \\ &\sum_{j\in F(J^l)} \lambda_j x_j = x_k \\ &\lambda_j \geq 0 \quad j \in F(J^l). \end{aligned} \tag{1}$$

where x_k is the input vector and y_k is the output vector of DMU_k; and $j \in F(J^l)$ indicates $DMU_j \in J^l$, i.e., F(.) is the equivalence from a set of DMU to the set of the respectively subscript index.

When l equals one, model (1) comes to be the original output-oriented CCR model, soall DMUs situated E^1 are considered as efficient and described as the first-level efficient frontier. If l is two, model (1) offers the second-level and DMUs in this level completely disregard the DMUs situated in the first-level. Along these lines, several levels of frontiers are identified. E^l is referred to as the lth-level efficient frontier. Then, the identification of these efficient frontiers by model (1) is completed by the sequent algorithm.

- *Step 1:* First set l =- 1. Evaluate the full set of DMUs, J^1, by model (1) to acquire the first-level efficient DMUs, set E^1
- *Step 2:* Disregard the efficient DMUs attained from the previous levels to get further DEA rounds. $J^{l+1} = J^l - E^l$. (When $J^{l+1} = \phi$ then end.)
- *Step 3:* Inefficient DMUs are continuously assessed, called the new subset of J^{l+1} and model (1) is also used to achievethe new efficient DMUs, E^{l+1}.
- *Step 4:* Let $l = l + 1$, then return to step 2.

- *Stopping rule:* If $J^{l+1} = \phi$, the process of algorithm ends.

Input-Oriented Context-Dependent DEA: After the first stage of clustering the whole set of DMUs, the DMUs are partitioned into some frontier levels called $E^{l+1} = (1,..,L)$. From these contexts, the relative attractiveness and progress score of each DMU can be attained by the following input-oriented model of context-dependent DEA.

Attractiveness: Examine the linear model for DMU$q = (x_q, y_q)$ in a particular level E^{l0}, $l_0 \in \{1,...,L-1\}$ as follows:

$$H_q^*(d) = \min H_q(d) d = 1,...,L - l_0$$

$$\text{subject to} \sum_{j\in F(E^{l_0+d})} \lambda_j x_j \le H_q(d) x_q;$$

$$\sum_{j\in F(E^{l_0+d})} \lambda_j y_j \ge y_q; \tag{2}$$

$$\lambda_j \ge 0 \quad j \in F(E^{l_0+d})$$

Note that both side of the model (2) divided by $H_q(d)$ provides;

$$\sum_{j\in F(E^{l_0+d})} \tilde{\lambda}_j x_j \le x_q,$$

$$\sum_{j\in F(E^{l_0+d})} \tilde{\lambda}_j y_j \ge \frac{1}{H_q(d)} y_q,$$

$$\tilde{\lambda}_j = \frac{\lambda_j}{H_q(d)_q} \ge 0 \quad j \in F(E^{l_0+d}).$$

where DMU$_q$ is in a particular level of E^{l0} and (I) $H_q^*(d) > 1$ for every $d = 1,...,L - l_0$, (ii) $H_q^*(d+1) < H_q^*(d)$.

Definition 1: $H_q^*(d)$ is *d-degree* attractiveness of DMU_q from a detailed level E^{l0} (input-oriented model).

The greater the $H_q^*(d)$ shows the more attractive of the DMU$_q$. Then the attractiveness score of DMU $_q$ is determined by applying model (2) while the outputs of this DMU are fixed at the present levels.

Progress: In terms of progress measurement, for a specific DMU$_q$ $\in E^{l0}$, $l_0 \in \{2,...,L\}$ its progess score is estimated by considering the following linear model.

$$G_q^*(g) = \min G_q(g) g = 1,...,l_0 - 1$$

$$\text{subject to} \sum_{j\in F(E^{l_0-g})} \lambda_j x_j \le G_q(\beta) x_q;$$

$$\sum_{j\in F(E^{l_0-g})} \lambda_j y_j \ge y_q;$$

$$\lambda_j \ge 0 \quad j \in F(E^{l_0-g})$$

where (i) $G_q^*(g) < 1$ for each $g = 1,...,l_0 - 1$ and (ii) $G_q^*(g + 1) < G_q^*(g)$.

Definition 2: $M_q^*(g) \equiv 1/G_q^*$ is g-degree progress of DMU$_q$ from a particular level E^{l0} in input-oriented model.

Noticeably, $M_q^*(g) > 1$. When $M_q^*(g)$ is large indicating that DMUs need more progress.

Data and Variables: In this study, a data set on agricultural cooperatives for the year 2013 derived from the Rural Development Division, Department of Agriculture and Rural Development in Dong Thap province of Vietnam, was used. At the end of each year, agricultural cooperatives submit their annual financial statements to the Rural Development Division.

Table 1: Data summary statistics of 64 agricultural cooperatives in Dong Thap province, Vietnam

Variables	Unit	Mean	Standard Deviation	Minimum	Maximum
Outputs					
Revenue	Mill.VND*	890.67	810.85	69	4529
Profit	Mill.VND	157.34	139.19	3	674
Inputs					
No. of members	Person	107.02	153.57	8	742
No. of ha. served	Ha	345.53	337.74	49	2000
Total Capital	Mill.VND	1032.94	1303.44	28	7417

Source: the Rural Development Division, Department of Agriculture and Rural Development in Dong Thap province;

*: 1 USD = 21, 270 VND (As of June 31, 2014)

By July 2014, there were 172 agricultural cooperatives in this province, of which 165 were active and seven were waiting to be dissolved. Due to the incompleteness of data reported, the data set on 64 agricultural cooperatives was therefore used for analyses in this study.

This study used two output variables and three input variables to characterize cooperative performance. Selection of the input and output variables used for analyses are based on the literature of previous studies related to cooperatives conducted by Caputo and Lynch [13], Guzmán and Arcas [14], Krasachat and Chimkul [15], Huang *et al*. [16] and Othman *et al*. [17]. The two outputs are revenue and profit of agricultural cooperative because they are important criterions representing the operation efficiency of the cooperative as other enterprises. In terms of input variables, the activity of agricultural cooperatives are mainly associated with agriculture sector, therefore, the three inputs are applied in this study including total capital, the number of cooperative members and the number of hectares served by the cooperative. The explanation of these inputs is as below.

- Members are included in the model due to their important contributions in many activities of cooperatives. Members are the major customers of the cooperatives by using services and they also have the right to join in decision-making in some important activities due to their owner roles.
- Total area served by cooperatives: this is an important criterion which shows the role of cooperatives in the context of social-economic in delivering their services for members and individual farmers in the nearby regions.
- Working capital comprises paid-in capital from members, mobilized capital, funds and other capitals. The description of these variables is summarized in Table 1.

RESULTS AND DISCUSSION

Efficiency of Agricultural Cooperatives: Technical and scale efficiency scores of 64 agricultural cooperatives were estimated with the DEAP 2.1 program [18] by applying the input-oriented DEA under variable returns to scale. The estimated results are displayed in Table 2. It has been found that the technical efficiency scores among these cooperatives show wide ranges from only 0.17 and 0.18 to 1.00. The mean technical efficiency under VRS was higher than under CRS (0.72 and 0.58, respectively) and the scale efficiency score was 0.81. The estimated results indicate that these cooperatives are not fully efficient and there are significant potentials for them to improve their efficiency. On average, the technical inefficiency (CRS) of cooperatives could be decreased by 42% by functioning at the optimal scale through referring the efficient cooperatives.

The distribution of technical and scale efficiency for agricultural cooperatives is reported in Table 3. The results show that approximately 15.63% of cooperatives obtained efficiency scores of ≥ 0.91 under CRS compared to 34.38% under VRS. This may be attributed to that VRS creates a convex hull of intersecting panels hence the data points are enveloped more tightly compared to CRS conical hull. Therefore the technical efficiency scores under VRS are often larger than those obtained by applying the CRS model [19]. Based on the mean efficiency scores, there is a potential for these cooperatives improve their technical efficiency and the average scale efficiency of 0.81 implies that technical efficiency of cooperatives could be improved by changing their scales. Approximately 40.63% of cooperatives had scale efficiency score of ≥ 0.91, about 50% cooperatives were in a score range from 0.51 to 0.90 and less than 10% of cooperatives experienced the scores of ≤ 0.50.

Table 2: Technical and scale efficiency scores for agricultural cooperatives

DMU No.	Name of cooperatives	Technical efficiency (CRS)	Technical efficiency (VRS)	Scale efficiency
1	[1]HTXNN sô 1 An Lac	0.47	0.52	0.91
2	HTXNN An Hòa	0.55	0.57	0.98
3	[2]HTX thauy san	1.00	1.00	1.00
4	HTXNN sô 1 Thuòng Phuóc 1	0.42	0.45	0.93
5	HTXNN sô 3 Thuòng Phuóc 1	0.29	0.31	0.91
6	HTXNN Long Hòa	0.27	0.45	0.60
7	HTXNN Long Hung	0.42	0.72	0.58
8	HTXNN Long Thói A	0.30	0.53	0.56
9	HTXNN Phú Hòa A	0.50	0.62	0.81
10	HTXNN Phú Thónh B	0.63	0.78	0.81
11	HTXNN Tân Phuóc	1.00	1.00	1.00
12	[3]HTX DVNN sô 1 Tân Thành A	0.33	0.64	0.51
13	HTX Phát Tài	0.29	0.37	0.79
14	HTXNN sô 1 TT. Tràm Chim	0.25	0.69	0.37
15	HTXNN sô 2 TT. Tràm Chim	0.91	0.98	0.92
16	HTXNN Quyêt Thăng TT. Tràm Chim	0.44	0.45	0.99
17	HTXNN Tân Tiên	0.39	1.00	0.39
18	HTXNN Phú Th C	1.00	1.00	1.00
19	HTXNN Tân Cuòng	0.38	1.00	0.38
20	HTXNN sô 1 Phú Hiêp	0.85	1.00	0.85
21	HTXNN sô 2 Phú Hiêp	0.64	0.73	0.87
22	HTX DVNN Phú An	0.67	0.69	0.97
23	HTXNN Quyêt Tiên B	0.76	0.80	0.95
24	HTXNN Hòa Phú	0.71	0.73	0.98
25	HTXNN Phú Tho	0.27	0.59	0.46
26	HTX NN Tân Hòa	0.59	0.59	1.00
27	HTXNN Bình Đinh	0.17	0.18	0.95
28	HTX Bình Hòa	0.19	0.31	0.62
29	HTXNN Hòa Bình	0.38	0.46	0.84
30	HTXNN Bình Thuân	0.38	0.42	0.91
31	HTXNN Bình Minh	0.26	0.34	0.77
32	HTXN Phong Phú	0.30	0.93	0.32
33	HTXNN Phát Đat	0.37	0.49	0.75
34	HTXNN Hòa Tiên	0.32	0.37	0.86
35	HTXNN Tân Thói	0.45	1.00	0.45
36	HTX DVNN 26 tháng 3	0.24	0.25	0.97
37	HTX DVNN sô 1 Gáo Giông	0.87	1.00	0.87
38	HTX DVNN sô 2 Gáo Giông	0.38	0.43	0.88
39	HTX DVNN sô 1 Phong Mỹ	0.89	1.00	0.89
40	HTX DVNN sô 1 Mỹ Long	0.85	1.00	0.85
41	HTX Mỹ Xuong	1.00	1.00	1.00
42	HTX Sen Gò Tháp	0.64	1.00	0.64
43	HTX DVNN Vuón Cò	0.59	1.00	0.59
44	HTXNN Đông Hiêp	0.55	0.63	0.88
45	HTXNN DV Đông Thành	0.18	0.22	0.83
46	HTXNN Đông Tâm	0.73	0.87	0.84
47	HTXNN Thành Công	1.00	1.00	1.00
48	HTXDVNN Van Loi	0.68	0.75	0.90
49	HTX DVNN Mỹ Hòa 1	0.45	0.79	0.57
50	HTX DVNN Mỹ Hòa 2	0.56	0.71	0.79
51	HTX Mỹ Hoà 4	0.64	0.87	0.74
52	HTX DVNN Mỹ Tân	0.41	0.57	0.73
53	HTX DVNN An Phong	0.83	1.00	0.83
54	HTXNN Phuóc Thành	0.68	0.71	0.95
55	HTXNN Bình Hiêp B	0.76	0.90	0.84
56	HTXNN sô 2 Đinh An	1.00	1.00	1.00
57	HTXNN sô 1 Đinh Yên	1.00	1.00	1.00
58	HTXNN sô 1 Mỹ An Hung A	1.00	1.00	1.00
59	HTXNN sô 1 Long Hung B	0.44	0.57	0.77
60	HTXNN sô 1 Vinh Thanh	0.62	1.00	0.62
61	HTXNN sô 2 Vinh Thanh	0.55	0.56	1.00
62	HTXNN Khánh Nhon	0.77	0.78	0.98
63	HTXNN sô 1 Long Thăng	0.97	1.00	0.97
64	HTXNN Tân Phú Đông	0.51	0.52	0.99
	Mean efficiency	0.58	0.72	0.81
	S. D.	0.26	0.25	0.19
	Minimum	0.17	0.18	0.32
	Maximum	1.00	1.00	1.00

[1]HTXNN: Agricultural Cooperative; [2]HTX: Cooperative and [3]HTX DVNN: Agricultural Service Cooperative

Table 3: Frequency distribution of technical and scale efficiency for agricultural cooperatives using DEA under CRS and VRS

	Technical efficiency (CRS)		Technical efficiency (VRS)		Scale Efficiency	
Efficiency score	No. of cooperatives	%	No. of cooperatives	%	No. of cooperatives	%
≤ 0.2	3	4.69	1	1.56	0	0.00
0.21-0.30	9	14.06	2	3.13	0	0.00
0.31-0.40	8	12.50	5	7.81	4	6.25
0.41-0.50	8	12.50	7	10.94	2	3.13
0.51-0.60	8	12.50	9	14.06	6	9.38
0.61-0.70	8	12.50	5	7.81	3	4.69
0.71-0.80	5	7.81	10	15.63	7	10.94
0.81-0.90	5	7.81	3	4.69	16	25.00
≥ 0.91	10	15.63	22	34.38	26	40.63

Table 4: Distribution of returns to scale for agricultural cooperatives

Returns to scale	Number of cooperatives	%
Constant returns to scale	8	12.50
Increasing returns to scale	38	59.38
Decreasing returns to scale	18	28.13
Total	64	100.0

The results of returns to scale for agricultural cooperatives are shown in Table 4. The results indicate that only 12.5% of cooperatives are under CRS which means that these cooperatives are operating at optimal scales. This also indicates that the majority of agricultural cooperatives in this study are operating with technical inefficiency. About 28.13% of cooperatives are operating at above optimal scale, while most of the cooperatives (59.38%) show their operation at increasingreturns to scale. In other words, 38 cooperatives need to expand their scales upon which technical efficiency can be further improved. It can be concluded that agricultural cooperatives in this study are in low efficiency. In comparision with Thai agricultural cooperatives, Krasachat and Chimkul [15] reported that in 2004 Thai agricultural cooperatives achieved relatively high technical efficiency (0.73 under CRS and 0.81 under VRS) and scale efficiency (0.89). Most of them (71%) showed their operational scale under decreasing returns to scale and hence the study suggests that agricultural cooperatives of Thailand could improve their operational efficiency by reducing the size of cooperatives.

Attractiveness and Progress Measures: Attractiveness and progress scores of cooperatives are calculated by the context-dependent DEA using the DEAFrontier software. Table 5 presents seven levels of the efficient frontier. It can be seen that eight cooperatives in E^1 are identified to be fully efficient by the CRS efficiency scores. Three cooperatives #27, 28 and 45 have the lowest efficiency scores and are situated in the last level of the efficient frontier set, E^7. However, the grouping of levels of efficient frontiers is totally independent of the rank of efficiency scores. For example, efficiency score of cooperative #40 is 0.85 and it is classified in the level 3, while cooperative #64 with an efficiency score of 0.51 and is categorized into the level 2. [9] also reported that the efficient frontier levels do not abide by the numeric order of the efficiency levels obtained under the original CRS.

Table 6 illustrates the results of the attractiveness scores for cooperatives in the first and second levels of the frontier. The ranking position of each attractiveness score is numbered to the right in a circle. The highest attractiveness score is considered as the best one and ranked the top position (①). Although all cooperatives in the first level are fully technical efficient under CRS, their attractiveness scores are largely different. It can be seen that on both of the evaluation context E^2 and E^3, cooperative #41 is the best one because of its largest attractiveness score or the first ranking position (①). In contrast, cooperative #18 is ranked the last one (⑧) because it has the smallest attractiveness score. In other words, no matter which evaluation context isunder consideration, cooperatives #41 and 18 are the most and the least attractive cooperatives, respectively. However, the ranking position of other cooperatives changes depending on the evaluation context chosen. For example, DMU #57 is ranked the second in E^2, while in E^3 and E^4 it is rated as the third position. According to Zhu [7] when an evaluation context is different, the attractiveness of DMUs may be different even though on the same level.

Table 5: Levels of efficiency cooperatives for CRS efficiency

Levels	Frontier cooperatives (DMU numbers)	Technical efficiency range
Level 1 (E^1)	3, 11 , 18, 41, 47, 56, 57, 58	1
Level 2 (E^2)	10, 15, 20, 22, 23, 37, 39, 48, 51, 53, 54, 55, 60, 62, 63, 64	0.51-0.97
Level 3 (E^3)	1, 4, 7, 9, 16, 21, 24, 25, 26, 40, 42, 43, 46, 50, 61	0.27-0.85
Level 4 (E^4)	2, 8, 14, 17, 29, 33, 35, 44, 49, 52, 59	0.25-0.55
Level 5 (E^5)	5, 6, 12, 19, 30, 32, 34, 38	0.27-0.38
Level 6 (E^6)	13, 31, 36	0.24-0.29
Level 7 (E^7)	27, 28, 45	0.17-0.19

Table 6: Attractiveness and progress for 24 agricultural cooperatives in E^1 and E^2 by the Context-dependent DEA

		Evaluation Context (Efficient frontier)			
Levels	DMU No.	1st-level (E^1)	2nd-level (E^2)	3rd-level (E^3)	4th-level (E^4)
		-	AS*	AS	AS
Level 1 (E^1)	3	-	1.81⑥	3.13②	6.85②
	11	-	2.03③	2.39⑤	2.85⑦
	18	-	1.40⑧	1.97⑧	2.72⑧
	41	-	2.37①	4.13①	7.18①
	47	-	1.90⑤	2.11⑦	3.29⑤
	56	-	1.91④	2.35⑥	3.61④
	57	-	2.32②	3.02③	4.17③
	58	-	1.55⑦	2.42④	2.91⑥
		PS*	-	AS	AS
Level 2 (E^2)	10	0.63③	-	1.26⑮	1.78⑪
	15	0.91⑮	-	1.56⑦	1.81⑩
	20	0.85⑫	-	1.88③	2.85③
	22	0.67⑤	-	1.54⑨	2.36⑤
	23	0.76⑨	-	1.55⑧	2.06⑧
	37	0.87⑬	-	1.53⑩	1.69⑫
	39	0.89⑭	-	1.30⑫	1.68⑬
	48	0.68⑦	-	1.28⑬	1.67⑭
	51	0.64④	-	1.26⑭	1.43⑯
	53	0.83⑪	-	1.88④	4.08①
	54	0.67⑥	-	1.17⑯	1.63⑮
	55	0.76⑧	-	1.73⑤	2.14⑦
	60	0.62②	-	1.43⑪	1.96⑨
	62	0.77⑩	-	1.63⑥	2.49④
	63	0.96⑯	-	1.93②	2.30⑥
	64	0.51①	-	1.99①	3.40②

* AS and PS represent attractiveness score and progress score, respectively; the number in a circle to the right of every score shows its ranking position, with ① denotes the top-rank position

The progress scoresfor cooperatives are also illustrated in Table 6. For the second level (E^2), the progress scores are obtained when cooperatives in level 1 (One level up) are selected as the context for evaluation. In every level, the lowest progress score is denotedas ①. The high score of progress means that the DMU is requested to develop its inputs largely. In other words, the lower the progress score, the less progress is needed for the respective cooperative to make. Given that cooperative #64 has the high score of attractiveness (Ranked the first and the second in E^3 and E^4, respectively) and the low score of progress (Ranked as the first in E^1), it can be referred to as the best cooperative in the second level (E^2). In contrast, cooperative #63 will be considered as the worst one due to the highest progress score which ranked the sixteenth in E^1. Nevertheless, this cooperative has a better performance due to its attractiveness score (Ranks the second and the sixth positions in E^3 and E^4, respectively). This means that this cooperative needs more progress in business activities compared to others at the same level.

CONCLUSION

The empirical findings of this study reveal that the average technical efficiency obtained by the DEA analysis are fairly low, 0.58 and 0.72 under CRS and VRS, respectively. The returns to scale results show that only 12.5 % of cooperatives are operating their organizations at optimal scales and almost 60% of them are under increasing returns to scale, suggesting that these cooperatives should be larger in scale than they currently are to be more efficient.

The context-dependent DEA approach first clusters the set of cooperatives to seven levels and then attractiveness and progress scores are calculated. Based on these scores, cooperatives are ranked in every efficiency level. The results of the attractiveness scores for cooperatives on the first level with regard to the evaluation context E^2 and E^3 show that cooperative #41 is the most attractive cooperative while cooperative #18 is the least attractive one. In the second level (E^2), cooperative #64 is the best due to the high score of attractiveness and the low score of progress, while cooperative #63 is the worst one due to the highest progress score.

Additional applications of the context-dependent DEA, as well as its adjustments, are recommended to assess efficiency and performance of agricultural cooperatives in Vietnam. The context-dependent DEA would be appropriate tool because it relies on a mathematical programming model such that it would allow the cooperative's officials to evaluate and facilitate the development of agricultural cooperatives; and it would be also useful for farmers to select the best option for their investigation and may lead to follow-up participation based upon the attractiveness scores.

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