Assessing the Operational Efficiency of Agricultural Cooperative in Thailand by Using Super-SBM DEA Approach

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Abstract- Agricultural product always has variability of its price at any time, because there is imbalance between supply and demand of agricultural product in Thailand. Thus, Thai government aims to solve this problem by augmenting agricultural cooperative to every province. This research assesse the data set of operational efficiency in agricultural cooperatives by using Super-SBM DEA approach. Super-SBM DEA approach has been integrated two approaches by combining super-efficiency DEA and SBM DEA. This approach is used to measure and compare the operation in term of efficiency and inefficiency of Decision Making Unites (DMUs) under variable return to scale (VRS). The findings of this research show that more than 80 percent all of Thai agricultural cooperatives have operational inefficiency and there are less than 20 percent have operational efficiency. Therefore, the empirical results can differentiate some problems and benchmarks to members and farmers. This research helps government recognize about the efficiency and inefficiency within all agricultural cooperatives in each province. In addition, it also help agricultural cooperatives where have inefficiency organization improve and increase their efficiency.

Index Terms- operational efficiency, agricultural cooperative, Thailand, Super-SBM DEA

I. INTRODUCTION

Agricultural cooperative has been established and gathered up among who has career is farmer. It was registered with the registrar of Cooperative Promotion Department in Thailand. Agricultural cooperative has operation type on multipurpose, it helps to encourage all members carry out activities together. It also remedies the suffering of occupation of its members and leverages the well-being of its members better of both economic and social under the rule of moral and ethical. Agricultural cooperative in Thailand has been developed like in developing and developed countries. It has been initiated by the government since 1915. The first agricultural cooperative by name Wat Chan Cooperative Unlimited Liability is in Phitsanulok province, it was used to improve the livelihood of small farmers and increased indebtedness problem from farmers who had suffering from the problem of economy and natural disaster such as drought and flood. The sufferings had effect to farmers regarding the inability to paid debts and losing their farmland. This first agricultural cooperative has been used to prevent many farmers lose their farmland by giving loan to owner farmland. These successes of cooperative type had prevailed in the country until 1938 and then there were other cooperative types had responded the people's needs. In 1968, Thai government had strengthened the movement of cooperative by launching the cooperative's enactment. This enactment leaded to establish the cooperative league of Thailand and had the amalgamation program of land improvement land settlement cooperatives, paddy and marketing cooperatives and neighboring small village credit cooperatives. They become a large scale cooperative at district level which provides multipurpose functions as agricultural cooperatives.

Nowadays, Agricultural cooperatives in Thailand has members increase every year from 5,950,809 persons in 2006 to 6,031,344 persons in 2012 because of the farmers got the problems from prices of agricultural products which declined in ever years (The Cooperative Promotion Department, 2016). Farmers didn't have power to bargains high prices from middleman. Thus, this research measures and has objectives to assess the operational performance of agricultural cooperative by comparing the financial statement of all agricultural cooperatives in Thailand. Moreover, this research has made new dataset from improvement of previous dataset both in input and output variables and also identified the benchmarks for improving some inefficiency agricultural cooperatives. The expected outcome of this research is to help boards and member in all Thai agricultural cooperatives realize in term of how to solve and improve the operational efficiency in organization from their benchmarks. Meanwhile, the results of this research can imply the position and direction of business running. According to data analysis, this research has used Super-SBM DEA approach become a tool for measuring the operational efficiency in all agricultural cooperatives. Super-SBM DEA approach has been used to many fields in research area. For instance Super-SBM DEA approach was used in the studying of the regional environmental efficiency evaluation in China. Li et al. (2013) focused on the environmental pollution which obtained the problem from energy consumption of China's fast developing economy and basis of current policies. This research used Super-SBM DEA approach under undesirable outputs to measure regional environmental efficiency during 1991–2001. The empirical results show that China's environmental has low efficiency and its gap between different areas and provinces is large.

This research has organized the rest by separating matters into 5 sections which can be explained as following. Section 2 has been designed to explain the using of Super-SBM DEA

approach which obtain from many previous literatures. Section 3 shows the dataset and overviews of Super-SBM DEA methodology. Section 4 identifies the benchmarks, performance levels and measures operational performance of Thai agricultural cooperatives. Moreover, section 5 exhibits the results of operational efficiency of agricultural cooperative in Thailand. Section 6 concludes and discusses the empirical results of all Thai agricultural cooperative.

II. Literature review

2.1 Agricultural Cooperative

Peter (2007) mentioned that the cooperatives were distinct values and institutional forms which differented from private corporations. The owners of cooperatives were member which had controlled by democratically system. This research considers the trend to lose distinct identity of cooperatives and query about the problem of why this occurs and how the distinct identity of cooperatives can be sustained. It has been summarized by suggesting from the experience of community cooperatives. Novkovic (2008) mentioned that the cooperative was main player in market economies, the value and principles of cooperative were importantly noted in economic literature. The cooperatives were laboratories for social innovation and aid in development in any fields. They can be in low labour areas, oligopoly and prevalent market failures. Özdemir (2005) stated that the important agricultural cooperative types in Turkey were Agricultural Credit Cooperatives (ACCs), Agricultural Sales Cooperatives (ASCs), and Agricultural Development Cooperatives (ADCs). Agricultural cooperatives had a limited impact in the area of economic, social, and industrial development of the country. This research has focused on cooperative–shareholder relations in three major types of cooperatives in Turkey. The results of this research conclude that all members of ADCs have contribution in trading within their cooperatives, because there are 90 percent of members in ASCs and 80 percent in ACCs were trading with their cooperatives. Nilsson (2001) concluded that the cooperatives were often criticized by economists. Most of topics talk about the members do not control in term of management and investments. Organizations in many cooperatives have done and prepared good function for their members. Moreover, Benson (2014) mentioned that the Ethiopia government considered the agricultural cooperatives were important mechanism for increasing productivity and driving farm income. This research considers the performance measurement in financial audit services by assessing the current status of agricultural cooperatives in Ethiopia from the demand and supply of financial audit services of them. This research has objective for reporting and addressing any emerging financial problems in cooperatives.

2.2 Super-SBM DEA

DEA is linear programming and non-parametric approach which has been used to measure of comparable set within decision making unites (DMUs). DEA is a frontier oriented approach use to analyse the efficiency and productive of many fields. Its concept was developed to be CCR model by Charnes, Cooper, and Rhodes in the early 1978. This model adjusted faultless DEA approach which it had implement as a ratio of input-output variables under condition of constant return to scale (Charnes et al. 1978). In 1984, Banker, Charnes, and Cooper had new idea to extend the original work of Charnes by generating the variable return to scale used in DEA approach, then BBC model was used (Banker et al. 1984). Continually, Andersen and Petersen (1993) developed the first super-efficiency DEA model on foundation of radial models. This model had the result of efficiency weight more than one. After that Tone (2001) developed SBM model by considering weight of desirable input and output variables. The SBM model was used to assess the efficiency of feasible input variables into attainable sets of output variables by analyzing the value of slack. After one year, Tone (2002) developed non-redial super-efficiency model by using the SBM model, then the development of this model became the new model (super-SBM model). According to previous studies of Super-SBM model, it had been used to measure the efficiency of both public and private sector. Düzakın, and Düzakın (2007) studied measuring the performance of 500 major industrial enterprises in Turkey by using super slacks based model of data envelopment analysis. This paper shows the results that there are weights of performance more than one. Moreover, Soetanto and Fun (2015) studied the stock performance of manufacturing industry listed in stock exchange of Indonesian by using super-SBM model. The findings show that the highest Super SBM efficiency is a miscellaneous industry and also find that the consumer goods industries are not efficient.

2.3 Input and output variables

Cooperative member is a group of people who has investment and acting together to meet the common needs. Ma and Abdulai (2016) examined the impact of cooperative membership on farm performance. This research has used apple yields, net returns and household income are indicators. The cross-sectional data obtains from a survey of farmers in China. The empirical results show that the cooperative membership is positive and significant impact on all indicators. Moreover, the findings in data analysis can be summarized that small-scale farms belong cooperative have benefit more than medium and large scale of normal farms. Chagwiza et al. (2016) studied the impact of cooperative members among dairy producers in Selale of Ethiopia. They had selection of 10 impact indicators from the proportion between dairy income and total household income, total dairy income, proportion between crossbreed cows and total number of cows in the herd, amount of feed bought, commercialization, price of milk per liter, milk production, milk productivity, price of butter per kg and the share of milk production as depend on the level of the household level. This research minimized the biases by comparing members and non-members. The findings of this research can suggest that when there are different domains of cooperatives' action, they should have different structural trade-offs.

Income is amount of money that has been received during a period of time. It obtains from the exchange between labour and services with the sale of goods. Zhang et al. (2007) stated that competitive agricultural producers were conducted in term of a cooperative where helped members sell their agricultural produce at a higher price then they got high income. Most of cooperatives or producers optimize have total incomes from the sales of output to the cooperative and other activity from their share of earnings.

Milford (2004) mentioned that the open cooperatives had a stronger pro-competitive than the alternative forms of organization. But in contrast, they provided a lower income to its members than a closed membership. Novkovic (2008) summarized that in case of monopsony and oligopoly markets, the cooperative could be created competitive advantage by increasing the price of output. This effect has been used to increases incomes of non-members.

Cost is the value of money that used to be the original resource to produce something. Cost is usually several valuation of (1) material, (2) resources, (3) time and utilities consumed, (4) risks incurred and (5) opportunity. Borgen (2004) stated that cooperative members decided to invest in a cooperatives with an understanding of intergenerational transfers of funds and the transaction costs of the alternatives when they had plan to invest in a cooperative. Novkovic (2006) studied on values and principles of cooperative which impact to decision-making, operational costs, capitalization and productivity. This paper surveyed on a small sample of Canadian cooperatives and found a much wider spectrum of organizations in cooperative. As the findings in this paper, they can confirm the agency theory about the impact of organizational structure in cooperative from accessing the capital and costly decision making.

Profit is the successful activity of business when has calculation from total sales minus by all costs and expenses in its operation. Homer (2005) mentioned that the profit not being important at all cases. In contrast, profit might be presented regarding a problem when wants to maintain a healthy cooperative. Moreover, Novkovic (2006) studied the context of operational cooperative under condition of principles and values. This research tries to show that the profit is the primary goal of such a successful manager. Moreover, it is an indicator of the widespread use of measures in operational cooperative.

III. Research Methodology

This research has proposed the super-efficiency model based on input-oriented under assumption of DMU is SBM efficiency. Moreover, the property of variable return scale (VRS) has been used to be restriction of Super-SBM model. The context of super-efficiency is discussed by the assumption that DMU(x_o, y_o) is SBM-efficiency, i.e., there is expectation that it will be stronger efficient.

Let the set of DMUs be J = {1,2,…,n}, where each DMU has m input and s outputs. This research reveals the vectors of inputs and outputs for DMU_j by giving $x_J = (x_{1j}, x_{2j}, \ldots, x_{mj})^T$ and let $y_j = (y_{1j}, y_{2j}, \ldots, y_{sj})^T$, respectively. Moreover, this research define input and output matrices in the form of X and Y by

$$X = (x_1, x_2, \ldots x_n) \in R^{mxn} \text{ and } Y = (y_1, y_2, \ldots y_n) \in R^{sxn} \quad (1)$$

Assume that all data are positive by X > 0, and Y > 0. Then, the production possibility set under VRS (P) can be defined by

$$P_{VRS} = \left\{ (x, y) | \, x \geq \sum_{j=1}^{n} x_j \lambda_j, 0 \leq y \leq \sum_{j=1}^{n} y_j \lambda_j, \sum_{j=1}^{n} \lambda_j = 1, \lambda \geq 1 \right\} \quad (2)$$

Where $\lambda = (\lambda_1, \lambda_2, \ldots \lambda_n)^T$ is called the intensity vector. Thus, the SBM-DEA model dealing with input-oriented for measuring DMU(x_o, y_o) is as follows.

$$P_I^* = \min 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^-}{x_{io}}$$

Subject to

$$x_{io} = \sum_{j=1}^{n} x_{ij} \lambda_j + s_i^- \ (i = 1, \ldots, m),$$

$$y_{ro} = \sum_{j=1}^{n} y_{rj} \lambda_j - s_r^+ \ (r = 1, \ldots, s),$$

$$\sum_{j=1}^{n} \lambda_j = 1,$$

$$\lambda_j \geq 0, s_j^- \geq 0, s_r^+ \geq 0 \quad (3)$$

Normally, the best performance within DEA approach has full efficiency which denote by 100% or equal 1. In fact, when there are many decision making units (DMUs) that have been used to compare their performance, the original SBM DEA approach cannot provide more accurate efficiency evaluation values. Thus, the combination between super-efficiency model and SBM model has been launched to be Super-SBM model by Tone in 2002. This new model can be exhibited as follow.

$$\delta_I^* = min \frac{1}{m} \sum_{i=1}^{m} \frac{\bar{x}_i}{x_{io}}$$

$$\bar{x}_i \geq \sum_{j=1, j \neq 0}^{n} x_{ij} \lambda_j \ (i = 1, \ldots, m),$$

$$\bar{y}_r \leq \sum_{j=1, j \neq 0}^{n} y_{rj} \lambda_j \ (r = 1, \ldots, s),$$

$$\sum_{j=1, j \neq 0}^{n} \lambda_i = 1$$

$$\bar{x} \geq x_0, \bar{y} \leq y_0, \bar{y} \geq 0, \lambda \geq 0 \quad (4)$$

According to accurate efficiency evaluation values, Super-SBM model may generate the efficiency value more than 100% (or more than 1). These model setup the condition under variable returns to scale (VRS) and has restrictions $\sum_{j=1}^{n} \lambda_j = 1$, in model (1) and $\sum_{j=1, j \neq 0}^{n} \lambda_j = 1$, in model (4) respectively.

3.1 Data selection

This research has been designed to use secondary data of operational cooperative and financial data from 77 agricultural cooperatives of 77 provinces in year of 2012. The input and output variables are considered by following the previous researches of input and output selection. As the definition of Dyson et al. (2001) and Zhou et al. (2008), the screening procedures of input and output variables in this research can be summarized as follow. First step considers suitable inputs and outputs variables that relate with this research. Second step collects all of input and output variables to examine the correlation by using statistics analysis. Third step calculates the numbers of DMUs and consider the DMUs rules, its numbers should larger than the multiple and should be at least two times larger than the amount of the number of input and output variable. As the data set of agricultural cooperatives in Table 3, the numbers of DMUs have been computed from the 77 agricultural cooperatives multiply by one year and then the total of DMUs is 77 DMUs. As the computation in this research, the numbers of DMUs larger than two time of amount of the number of input and output variables. Thus, they are suitable for using in this research. According to descriptive statistics of input and

output variables in Table 1, the distribution of data selection is demonstrated and ensured by arithmetic mean and standard division. Moreover, the correlation coefficients among input and output variables are analysed the relationship in Table 2. The findings in this research can be summarized that all variables have medium correlations among independent variables when consider the standard of correlation coefficients at 0.5. In addition, the results show that there are positive correlation between feasible input and output variables which can be summarized that when input has value increase will effect to the increasing of value in output. Therefore, the findings in Table 2 can be mentioned that all of variables are consistent with the hypothesis of constant return to scale.

Table 1 Descriptive statistics of all Thai agricultural cooperatives

Variable	Maximum	Minimum	Mean	Std. dev.
Input items				
Member	298,060	3,519	78,329	63,506
Income	13,361,535,047	5,599,044	2,135,318,505	2,464,509,266
Costs	13,088,673,128	5,483,683	2,083,957,140	2,428,539,835
Output items				
Profit	272,861,918	-41,176,936	51,361,364	55,748,808

Source: Author's calculations

Table 2 Correlation coefficients among inputs and outputs variables

	Member	Income	Costs	Profit
Member	1			
Income	0.316	1		
Costs	0.306	0.999	1	
Profit	0.650	0.651	0.638	1

Source: Author's calculations

Table 3 Operational statistic of all agricultural cooperatives in Thailand

DMU	Province	Member/ person	DMU	Province	Member / person
DMU1	Kanchanaburi	57,269	DMU40	Udon Thani	148,982
DMU2	Chai Nat	54,992	DMU41	Phetchabun	116,799
DMU3	Nonthaburi	11,240	DMU42	Phrae	83,893
DMU4	Pathum Thani	18,593	DMU43	Kamphaeng Phet	108,754
DMU5	Ayutthaya	50,920	DMU44	Tak	33,577
DMU6	Lop Buri	64,361	DMU45	Nakhon Sawan	116,375
DMU7	Saraburi	37,831	DMU46	Nan	107,515
DMU8	Sing Buri	20,554	DMU47	Phichit	77,784
DMU9	Suphan Buri	90,407	DMU48	Phitsanulok	111,366
DMU10	Ang Thong	39,491	DMU49	Sukhothai	115,294
DMU11	Uthai Thani	57,852	DMU50	Uttaradit	98,172
DMU12	Chanthaburi	44,024	DMU51	Chiang Mai	159,284
DMU13	Chachoengsao	46,746	DMU52	Chiang Rai	169,087
DMU14	Chon Buri	23,739	DMU53	Mae Hong Son	8,691
DMU15	Trad	22,036	DMU54	Phayao	72,292
DMU16	Nakhon Nayok	22,862	DMU55	Lampang	101,304
DMU17	Prachin Buri	33,907	DMU56	Lamphun	67,197
DMU18	Rayong	27,605	DMU57	Krabi	24,805
DMU19	Samut Prakan	6,576	DMU58	Chumphon	51,178
DMU20	Sa Kaeo	48,627	DMU59	Nakhon Si Thammarat	135,036
DMU21	Chaiyaphum	152,807	DMU60	Phangnga	31,718
DMU22	Nakhon Ratchasima	298,060	DMU61	Phuket	3,519
DMU23	Buri Ram	193,576	DMU62	Ranong	15,275
DMU24	Maha Sarakham	165,453	DMU63	Surat Thani	73,283
DMU25	Surin	186,431	DMU64	Trang	49,376
DMU26	Kalasin	131,592	DMU65	Narathiwat	32,852
DMU27	Mukdahan	43,547	DMU66	Pattani	40,380
DMU28	Yasothon	85,031	DMU67	Phatthalung	87,048
DMU29	Roi Et	198,162	DMU68	Yala	24,068
DMU30	Si Sa Ket	197,648	DMU69	Songkhla	97,282

DMU31	Amnat Charoen	64,159	DMU70	Satun	19,343
DMU32	Ubon Ratchathani	282,131	DMU71	Bangkok	7,286
DMU33	Loei	93,018	DMU72	Phetchaburi	48,534
DMU34	Khon Kaen	214,881	DMU73	Nakhon Pathom	33,208
DMU35	Nakhon Phanom	71,090	DMU74	Prachuap Khiri Khan	34,190
DMU36	Bueng Kan	19,109	DMU75	Ratchaburi	40,239
DMU37	Sakon Nakhon	125,246	DMU76	Samut Songkhram	4,824
DMU38	Nong Khai	97,344	DMU77	Samut Sakhon	13,916
DMU39	Nong Bua Lam Phu	68,701		Total	6,031,344

Source: Cooperative Auditing Department, (2016)

IV. EMPIRICAL RESULT

This research aims to use input-oriented super-SBM DEA model for evaluating efficiencies and inefficiencies of operation in 77 agricultural cooperatives of Thailand in year 2012. As the results in Table 4 and Figure 1, the findings show that the agricultural cooperative of Samut Songkhram province (DMU76) has highest operational efficiency more than other provinces. This Samut Songkhram province (DMU76) does not adjust about increasing and decreasing of the quantity within input and output variables. Moreover, the agricultural cooperative of Phuket province (DMU61), Phetchaburi province (DMU72), Nakhon Ratchasima province (DMU22) and Ubon Ratchathani province (DMU32) where have operational efficiency are 5.116, 1.903, 1.489, 1.386 and 1.252, respectively. These four DMUs may be adjusted about the quantity from some input and output variables by using reference set as show in Table 4, for instant Ubon Ratchathani province (DMU32) should be adjusted the operational efficiency by following the benchmark of Nakhon Ratchasima province (DMU22) and Phetchaburi province (DMU72), then Ubon Ratchathani province (DMU32) will has good efficiency. In contrast, Loei province (DMU33), Nakhon Pathom province (DMU35) and Nong Bua Lam Phu province (DMU39) where have operational inefficiency are 0.019, 0.027 and 0.030, respectively. These three DMUs should have adjustment the efficiency in any input and output variables by following the benchmarks from higher operational efficiency DMUs, for instance Loei province (DMU33) should be adjusted in any input and output variables by following the benchmark of Samut Songkhram province (DMU76), then, this DMU will has good operational efficiency and good profit in the further.

Table 4 Efficiency Score and ranking of all DMUs

List of DMU	Score	Rank	Benchmark set	List of DMU	Score	Rank	Benchmark set
DMU1	0.313	29	DMU61, DMU72	DMU40	0.276	36	DMU61, DMU72
DMU2	0.716	12	DMU61, DMU72	DMU41	0.152	56	DMU61, DMU72
DMU3	0.531	18	DMU61, DMU72	DMU42	0.238	45	DMU61, DMU72
DMU4	0.169	54	DMU61, DMU72	DMU43	0.141	60	DMU61, DMU72
DMU5	0.312	30	DMU61, DMU72	DMU44	0.213	50	DMU61, DMU72
DMU6	0.306	32	DMU61, DMU72	DMU45	0.289	34	DMU61, DMU72
DMU7	0.307	31	DMU61, DMU72	DMU46	0.258	38	DMU61, DMU72
DMU8	0.574	16	DMU61, DMU72	DMU47	0.185	52	DMU61, DMU72
DMU9	0.833	9	DMU32, DMU72	DMU48	0.252	40	DMU61, DMU72
DMU10	0.534	17	DMU61, DMU72	DMU49	0.129	62	DMU61, DMU72
DMU11	0.216	49	DMU61, DMU72	DMU50	0.806	10	DMU32, DMU69
DMU12	0.422	21	DMU18, DMU61	DMU51	0.228	47	DMU61, DMU72
DMU13	0.347	26	DMU61, DMU72	DMU52	0.235	46	DMU61, DMU72
DMU14	1.050	7	DMU18, DMU61	DMU53	0.247	42	DMU76
DMU15	0.588	15	DMU61, DMU72	DMU54	0.056	71	DMU61, DMU72
DMU16	0.164	55	DMU61, DMU76	DMU55	0.281	35	DMU61, DMU72
DMU17	0.099	66	DMU61, DMU76	DMU56	0.246	43	DMU61, DMU72
DMU18	1.088	6	DMU14, DMU61	DMU57	0.254	39	DMU61, DMU72
DMU19	0.506	19	DMU61, DMU76	DMU58	0.035	74	DMU61, DMU76
DMU20	0.073	69	DMU61, DMU76	DMU59	0.146	58	DMU61, DMU72
DMU21	0.102	65	DMU61, DMU72	DMU60	0.092	68	DMU61, DMU76
DMU22	1.386	4	DMU32, DMU69	DMU61	1.903	2	DMU61, DMU76
DMU23	0.326	27	DMU32, DMU72	DMU62	0.110	64	DMU76
DMU24	0.246	44	DMU61, DMU72	DMU63	0.126	63	DMU61, DMU72
DMU25	0.376	24	DMU32, DMU72	DMU64	0.296	33	DMU18, DMU61
DMU26	0.259	37	DMU61, DMU72	DMU65	0.143	59	DMU61, DMU76
DMU27	0.068	70	DMU61, DMU76	DMU66	0.170	53	DMU61, DMU76

DMU28	0.050	72	DMU61, DMU76	DMU67	0.601	13	DMU69, DMU72
DMU29	0.399	22	DMU32, DMU72	DMU68	0.152	57	DMU61, DMU72
DMU30	0.589	14	DMU32, DMU72	DMU69	1.000	8	DMU14
DMU31	0.391	23	DMU61, DMU72	DMU70	0.314	28	DMU61, DMU72
DMU32	1.252	5	DMU22, DMU72	DMU71	0.482	20	DMU61, DMU76
DMU33	0.019	77	DMU76	DMU72	1.489	3	DMU2, DMU9
DMU34	0.370	25	DMU32, DMU72	DMU73	0.791	11	DMU61, DMU72
DMU35	0.027	76	DMU76	DMU74	0.040	73	DMU61
DMU36	0.093	67	DMU61, DMU76	DMU75	0.252	41	DMU61, DMU72
DMU37	0.199	51	DMU61, DMU72	DMU76	5.116	1	DMU71
DMU38	0.135	61	DMU61, DMU72	DMU77	0.220	48	DMU61, DMU72
DMU39	0.030	75	DMU76				

Source: Author's Calculation

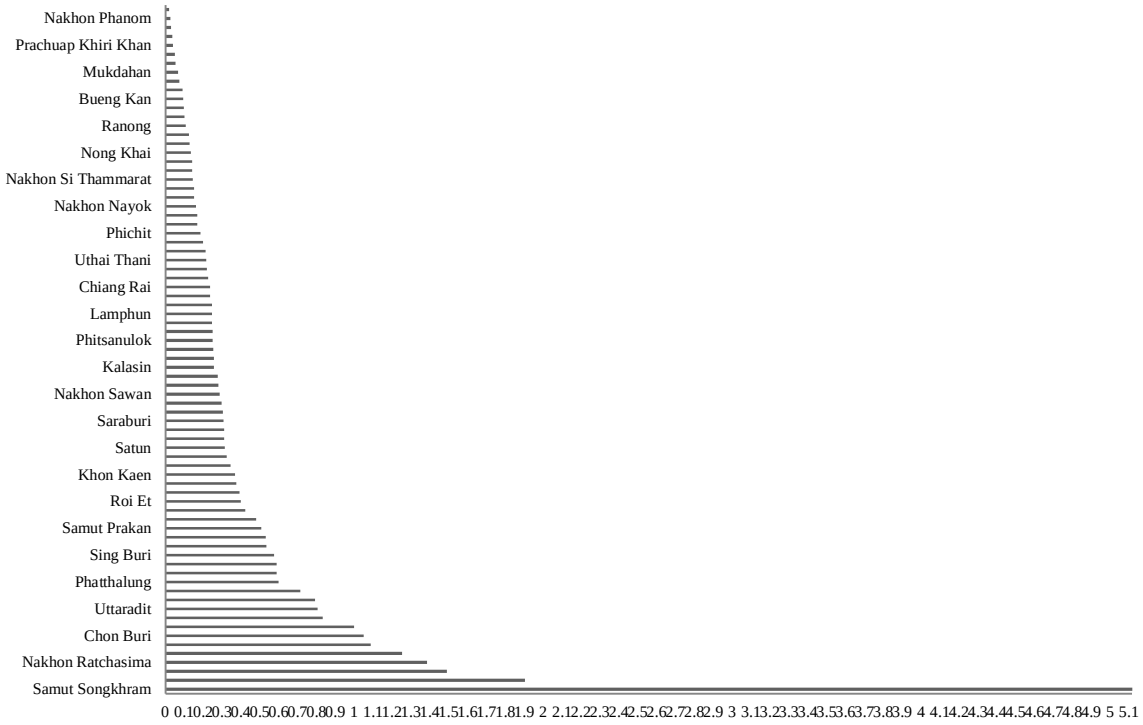

Figure 1 Efficiency score of all DMUs under VRS
Source: Author's Calculation

V. Conclusion and Discussion

This research aims to assessing the operational efficiency of agricultural cooperatives in Thailand. The Super-SBM DEA approach has been integrated from two approaches by using Super-efficiency DEA and SBM DEA. This approach is used to measure and compare the operation of both efficiency and inefficiency from the benchmarks of all DMUs. This approach also uses to rank 77 DMUs of all Thai agricultural cooperatives in year 2012. The findings in this research show that all of input and output variables have medium correlations among independent variables when consider the standard of correlation coefficients at 0.5. Moreover, there are positive correlation between feasible input and output variables which can be summarized that when input has value increase, it will effect to the increasing of value in output. Therefore, all of variables are consistent with the hypothesis of constant return to scale. As the empirical results show that the agricultural cooperative of Samut Songkhram province has highest operational efficiency and following by the cooperative of Phuket, Phetchaburi, Nakhon Ratchasima and Ubon Ratchathani province, respectively. These five DMUs have been often used to reference for identifying the benchmarks to inefficiency DMUs. In contrast, agricultural cooperative of Loei province has lowest operational efficiency when compared with other cooperatives and follow by the agricultural cooperative in Nakhon Phanom and Nong Bua Lam Phu province also have low operational efficiency. These operational inefficiency DMUs should be adjusted the efficiency in any input and output variables by following the benchmarks from higher operational efficiency DMUs

According to the empirical findings, there are more than 80 percent of all Thai agricultural cooperatives have operational inefficiency which lead to generate some problems to members and farmers. Therefore, the empirical results of this research can

help related government knows about the efficiency within all agricultural cooperatives in each province in Thailand. Moreover, this research can help Thai agricultural cooperative where have inefficiency within organization improve and increase their efficiency by considering input and output variables from benchmarks.

REFERENCES

[1] Andersen, P. & N. C. Petersen (1993). A Procedure for Ranking Efficient Units in Data Envelopment Analysis, Management Science, 1261-1264.
[2] Banker R. D., Charnes A., & Cooper W.W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Science, 1078–92.
[3] Benson, T. (2014). Building good management practices in Ethiopian agricultural cooperatives through regular financial audits. Journal of Cooperative Organization and Management, 72-82.
[4] Borgen, S.O. (2004). Rethinking incentive problems in cooperative organizations. The Journal of Socio-Economics, 383–393.
[5] Chagwiza, C., Muradian, R., & Ruben, R. (2016). Cooperative membership and dairy performance among smallholders in Ethiopia. Food Policy, 165-173.
[6] Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units, EurJOper, 429–44.
[7] Cooperative Promotion Department (2016). The annual report year 2012 of Cooperative Promotion Department. Available at: http://www.cpd.go.th/
[8] Dyson R. G., Allen R., Camanho A. S., Podinovski V. V., Sarrico C. S., & Shale E. A. (2001). Pitfalls and protocols in DEA. European Journal of Operational Research, 245-259.
[9] Düzakın, E., and Düzakın, H. (2007). Measuring the performance of manufacturing firms with super slacks based model of data envelopment analysis: An application of 500 major industrial enterprises in Turkey. European Journal of Operational Research, 1412-1432.
[10] Homer, Neil (2005). Implementing a balanced scorecard at Oxford Swindon and Gloucester. Paper presented at the Symposium on Cooperative Accounting, June 2-4, Saint Mary's University, Halifax, NS.
[11] Li, H., Fang, K., Yang, W., Wang, D., & Hong, X. (2013). Regional environmental efficiency evaluation in China: Analysis based on the Super-SBM model with undesirable outputs. Mathematical and Computer Modelling, 1018-1031.
[12] Ma, W., & Abdulai, A. (2016). Does cooperative membership improve household welfare? Evidence from apple farmers in China. Food Policy, 94-102.
[13] Milford, A. (2004). Coffee, Cooperatives and Competition: The Impact of Fair Trade. CMI Report R 2004, 6. Chr. Michelsen Institute, Bergen, Norway. Available at: http://www.cmi .no/publications April 2007.
[14] Nilsson, J. (2001). Organisational principles for cooperative firms. Scandinavian Journal of Management, 329-356.
[15] Novkovic, S. (2006). Cooperative business: the role of cooperative principles and values. Journal of Co-operative Studies, 5–16.
[16] Novkovic, S. (2008). Defining the cooperative difference. The Journal of Socio-Economics, 2168-2177.
[17] Özdemir, G. (2005). Cooperative–shareholder relations in agricultural cooperatives in Turkey. Journal of Asian Economics, 315-325.
[18] Peter, S. (2007). Co-operative identity. Journal of Cooperative Studies, 5-17.
[19] Soetanto, T. V., & Fun, L. P. (2015). Super Slack-Based Model Efficiency and Stock Performance of Manufacturing Industry Listed in Indonesian Stock Exchange. Procedia - Social and Behavioral Sciences, 1231-1239.
[20] Tone, K. (2001). A slacks-based measure of efficiency in data envelopment analysis, European Journal of Operational Research, 498-509.
[21] Tone, K. (2002). A slacks-based measure of super-efficiency in data envelopment analysis, European Journal of Operational Research, 32-41.
[22] Zhang, J., Goddard, E., & Lehrol, M., (2007). Estimating pricing games in the wheat-handling market in Saskatchewan: the role of a major cooperative. In: Novkovic, S., Sena, V. (Eds.), Advances in the Economic Analysis of Participatory and Labor-Managed Firms. Co-operative Firms in Global Markets: Incidence, Viability and Economic Performance, 151–18.
[23] Zhou. P., Ang. B. W., & Poh. K. L. (2008). A survey of data envelopment analysis in energy and environmental studies. European Journal of Operational Research, 1-18.

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