Evaluating business performance of agricultural cooperation groups with Data Envelopment Analysis

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Abstract

Agricultural cooperation groups in Taiwan have permanently been the primary units for agricultural economy production, learning, and knowledge exchange and, under the planned counseling of the government, are still responsible for the development of local agriculture. This is the era of global competition and knowledge economy, while the transition and development of agricultural cooperation groups play the critical role in agriculture in Taiwan facing the challenge of knowledge innovation, breaking through old business modes, and further developing competitive innovative brand in the future. Accordingly, this study intends to deeply understand the factors in the business performance of agricultural cooperation groups and expects to provide successful cases of agricultural cooperation groups moving towards corporate management in Taiwan. Data Envelopment Analysis is applied to evaluate the efficiency, and Sensitivity Analysis is utilized for analyzing and searching for the key factors in the management of agricultural cooperation groups. The research results show that 2 DMUs present strong form efficiency, with the efficiency=1, 5 DMUs display marginal inefficiency, with the efficiency between 0.9 and 1, and 11 DMUs appear obvious inefficiency, with the efficiency less than 0.9. It is expected that this study would provide agricultural cooperation groups in Taiwan with successful cases of corporate management.

Keywords: Agriculture. Business Performance. Data Envelopment Analysis. Agricultural Cooperation Groups. Economic benefits

1. Introduction

Because of restricted natural resources, actively expanding the international trade space is important to enrich the nation and the citizens in Taiwan. Global trade liberalization

has become a trend, and the world trade moving towards liberalization, facilitation, and institutionalization is inevitable. Any nations in the world would not completely prohibit certain agricultural produce from import in order to protect the agriculture.

In face of such an international situation, it is essential to apply liberalization to agriculture. To cope with the trend of internationalization, Council of Agriculture, Executive Yuan, requests Agriculture and Forest Agency and relevant units to review various agricultural promotion or cooperation organizations in past years so as to establish systematic agricultural promotion organizations and modern agricultural production and marketing counseling system to effectively apply agricultural resources to cope with the impact of trade internationalization and liberalization. It becomes the focus for the management of agricultural production and marketing in Taiwan.

Petty farmer management with fragile land has been the major style of the agricultural management in Taiwan. Nevertheless, such family farms with narrow operation scales have become the bottleneck of agricultural development. In order to expand the operating area of farms so as to reduce production costs, agricultural affair units combined limited land, labors, and cooperative applications as well as integrated machines and materials through agricultural affair teams, collaboration, and collective agriculture to expand operation scales and promote education since 1952.

To cope with the impact of Taiwan joining in World Trade Organization on agriculture, agricultural affair units helped agricultural cooperation groups expand the operation scale to achieve the operation efficiency of “small but beautiful, beautiful and strong”. Apparently, promoting the competitiveness of agricultural cooperation groups has become a primary policy for agricultural affair units. Nonetheless, the development of knowledge-based agricultural industry has some villages input explicit knowledge and tacit knowledge to the production to enhance the quality of agricultural produce and allows the agricultural produce presenting local brands through marketing.

Agricultural organizations therefore should grasp such an opportunity to develop the corporate systems of agriculture, thoroughly develop quality agriculture, reinforce corporate management, seek for core competitiveness, and adjust the industrial structure of agriculture to enhance the competitiveness of advantageous industry. Consequently, this study aims to deeply understand the factors in the business performance of agricultural cooperation groups and provide agricultural cooperation groups with successful cases of corporate management.

2. Literature Review

2.1. Agricultural cooperation groups

Agricultural cooperation groups used to be cooperative management groups (Shen, Chen & Zhang, 2012). Starting from the establishment of the comprehensive agricultural research group in 1952, cooperative management groups taught new farming techniques. Farmers were then taught to collaboratively operate new technologies in 1953.

It was renamed the cooperative cultivation group and the comprehensive paddy cultivation group in 1963 and 1966, respectively. The cooperative management group was organized with farmers as the core since 1971. Cooperative management groups used to be commonly promoted and became the primary units for local agriculture development, when agricultural land was utilized by comprehensive planning in 1985.

Counseling Methods for Agriculture Cooperation Organizations was formulated in December, 2001, to enhance corporate, informational, and systematic management.

Agricultural Development Act, revised on January 13 of 2003, formally defined agricultural cooperation groups as "an agricultural organization which is voluntarily formed and managed by farmers together whose lands are adjacent or close to each other, or manage the same type of agricultural activities" (Hu, 2014).

Lu, Huang, Chang & Chien (2010) concluded the key development of agricultural cooperation groups as following.

Healthy organizational system of cooperation groups.

- A cooperation group counseling system is planned the assignment of responsibilities among the central government, province, counties, and towns;
- The internal organizational structure of an cooperation group including the members of the president, vice president, clerk, accountant, and sub-groups for production and marketing operation is established;
- The cadres are elected by the group members;
- Regular meetings are held for decision making and inquiries;
- Members could freely join in and quit the group, but follow the convention and code of practice;
- A location for education, activities, meeting, exchange, production and marketing information center is established for the foothold and the sense of belonging;
- Members are cultivated to develop the leadership, planning, and management

capabilities.

Promotion of operating abilities of cooperation groups

- In the beginning of establishment, counseling units would intervene in a cooperation group by offering necessary training, observation, and instruction to establish the organizational scale and operation model;
- The training is divided into three phases, including preliminary training, higher level training, and advance training. In addition to training plans, technical observation among the same industry and instructions beyond agriculture are observed;
- The finance, information processing, and collection and application are assisted as needed;
- Cooperation groups are assessed the operation annually.

Promotion of corporate management.

- The basic 5s movements and reasonable management are developed from the internal management of cooperation groups;
- Basic financial management systems are established for collaborative management and application;
- A production goal combined with production plan, marketing plan, product processing plan, and human resource plan is set for an energetic production group;
- Large-scale management with labor reduction and automation is promoted;
- Market consumer oriented new products, brand, and image are developed;
- Each part from production to sales and organizational growth stages are diagnosed and improved by academic experts;
- Based on the counseling model of China Productivity Center for corporate development, corporate management is introduced to the preliminary production and marketing organizations to establish systems and counseling models;
- An agricultural enterprise focuses on commercialization of agricultural products and collaborative management by cooperation group members;
- Agriculture from first-level industry is enhanced to second-level and third-level industries;
- The cooperation group cadres are cultivated the concepts, attitudes, and methods as corporate managers and entrepreneurs.

Production and marketing information for sales channels

- Cooperation groups are counseled to prepare necessary information processing and communication devices, like computers and fax machines;
- Cooperation groups in same industries are assisted to establish the production and marketing network;
- Production and marketing conference for different industries is held to exchange opinions in production and marketing information markets;
- Cooperation groups are helped to establish sales channels and select the marketing closest to consumers, such as direct sales, lists in supermarkets, offer to agricultural produce processing centers, collaborative marketing to cities, and wholesalers;
- Various exhibitions and promotion are conducted to actively promote products to consumers.

2.2. Business performance

Business performance refers to the degree of an organization achieving the strategic objectives. For evaluating performance, various evaluation dimensions have been proposed by researchers, while most of them regard performance as the measurement of objectives being achieved; the execution of strategies and activities aims to promote "performance" (Chandler & Vargo, 2011).

Edvardsson et al. (2011) measured with single standard and regarded the achievement of an organization as the final standard, such as the factors of productivity, net profits, organizational growth, and stability. Grönroos (2011) indicated that few performance evaluations were comparatively easy for investigation and analyses, while special necessity could be designed and operated. However, according to such indicators, the intervened angle, level, and applicable organizations are distinct, and the relationship was not clear.

Aiming at the drawback of univariate, Homburg et al. (2010) applied a series of indicators to evaluate performance in order to avoid personal subjective deviation and discussed the relationship among variables. Such a method aimed at different organizational functions being evaluated with distinct characters and both the process and results being considered for business performance. Steers organized 17 multiple efficiency indicators,

where “adaptation-flexibility” appeared the most, followed by productivity and satisfaction (Greg et al., 2013).

Lusch (2011) divided the measurement of performance into the evaluation of subjective and objective data. Akaka et al. (2013) considered that accurately acquiring data was not easy, especially some data related to performance; besides, data errors could be generated because of different accounting procedures; subject evaluation therefore could be used for replacing the evaluation of objective data. It was therefore suggested that subject approach could be compared with industrial competitors when proper objective data could not be acquired; however, objective data should be based as much as possible (Vargo et al., 2010).

McColl-Kennedy et al. (2012) mentioned that measuring the business performance of agricultural cooperation groups should particularly stressed on performance indicators and performance standards. The selected performance indicators should be able to present an organization or the performance of strategic operation; the performance standard, on the other hand, stood for the anticipation to objective contributions and could respond the contribution of an organization or the strategic operation (Vargo & Lusch, 2010).

In regard to the business performance evaluation of agricultural cooperation groups, a lot of researchers proposed various performance evaluation indicators and benefits. Lo (1984) proposed the contents of cooperative management:

- Economic benefits, including to enhance production volume, reduce production cost, increase net income, enhance productivity, and promote agricultural income and farmer income (Vargo & Lusch, 2011);
- Technical benefits, containing various farming techniques and enhancing technical standard;
- Social benefits, referring to the participation of farmers and the interaction among farmers;
- Organizational benefits, the group spirit of members and the integration of groups (Vargo & Akaka, 2012).

McColl-Kennedy et al. (2012) proposed the following performance indicators for agriculture cooperation organizations:

- Economic performance, analyzing an entire set of indicators with finance;
- Social (public) performance, measuring the effect of an enterprise practicing

social responsibilities (Vargo & Lusch, 2012);

- Organizational performance, measuring the interaction among members in the cooperation organization.

Accordingly, the performance evaluation of agricultural cooperation groups should take various economic, social, and organizational indicators into account for the actual achievement of a cooperation group to the operation objectives (Wennerholm, 2012).

3. Research design

3.1. Screening of input and output

To combine the selection of inputs and outputs with expert opinions, reduce input costs, and avoid fuzziness, Modified Delphi Method is utilized for screening inputs and outputs. For special considerations, brainstorming open questionnaire is eliminated; and, a structural questionnaire, for the first run questionnaire survey, is developed after referring to large quantity of literatures for the revision.

It is Modified Delphi Method, which direct uses the structural questionnaire for the first run survey, could reduce time and have experts focus on the research subject, without making guesses on open questionnaires.

Total 16 copies of questionnaires are distributed, and 12 valid copies are retrieved, with the retrieval rate 75%. The variables used in this study are open statistical data from Ministry of Interior. The variables are defined as below.

Inputs:

- Number of years: Number of operation years of a cooperation group.
- Number of people: Number of members in a cooperation group.

Outputs:

- Operating area: Operating area of a cooperation group.
- General assets: General assets of a cooperation group.
- Sales volume: Annual sales volume of a cooperative operation (growth rate of sales income).

3.2. Efficiency evaluation and analysis

From the aspect of economics, the fewer inputs but more outputs of an operation unit reveals the better "performance"; such a performance measurement could have "efficiency" be the evaluation standard. From the comparisons of inputs and outputs, efficiency is defined efficiency＝weighted sum of outputs/weighted sum of inputs.

The maximum output function is called "production function", which is generally smaller than the yield of production function. Production function is the maximum frontier of distinct production that it is called "production frontier". The geometric meaning of efficiency reflects the inputs and outputs of an evaluated decision-making unit with the principle of envelope to evaluate the relative efficiency, find out the efficiency envelope of all observed data, form the efficiency frontier, and calculate the distance between the observed value of individual decision-making unit and the efficiency envelope for the relative efficiency standard.

Data Envelopment Analysis (DEA) is used for evaluating efficiency in this study. It envelops the data of various samples and tries to find out the relationship that it presents the advantage for a favorable efficiency evaluation model. Linear planning, considering that the evaluated units could use it for measuring the performance, is applied in the method, and units with similar characteristics are compared the performance.

Farrell (1957) replaced "non-preset production function" with common "preset function" to estimate efficiency and calculated the production efficiency frontier, i.e. efficiency production function, with mathematical planning. Farrell proposed two contents of efficiency. Technical efficiency (TE) reacted under fixed inputs to acquire the maximum outputs; and, allocative efficiency (AE), or price efficiency (PE), reacted under fixed input prices to use the inputs for the optimal proportion. Under the assumptions of constant returns to scale and constant input price, Farrell divided overall efficiency into technical efficiency, related to real inputs and outputs, and allocative efficiency, related to the optimal elements. The multiplication of the two was the total economic efficiency.

The application was based on the following hypotheses. 1. Production frontier was the most efficient evaluated unit, and inefficient units were under the frontier (on the right back of the frontier). 2. Production frontier was convex and the slope of each point appeared negative. 3. Outputs and inputs presented constant returns to scale.

4. Empirical analysis of business performance of agricultural cooperation groups

4.1. Analysis of public sectors developing local sustainability

Various input/output indicators are substituted to CCR and BCC models to calculate the total production efficiency and pure technical efficiency of agricultural cooperation groups in different counties and cities; such two values are further divided by each other to acquire the returns to scale of agricultural cooperation groups in different counties and cities. The total production efficiency, pure technical efficiency, and scale efficiency are organized in Table 1.

From Table 1, Tainan City and Changhua County, with the total production efficiency=1, are relatively efficient county and city. The rest counties and cities, with lower production efficiency, are relatively inefficient, especially Chiayi City showing the lowest total efficiency. In other words, 16 DMUs are relatively inefficient, except the ones with relative total production efficiency 1. It needs further analysis whether the inefficiency is caused by not effectively applying inputs or not achieving the optimal production scale.

Table 1: Relative efficiency of business performance of agricultural cooperation groups

Agricultural cooperation groups in counties and cities	Total efficiency	Technical efficiency	Scale efficiency
Taipei City	0.73	0.76	0.70
Taichung City	0.90	0.91	0.89
Tainan City	1.00	1.00	1.00
Kaohsiung City	0.92	0.92	0.92
Hsinchu City	0.71	0.75	0.68
Chiayi City	0.66	0.64	0.67
Taoyuan County	0.78	0.77	0.78
Hsinchu County	0.80	0.79	0.81
Miaoli County	0.88	0.87	0.89
Changhua County	1.00	1.00	1.00
Nantou County	0.93	0.94	0.92
Yunlin County	0.86	0.85	0.86
Chiayi County	0.95	0.93	0.96
Pingtung County	0.97	0.96	0.98
Yilan County	0.84	0.84	0.85
Hualian County	0.75	0.76	0.75
Taitung County	0.82	0.83	0.81
Penghu County	0.70	0.70	0.70

4.2. Sensitivity Analysis

Sensitivity Analysis is applied to analyze and find out the key factors in the management of agricultural cooperation groups. By gradually removing inputs and outputs, DEA is practiced to understand the efficiency sensitivity. Taking the sensitivity rate of change as the evaluation basis, the research results show the sensitivity factors of number of years, number of people, operating area, general assets, and sales volume.

From Table 1, counties and cities with better total efficiency on the business performance are the ones with better sales volume efficiency. Apparently, this study could assist agricultural cooperation groups in controlling and managing the risk factors in the business development for the smooth development. From Table 2:

- After removing "number of years", the efficiency of all DMUs is lower than original efficiency, presenting the higher importance of number of years to all DMUs.
- After removing "number of people", the efficiency of all DMU is lower than original efficiency, revealing the higher importance of number of people to all DMUs.
- After removing "operating area", the efficiency of all DMUs is lower than original efficiency, showing the higher importance of operating area to all DMUs.
- After removing "general assets", the efficiency of all DMUs is lower than original efficiency, revealing the higher importance of general assets to all DMUs.
- After removing "sales volume", the efficiency of all DMUs is lower than original efficiency, presenting the higher importance of sales volume to all DMUs.

Table 2: Sensitivity Analysis of gradually removing single input and output

DMU	Original relative efficiency	Removing number of years	Removing number of people	Removing operating area	Removing general assets	Removing sales volume
Taipei City	0.73	0.70	0.72	0.68	0.72	0.65
Taichung City	0.90	0.86	0.85	0.82	0.86	0.84
Tainan City	1.00	0.99	0.83	0.85	0.92	0.87
Kaohsiung City	0.92	0.88	0.86	0.85	0.89	0.85
Hsinchu City	0.71	068	0.64	0.67	0.66	0.62
Chiayi City	0.66	0.64	0.63	0.64	0.62	0.60

Taoyuan County	0.78	0.76	0.75	0.74	0.72	0.73
Hsinchu County	0.80	0.74	0.76	0.72	0.71	0.78
Miaoli County	0.88	0.83	0.85	0.82	0.81	0.84
Changhua County	1.00	0.86	0.87	0.90	0.91	0.87
Nantou County	0.93	0.81	0.80	0.79	0.83	0.77
Yunlin County	0.86	0.80	0.75	0.78	0.81	0.78
Chiayi County	0.95	0.84	0.83	0.86	0.81	0.80
Pingtung County	0.97	0.86	0.80	0.82	0.75	0.76
Yilan County	0.84	0.73	0.71	0.75	0.70	0.72
Hualian County	0.75	0.69	0.62	0.64	0.67	0.65
Taitung County	0.82	0.71	0.74	0.78	0.79	0.72
Penghu County	0.70	0.65	0.67	0.63	0.68	0.63
Number of efficient DMUs	2	0	0	0	0	0

Data source: Self-organized in this study

5. Conclusion and Suggestion

According to the efficiency acquired from DEA and the information from variables, agricultural cooperation groups in 2 DMUs appear strong form efficiency, with the efficiency=1, about 11.1% of all DMUs, showing the better efficiency. Agricultural cooperation groups in 5 DMUs present marginal inefficiency, with the efficiency between 0.9 and 1, about 27.8% of all DMUs, presenting the efficiency of agricultural cooperation groups in such counties and cities being easily enhanced.

Agricultural cooperation groups in 11 DMUs appear obvious inefficiency, with the efficiency lower than 0.9, about 61.1% of all DMUs, where agricultural cooperation groups in Chiayi City reveals the lowest efficiency. The analysis with DEA presents certain production and marketing quantity of the members in agricultural cooperation groups that the collaborative sales volume would appear certain degree of growth after adding in cooperation groups.

Furthermore, the counseling and subsidies from the government and agricultural affair units could rapidly accumulate the input of resources that cooperation groups could rapidly change from the establishment to the growth. It conforms to the research result of less influence of number of years.

According to above research results, the following suggestions are proposed for agricultural cooperation groups:

- Formulation and practice of convention for agricultural cooperation groups. The primary work for agricultural cooperation groups is to ensure the organizational norms, objectives, and rules. Organizational norms involve in organizational value orientation and constraints that they need to be clarified for the members of agricultural cooperation groups to follow or avoid. When confirming organizational norms, objectives, and rules, the meanings and reasons should be explain publically for the actual understanding and acceptance of the members. Being ambiguous or cursory could result in misunderstanding or unwillingness to accept. Most importantly, the formulation of organizational convention should have all members of agricultural cooperation group participate in and make decisions. Making decisions simply by few representatives is considered as monopoly or arbitrary.
- Measures to reduce production and marketing costs. The cooperative purchase of production and marketing materials are mostly purchased by the members of agricultural cooperation groups. It is suggested that the members' demands for production and marketing materials could be integrated to collectively bargain with manufacturers so as to reduce the purchase costs. Moreover, the collaborative use and operation of equipment could be negotiated and assisted by counseling units; future purchase of new farming equipment could be purchased by agricultural cooperation groups; besides, the harvest period could be negotiated with the members in order to increase the exchange working hours and enhance the collaboration and utilization as well as reduce production costs.
- Product marketing and quality control. Current brand use and grading & packaging in agricultural cooperation groups present favorable performance, and self-created brand or the brand offered by farmers' associations is used for sales and package. However, it is worth noticing that the collection of marketing information and cooperative marketing are inadequate; most agricultural

cooperation groups still allow personal marketing and sales of the members. It is suggested that agricultural cooperation groups could reinforce the counseling and provide effective marketing information as well as reinforce the promotion of cooperative marketing so as to enhance the sales of agricultural produce and the sales prices to increase the members' benefits.

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