An Assessment of the Impact of Strategic Alliances in Food Processing on the Technical Efficiency of Housewives Groups in Thailand

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Abstract— **The cottage food processing industry in Thailand comprises mainly small-scale enterprises such as the 'housewives groups' that consist of a number of housewives who combine their food processing activities in a particular district or village. The effects of various factors on the performance of these housewives groups is assessed using survey data to estimate a stochastic input distance model. Our results show that membership of vertical strategic alliances at a high level is associated with higher levels of technical efficiency. Other factors positively influencing technical efficiency within these groups are the level of experience of group members, the ratio of workers to total members, government support, the community base of the group as opposed to private ownership, and the availability of funds to invest in business activities that have been derived from savings activities by group members. The ability of housewives groups to exploit cost complementarities by combining fruit and vegetable processing activities is tested by estimating scope and diversification economies for fruit and vegetable processed outputs. While diversification economies were found to exist, the more rigorous test for scope economies did not support their existence.**

Keywords—**Housewives group, scope economies, strategic alliance**

I. INTRODUCTION

The food industry in Thailand comprises various types of food manufacturers, including local processors who produce so-called 'cottage foods'. The cottage food processing industry mainly comprises enterprises such as the 'housewives groups' that combine their resources to undertake food processing activities in a particular district or village. Most of these groups are community-based but some are privately owned operations.

Housewives groups in northern Thailand produce a variety of fruit-based and vegetable-based cottage foods, and have used strategic alliances as one of their key strategies to retain their competitive advantage. We report the results of an analysis of the impacts of strategic alliances entered into by these housewives groups on the technical efficiency of their operations, building on an earlier analysis by Nonthakot, Villano and Fleming [1]. Our analysis departs from that by Nonthakot et al. [1] in that we conduct a multi-output analysis, which enables scope economies in food production to be estimated, and we include a wider range of efficiency variables. The paper is organized as follows. In the next section, a brief description is provided of housewives groups, along with the nature and structure of strategic alliances in Thailand. Section 3 contains the conceptual framework of the study, details on the model to be estimated and a description of the efficiency variables included in the model. An outline of the data is given in section 4. The empirical estimates and results of the tests of propositions are presented and discussed in section 5, and conclusions are drawn in the final section.

II. HOUSEWIVES GROUPS AND THEIR STRATEGIC ALLIANCES IN THAILAND

A housewives group is defined as rural women who combine into a group to share knowledge, money and their labour. The original purposes of such groups were to help each other achieve welfare, health and family goals through activities such as food processing, art work and handicrafts. First set up in 1975, the housewives groups have recently encountered problems brought about by the varying abilities among groups to develop their commercial activities and threats to their business operations from both new entrants and large commercial food processors [1].

Nonthakot et al. [1] reported that the housewives groups suffer from a number of weaknesses that threaten the viability of their businesses. They noted that these weaknesses are broadly similar to those faced by all small- and medium-sized enterprises engaged in food processing throughout Asia. First, small-scale producers often achieve suboptimal levels of production because of a lack of suitable machinery and inadequate quality control systems. Technologies used are simple and usually labour-intensive, and the pace of innovation is slow. These deficiencies are expected to be especially a problem for seasonal producers (those groups that produce for only part of the year when locally produced agricultural products are in season). Second, the groups lack access to information, especially about input supply and product marketing activities. This problem is also likely to be more acute for seasonal producers who are likely to be less knowledgeable about the industry. Third, groups lack of business scope and find it difficult to exploit scope economies. Fourth, they often do not have regular orders for their products and lack good marketing practices. Finally, difficulties are encountered in sourcing inputs because of variations in seasonal conditions, high perishability, high transport costs and irregular availability of infrastructural facilities. Sourcing raw materials is likely to cause most problems to year-round producers during the off-season for many agricultural products.

Strategic alliances have emerged as a means of countering these weaknesses. In this paper, we aim to answer the question: do these strategic alliances benefit the housewives groups by overcoming the weaknesses noted above and enable them to improve the technical efficiency of their operations?

Besanko et al. [3, p. 149] defined a strategic alliance ‘as a way to organize complex business transactions collectively without sacrificing autonomy’. These alliances come about when two or more independent organizations cooperate by sharing their goals, strategies and knowledge to achieve profit [4], or indeed other forms of benefit if the definition is expanded to include organizations other than business firms.

Ketchen and Hult [5] posited that strategic alliances have become more important as growing rivalry between supply chains has encouraged the emergence of ‘best value supply chains’. Individual firms benefit from belonging to such a supply chain as it increases its value and this additional value is distributed among its members.

According to Nonthakot et al. [1], housewives groups commenced their involvement in strategic alliances in 2004, entering into either horizontal or vertical strategic alliances. Vertical alliances include all relationships between firms at different levels in the supply chain while horizontal alliances take place among organizations at the same level in the chain or with other groups such as research institutes and government agencies.

Nonthakot et al. [1] reported the findings of previous studies, supported by results from their own empirical analysis, that vertical alliances should serve producers in a food supply chain better than horizontal alliances. This expected outcome derives from the greater potential for developing a ‘best value supply chain’ involving retailers, manufacturers, distributors and farmers. Nonthakot et al. [1] also reported evidence that alliances involving high-level (provincial and regional) cooperation have a stronger positive effect on technical efficiency than alliances involving low-level (village, district and sub-provincial) cooperation.

Strategic alliances are also used for public relations and for advertising *One Tumbon One Product* (OTOP) brands, which are a measure of product quality. They can also involve financial operations that result in sharing money and capital for investment in business operations such as food processing. Finally, groups engage in the development of their human resources through training and the sharing of knowledge.

III. ANALYTICAL METHOD

A multiple-output, multiple-input stochastic input distance function is estimated to capture the production technologies of the processing enterprises of housewives groups. This method assumes a translog functional form for the relationships between inputs and outputs among best-practice processors.

Following Coelli and Perelman [2], the translog input distance function is defined as:

$$\begin{aligned}\ln d_1 &= \beta_0 + \sum_{m=1}^{5}\beta_m \ln X_m + \sum_{n=1}^{2}\alpha_n \ln Y_n \\ &+ 0.5\sum_{m=1}^{5}\sum_{m'=1}^{5}\beta_{mm'} \ln X_m \ln X_{m'} \\ &+ 0.5\sum_{n=1}^{2}\sum_{n'=1}^{2}\alpha_{nn'} \ln Y_n \ln Y_{n'} \\ &+ 0.5\sum_{m=1}^{5}\sum_{n=1}^{2}\varpi_{mn} \ln X_m \ln Y_n + \sum_{k=1}^{2}\phi D_k\end{aligned} \tag{1}$$

where X_m is the m-th input, Y_n is the n-th output, and α, β, ω and ϕ are parameters to be estimated.

We set $-\ln d_1 = v - u$ in equation (1) and impose the restriction required for homogeneity of degree +1 in inputs ($\Sigma\beta_m = 1$) to obtain the estimating form of the stochastic input distance function:

$$
\begin{aligned}
-\ln X_1 = {} & \beta_0 + \sum_{m=1}^{4}\beta_m(\ln X_m / \ln X_1) + \sum_{n=1}^{2}\alpha_n \ln Y_n \\
& + 0.5\sum_{m=2}^{5}\sum_{m'=2}^{5}\beta_{mm'}(\ln X_m / \ln X_1)(\ln X_{m'} / \ln X_1) \\
& + 0.5\sum_{n=1}^{2}\sum_{n'=1}^{2}\alpha_{nn'} \ln Y_n \ln_{n'} \\
& + 0.5\sum_{m=2}^{5}\sum_{n=1}^{2}\varpi_{mn}(\ln X_m / \ln X_1)\ln Y_n + \sum_{k=1}^{2}\phi D_k + v - u
\end{aligned}
\quad (2)
$$

where X_1 is production inputs (in baht); X_2 is labour inputs (in baht); X_3 is marketing inputs (in baht); X_4 is managerial inputs (in baht); X_5 is the value of group assets (in baht); Y_1 represents the total fruit processing revenue per year (in baht); Y_2 represents the total vegetable processing revenue per year (in baht); and αs and βs are unknown parameters to be estimated. The vs are assumed to be independently and identically distributed with mean zero and variance, σ_v^2; and the us are technical efficiency effects that are assumed to be half-normal and independently distributed such that u is defined by the truncation at zero of the normal distribution with known variance, σ_u^2.

The inputs are implied inputs in that they are measured as costs assuming all groups face the same input prices and no changes occurred in input prices during the period when the survey was undertaken. Similarly, outputs are implied outputs in that they are measured as revenue assuming all groups face the same output prices. Dummy variable D_1 is used for the incidence of zero observations in the managerial inputs variable so that the appropriate parameters of production functions can be estimated in an unbiased way [6]. D_2 is a dummy variable for location of the group in the northern region, with a value of 1 if the group is located in the lower north and 0 if it is located in the upper north. The inclusion of this variable is to take account of the more favourable conditions for the supply of raw materials and better infrastructural facilities and services that exist in the lower north.

We employ the method developed by Hajargasht, Coelli and Rao [7] to estimate the economies of scope parameter. The condition for scope economies for each pair of outputs in the production system is defined by Hajargasht et al. [7] as:

$$\left\{D_y D_y{}' + D_{yx}\left[D_{xx} + D_x D_x{}'\right]^{-1} D_{xy} - D_{yy}\right\} < 0 \quad (3)$$

where y represent outputs and x represent inputs. A significantly negative sign on the parameter indicates the presence of scope economies. This test result for scope economies is compared with the result for the weaker test of diversification economies defined by Coelli and Fleming [8] as the second cross partial derivative of the output variables (D_{yy} in equation (3)). A positive value in the latter case is a necessary *but insufficient* condition for the presence of scope economies; if it is significantly negative, it is a necessary *and sufficient* condition for the presence of scope diseconomies.

Some additional variables to those included by Nonthakot et al. [1] were tested for inclusion in the technical inefficiency model. We follow Battese and Coelli [9] in defining the model as:

$$u_i = \delta_0 + \sum_{j=1}^{19}\delta_j Z_{ji}, \quad (4)$$

where: the δ_j (j = 0, 1,…, 19) are unknown parameters; Z_1 is the number of processed products; Z_2 is the quality levels of products designated by OTOP; Z_3 is years of group establishment; Z_4 is years of business establishment; Z_5 is the level of education of the group leader; Z_6 is the experience of the group leader; Z_7 is mean age of group members; Z_8 is mean number of years schooling of group members; Z_9 is the number of years of business experience of group members; Z_{10} is the ratio of workers to all group members; Z_{11} is the level of borrowing by the group; Z_{12} is the level of government support; Z_{13} is the number of marketing channels used by the group; Z_{14} is the level of membership of an alliance; Z_{15} is a dummy variable for horizontal alliance; Z_{16} is a dummy variable for dividends paid to group members; Z_{17} is the type of management used; Z_{18} is the time allocated by group members to other activities; and Z_{19} is the amount of funds for business investment provided by the saving sub-group in the housewives group.

The variance parameters, σ_v^2 and σ_u^2, are replaced by $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ and $\sigma_s^2 = (\sigma_u^2 + \sigma_v^2)$. The input distances are predicted as $d_i = E[\exp(u)|e]$, where $e = v - u$ [2].

The sign on the coefficient of the number of processed products variable is expected to be negative (that is, lower technical inefficiency) because housewives groups with a variety of product lines can respond more readily to consumer demand. The sign on the coefficient of the OTOP product quality variable is also expected to be negative: if firms can control the quality of their products, they should receive higher product prices. The signs on the coefficients of year of group establishment, year of business establishment, and age, education and experience variables are expected to be negative although older members may have less ability to perform physical tasks and be less open to new ways of doing things. Longer-established housewives groups and educated and experienced group leaders and members should have accumulated more knowledge of the processing activities, developed greater business management experience, and be more capable of performing production tasks. We expect higher technical efficiency in groups with higher proportions of group members who work in the business operations. Nonthakot et al. [1] argued that the sign on the coefficient of borrowing could be negative or positive, depending on how the credit is provided. The coefficient of government support is expected to have a negative sign because a higher level of government support should enable housewives groups to increase total output for a given set of resources. Access to a wide array of marketing channels should result in greater marketing flexibility that enhances the efficiency of a group's processing operations. But it is more costly to maintain a wide range of market outlets so the sign on this variable is uncertain. As mentioned above in respect of the strategic alliance factors, the coefficient of the level of membership of an alliance is expected to have a negative sign because a higher level of a member alliance is usually associated with more relevant collaboration in the supply chain. The coefficient of the form of alliance is expected to be positive because a vertical alliance is expected to be more beneficial than a horizontal alliance. A traditional management structure is expected to result in lower technical efficiency than more modern, business-oriented managerial structures. The time that members allocate to group business activities should reflect their commitment to the housewives group and thus be associated with lower technical inefficiency. Finally, the dividend variable indicates that the housewives group is community-based rather than privately operated. While the sign on the coefficient of this variable could be negative or positive, the community-based groups have had a history of greater commitment by members to their activities than the privately operated groups and therefore are expected to have lower technical inefficiency.

Estimates of the parameters of the model were obtained using two methods. A Markov chain Monte-Carlo (MCMC) Bayesian model was estimated to test for scope economies between processed fruit and vegetable outputs because it provides an estimated standard deviation of the scope economies parameter. A maximum-likelihood procedure was used to test the efficiency variables for significance by running the FRONTIER 4.1 program.

IV. DATA

Data were collected in 16 provinces in the north of Thailand. The provinces are divided into two areas: upper north (Nan, Chiangmai, Lamphun, Maehongson, Lampang, Chiangrai and Phayao provinces) and lower north (Sukhothai, Uttaradit, Phitsanulok, Phichit, Phrae, Phetchaboon, Kumpangphet, Tak and Uthaithani provinces). The main differences between these two areas are topography and climate. The upper north area is characterized by a mountainous terrain with long valleys while the lower north area is located on the plains where the weather is warmer. There are also ethnic, sociological and cultural differences between lowlanders and highlanders.

It is estimated that 643 housewives groups are engaged in processing fruits and vegetables in the region. Those groups receiving more than half their incomes from these processed products were selected as the sample for the study. The data were obtained from surveys conducted by the senior author who collected a wide range of information about the housewives groups, reported by Nonthakot et al. [1]. This information covers the characteristics, business operations and financial situation of the groups, and demographic data are provided on group leaders and their members. The data set also includes information on strategic alliances in fruit and vegetable processing. A total of 215 groups were surveyed but suitable data sets were only available from 210 groups for the analysis.

V. RESULTS AND DISCUSSION

A. Production frontier estimates

The maximum-likelihood results of the estimated stochastic distance model using the FRONTIER 4.1 program are presented in Table 1. They are similar to the results obtained by estimating the MCMC Bayesian model, as would be expected given the use of non-informative and diffuse priors in the latter model.

Table 1 Estimates of stochastic frontier production function using the FRONTIER 4.1 program

Variable	Estimated coefficient	Standard error	*t*-value
Constant	4.551	0.280	16.207
Fruit revenue	-0.258	0.080	3.237
Vegetable revenue	-0.961	0.062	-15.56
Fruit revenue^2	-0.074	0.015	-4.964
Vegetable revenue^2	0.073	0.015	4.802
Fruit revenue*Vegetable revenue	0.037	0.003	14.679
Labour cost/production cost (LP)	0.213	0.034	5.991
Marketing cost/production cost (MP)	0.138	0.024	5.753
Asset/production cost (AP)	0.050	0.020	2.354
Managerial cost/production cost (MGP)	0.200	0.028	7.119
LP^2	0.166	0.067	2.497
MP^2	0.070	0.026	2.686
AP^2	0.005	0.015	0.298
MGP^2	0.044	0.024	1.812
LP * MP	-0.040	0.028	-1.430
LP * AP	-0.057	0.022	-2.523
LP * MGP	-0.023	0.024	-0.956
MP * AP	-0.010	0.015	-0.648
MP * MGP	-0.002	0.015	-0.141
AP * MGP	0.003	0.014	0.228
γ	0.545	0.106	5.128

The coefficients of the variables for production, labour, marketing and asset inputs are all of the expected positive sign and significant at 1 per cent significance level. Because the logged variables of the translog model were mean-corrected to zero, the first-order coefficients are the estimates of elasticities at the mean input levels. The sum of the estimated coefficients of the input variables is 0.60. Given the restriction required for homogeneity of degree +1 in inputs, the elasticity for the production inputs in fruit and vegetable processing is 0.40. As expected, this is the highest partial output elasticity, followed by labour and managerial inputs at 0.21 and 0.20, respectively.

The coefficients on the two output variables, fruit revenue (-0.258) and vegetable revenue (-0.961), are negative, as expected, and highly significant at less than one per cent significance level. The negative signs reflect the fact that an increase in outputs, other things remaining unchanged, reduces the distance to the frontier. The sum of the coefficients of the fruit and vegetable output variables is -1.219. The negative of the inverse of this figure, 0.820, suggests that the production function exhibits decreasing returns to scale, significant at the 10 per cent significance level.

B. Estimates of diversification and scope economies

The diversification economies parameter between fruit and vegetable processed outputs is estimated as +0.334 with a standard deviation of 0.106. The positive and significant parameter suggests diversification economies are present between the two groups of outputs. But this test is not sufficient to prove the existence of scope economies and so the more rigorous test recommended by Hajargasht et al. [7] was applied. The scope economies parameter using this method was estimated as +0.263 with a standard deviation of 0.401. This positive and insignificant coefficient indicates an absence of scope economies.

C. Technical inefficiency estimates

The maximum likelihood estimates of the parameters of the inefficiency effects model for the translog function using the FRONTIER 4.1 program are presented in Table 2.

Table 2 Maximum likelihood estimates for parameters of the inefficiency effects model using the FRONTIER 4.1 program

Variable	Maximum likelihood estimate	
	Coefficient	SE
Constant	0.541	0.672
Number of products	-0.022	0.021
Product quality level assigned by OTOP	-0.026	0.045
Years of group establishment	0.023	0.013
Year of business establishment	0.035	0.038
Level of education of the group leader	0.007	0.021
Experience of the group leader	0.025	0.025
Mean age of members	-0.004	0.009
Mean years of schooling of members	-0.005	0.022
Experience of the group members	-0.054	0.031
Ratio of workers to members in group	-1.011	0.311
Borrowing	-0.052	0.177
Government support	-0.170	0.133
Number of marketing channels	0.178	0.093
Level of a member of alliance	-0.397	0.142
Horizontal form of alliance	1.149	0.412
Dividend	-1.708	0.461
Type of management	0.048	0.050
Allocated time for other activities	0.0005	0.001
Funds invested from the saving group	-0.587	0.224

Estimates of the coefficients of the variables explaining differences in group efficiency due to strategic alliances, number of years of group establishment and number of years of establishment of business enterprises provide broadly similar results to those obtained by Nonthakot et al. [1]. The coefficient of the variable denoting the level of a member alliance is significant at the 1 per cent level and has a negative coefficient. This result indicates that a higher level of a member alliance is associated with greater efficiency, a result that is consistent with the proposition, presented above, that there are several benefits derived by housewives groups from a higher-level marketing alliance. Other things being equal, groups with horizontal alliances are less efficient than those with vertical alliances given the positive coefficient on the horizontal alliance dummy variable that is significant at the 1 per cent level. This result is consistent with the expectation that most efficiency gains are to be made from linkages with other members of the supply chain rather than from alliances with fellow housewives groups and other food processors, and with government agencies. The insignificance of the coefficient on the product quality variables is a surprising result. It contrasts with the finding by Nonthakot et al. [1] that higher product quality is associated with higher technical efficiency.

Although of expected negative sign, the estimated coefficient on the number of products variable is insignificant whereas it was highly significant in the model estimated by Nonthakot et al. [1]. It appears that the inclusion of multiple outputs in the distance function has picked up this effect in the frontier rather than in the inefficiency effects model. Government support now appears to have improved the efficiency levels of housewives groups, as expected, in contrast to the finding by Nonthakot et al. [1] that there is no significant effect.

A number of the variables additional to those included by Nonthakot et al. [1] were found to be associated with higher efficiency levels of housewives groups, as hypothesised. They include the ratio of workers to group members, community-based groups that provide dividends to members, the experience of group members and groups engaged in savings activities. Inclusion of the last-mentioned variable has made the borrowing variable now insignificant, whereas it was marginally significant in the model of Nonthakot et al. [1].

The number of marketing channels used is associated with higher technical inefficiency. This result indicates that the benefits of greater marketing flexibility are outweighed by the higher costs associated with marketing through a variety of channels.

A number of variables not mentioned above were estimated to have insignificant effects on technical efficiency. They are the level of education and experience of the group leader, mean age and number of years schooling of group members, type of management structure and time allocated by members to other activities.

Overall, the mean efficiency estimate for food processing groups is 84.7 per cent, implying that, on average, the output of the housewives groups is around 15 per cent below its potential. Housewives groups engaged in vegetable processing are less efficient than those who are engaged in fruit processing or in both fruit and vegetable processing (Table 3).

Table 3 Mean technical efficiency estimates of housewives groups engaged on fruit processing, vegetable processing and both forms of processing

	Vegetable processing	Fruit processing	Both
Mean	0.831	0.862	0.861
Standard deviation	0.157	0.135	0.179
Maximum	0.973	0.971	0.967
Minimum	0.336	0.314	0.164

A negatively skewed distribution of these efficiency estimates for all housewives groups is presented in Figure 1. Distributions for the sub-groups of predominantly vegetable processors, predominantly fruit processors and processors producing approximately the same proportions of fruit and vegetable products exhibit fairly similar shapes to that for all groups but with some minor variations.

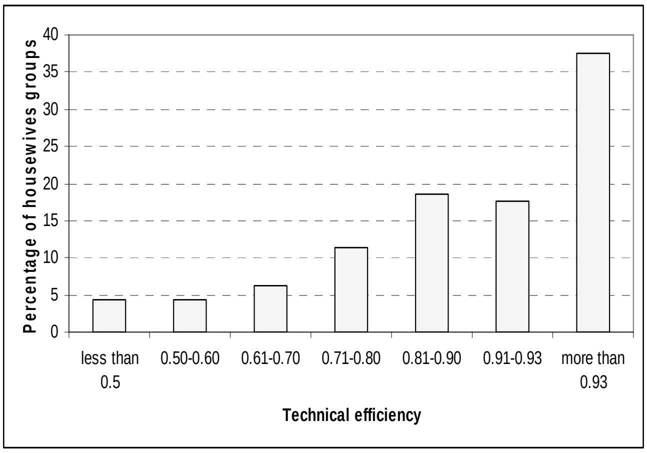

Fig. 1 Distribution of technical efficiency estimates for all sub-groups

VI. CONCLUSION

We have examined the importance of membership of particular types of strategic alliances, among other factors, for housewives groups in northern Thailand. Results are reported revealing that vertical strategic alliances at a high level have had the expected positive impact on technical efficiency in the fruit and vegetable processing operations of the housewives groups. They are consistent with the views of group leaders, who ranked increased market information and improved distribution services as overwhelmingly the two major benefits of strategic alliances.

Other efficiency variables that are shown to have had the expected significant and positive association with technical efficiency are the experience of group members, the ratio of workers to all members of a group, government support, the dummy variable for community-based as opposed to private groups, and the availability of funds to invest in the group that have been derived from its savings activities. A number of other variables were found not to be significant factors influencing technical efficiency while the year of group establishment and the number of marketing channels used by the group were found to be positively associated with technical inefficiency. The results offer useful directions to improve the processing performance of housewives groups that currently lag behind best-practice groups in processing fruits and vegetables in northern Thailand.

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