

# Does A Rising Tide Lift All Boats? The Case of Vertical Strategic Alliances Involving Housewives Groups in Northern Thailand

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**Abstract.** *We analyse factors influencing the technical inefficiency of housewives groups in northern Thailand and test for the productivity effects of vertical strategic alliances. Technical efficiency gains could be reaped by housewives groups joining vertical strategic alliances, with higher efficiency gains at higher levels of alliance. However, no technological gains were evident from group membership of vertical alliances. No evidence of scope economies was found while decreasing returns to scale are reported, suggesting that housewives groups would need to adopt more industrial food processing modes to escape scale diseconomies. Such a move would have ramifications for their financial and social structure.*

**Keywords:** *Value chain, strategic alliances, scope economies, Thailand*

**JEL codes:** *D12, D13*

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## Introduction

The food industry in Thailand comprises various types of food manufacturers including local processors who produce cottage foods, defined as foods produced in a home with little capital requirement and without the use of a commercial kitchen. The cottage food processing industry mainly comprises community enterprises such as the so-called 'housewives groups'. These groups consist of a number of rural housewives who combine their resources to partake in various activities, including food processing activities, in a particular district or village. Our main objective is to assess the impact of vertical strategic alliances on the productivity of these housewives groups in the cottage foods industry in northern Thailand. In particular, we focus on this type of alliance as a conduit to raise the productivity of these groups in producing processed fruit and vegetable products. Vertical alliances are implemented by entering into relationships with groups in the supply chain that supply them with inputs or buy their outputs. Horizontal alliances, in which all housewives groups participate, are implemented to exchange information on product marketing and inputs for production, improve distributional services, exert greater marketing power, and share technology and equipment among groups at the same level in the supply chain. Entry into an

alliance presupposes the presence of positive externalities within the chain that could be 'internalized' by a participant through collaboration with some or all of the other chain participants.

We also assess whether higher levels of vertical strategic alliance are more productive than lower levels. Five levels of strategic alliance can be identified for housewives groups in Thailand, in ascending order of aggregation: village; district; *aumphur* (sub-provincial); provincial; and regional. Greater productivity gains are expected at higher levels of strategic alliance because they should open up a broader range of opportunities to improve processing performance.

The paper is structured as follows. In the next section, we assess the competitive position of housewives groups in the processed foods industry in Thailand. It is followed by a review of the potential role of strategic alliances to strengthen competitive advantage. The analytical method employed in the study is then outlined, followed by a description of the data and variables included in the estimated model. Empirical results are presented and their implications discussed. The paper is completed with some conclusions.

## **Review of Literature**

### *Competitive weaknesses in the operations of housewives groups*

Housewives groups have suffered from various weaknesses in operating their businesses, with three weaknesses particularly evident according to Nonthakot, Villano and Fleming (2008). First, each group produces independently and experiences diseconomies of small scale. Second, they lack knowledge about input supply and product marketing information. Third, for many their activities are limited by the rudimentary processing technologies they employ while others have found it difficult to use more modern processing technologies effectively.

Membership of a value chain should help them overcome these weaknesses. Here, we distinguish a value chain from a supply chain by its market orientation whereby chain participants focus on 'continuous value creation for the customer' (Micheels and Gow, 2008, p. 128). But the ability of housewives groups to benefit from value creation is constrained by the potential for misalignment between financial incentives for individual participants in the chain and the collective incentives to chain participants. This misalignment is similar in nature to an underinvestment in public goods and the presence of public bads in the general economy. Value chain participants maximize their private net benefits, leading to suboptimal chain performance because of an underinvestment in what we term 'chain goods' (the value chain equivalent of club goods) and possible overinvestment in 'chain bads' (the value chain equivalent of club bads). Underinvestment in chain goods is likely to be especially damaging to the competitiveness of small-scale participants such as housewives groups because of their extremely limited ability, compared with large-scale participants, to internalize the externalities created by chain goods.

Chain goods resemble club goods in that they are non-rivalrous and selectively excludable. That is, members of society outside the value chain are excluded from sharing in any benefits derived from collective action within the chain. Two examples of chain goods are particularly relevant to this study. The first is an underinvestment in research and development (R&D) within the cottage goods value chain that would lead to superior performance through the adoption of improved production technologies, but which is not financially attractive to a single participant in the chain. Second, the presence of network externalities among participants at different levels in the chain is a common factor leading to suboptimal levels of exchange of information and ideas. These externalities represent the marginal benefit derived from interacting with other

participants in the value chain (for example, by the exchange of market, product and processing information). Small processors such as housewives groups are again at a relative disadvantage in engaging in networks because they lack the means to develop and participate in them. In his study of Thailand's competitiveness, Porter (2003) noted a low level of productivity and coordination across the food cluster, suggestive of a failure to invest sufficiently in chain goods.

An example of a chain bad is the undue exertion of monopoly power or monopsony power by dominant firms in the value chain. This is a potential problem for housewives groups because they have extremely limited market power.

### *Exploiting strategic alliances for competitive advantage*

Chain goods can be captured (that is, the externalities they create can be internalized) when participants engage in strategic alliances that improve their productivity, and increase and enrich their interactions. Strategic alliances provide a suitable vehicle to help housewives groups, in particular, overcome the constraints they face, and raise their level of participation in the food processing supply network in general and the cottage foods value chain in particular. Entry into such alliances is consistent with the idea espoused by Crook and Combs (2007) that 'collaborative supply chain management' results in 'a rising tide that lifts all boats'. It is also consistent with the idea of developing a 'best value supply chain', as championed by Ketchen and Hult (2007). Small processors enter into strategic alliances for a variety of purposes. Some purposes, such as countering the buying and selling power of others in the marketing system (reducing or eliminating the impact of a chain bad), have little bearing on their productivity. But other purposes do have an impact on productivity. Membership of strategic alliances within the value chain for cottage foods can increase the productivity of housewives groups in two broad ways: through innovation and the adoption of improved processing technologies (shifting the production frontier upwards), and through improved technical efficiency in processing operations (moving closer to the production frontier).

In terms of technical efficiency, vertical alliances enable small participants in the value chain such as the housewives groups to benefit from more efficient practices through better access to the resources, practices, skills and market information available to other firms in the value chain. Rolle (2006), for example, suggested that most raw material suppliers respond to entry into alliances by upgrading their operations to become more efficient. Horizontal alliances may also raise technical efficiency through the interactions between housewives groups, and between these groups and other institutions. The Thai government accelerated the level of involvement of housewives groups in processed food markets when it began a cluster project in 2004, to help firms strengthen their horizontal linkages. In order to increase productivity, government officers delineated the degree of cluster strength and potential in six clusters by considering global demand growth, market share, growth in output value and the employment growth rate (Ministry of Industry, 2004). Characteristics of small producers and quality control of their products were used to evaluate the degree of cluster strength and potential. Training courses are now in place for the cottage foods industry in the use of processing equipment, adherence to current international quality standards, and in effectively undertaking financial and marketing activities associated with food processing. These courses were developed to increase management and technical skills at the enterprise level using rural universities and cooperatives. The cooperatives focus on production skills whereas the universities emphasize business skills. The accumulation of production, financial and marketing skills is expected to enable the housewives groups to improve technical efficiency in

their organizations. Also, government support may facilitate access to credit for small-scale processors in the clusters, making them better able to overcome the technical, institutional and informational constraints they face. Success is not guaranteed, however. Schmitz and Humphrey (2002) observed that clusters are inserted into global value chains in different ways, and that this has consequences for enabling, or disabling, local-level upgrading efforts. They paid particular attention to the position of developing country firms selling to large, global buyers.

Technological advances by housewives groups in their processing operations may also emanate from vertical and horizontal strategic alliances. Public R&D and the distribution of modern machinery by government agencies to firms within the cottage goods industry may bring about better processing methods. Rolle (2006) observed that horizontal alliances can be particularly useful in the application of new skills and technical expertise by sharing development R&D knowledge and experiences, and that links with government agencies and research institutes can facilitate learning to help chain participants overcome existing technological constraints. Housewives groups may also benefit through vertical alliances from innovations and improved processing technologies that are made available to them by larger and more technologically advanced firms in the value chain. In both ways, knowledge gained from product innovation may lead to better quality products and process innovation may lead to lower-cost products (Chang and Ahn, 2005). The ability to produce better quality and lower-cost products can be considered as an organizational competence, developed by deploying knowledge assets (Teece, 1998) or through knowledge management and innovation.

## **Method of Analysis**

### *Distance functions*

In analysing the productivity of housewives groups, a distance function is preferred to a production function because there are two distinct categories of products in fruit processing and vegetable processing. The usefulness of econometric distance functions in the analysis of production in a multi-output multi-input production function was demonstrated by Hajargasht, Coelli and Rao (2006). An input distance function is used because producers have more control over inputs than over outputs. A multi-input multi-output stochastic input distance function is used to estimate the production function for processed fruit and vegetable products, to calculate technical inefficiency measures and to evaluate economies of scope and scale, and complementarities between fruit products and vegetable products. Input and output elasticity estimates are obtained using the translog functional form, which is assumed because it is flexible, easy to calculate and permits the imposition of homogeneity. A test of the Cobb-Douglas against the translog function provided conclusive evidence that it was not an adequate representation of the data. Details of the estimation procedure adopted in the analysis are provided in Appendix 1.

### *Scope and scale economies*

In considering the product set of the housewives groups, groups sell only processed fruit, only processed vegetables or both processed fruit and processed vegetables. The question is whether selling both fruit and vegetables is more productive than specialization. The concept of the multiproduct firm was introduced by Panzar and Willig (1975, 1981) and Baumol, Panzar and Willig (1982) who explained that it can be efficient to combine two or more multi-product firms.

The presence of scope economies explains why multi-output production should be organized within a single multiproduct firm. Teece (1980) explained that multiproduct firms exist when their inputs or services are difficult to trade among markets or high transaction costs prevail (associated with the specialization of a firm), situations that are likely to be prevalent among housewives groups. Levy and Haber (1986) revealed that the variation of demand for output causes inputs transference in a multiproduct firm. These inputs transfer into a higher-valued use in another product line within the firm. As a result, multiproduct firms can reduce the adjustment costs of rapidly accumulating firm-specific capital by transferring inputs.

Coelli and Fleming (2004) demonstrated how the second cross partial derivative of the input distance function differs from that of the cost function. They used the term, diversification economies, to make the distinction whereas we follow Chavas and Kim (2007) and use the term, product complementarities. The derivation of product complementarities is described in Appendix 1.

## Data and Variables

This study covers representatives of the housewives groups in northern Thailand and their production of processed fruit and vegetables during 2006-2007. Samples used in this study were selected using stratified random sampling, followed by random selection of subjects from each stratum using a three-stage sampling process. In the first stage, the population in 16 provinces was divided into mutually exclusive groups relevant to the study. Villages were selected according to fruit and vegetable processing categories. In the second stage, the housewives groups selected in the first stage were classified according to the proportion of income they gained from fruit and vegetable processing, which should be more than 50 per cent of their total income. In the final stage, a sample of 210 housewives groups was drawn using simple random sampling.

The production function comprises the four main input categories of labour, materials, managerial inputs and assets (representing capital). The inefficiency effects model includes a range of factors influencing the efficiency of processing operations. It is specified following Battese and Coelli (1995) as:

$$u_i = \delta_0 + \sum_{j=1}^{12} \delta_j Z_{ji},$$

where the  $\delta_j$  ( $j = 0, 1, \dots, 12$ ) are unknown parameters;  $Z_1$  is the level of strategic alliance;  $Z_2$  defines the form of the alliance;  $Z_3$  is the number of the products;  $Z_4$  is the level of quality attributed to the product by the *One Tambon One Product* (OTOP) process (Nonthakot et al. 2008);  $Z_5$  is a dummy variable that takes the value 1 if a group borrows funds to finance their processing operations, otherwise 0;  $Z_6$  represents receipt of government support, and equals 1 if a group has received one form of support, 2 if it has received two forms of support and 3 if it has received three forms of support;  $Z_7$  is the number of years that the group has been established;  $Z_8$  is the number of years the group has operated a food processing business;  $Z_9$  is a dummy variable that equals 1 if the group engaged in production network activity, otherwise 0;  $Z_{10}$  is a dummy variable that equals 1 if the group engaged in marketing network activity, otherwise 0;  $Z_{11}$  is a dummy variable that equals 1 if the group is engaged in financial network activity, otherwise 0; and  $Z_{12}$  is a dummy variable that equals 1 if the group is engaged in human resource network activity, otherwise 0.

**Results and Discussion**

*Distance function estimates*

Maximum likelihood (ML) procedures were applied to estimate the stochastic input distance function and relevant parameter estimates were used to assess the impact of strategic alliances on production technology and technical efficiency. The model was also estimated as a Markov chain Monte Carlo (MCMC) Bayesian model with non-informative priors to test for scope economies and product complementarities between processed fruit and vegetable products. This method was added specifically to provide an estimated standard deviation of the scope economies measure.

Estimates of the partial input and output elasticities derived from the stochastic input distance function model are presented in Table 1. The coefficients of the variables for all inputs are 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 partial output elasticities at the mean input levels.

The sum of the estimated coefficients of the input variables is 0.604. Given the restriction required for homogeneity of degree +1 in inputs, the elasticity for the production inputs in fruit and vegetable processing is therefore 0.396. As expected, this is the highest partial output elasticity, followed by labour and marketing inputs at 0.228 and 0.150, respectively. The coefficients on the two output variables are negative, as dictated by theory, and highly significant at less than the 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.

**Table 1** Estimates of the Input and Output Elasticities

Variable	Estimated elasticity	Standard error	z-value
Input:			
Labour input	0.228	0.073	7.76
Marketing input	0.150	0.021	7.27
Assets	0.046	0.016	2.94
Managerial input	0.180	0.022	8.09
Output:			
Processed fruit	-0.245	0.009	-26.48
Processed vegetables	-0.958	0.073	-13.10

*Measures of product complementarities and scope economies*

The complementarities parameter between the processed fruit and vegetable outputs is estimated to be -0.334 with a standard deviation of 0.106. Based on this result, the negative and significant parameter suggests that complementarities are present between these two groups of processed products. But this test is not sufficient to prove the existence of scope economies and so the more rigorous test recommended by Hajargasht et al. (2006) was applied. The scope economies parameter using this method was estimated to be +0.263 with a standard deviation of 0.401. This positive and insignificant coefficient indicates an absence of scope economies.

*Estimated returns to scale*

The sum of the coefficients of the fruit and vegetable output variables is -1.203. That is, a 1.203 per cent increase in all inputs is needed to sustain a 1 per cent increase in fruit and vegetable outputs. The inverse of this parameter, 0.831, suggests that the production function exhibits decreasing returns to scale, significant at the 5 per cent

level. The existence of decreasing returns to scale is likely to be counteracting the product complementarities, noted above, and contributing to a lack of scope economies (Chavas and Kim, 2007).

On the surface, this result appears not to support the observation made above that housewives groups experience diseconomies of small scale. However, it needs to be viewed in the context of the narrow production technologies currently available to housewives groups. Groups may rapidly reach optimal scale for the production of cottage foods as they expand production. They would then need to shift to production technologies employing industrial processing methods and to operate on a more commercial basis to take advantage of the scale economies available in the processed fruit and vegetables food industry as a whole.

#### *Effects of vertical strategic alliances on production technology*

Two likelihood ratio tests were conducted on the effects of vertical strategic alliances on production technology. First, a dummy variable for the effect on production technology of a vertical strategic alliance was included in the estimation of the production frontier and tested for significance. No evidence was found that entering into a strategic alliance resulted in an expanded frontier. A second more specific test was conducted for the presence of an expanded frontier at higher levels of vertical strategic alliance. Again, no evidence was found that entering into a vertical strategic alliance at a higher level resulted in a higher frontier. It is concluded that entering a vertical strategic alliance does not enable housewives groups to take advantage of a superior production technology.

#### *Technical inefficiency estimates*

The ML estimates of the parameters of the inefficiency effects model are presented in Table 2. Significance levels are reported below for two-tail tests where the outcome is uncertain and one-tail tests where a particular direction of relationship is expected.

Estimates of the coefficients of the variables explaining differences in group efficiency due to strategic alliances provide interesting results. First, other things being equal, groups with only horizontal alliances are less efficient than those also with vertical alliances. This result is consistent with the proposition that most efficiency gains are to be made from linkages with other members of the value chain rather than from alliances with fellow housewives groups and other food processors and with government agencies. Second, a higher level of a member alliance is associated with greater efficiency. This result is consistent with the proposition that there are several benefits derived by housewives groups from joining a higher-level marketing alliance.

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. (2008). It appears that the inclusion of the two output categories in the distance function has picked up this effect in the frontier rather than in the inefficiency effects model.

Three variables additional to those included by Nonthakot et al. (2008) were found to be associated with higher efficiency levels of housewives groups. First, the ratio of workers to group members reduces inefficiency because groups are more business-oriented. Second, community-based groups that provide dividends to members are more efficient than privately run groups. Third, groups engaged in savings activities that are used to fund the business venture are associated with greater efficiency. Getting people in rural areas of developing countries to save contributes to a greater likelihood of success in business, as one would expect.

**Table 2** Estimated Parameters in the Inefficiency Effects Model

Variable	Co efficient	Standard error
Constant	-2.663	0.117 <sup>a</sup>
Member of horizontal alliance only	3.652	1.844 <sup>b</sup>
Level of membership of vertical alliance	-1.516	0.643 <sup>b</sup>
Number of products	-0.145	0.153
Number of products granted quality logo	-0.078	0.194
Years of group establishment	0.064	0.058
Years of business establishment	0.203	0.130
Years of schooling of the group leader	0.017	0.074
Years of experience of the group leader	0.117	0.122
Mean age of group members	-0.005	0.031
Mean years of schooling of group members	-0.033	0.095
Mean years of experience of group members	-0.268	0.130 <sup>b</sup>
Ratio of workers to group members	-2.435	1.169 <sup>b</sup>
Financing	-0.941	0.723
Government support	-0.547	0.492
The number of marketing channels	0.431	0.387
Community group	-7.991	3.484 <sup>b</sup>
Traditional management structure	0.046	0.245
Time allocated to other activities	0.002	0.005
Funds for investment from the savings sub-group	-1.968	1.019 <sup>c</sup>

Note: <sup>a</sup> Significant at 0.01 level; <sup>b</sup> Significant at 0.05 level <sup>c</sup> Significant at 0.10 level.

The insignificance of the coefficient on the product quality variables is a surprising result because a higher proportion of products awarded the OTOP brand for quality was expected to be associated with greater efficiency. It contrasts with the finding by Nonthakot et al. (2008) that higher product quality is associated with higher technical efficiency.

It was initially surprising to find that the number of years of group establishment and the number of years in which they have engaged in business have positive associations with technical inefficiency, albeit at low levels of significance. This result suggests that the longer-established housewives groups tend to be more inefficient. It might be explained by the fact that long-established groups did not necessarily conduct business enterprises in their early years. Their objectives tended to be the promotion of harmonious relationships rather than the conduct of business. On the other hand, many other groups that have been established in the past 10 years commenced their business enterprises immediately. That said, even the length of establishment of business enterprises is also associated with higher technical inefficiency, although its coefficient is significantly greater than zero only at the 12 per cent level. The significantly negative coefficient for the mean years of experience of individual members suggests that their experience is more important than the length of group establishment in raising technical efficiency. This variable is also more important than the level of years of schooling of both members and the group leader.

The coefficient estimates for three variables were significant at only low levels. First, the number of marketing channels used is associated with higher technical inefficiency but only at the 30 per cent level using a two-tail test. This result indicates that the benefits of greater marketing flexibility are probably outweighed by the higher costs associated with marketing through a variety of channels. Second, government

support appears to have improved the efficiency levels of housewives groups, as expected, but only at 14 per cent significance level using a one-tail test. Finally, the financing variable is marginally significant, as it was in the model of Nonthakot et al. (2008), but only at the 10 per cent significance level using a one-tail test.

The mean technical efficiency for all housewives groups is 0.847, implying that, on average, their production is well below its potential. But a majority of the technical efficiency estimates are between 0.81 and more than 0.93, whereas only 15 per cent of the groups have a technical efficiency estimate less than 0.70. These results imply that most housewives groups operate at a reasonably high level of technical efficiency. Specialist fruit processing has a slightly higher mean technical efficiency than specialist vegetable processing and combined fruit and vegetable processing. However, a statistical test indicates no significant difference between these mean efficiency estimates.

## **Implications**

Our main concern was to test whether ‘collaborative supply chain management’ (Crook and Combs 2007) through vertical strategic alliances enables housewives groups to benefit from increased productivity. Results reveal that high-level vertical strategic alliances have had a positive impact on one component of productivity of housewives groups: their technical efficiency. These groups improve the efficiency of their processing operation relative to those groups engaging only in horizontal alliances. But model results show that vertical strategic alliances, including higher levels of vertical alliance, are not associated with improved production technology in that their production frontiers are no higher than those achieved from horizontal strategic alliances alone. This finding suggests that their influence is confined to generating higher technical efficiency.

Teece (2003) argued that both horizontal and vertical alliances are necessary for housewives groups to derive greatest benefit from the development of technology and innovation. His proposition suggests that the development of appropriate technology from research should combine vertical and horizontal strategic alliances to add value within the cottage foods value chain. But it finds little support in our study of food processing by housewives groups in North Thailand. The failure of housewives groups to benefit from improved technology through vertical strategic alliances may be attributed to three potential causes. First, technological dissonance and scale differences between large food processors and housewives groups in the value chain could negate any potential technological advances by the latter. The rudimentary nature and small scale of cottage food processing may be incompatible with the technological platform of the larger processors, rendering the exchange of information and ideas on better processing technologies ineffective. Second, the nature of contractual arrangements between housewives groups and other processors in the value chain may further discourage the exchange of information and ideas on processing technologies. Contractual arrangements that housewives groups have with large food processors can be structured in various ways, depending on their objectives, production resources, planning processes and experience. If housewives groups have the most suitable processing enterprise for contracting to supply larger processing firms, namely a formal pattern of production and year-round supply, an alliance based on intermediaries is the most common model that they follow. In this model, large food processing companies contract to purchase cottage foods from individual intermediaries who have their own informal arrangements with housewives groups and are often the group leaders of housewives groups (FAO, 2001). Such a contractual arrangement tends to restrict the potential for housewives groups to interact with large

food processors on matters relating to production technologies. Finally, and relatedly, large food processors prefer to exert strict control over material and technical inputs and the quality of products they order from housewives groups. They tend to approach the use of intermediaries with caution because of the danger of losing some of this control and are therefore discouraged from forming alliances with housewives groups that entail supplying processed foods under contract.

The extent of these constraints on housewives groups learning about improved production technologies from larger processors and others in the value chain needs to be explored. Value chain participants such as research institutions and government agencies, acting as non-equity horizontal alliance partners to develop relationships with housewives groups and private firms in the same industry, have the greatest potential to conduct such research. The incentives to other value chain participants, especially large processing firms, to conduct research aimed at capturing chain goods are likely to be small relative to those for housewives groups with very limited ability to internalize chain externalities and with negligible market power. The aim of this research would be to encourage investment in new technology, new products and new processes consistent with meeting contractual requirements with large processors while being tailored closely to the resource base and knowledge of technologies possessed by housewives groups. Further integration of vertical and horizontal alliances through this approach could also be useful for participants in sharing R&D results and knowledge between government and private firms, and engaging in technical training programs as ways to exploit chain goods.

The finding of significant product complementarities between the two enterprise categories of fruit processing and vegetable processing also demands further analysis. It suggests that there is an opportunity to expand processing output by strategies such as managing off-season production, but an absence of scope economies found from a more rigorous test of synergies between fruit and vegetable processing indicates that groups are unable at present to benefit financially from this form of diversification. Decreasing returns to scale is likely to be a key factor inhibiting the ability of housewives groups using cottage food processing methods to exploit product complementarities. To avoid this outcome, the groups would need to alter their processing methods and move to a more industrial-based food processing mode that entails greater capital investment and the use of a commercial kitchen. This move, however, would have momentous implications for the institutional structure of the groups.

## **Conclusions**

We estimated a multi-input multi-output stochastic input distance function of fruit and vegetable processing by 210 sampled housewives groups in northern Thailand using a cross-sectional data set, and analysed various factors influencing technical inefficiency. We also tested for differences in production frontiers according to membership of different types of vertical strategic alliance. Technical efficiency gains could be reaped by housewives groups joining vertical strategic alliances, with higher efficiency gains at higher levels of vertical alliance. However, no technological gains were evident from membership by groups of vertical alliances.

Significant product complementarities were found to exist between the two enterprises, fruit processing and vegetable processing, but these complementarities did not translate into scope economies. Decreasing returns to scale were estimated, suggesting that housewives groups soon reach their optimal scale using cottage food processing methods, and would need to move to more industrial food processing modes to escape scale diseconomies.

## References

- Ang, J. S., and Lin, J.W. 2001. A fundamental approach to estimating economies of scale and scope of financial products: the case of mutual funds. *Rev. Quant. Finance Account.* 16(3): 205-221.
- Asai, S. 2006. Scale economies and scope economies in the Japanese broadcasting market. *Info. Econ. Pol.* 18(3): 321-331.
- Baumol, W. J. 1977. On the proper cost tests for natural monopoly in a multi-product industry. *Amer. Econ. Rev.* 67(5): 809-822.
- Baumol, W. J., Panzar, J. C., & Willig, R. D. 1982. *Contestable markets and the theory of industry structure*. New York: Harcourt Brace Jovanovich.
- Cayseele, P. V., & Wuyts, C. 2007. Cost efficiency in the European securities settlement and depository industry. *J. Banking Finance.* 31(10): 3058-3079.
- Chang, S.-G., & Ahn, J.-H. 2005. Product and process knowledge in the performance-oriented knowledge management approach. *J. Know. Man.* 9(4): 114-132.
- Chavas, J.-P., & Kim, K. 2007. Measurement and sources of economies of scope: a primal approach. *J. Inst. Theoretical Econ.* 163: 411-427.
- Coelli, T. J., & Fleming, E. 2004. Diversification economies and specialization efficiencies in a mixed food and coffee smallholder farming system in Papua New Guinea. *Agr. Econ.* 31(2/3): 229-239.
- Coelli, T. J., & Perelman, S. 2000. Technical efficiency of European railways: a distance function approach. *Appl. Econ.* 32(15): 1967-1976.
- Crook, R., & Combs, J. G. 2007. Sources and consequences of bargaining power in supply chains. *J. Operations Man.* 25(2): 546-555.
- Deller, S. C., Chicoine, D. L., & Walzer, N. 1988. Economies of size and scope in rural low-volume roads. *Rev. Econ. Stat.* 70(3): 459-465.
- FAO 2001. Contract farming: partnerships for growth. Downloaded from: <http://www.fao.org/docrep/004/y0937e/y0937e05.htm>
- Fare, R., & Primont, D. 1995. *Multi-output production and duality: Theory and applications*. Boston: Kluwer Academic Publishers.
- Hajargasht, G., Coelli, T. J., & Rao, D. S. P. 2006. A dual measure of economies of scope, Centre for Efficiency and Productivity Analysis, School of Economics, University of Queensland, Brisbane.
- Ketchen, D. J., & Hult, G. T. M. 2007. Bridging organization theory and supply chain management: the case of best value supply chains. *J. Operations Man.* 25(2): 573-580.
- Levy, D., & Haber, L. J. 1986. An advantage of the multi-product firm: the transferability of firm-specific capital. *Journal of Economic Behavior and Organization*, 7(3), 291-302.
- Micheels, E. T., & Gow, H. R. 2009. Do market oriented firms demonstrate clarity on their value discipline? Evidence from Illinois beef producers. *International Food and Agribusiness Management Review*, 12(3), 127-152.
- Ministry of Industry. 2004. *Cluster: Concept and development*, Bangkok.
- Nonthakot, P., Villano, R., & Fleming, E. 2008. Can strategic alliances in food processing increase the technical efficiency of housewives groups in Thailand? *J. Chain and Network Sci.* 8(1): 83-92.
- Panzar, J. C., & Willig, R. D. 1975. Economies of scale and economies of scope in multi-output production, Unpublished Working Paper.
- Panzar, J. C. & Willig, R. D. 1981, Economies of scope. *Amer. Econ. Rev.* 71(2): 268-272.
- Porter, M. E. 2003. *Thailand's competitiveness*. Institute for Strategy and Competitiveness, Bangkok: Harvard Business School.

- Rolle, R. S. 2006. Processing of fruit and vegetables for reducing postharvest losses and adding value. In R. S. Rolle (ed.), *Postharvest management of fruit and vegetables in the Asia-Pacific region* (pp. 32-42), Tokyo: Asian Productivity Organization.
- Schmitz, H., & Humphrey, J. 2002. How does insertion in global value chains affect upgrading in industrial clusters? *Reg. Stud.* 36(9): 1017-1027.
- Teece, D. J. 1980. Economies of scope and the scope of the enterprise. *J. Econ. Behav. Organ.* 1(3): 223-247.
- Teece, D. J. (1998). Capturing value from knowledge assets: the new economy, markets for know-how, and intangible assets. *Calif. Manage. Rev.* 40(3): 55-80.
- Teece, D. J. 2003. *Essays in technology management and policy: Selected papers of David J. Teece*. Singapore: World Scientific Publishing.
- Wang, S.-E., & Liao, C.-H. 2006. Cost structure productivity growth of the Taiwan railway. *Transportation Research. Part E, Logist. Trans. Rev.* 42(4):317-339.

## Appendix 1

Coelli and Perelman (2000) defined the production technology of a firm using the output set,  $P(X)$ , which represents the set of all output vectors,  $Y \in R_+^M$  that can be produced using the input vector,  $X \in R_+^K$ . That is,

$$P(X) = \{Y \in R_+^M : X \text{ can produce } Y\}. \quad (1)$$

They assumed that the technology satisfies the standard axioms, including convexity and weak disposability (Fare and Primont, 1995). The input distance function focuses on how much the input vector contracts with the output vector held fixed, assuming that the technology satisfies the standard properties listed by Fare and Primont (1995). It is defined on the input set,  $L(Y)$ , as

$$D_I(X, Y) = \max \{ \varphi : (X / \varphi) \in L(Y) \}, \quad (2)$$

where  $\varphi$  is the scalar distance by which the input vector can be deflated, and the input set  $L(Y)$  represents the set of all input vectors,  $X \in R_+^K$ , that can produce the output vector,  $Y \in R_+^M$ . That is,

$$L(Y) = \{X \in R_+^K : X \text{ can produce } Y\}. \quad (3)$$

The input distance function,  $D_I(X, Y)$ , is non-decreasing, positively linearly homogeneous and concave in  $X$ , and increasing in  $Y$ . It takes a value greater than or equal to one if the input vector,  $X$ , is an element of the feasible input set,  $L(Y)$ . That is,  $D_I(X, Y) \geq 1$  if  $X \in L(Y)$ . It takes a value of unity if  $X$  is located on the inner boundary of the input set.

Scope economies exist when for all output,  $u_1$  and  $u_2$ , the cost of the joint product is less than the cost of producing each output separately. The scope economies are expressed as

$$C(u_1, u_2) < C(u_1, 0) + C(0, u_2) \quad (4)$$

where  $C(u_1, u_2)$  denotes the cost for the production of  $u_1$  units of product A and  $u_2$  units of product B. Scope and scale economies are related to organizational structure in terms of perfect competition which is explained by Baumol (1977). If firms have perfect competition, they do not have scale or scope economies. The measure of scale economies for multiple products proposed by Baumol et al. (1982) as an extension of the single output is defined by

$$S(Y) = \frac{C(Y)}{\sum_{i=1}^n Y_i C_i(Y)} \quad (5)$$

where  $Y_i$  is the  $i$ th component of the output vector  $Y$  and  $C_i(Y)$  is the partial derivative of  $C(Y)$  with respect to  $Y_i$ . The right-hand side of the  $S(Y)$  equation can be interpreted as the inverse of the sum of the cost elasticities by

$$S(Y) = \left[ \left( \sum Y_i C_i(Y) / C(Y) \right) \right]^{-1} = \left[ \sum \partial C(Y) / \partial Y_i * Y_i / C(Y) \right]^{-1} \quad (6)$$

The effect of multi-output production on cost is captured by the concept of scope economies, which compare between cost saving and the cost of separate production. In their study of scope economies in rural low-volume roads, Deller, Chicoine and Walzer

(1988) estimated a cost function by using the second cross partial derivatives of the cost function to test for scope economies as

$$\frac{\partial^2 C}{\partial y_i \partial y_j} < 0, \quad i \neq j, i, j = 1, \dots, m, \quad (7)$$

where  $C$  is the cost of  $m$  outputs and  $y_i$  is the  $i$ -th output variable. There are scope economies if the second cross partial derivative of the cost function has a negative sign because when we produce one unit of product A, the marginal cost of product B should be decreased. Many other studies have used an econometric estimate of a cost function to measure scope and scale economies (e.g. Ang and Lin, 2001; Asai, 2006), productivity growth (e.g. Wang and Liao, 2006) and cost efficiency (e.g. Cayseele and Wuyts, 2007).

Product complementarities exist if

$$\frac{\partial^2 D}{\partial Y_i \partial Y_j} < 0, \quad i \neq j, i, j = 1, \dots, m, \quad (8)$$

Hajargasht et al. (2006) presented the duality between the cost and input distance functions for a measure of scope economies, and we employ the method they developed. Derivation of this method begins with a translog input distance function which defined by Hajargasht et al. (2006) as:

$$\begin{aligned} \ln D(x, y) = & \alpha_0 + \sum_{i=1}^n \alpha_i \ln(x_i) + \sum_{i=1}^m \beta_i \ln(y_i) + \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n \alpha_{ij} \ln(x_i) \ln(x_j) \\ & + \frac{1}{2} \sum_{i=1}^m \sum_{j=1}^m \beta_{ij} \ln(y_i) \ln(y_j) + \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^m \gamma_{ij} \ln(x_i) \ln(y_j). \end{aligned} \quad (9)$$

The following homogeneity restrictions are imposed:

$$\sum_{i=1}^n \alpha_i = 1, \quad \sum_{k=1}^n \alpha_{ik} = 0, i = 1, 2, \dots, n, \text{ and } \sum_{j=1}^m \gamma_{ij} = 0, i = 1, 2, \dots, n.$$

To satisfy symmetry restrictions due to Young's theorem:

$$\alpha_{ik} = \alpha_{ki} \text{ and } \beta_{jl} = \beta_{lj}, \text{ for all } i, k, j \text{ and } l.$$

The calculation of scope economies requires calculation of the following derivatives:  $D_x$ ,  $D_y$ ,  $D_{xx}$ ,  $D_{yy}$  and  $D_{yx}$ . These derivatives can be obtained for the translog function as (Hajargasht et al., 2006):

$$g_k = \frac{\ln D(x, y)}{\partial \ln x_k} = \alpha_k + \sum_{j=1}^n \alpha_{kj} \ln x_j + \sum_{j=1}^m \gamma_{kj} \ln y_j$$

and

$$h_l = \frac{\ln D(x, y)}{\partial \ln y_l} = \beta_l + \sum_{j=1}^m \beta_{lj} \ln y_j + \sum_{i=1}^n \gamma_{il} \ln x_i$$

Obtain the first order derivatives as:

$$D_x = \{d_k^x\}, \text{ where } d_k^x = \frac{D}{x_k} g_k,$$

$$D_y = \{d_l^y\}, \text{ where } d_l^y = \frac{D}{y_l} h_l.$$

To obtain the second order derivatives, it is necessary to take derivatives from the above relations and define them as (Hajargasht et al., 2006):

$$D_{xx} = \{d_{kl}^{xx}\}, \text{ where } d_{kl}^{xx} = \begin{cases} \frac{D}{x_k^2} (g_k^2 - g_k + \alpha_{kk}), k = l \\ \frac{D}{x_k x_l} (g_k g_l + \alpha_{kl}), k \neq l \end{cases}$$

$$D_{yy} = \{d_{kl}^{yy}\}, \text{ where } d_{kl}^{yy} = \begin{cases} \frac{D}{y_k^2} (h_k^2 - h_k + \beta_{kk}), k = l \\ \frac{D}{y_k y_l} (h_k h_l + \beta_{kl}), k \neq l \end{cases}$$

where

$$D_{yx} = \{d_{lk}^{yx}\}, \text{ where } d_{lk}^{yx} = \frac{D}{y_l x_k} (h_l g_k + \gamma_{lk}).$$

Simpler expressions for these derivatives can be obtained if all inputs and outputs are scaled so that their means are equal to one, then the log of means are equal to zero. The first derivatives simplify to:

$$\frac{\partial D}{\partial x_i} = \alpha_i \text{ and } \frac{\partial D}{\partial y_j} = \beta_j,$$

The second derivatives become (Hajargasht et al., 2006):

$$\frac{\partial^2 D}{\partial x_i^2} = \alpha_i^2 - \alpha_i + \alpha_{ii}, \quad \frac{\partial^2 D}{\partial x_i \partial x_j} = \alpha_i \alpha_j + \alpha_{ij} \text{ and } \frac{\partial^2 D}{\partial x_i \partial y_j} = \alpha_i \beta_j + \gamma_{ij}.$$

The condition for scope economies for each pair of outputs in the production system is then defined by Hajargasht et al. (2006) as:

$$\left\{ D_y D_y' + D_{yx} \left[ D_{xx} + D_x D_x' \right]^{-1} D_{xy} - D_{yy} \right\} < 0 \quad (10)$$

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 product complementarities defined as the second cross partial derivative of the output variables ( $D_{yy}$ ). While product complementarity is an important contributor to scope economies, a positive value for the second cross partial derivative of the output variables is an insufficient condition for the presence of scope economies. Chavas and Kim (2007) pointed out that it can be outweighed by the effects of concavity in the production technology, decreasing returns to scale and negative catalytic effects, or enhanced by convexity in the production technology, increasing returns to scale and positive catalytic effects.