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Estimating Profit Efficiency of Rice Farmers in Vietnam's Mekong Delta Using Stochastic Frontier Analysis

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Abstract: This study estimated profit efficiency among cooperative and non- cooperative rice farmers in the Mekong Delta of Vietnam and determined factors affecting the profit efficiency using a stochastic profit frontier model. The results revealed that rice farmers in cooperative obtained higher level of profit efficiency (0.670) compared to farmers in non-cooperatives (0.643) showing that rice farmers in the two groups could improve their profit efficiency by about 33.0% and 35.7%, respectively. Factors related to differences in the profit efficiency included age, education and experience of the farmer, household size, credit access and technical trainings. Farmers who had higher level of education performed higher level of efficiency. Credit access was found to be significantly positive on technical inefficiency for both groups of farmers. Training for improving technical efficiency was only found for cooperative farmers. Therefore, this study suggests that technical trainings targeted individual farmers would improve their production efficiency. In addition to providing rice farmers with better chance of credit access, it is also necessary to accompany with trainings on capital manageral skills for their efficient improvements.

Key words: Agricultural Cooperative · Mekong Delta · Rice Farmers · Stochastic Profit Frontier · Profit Efficiency

INTRODUCTION

In recent years, the leading role of rice for rural development and poverty reduction in Vietnam has been subsided. Although rice is an economically important crop of the Mekong delta, rice farmers in general are still in difficult life situations. One of the reasons is the rapidly rising cost in inputs such as fertilizer, agricultural chemicals and labors, as a result higher rice price is derived [1]. Moreover, small farm size and working independently are also contributed to high operation costs. In addition, the fluctuation of rice market price is also a constant challenge to rice farmers in the region. These factors lead to the reduction of rice farmers' income that eventually forces some farmers out of production. Hence, it is crucial to find out the operation performance of rice farmers by identifying the status efficiency annually so that it can facilitate the improvement strategy to assist rice farmers' competiveness in this region.

Many studies have been conducted in estimating technical efficiency of rice producers and rice production in the Mekong Delta [2-7], however, only a quite limited number of study on measuring profit efficiency of rice farmers was conducted in the Mekong delta and whole country as well. In the Mekong delta, for instance, Thong *et al.* [8] estimated profit efficiency of 479 rice farmers in four provinces in the Mekong delta including Hau Giang, Can Tho, Vinh Long and Long An for 2009 cropping seasons. Dang [9] estimated profit efficiency of 302 rice producers in Kien Giang province for the crop of 2015.

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On the other hand, agricultural cooperatives are considered as one of key elements to foster rural development. Cooperatives, theoretically integrate small individual producers together as a whole to gain the economies of scale such that the lower cost can be realized. Agricultural cooperatives not only offer a wide range of services needed in the farming activities, but also allow smallholder farmers to participate in decision-making process at all levels. Small farmers can therefore secure their livelihoods [10]. However, the numbers of agricultural cooperatives in the Mekong Delta is low and they in general perform poorly. In 2008, there were 1,623 agricultural cooperatives in the Delta, accounted for only 8.93% of total number in Vietnam [11].

Despite the fact that agricultural cooperatives are playing crucial roles in rural areas, especially in agricultural countries, little attention has been given to measuring efficiency of these cooperatives and addressing on comparison between cooperative and non-cooperative farmers. This study therefore aims to better understand whether rice farmers in cooperatives are more profitability than individual farmers and to detect factors influencing their profit efficiency. Recommendations drawn from the findings of this study could be useful for both farmers and policymakers to adjust their related strategies and policies for better performances.

MATERIALS AND METHODS

Data Collection: In this study, cross-section data at the farm level were used, which were collected from 400 rice producers of Tra Vinh and Dong Thap provinces in the Mekong Delta of Vietnam in 2014. Data related to the rice production of the winter-spring season were gathered to estimate profit efficiency including output price and input prices such as fertilize seed, labor and farm capital assets (expressed in thousand VND, 1USD= 21,270 VND in 2014). In addition, socio-economic characteristics of the farmers such as rice cultivated land, family size, the level of education, age, rice growing experience, credit access and training received were also collected.

Empirical Model: The Cobb-Douglas functional form was applied for estimating profit efficiency of the rice farmers in the study sample. The model is specified as follows:

$$\ln \pi_i = \beta_0 + \beta_1 \ln P_{1i} + \beta_2 \ln P_{2i} + \beta_3 \ln P_{3i} + \beta_4 \ln Z_{1i} + \beta_5 \ln Z_{2i} + V_i - U_i \quad (1)$$

where: π_i represents nomalized profit which is calculated as total revenue less variable cost divided by farm specific rice price; P_1 represents nomalized average price per kg of seed; P_2 represents the nomalized average price per kg of fertilizer; P_3 represents nomalized average price per day of labor; Z_1 represents farm capital use (1000 VND/farm); Z_2 represents rice land cultivated (ha).

The inefficiency model is applied to measure relationship between profit inefficiency and household attributes. The model can be specified as

$$U_i = \delta_0 + \delta_1 X_1 + \delta_2 X_2 + \delta_3 X_3 + \delta_4 X_4 + \delta_5 X_5 + \delta_6 X_6 \quad (2)$$

where X_1 is age of farmer (years); X_2 is education of the farmer (years); X_3 is experience of farmer; X_4 is credit access (dummy variable is 1 if farmer accessed to credit in the previous year, 0 otherwise); X_5 is training (dummy variable is 1 if farmer took training in the previous year, 0 otherwise); and X_6 is household size (people).

RESULTS AND DISCUSSION

Descriptive Statistics: The descriptive statistics of the variables collected from the rice farms are illustrated in Table 1. Inspection of the table reveals that average price of output and of three inputs (seed, fertilizer and labor) in cooperative farms were all higher than those in non-cooperative farms. Members of cooperatives had larger rice farm compared to individual farmers (1.79 and 1.38, respectively). There were also some differences between the two farm categories in terms of household characteristics. In comparision with non-member farmers, cooperative farmers had higher education level, higher percentage in taking technical trainings, but their rice growing experience and percentage of credit access were lower.

Profit Efficiency Estimates: The computer program FRONTIER Version 4.1 [12] was used for estimating profit efficiency and inefficiency model as well. The results of maximum likelihood estimates are presented in Table 2. Variance parameters situated in the middle part of the table showed the significance of the model applied. The value of "LR test of the one-sided error" is an indicator used for testing whether or not profit inefficiency effects exist from the frontier. The values in both groups were significant because they were all higher

Table 1: Summary statistics of variables for rice farms

	Cooperative farms		Non-cooperative farms	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
Output and inputs variables				
Rice yield (kg/farm)	13,004.37	11,057.08	9,860.83	9,523.31
Rice price (1000 VND*/kg)	5.72	0.44	5.40	0.40
Profit (1000 VND/farm)	38,314.35	32,582.85	24,283.93	24,926.33
Seed price 1000 (1000 VND/kg)	11.39	2.76	9.06	3.21
Fertilizer price (1000 VND/kg)	10.55	1.33	10.51	1.92
Labor price (1000 VND/man-day)	116.36	7.05	106.48	5.53
Farm capital use (1000 VND/farm)	36,906.92	31,675.18	28,356.36	24,850.20
Land (ha)	1.79	1.56	1.38	1.27
Farms' characteristics				
Age of the farmer (years)	48.05	10.37	47.76	10.24
Experience of the farmer (years)	24.45	9.45	25.17	9.03
Education of the farmer (years)	7.50	2.86	6.35	3.07
Credit access(dummy)	0.35	0.48	0.43	0.50
Training (dummy)	0.73	0.45	0.49	0.50
Size of the household (people)	4.81	1.40	4.68	1.40

*1 US$ = 21,270 VND (as of June 31, 2014)

than 14.853, the value in Table 1 of Kodde and Palm [13] for 8 degree of freedom. These indicated the existence of profit inefficiency in rice production in the study sample. The values of gamma (γ) in cooperative farms and non-cooperative farms were 0.945 and 0.863 and significant at 1% level showing that 94.5% and 86.3% of the random variation in the two groups were caused by profit inefficiency. Only small shares (5.5% and 13.7%) of the inefficiency were due to random errors which farmers cannot control such as weather condition effects.

The coefficients in profit function show input effects on profit efficiency in the study. The negative signs of input variables mean that increases of these inputs will reduce profitability of rice farmers and vice versa. The results showed negative and significant effects of seed price and labor price on rice farmers' profit in both types of farms implying that when price of the two inputs increase, profit of rice farmers will decrease. Specifically, a 1% rise in seed price and labor price will reduce profits of rice farmer by about 0.08% and 0.2% in cooperative and 0.28% and 1.16% in non-cooperative.

The response of rice cultivated land to profit were positive and high significant as expected. This displayed that the farms with larger area tend to obtain higher profit efficiency rice farming. The coefficient values revealed that a 1% increase in rice cultivated area will improve profits by almost 1% in cooperative farms and 0.81% in non-cooperative farms. This results confirmed the findings of previous studies [5, 14, 15].

Factors Influencing Profit Efficiency: Concerning the sources of these efficiency differentials among sample respondents, the variables related to households' characteristics are used to determine their possible influences on the profit efficiency of rice farmers. These relationships were estimated in the inefficiency model which were displayed in the lower part of Table 2. It can be seen that all variables showed the same sign effects on profit inefficiency in both farm groups, except for training variable.

Results for education levels were negative and statistically significant at 1%, as expected. This implied that farmers who were well educated produced more efficiently or better than those without education. This was consistent with the findings of Khai and Yabe [4], Rahman [16], Chi and amada [17], Tien and Thong [18], Hyuha *et al.*[19], Reimers and Klasen [20], Nargis and Lee [21], Shamsudin [22]. As explained by Nargis and Lee [21] that farmers with higher education are often more efficient because they may have better skills in making good farm planning and accessing to useful information for their farming. However, the opposite results were reported by Linh [5] and Rahman,Schmitz and Wronka [23].

The experience variable had inverse relationship with the profit inefficiency. Hence, experience of the rice farmers showed an important role in reducing profit inefficiency and hence increasing profitability. As stated by Rahman [16] that experience helped Bangladeshi rice farmers obtain higher profit efficiency and reduce profit loss.

Table 2: Maximum Likelihood Estimates of the Stochastic Profit Frontier Function

		Cooperatives farms		Non-Cooperatives farms	
Variables	Parameters	Coefficients	*t*-ratio	Coefficients	*t*-ratio
Profit function					
Constant	β_0	9.973	3.789***	10.502	4.625***
lnSeed	β_1	-0.079	-1.423*	-0.197	-3.264***
lnFertilizer	β_2	-0.017	-0.131	0.266	2.339***
lnLabor	β_3	-0.275	-1.545*	-1.158	-3.850***
LnCapital	β_4	-0.041	-0.155	0.140	0.719
LnLand	β_5	0.978	3.678***	0.809	4.090***
Variance parameters					
$\sigma^2= \sigma^2_u+ \sigma^2_v$	σ^2	0.059	6.244***	0.083	5.946***
$\gamma= \sigma^2_u/(\sigma^2_u+ \sigma^2_v)$	γ	0.945	13.648***	0.863	6.509***
Log likelihood		23.493		-10.182	
LR test		32.458		56.161	
Inefficiency effects					
Constant	δ_0	0.499	3.228***	0.309	1.382*
Age of the farmer	δ_1	0.007	2.300**	0.014	2.729***
Education level	δ_2	-0.006	-1.956**	-0.013	-2.162**
Experience	δ_3	-0.022	-2.758***	-0.028	-2.982***
Credit access	δ_4	0.068	1.536*	0.202	3.366***
Training	δ_5	-0.087	-1.922**	0.209	3.144***
Household size	δ_6	-0.013	-0.853	-0.050	-2.556***
Number of observations		200		200	

* Significant at 10% level ** Significant at 5% level; *** Significant at 1% level

With respect to credit access, it positively affected profit inefficiency, which were not as expectated. This implies that access to credit lead to increase in inefficiency for both farm types in the study. The similar finding was found and explained by Hien, Kawaguchi and Suzuki [2] that rice farmers with small farm size and low education qualification hesitated in borrowing money because they were afraid of risk. Moreover, some of them even did not know what to do and how to use the loan effectively. Therefore, the possible explanations for this indicator may be because rice producers in this study lacked appropriate skills at managing and allocating ther agricultural capital and sometimes they did not use the loan for right purposes.

For the effect of training, in the case of cooperative farms, taking training resulted in a statistically significant decrease in farm inefficiency, but it showed an opposite direction for non-cooperative farms. This meant that training enabled the cooperative farmers be more efficient. This finding was consistent with the data presented in Table 1 that 73% of cooperative farmers received training while only 49% for non-cooperative farms. This could be considered as one of positive impacts of agricultural cooperatives on members. Being members of cooperatives, famers have better opportunities to access advanced technology through trainings. They are also willing to share their precious experiences on farming practices. These have great contributions to their improvements in rice production and profit as well.

Distribution of Profit Efficiency: Table 3 illustrates the summary of frequency distribution of efficiencies of rice farmers in the sampled area. On the average, profit efficiency of cooperative farms was 0.670 efficient in utilizing their technology while the figure for non-cooperative farms was on the average of 0.643 efficient. It can be seen that farmers in two groups showed wide range of efficient scores ranging from 0.349 to 0.971 in cooperatives and from only 0.274 to 0.958 in non-cooperative farms. The results clearly showed that the higher profit efficiency was mainly identified for the farmers in cooperatives. It can be seen that rice producers in this study obtained relatively low profit efficiency. As stated by Rahman [16], profits of rice producer could be increased by improving their efficiency such as technical, allocative and scale efficiency. Therefore, the farmers in cooperatives and non-cooperatives could improve their profit efficiency by about 33.0 % and 35.7% by improving their farming efficiency through adopting new technology, using appropriate and balanced inputs for rice production.

Table 3: Distribution of profit efficiencies of rice farmers

	Cooperatives farms		Non-Cooperatives farms	
Range (%)	Number	Frequency (%)	Number	Frequency (%)
90-100	14	7.0	9	4.5
80-90	31	15.5	29	14.5
70-80	36	18.0	44	22.0
60-70	41	20.5	34	17.0
50-60	51	25.5	39	19.5
<50	27	13.5	45	22.5
Total	200	100.0	200	100.0
Mean	0.670		0.643	
Minimum	0.349		0.274	
Maximum	0.971		0.958	
Std. deviation	0.145		0.157	

Table 4: Profit loss estimation for rice farmers

		Cooperatives farms		Non-Cooperatives farms	
Iterms	Unit	Mean	Std. Dev.	Mean	Std. Dev.
Actual profit	1000 VND/ha	22213.59	5977.41	17853.31	6274.66
Profit loss	1000 VND/ha	10768.30	4711.80	9575.77	4348.97
Potential profit	1000 VND/ha	32981.89	3690.32	27429.08	5084.58

Profit loss= Actual profit * (1-Profit efficiency)/ Profit efficiency; Potential profit=Actual profit+Profit loss.

Estimates Profit Loss: The measurements profit loss and potential profit of rice farmers in the two farm groups are illustrated in Table 4. It can be seen that the higher profit efficiency score of rice farmers in cooperatives was due to their high achievement in actual profit (over 22213 thousand VND/ha), while the farmers in non-cooperatives were in contrast position because of their low actual profit (just about 17853 thousand VND/ha). There were potentials for them to improve profit efficiency to achieve potential profit. Therefore, rice producers in the study, especially individual rice farmers, could rise profit by paying more attentions on their farming practices comprising technical, allocative and scale efficiency.

CONCLUSION

From the study, it can be concluded that rice growing farmers were not fully efficient and the higher efficiency mainly identified for the cooperative farms compared to those in individual farms (0.670 and 0.643, respectively). Having higher education level, more experience in rice growing and larger household size were related to higher profit efficiency in rice production. Credit access did not show positive effects on improving profit efficiency for the rice farmers. The role of technical trainings in reducing technical inefficiency was only found in cooperative farms, while it was not applicable in non-cooperative ones. Because the agricultural cooperative has been playing a key factor in Vietnamese rural development programs, information about efficiency of cooperatives as well as their members are both necessary for government and individual farmers. Thus we suggest that more studies in the future should be conducted on efficiency of cooperative farms in order to confirm their role in rural areas and to facilitate the policy formulation for efficiency enhancement.

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