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Chapter 5
Measuring Cost Efficiency and Its Determinants in Rice Farming in the Mekong River Delta

Phuc Trong HO

Summary: This chapter investigates rice production cost efficiency and investigates the determinants of cost inefficiency in rice production using a true random-effects model approach. The study used the survey data of 350 rice farmers in the Mekong River Delta, Vietnam. The findings show that the mean cost efficiency score is 0.92, with a wide variation (0.26–0.99). This study indicates that there is still room for inefficient rice farmers to save production costs by improving their cost efficiency. The research also finds that farm size, natural disasters, and rice diseases have a positive effect on cost inefficiency, implying that rice farmers lack the skills to manage input costs if farm sizes increase or when natural disasters and rice diseases occur. This study suggests that supportive policies should focus on improving rice farmers' skills to manage production inputs and deal with rice diseases and natural disasters to minimize production costs.

1. Introduction

Rice plays a crucial role in economic development and food security across developing and underdeveloped nations, sustaining populations and driving agricultural economies (Trong Ho et al. 2022). However, contemporary farming practices, particularly the excessive application of chemical fertilizers and pesticides, have created a complex web of challenges: farmers face mounting production costs, ecosystems suffer from environmental degradation, communities grapple with emerging health concerns, and the resulting rice crops often exhibit diminished quality. The implementation of more efficient input management strategies could offer a pathway to address these interconnected issues. While numerous research efforts have investigated rice farming efficiency on a global scale (Trong Ho et al. 2022), the academic literature has predominantly concentrated on measuring technical efficiency aspects. This narrow focus has led to an unfortunate oversight of input prices, a crucial economic factor that substantially shapes farmers' decision-making processes regarding input utilization and resource allocation (Trong Ho 2021).

Various research efforts have previously explored the relationship between price effects and efficiency measurements in rice farming through the application of cost frontier functions to calculate cost efficiency (CE) (Coelli et al. 2002; Huang et al. 2002; Siagian and Soetipto 2020; Thanh Nguyen et al. 2012; Tu and Trang 2016). These studies have provided valuable insights into the economic aspects of rice production and farming practices. Nevertheless, a significant limitation of these prior investigations lies in their failure to account for farm heterogeneity — the inherent differences between individual farming operations — which could potentially result in skewed estimates and inaccurate cost-efficiency scores.

To address this crucial research gap and enhance the accuracy of efficiency measurements, our study implements the sophisticated true random-effects (TRE) model (Green 2005a; b). This advanced methodological approach allows us to comprehensively evaluate both cost efficiency and its key determining factors in rice farming throughout the Mekong River Delta region, while properly accounting for the diverse characteristics and conditions of individual farms.

2. Data and Methodology

(1) Data Collection

This study used detailed farm-level data collected through an extensive survey conducted in the Mekong River Delta region of Vietnam. This important area serves as Vietnam's primary rice cultivation region, accounting for more than half of the country's total paddy production and harvested rice area, making it an ideal location for agricultural research.

To ensure representative sampling across the region's diverse agricultural landscape, we employed a carefully designed stratified random sampling methodology to identify study participants. Data collection was conducted through comprehensive face-to-face interviews with selected rice farmers, allowing us to gather insights and detailed information about their farming practices and experiences. The final dataset encompasses 350 rice farmers, yielding 918 distinct observations. This expanded sample size was achieved because each farmer typically cultivates rice across multiple growing seasons, with individual farmers managing two or three seasonal harvests throughout the year.

(2) Research Methodology

This study employs the True Random Effects (TRE) Model to measure cost efficiency and investigate its key determining factors that influence cost efficiency in rice farming. This analytical approach allows for a comprehensive examination of both cost inefficiency and stochastic noise components. Based on this econometric framework, the study can identify input allocation strategies and socio-economic characteristics that significantly contribute to cost efficiency variations among rice farmers. The first step is to run a translog cost frontier function (1) and then implement the inefficiency model (2).

Translog cost frontier function

$$\ln C_{it} = \alpha_0 + \sum_{j=1}^{2} \alpha_j \ln W_j + \beta_1 \ln Y + \frac{1}{2} \sum_{j=1}^{2} \sum_{h=1}^{2} \alpha_{jh} \ln W_j \ln W_h + \frac{1}{2} \beta_{11} \ln Y^2 + \sum_{j=1}^{2} \gamma_j \ln W_j \ln Y + \sum_{m=1}^{3} \delta_m D_m + w_i + v_{it} + u_{it} \quad (1)$$

Inefficiency model

$$\log \sigma^2_{uit} = \delta_0 + \sum_{m=1}^{10} \delta_m Z_{mit} \quad (2)$$

where, C is the variable cost, Y is the output quantity and W_j is a vector of input prices. α, β, γ, and δ are parameters to be estimated, v_{it}, u_{it}, and w_i are random noise, inefficiency terms, and farm heterogeneity. Z_m are explanatory variables.

3. Estimation of Cost Efficiency and Influential Factors

Table 5.1 provides a detailed analysis of rice production costs utilizing the Translog Stochastic Cost Frontier Function methodology, which enables a comprehensive assessment of cost production efficiency under socio-economic, farm, and variable weather conditions. As expected, all input variables (i.e., seed cost and fertilizer cost) and output quantity are positively significant at the level of 0.01. The results from the TRE model provide an effective assessment by producing more statistically reliable and robust estimation results. In addition, the analysis of cost inefficiency models identifies three key factors that significantly increase farmer inefficiency: rice cultivation area size, natural disaster impact, and rice disease prevalence. All three factors show positive correlations with higher cost inefficiency, highlighting critical areas needing improvement.

Table 5.1. Estimates of the Translog Stochastic Cost Frontier Function

Variable	Pooled		TRE	
	Coef.	**S.D.**	**Coef.**	**S.D.**
Constant	-0.304***	0.023	-0.320***	0.022
lnWseed	0.252***	0.035	0.250***	0.040
lnWfert	0.587***	0.042	0.555***	0.055
lnY	0.914***	0.013	0.872***	0.015
0.5lnWseed_sq	0.176	0.107	0.196*	0.109
0.5lnWfert_sq	0.424	0.274	0.686***	0.328
0.5lnY_sq	0.091***	0.015	0.113***	0.015
lnWseed_Wfert	-0.118	0.134	-0.201	0.133
lnWseed_Y	0.002	0.027	0.000	0.026
lnWfert_Y	0.104***	0.040	0.074	0.045
D_{S_A}	0.184***	0.017	0.178***	0.010
D_{A_W}	0.205***	0.019	0.180***	0.012
D_{HQV}	-0.047***	0.017	-0.028*	0.016
Estimates of cost inefficiency model				
Constant	-3.541***	0.640	-4.500***	0.821
Gender	-0.586	0.506	0.032	0.690
Education	-0.088	0.120	-0.082	0.140
Experience	0.044	0.119	-0.071	0.142
Extension	-0.078	0.109	-0.104	0.136
House-size	-0.197*	0.111	-0.156	0.120
Land-own	-0.178	0.110	0.081	0.136
Farm-size	0.188	0.120	0.299**	0.124
Disaster	1.121***	0.156	1.211***	0.147
Disease	0.231**	0.103	0.219**	0.096
Distance	0.164*	0.091	0.101	0.120
Model properties				
σ_{w_i}	-	-	0.174***	0.009
E ($\sigma_{u_{it}}$)	0.163	-	0.139	-
$\sigma_{v_{it}}$	0.192***	0.006	0.106***	0.005
Log-likelihood	130.05		286.65	

“Note: ***, **, * represent for significant levels at 1%, 5%, 10%, respectively. S.D. is the standard deviation

Source: Author’s calculation

Table 5.2 presents the summary of partial cost elasticities with respect to both input prices and output quantity. These elasticities provide valuable insights into how changes in various input costs and production volumes affect the overall cost structure, allowing for a deeper understanding of the economic relationships underlying the production process.

Table 5.2. Summary of Partial Cost Elasticities to Input Prices and Output Quantity

Variable	**Pooled**		**TRE**	
	Coef.	**S.D.**	**Coef.**	**S.D.**
Seed price	0.239	0.065	0.239	0.067
Fertilizer price	0.543	0.137	0.521	0.165
Labor price	0.218	0.159	0.240	0.162
Output quantity	0.876	0.093	0.827	0.107

Source: Author's calculation

A summary of cost efficiency by cropping seasons and rice varieties is shown in Table 5.3. The overall cost efficiency (TRE model) is 0.92, with efficiency scores ranging substantially from 0.26 to 0.99. The efficiency scores vary widely, indicating that less efficient rice farmers could significantly reduce production costs through better resource management and targeted efficiency improvements.

Table 5.3. Summary of Cost Efficiency by Cropping Seasons and Rice Varieties

Variable	**Observation**	**Pooled**		**TRE**	
		Coef.	**S.D.**	**Coef.**	**S.D.**
By cropping season					
Winter–Spring	339	0.920	0.089	0.936	0.080
Summer–Autumn	329	0.905	0.073	0.924	0.062
Autumn–Winter	250	0.875	0.115	0.890	0.114

By rice variety					
High–quality rice varieties	384	0.893	0.114	0.909	0.106
Conventional rice varieties	534	0.910	0.074	0.926	0.070
Overall cost efficiency	918	0.903	0.093	0.919	0.087

Source: Author’s calculations

4. Conclusion

This study attempted to measure cost efficiency and influential factors on rice farming in the Mekong Delta.

A consideration in the analysis is accounting for unobserved farm heterogeneity, which the True Random Effects (TRE) model effectively addresses by producing more statistically reliable and robust estimation results. This methodological approach ensures that the analysis captures the complex variations between individual farming operations that might otherwise remain hidden.

The analysis reveals a mean cost efficiency of 0.92, with efficiency scores ranging substantially from 0.26 to 0.99. This wide variation in efficiency scores indicates significant room for improvement among less efficient rice farmers, who could potentially achieve considerable reductions in their production costs through targeted efficiency enhancements and better resource management practices.

Through detailed examination of the cost inefficiency model estimates, the study identifies three factors that significantly contribute to increased cost inefficiency among farmers: the size of rice cultivation areas, the impact of natural disasters, and the prevalence of rice diseases. Each of these factors demonstrates a positive correlation with higher levels of cost inefficiency, highlighting key areas that require attention for improvement.

Based on these findings, the study strongly recommends the development and implementation of comprehensive training programs specifically designed to enhance rice farmers' production capabilities. These programs should focus particularly on three critical areas: advanced input cost management strategies, effective disease prevention and control methods, and improved disaster preparedness and response techniques. Such targeted training initiatives would help farmers minimize paddy losses and optimize their operational efficiency.

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Chapter 5. Measuring Cost Efficiency and Its Determinants in Rice Farming in the Mekong River Delta

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