Emerging Markets Queries in Finance and Business

Organic Production Practices and Technical Inefficiency of Durian Farms in Thailand

Wirat Krasachat

Abstract

The primary purpose of this study is to measure and investigate organic production practices affecting technical inefficiency of durian farms in Thailand. This study applies a stochastic frontier production function approach to measure farm-specific technical inefficiency using the 2011 farm-level cross-sectional survey data of Thai durian farms in a single estimation technique applying the maximum likelihood estimation method. The non-negative technical inefficiency effects are modelled as a function of farm-specific socio-economic, organic production practice and other production management factors. The empirical results suggest two important findings. First, there is confirmation that producer’s education, the application of organic farm system and soil improvement practices influenced the technical inefficiency of durian farms. Second, the considerable variability of fertiliser types does not have different impacts on technical inefficiency in Thai durian production in different farms. The results indicate advantages in increasing years of schooling and using organic farm practices in Thai durian farms. Therefore, the policies on encouraging farmers to increase continuing education and suggesting the farmers to use organic production practices in Thai durian farms are recommended to increase technical efficiency in durian production in Thailand.

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1. Introduction

Durian has become increasingly important to the Thai agriculture. In 1999, 137,649 hectares were planted to

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durian and 927,194 tonnes were produced. Around 98 per cent of total annual output of durian was
domestically consumed (calculated from Ministry of Agriculture and Cooperatives, 2008) while the rest was
exported to Hong Kong, Singapore, Taiwan and China. Although both the volume and value of Thai durian
exports during 1997-2001 increased continuously (due to the government promotion for durian as a strategic
export fruit), to sustain the demand and supply chain of exported durian, its production improvement is the
main concern of this sector. There are at least three causes for worry concerning the future development of
durian production in Thailand. First, durian is normally cultivated by small farms. Second, as mentioned above,
durian has been mostly sold in domestic consumption and the rest for export market. Finally, the Thai
government has significantly influenced Thai agriculture through a variety of policies over the past several
decades. These could cause imperfect competition in those inputs and in output markets. Because of the above
factors, economists and policy makers have raised the question of the technical efficiency of durian production
and farm practices in Thailand, especially at farm level. The primary purpose of this study is to measure and
investigate organic production practices influencing Thai durian farms’ technical efficiency. To estimate
efficiency scores, the stochastic frontier production function approach is applied to the 2011 farm-level cross-
sectional survey data of durian farms in two districts of two provinces in the Southern Region of Thailand.
Previous studies have investigated technical efficiency and its components at both the farm and aggregate
levels in Thai agriculture. Previous studies have investigated economic efficiency and its components at both
the farm and aggregate levels in Thai agriculture e.g., Krasachat, 2000, 2001a, 2001b, 2004a, 2004b, 2008,
2009, 2010. However, this study, to the best of our knowledge, has been the first application of the stochastic
frontier production function approach in order to measure and explain the impact of organic farm practices on
technical inefficiency of durian farms in Thailand. This enables more detailed understanding of the effect of the
organic practices on technical efficiency in durian production in Thailand. The empirical results of technical
efficiency and influencing the organic practices and other factors are necessary for policy makers to enable
them to choose the appropriate direction of development planning to increase productivity and, thus, to sustain
the demand and supply chain of durian in Thailand. This paper is organised into five sections. Following this
introduction, the methods are described. Next, the results are described. The last two sections cover the
discussion and conclusions of this study.

2. Methods

The stochastic frontier production function was independently introduced by Aigner, Lovell and Schmidt ,
1977; Meeusen and van den Broeck, 1977. This function contains a disturbance term that comprises two
components: one to account for technical inefficiency and the other to permit random events to impact
production. Coelli, 1995, among many others, indicated that the stochastic frontier production function
approach has two main advantages in estimating efficiency scores. That is, it deals with stochastic noise and it
permits statistical tests of hypotheses pertaining to production structure and the degree of inefficiency.

The firm’s technology is represented by a stochastic frontier production function as follows:
\[ y_i = f(x_i; \beta) + \varepsilon_i \]
\[ i = 1, 2, ..., N \]
where \( y_i \) is the output of the \( i \)th firm, \( x_i \) is a vector of input quantities used by \( i \)th firm, \( \beta \) is a vector of
parameters to be estimated and \( \varepsilon_i \) is the composed error term. Following Aigner, Lovell and Schmidt, 1977;
Meeusen and van den Broeck, 1977, \( \varepsilon_i \) is defined as:
\[ \varepsilon_i = v_i - u_i \]
where \( v_i \) accounts for random variations in production due to factors outside of the control of the producers, as
mentioned earlier, and is assumed to be independently and identically distributed $N(0, \sigma^2)$ random errors and $u_i$ accounts for technical inefficiency in production and is assumed to be an independent and identical half-normal distribution see Greene, 1993; Coelli et al., 2005, for alternative distributional assumptions. A number of studies have explored the determinants of technical efficiency by using the two-stage estimation procedure e.g., Parikh and Shah, 1994; Sharma, Leung and Zaleski, 1999. In the first stage, $u_i$ is estimated from the stochastic frontier production function. In the second stage, the calculated values of $u_i$ from the first stage are regressed against firm-specific factors that are assumed to explain the differences in $u_i$ between firms. Battese and Coelli, 1995 indicated that these firm-specific factors should be incorporated directly in the estimation of the production frontier because they may have a direct impact on efficiency. To overcome this problem, the parameters of the stochastic production frontier and the inefficiency model are estimated simultaneously given that the technical inefficiency effects are stochastic. In this case, the $u_i$ are assumed to be non-negative random variables, independently distributed and arising from the truncation at zero of the normal distribution with variance, $\sigma^2$, and mean, $z_i \sigma$, where $z_i$ is a vector of firm-specific factors assumed to explain technical inefficiency and $\sigma$ is a vector of parameters to be estimated Wilson et al., 1998. Several previous studies have specified a Cobb-Douglas production function to represent the frontier function e.g., Son, Coelli and Fleming 1993; Sharma, Leung and Zaleski 1999. In this study, the stochastic frontier production function of the Thai durian farms is specified as:

$$\ln y_i = \beta_0 + \sum_{k=1}^{3} \beta_k \ln x_{ki} + v_i - u_i$$

where $y$ and $x$ are variables as defined in Table 1, $\beta$s are parameters to be estimated and $v_i$ is a random noise term assumed to be distributed as $N(0, \sigma^2)$. $u_i$ is a farm-specific inefficiency effect term assumed to be satisfied by the truncation (at zero) of the $N(\mu, \sigma^2)$ where the firm-specific mean, $\mu_i$, is specified as:

$$\mu_i = \delta_0 + \sum_{p=1}^{5} \delta_p z_i$$

where the $\delta$ s are parameters to be estimated and $z_i$ is a vector of firm-specific factors assumed to explain technical inefficiency defined in Table 2.

Table 1. Variable definitions and measurement

<table>
<thead>
<tr>
<th>Variables</th>
<th>Units</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durian output ($y$)</td>
<td>Kilogram</td>
<td>Quantity of durian produced per farm</td>
</tr>
<tr>
<td>Land ($x_1$)</td>
<td>rai</td>
<td>Cultivated area per farm (1 rai = 0.16 hectare)</td>
</tr>
<tr>
<td>Labour ($x_2$)</td>
<td>Man-days</td>
<td>Quantity of labour used</td>
</tr>
<tr>
<td>Other inputs ($x_3$)</td>
<td>THB</td>
<td>Total costs incurred for using all variable expenses, except the above inputs (THB 30 = USD 1)</td>
</tr>
</tbody>
</table>

Note that the maximum likelihood estimation proposed by Battese and Coelli, 1995 is used to simultaneously estimate the parameters of the stochastic production frontier and the technical inefficiency effects model using the computer program, FRONTIER Version 4.1 described in Coelli, 1996. The data used in this study is based on a direct interview survey of 103 randomly selected durian farm households in seven districts of Chanthaburi Provinces in the Eastern Region of Thailand. The selected districts were Lam Sing, Tha Mai, Khlong, Na Yai Arm, Prong Nam Ron, Muang and Ma Kham which are predominantly durian producing
areas in the Eastern Region of Thailand. The data were for 2011. The farms selected were owner operated and had faced a similar economic and marketing environment for inputs and outputs.

Table 2. Variable definitions for inefficiency effects

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFARM</td>
<td>Dummy variable proxied for a producer who applied organic farm practices and zero otherwise</td>
</tr>
<tr>
<td>SOIL</td>
<td>Dummy variable with a value of one if producer used soil improvement practices and zero otherwise</td>
</tr>
<tr>
<td>OFER</td>
<td>Dummy variable with a value of one if producer used organic fertiliser and zero otherwise</td>
</tr>
<tr>
<td>CFER</td>
<td>Dummy variable with a value of one if producer used chemical fertiliser and zero otherwise</td>
</tr>
<tr>
<td>EDU</td>
<td>Producer’s years of schooling</td>
</tr>
</tbody>
</table>

One output and three inputs are used in the empirical application of this study. The three inputs groups are land, labour and “other inputs”. Several farm-specific factors are analysed to assess their influence on productive efficiency. The farmer’s education is derived from a farmer’s years of schooling while dummy variables are introduced as proxy for the differences in types of farm practices and fertilisers used in different farms. The input and output variables are defined in Table 1 whilst the variables selected for use to investigate inefficiency effects are in Table 2.

3. Results

The parameter estimates of the Cobb-Douglas stochastic production frontier and the technical inefficiency effects model are reported in Table 3. Approximately a half of the estimated parameters are at least twice their corresponding standard errors. This indicates that the goodness of fit of the model is fair. Following Coelli et al. (2005), the technical efficiency of $i$th farm is calculated. The minimum estimated efficiency score is 0.270, the maximum score is 0.958 and the mean score is 0.779 with a standard deviation of 0.174. This indicates that there are possibilities to increase efficiency levels in Thai durian farms. Wilson et al., 1998 indicated that, given the difference in efficiency levels among production units, it is valuable to question why some producers can achieve relatively high efficiency while others are technically less efficient. Variation in the technical efficiency of producers may arise from farm-specific socio-economic and management factors that impact the ability of the producer to adequately use the existing technology. The parameter estimates for the inefficiency effects model shown in Table 3 suggest three important findings. First, the estimated coefficients of years of schooling and dummy variable proxied for a producer who applied organic farm practices are negative. This implies that producers with more years of schooling and used organic farm practices achieved higher levels of technical efficiency. In other words, producers with the higher education and used organic production systems are likely to get higher levels of technical efficiency in their farm management. Second, the empirical results indicate that the farmer’s soil improvement practices have a positive effect on technical inefficiency. This suggests that farmers who applied soil improvement practices achieved lower levels of technical efficiency which is unexpected. This may possibly be because soil improvement practices need better skills and farm planning which stemmed more from farm practices than from formal education. Finally, there is no confirmation that the differences in the types of fertiliser application have influenced the technical inefficiency of durian farms. This implies that the considerable variability of fertiliser types does not have different impacts on technical efficiency in Thai durian production in different farms.
Table 3. Maximum likelihood estimation results

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stochastic frontier:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.811</td>
<td>0.477</td>
</tr>
<tr>
<td>lnX1</td>
<td>0.013</td>
<td>0.078</td>
</tr>
<tr>
<td>lnX2</td>
<td>0.353</td>
<td>0.081</td>
</tr>
<tr>
<td>lnX3</td>
<td>0.597</td>
<td>0.066</td>
</tr>
<tr>
<td>Inefficiency model:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-2.272</td>
<td>2.137</td>
</tr>
<tr>
<td>OFARM</td>
<td>-0.856</td>
<td>0.478</td>
</tr>
<tr>
<td>SOIL</td>
<td>0.867</td>
<td>0.388</td>
</tr>
<tr>
<td>OFER</td>
<td>2.317</td>
<td>1.907</td>
</tr>
<tr>
<td>CFER</td>
<td>0.425</td>
<td>0.447</td>
</tr>
<tr>
<td>EDU</td>
<td>-0.129</td>
<td>0.064</td>
</tr>
<tr>
<td>Variance parameters:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>σ² = σ² + σ²</td>
<td>0.230</td>
<td>0.072</td>
</tr>
<tr>
<td>γ = σ² / σ²</td>
<td>0.739</td>
<td>0.086</td>
</tr>
<tr>
<td>Log-Likelihood</td>
<td>-29.228</td>
<td></td>
</tr>
</tbody>
</table>

4. Discussion

The primary contribution of this study is that it, to the best of our knowledge, has been the first application of the stochastic frontier production function approach in order to measure and explain technical inefficiency of durian farms in Thailand. This enables more detailed understanding of the nature of technical efficiency in durian production in Thailand. The empirical results of technical efficiency and influencing factors are necessary for policy makers to enable them to choose the appropriate direction of policy implications to increase productivity and, thus, to sustain the demand and supply chain of durian in Thailand. The second contribution of this study is the provision of information on the effect of the organic farm practices and education on technical efficiency, especially in Thai durian farms. The third contribution of this study is that, by using empirical results, Thai policy makers can better understand that the considerable variability of fertiliser types does not have different impacts on technical efficiency in Thai durian production in different farms.

5. Conclusions

This study applies a stochastic frontier production function approach to measure farm-specific technical inefficiency using the 2011 farm-level cross-sectional survey data of Thai durian farms in a single estimation technique applying the maximum likelihood estimation method. The empirical results indicate that there are possibilities to increase efficiency levels in Thai durian farms. Producers with more years of schooling and who used organic farm practices achieved higher levels of technical efficiency. In addition, the producers who used soil improvement practices achieved a lower level of technical efficiency. Finally, there is no confirmation that the differences in fertiliser types have influenced the technical inefficiency of durian farms. However, the results must be viewed with caution due to the small sample of the data set. The results indicate advantages in
increasing years of schooling and using organic farm practices in Thai durian farms. Therefore, development policies of the above areas should be used to increase the technical efficiencies of these inefficient farms in Thailand. That is, the policies on encouraging farmers to increase continuing education and suggesting the farmers to use organic production system in Thai durian farms are recommended to increase technical efficiency in durian production in Thailand.

References