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Determinants of Technical Efficiency among Smallholder Cocoa Farmers in Malaysia

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Abstract

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The determinants technical efficiency among smallholder cocoa farmers has been well studied in agricultural literature. Among the factors identified are the demographic characteristics that affect farmers' decision-making process and the ability of farmers to execute the decision effectively. In Malaysia, cocoa production is characterized by several problems that lead to low productivity. First is the negligence of the agricultural sector by the past administration due to shift in policy favoring manufacturing sector that now accounts for the bulk of foreign exchange earnings. Second is the endemic problem in the cocoa industry. The low productivity has resulted in the continuous fall in percentage share of cocoa output since 2001. Therefore, increasing productivity would increase the percentage share of cocoa production. Accordingly, this study explores the determinants of technical efficiency among cocoa farmers in Malaysia. The study relies upon primary data gathered during the 2013 production season. Data are collected from a set of structured questionnaire administered on 375 smallholder cocoa farmers throughout Malaysia. Results of the analysis show that record keeping, level of knowledge and status of farmers (either part-time or full-time) affects efficiency. This finding suggests that policies that would directly affect these identified variables should be pursued.

Keywords: Cocoa; technical efficiency; Tobit analysis.

1. Introduction

In 1990, Malaysia was the fourth largest cocoa producing countries in the world after Ivory Coast, Ghana and Brazil. However, in 2010, Malaysia was ranked 13th in the world. The decline of Malaysia's position as a major exporter of cocoa in the world was due to the reduction in the local production of cocoa beans. According to Malaysian Cocoa Board (MCB hereafter), small-scale farmers

prefer to grow oil palm and rubber trees instead of cocoa. The preference for oil palm and rubber trees is attributed to the simplicity in the plantation process. About 90 percent of cocoa productions in Malaysia are managed by small-scale farmers (Malaysian Cocoa Board). Despite the initiatives taken by MCB to increase the efficiency among the small-scale farmers, the industry has not yet able to reach its targeted production level of 40,000 tonnes of cocoa per annum. In 2014, the industry only managed to produce 2,665 tonnes of cocoa. Therefore in order to encourage farmers to grow cocoa and increase productivity of cocoa production, a number of incentives and programmes have been introduced by MCB. These include among others the Cocoa Smallholder Development Program), Consolidated Group Development Program, Entrepreneur Development Cocoa Program and Capacity Building Program.

The main objective of these programmes is to improve production efficiency among small-scale farmers from the average of 0.5 tonnes (per hectare / per year) to 1.5 tonnes (per hectare/per year). If this output level is reached, the farmers are considered efficient by MCB definition. Nevertheless, production efficiency can also be measured by decomposing the production efficiency into its technical and scale components. This is important because the production efficiency can also be influenced by factors such as age, education level and family size as discussed by Amos (2007). Therefore, this study investigates the sources of technical efficiency among cocoa farmers in Malaysia. For this purpose, the study will utilize Tobit estimator to investigate the determinant factors of technical efficiency.

The rest of the study is organized as follows. Section 2 reviews measures of technical efficiency and literatures on determinants of production efficiency. Section 3 presents the empirical model and data. Section 4 discusses the empirical results and section 5 concludes.

2. Technical Efficiency Measures and its Determinants

2.1. Technical Efficiency Measures

Parametric frontier models and non-parametric methods have monopolized the recent literature on productive efficiency measurement. Parametric approach involves testing procedures that are based on a number of assumptions. It requires the construct of a production function to describe the level of technology, normality assumptions that need to be met and mathematical modeling in the form of time series analysis. According to Coelli et al. (2005), the measurement efficiency can be categorized in two functions; the stochastic frontier production and cost functions.

In the parametric approach, the stochastic frontier production is based on the Cobb-Douglas production function incorporated into various estimation methods such as ratio analysis, Ordinary Least Square (OLS), Total Factor Productivity and Stochastic Frontier Analysis (SFA). Of these three methods, SFA is the most commonly employed technique in literatures. The non-parametric method that is commonly employed in literature on productive efficiency is Data Envelopment Analysis (DEA). It is a linear programming model, assuming no random mistakes, used to measure technical efficiency of decision making units (or DMUs).

2.2 Determinants of Production Efficiency

Studies on factors affecting the level of efficiency are as important as the study estimating the level of efficiency (Chirwa, 2007). Efficiency of cocoa farmers in Malaysia could be improved if the factors

influencing the efficiency can be determined. In practice, it is rather difficult for farmers to reach the desired level of efficiency even with employing the optimum combination of technology and inputs available. This is because the final output is not only dependent upon the optimum combination of inputs available but also subject to internal and external factors that would ultimately affect the final output produced (Coelli et al., 2005).

Tauer and Belbase (1987) opined that systematic record keeping significantly affect efficiency of farmers. Similaly, Zepeda (1994) found that good record-keeping practices greatly influence the efficiency of dairy farm farmers in California. Knowledge of good farming techniques is equally important factor influencing efficiency (Godtland et al., 2004; Rasula et al., 2012; Gholami et al., 2013; and Abang et al., 2014). Wadud and White (2000) analyzed the technical efficiency of 150 farmers using DEA method. The study showed that the coefficient on years of schooling is positive indicating that the farmers with more years of schooling tend to be more technically efficient in agricultural production. Asadullalingh and Rahman (2009) found that education level among farmers is significant in reducing production inefficiency, increasing productivity and total output.

In addition, Nyagaka dan Obare (2010) found that demographic factors such as age, gender and education level have positive influence on efficiency. In other related work by Aneani et al. (2011), they found that age of farmers greatly influence cocoa output in Ghana. The authors recommend greater involvement of young households in farming activities to help increase cocoa output.

3. Data and Empirical Model

3.1 Sampling Method and Data Collection

This study uses cross-section data for the production year 2013. The data for this study is collected through a cross sectional survey of cocoa farmers in the West and East Malaysia involving 375 smallholder cocoa farmers using simple cluster random sampling. Information are gathered using face-to-face interview via structured questionnaire designed for collecting information on output, inputs, prices of variables, and some important socio economic variables about the farmers. These include characteristics of farmers such as age, education level, experience, and other relevant information. Prior to data collection, a pilot study was conducted to test the understanding of cocoa farmers on questions pertaining to the use of input and output produced.

From the 375 samples collected, 65% (or 244 samples) are obtained from West Malaysia (i.e Peninsular Malaysia) and the remaining 35% are sourced from East Malaysia (i.e Sabah and Sarawak). One may argue that the samples gathered may not be representative of cocoa industry in Malaysia. As of 2014, 76% from the total of 16,102 hectares of cocoa cultivated farms are in East Malaysia and the remaining 3,822 hectares are in Peninsular Malaysia. The disproportionate sampling distribution is inevitable due to logistic constraints encountered upon accessing the cocoa farms and collecting the questionnaires distributed.

The questionnaires are distributed to various districts covering several states in the Peninsular Malaysia namely Beseri in Perlis, Kampung Pulau Nyiur and Bukit Wang in Kedah, Batu kawan and Cerok Tok Kun in Penang, Terong, Grik and Pengkalan Hulu in Perak, Kuala Selangor district, Sabak Bernam, Klang in Selangor, Kuantan in Pahang, Ledang and Muar in Johor, Dungun in Terengganu

and Machang district in Kelantan. In Sabah and Sarawak, the areas covered are Tenom, Tawau, Miri and several other districts.

3.2 Empirical Model: Tobit Estimator

In technical efficiency literatures, the Tobit estimator is usually applied in a two-stage analysis procedure; the first stage normally involves estimating a parametric or non-parametric measure such SFA or DEA. Result from the first stage analysis (in this case the efficiency score index) enters the second stage analysis to determine sources of technical efficiency among cocoa-producing farmers. This study will not discuss result from the first stage analysis to conserve space[1]. The maximum likelihood Tobit regression specified for Malaysian cocoa farmers is as follows:

$$y_{t*} = \beta x_t + \mu_t$$
$$yt = y_{t*} \text{ if } y_{t*} > 0; \text{ and } y_t = 0, \text{ otherwise} \quad (1)$$

using maximum likelihood function, equation (2) can be solved by:

$$L = \prod_{y_{t=0}}(1 - Ft) \prod_{y_{t>0}} \frac{1}{(2\prod\sigma^2)^{1/2}}\, xe^{-1/2\sigma 2)(yt-\beta xt)2}$$

with

$$Ft = \int_{\to\infty}^{fxt/\sigma} \frac{1}{(2\prod)^{1/2}} e^{-t^2/2} dt \quad (2)$$

The first part of equation (2) refers to efficient farmers (y=1) and second part of equation (2) represents inefficient farmers (y <1). The demographic and socio-economic factors are shown in Figure 1 below.

Figure 1. Variable definitions

Variable	Definition
RATIO	Ratio of labor usage to land size
AGE	Age of farmer as of January 2013
EXP	Experience of farmers in cocoa plantation (years)
EDU	Education level, entered between scale 1 to 9
INVOLVE	Score for spouse involvement, 0 to 48
DIST	Distance between house and farm (kilometers)
RECORD	Quantity of information recorded, maximum 30
KNOW	Score of correctly answered questions regarding basic cocoa farming skills; minimum 0, maximum 20
STATUS	Farmer status; 0 if part time basis, 1 if full time basis

4. Data and Empirical Model

Table 2 shows results of Tobit regression analysis. Results show that variables **RATIO, EXP, RECORD, KNOW** and **STATUS** are statistically significant at 1% level of significance. Meanwhile, variables **AGE**, **EDU, DIST** and **INVOLVE** are not statistically significant. These results show that

[1] This study uses DEA method to estimate the technical efficiency index of Malaysian cocoa farmers. Results are available upon request from the author.

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farmers' experience and socio-economic factors such as level of knowledge, record keeping and farmer's status could affect productivity. For KNOW, it reveals that farmers who possess basic skills and knowledge on cocoa farming are more efficient and productive. This finding supports the study by by Gotland et al., (2003), Rasula et al., (2012) and Abang et al., (2014). In Malaysia, cocoa harvesting are not yet mechanized**.** The cocoa pods are still hand-harvested throughout Malaysia, making this industry more labor-intensive than other agricultural sectors. Thus causing productivity of labor strongly correlated with farm size and age of farmers. For record keeping, the study finds a statistically significant relationship with efficiency index of cocoa farmers. It proves that cocoa farmers with proper record keeping tend to be more efficient than farmers who do not.

Finally, variables that explain education, age and involvement of spouse or partner in farming are not statistically significant in determining the technical efficiency of cocoa farmers in Malaysia. This is not surprising because most of the samples interviewed are those age 55 and above with only primary or secondary level of education. Although spouse or partner's involvement is an important determinant of productivity, this study finds only a small number of farmers received assistance from spouse.

Table 2. Results of Tobit regression analysis

Variable	**Coefficient**
C	-0.1035 *(0.1103)*
RATIO	0.0370 *(0.0088)***
AGE	0.0018 *(0.0013)*
EXP	0.0038 *(0.0015)***
EDU	-.01003 *(0.0074)*
INVOLVE	-0.0016 *(0.0024)*
DIST	0.0016 *(0.0031)*
RECORD	0.0217 *(0.0063)***
KNOW	0.0174 *(0.0042)***
STATUS	0.3226 *(0.0282)***
Respondent	375
Prob>Chi2	0.000
Pseudo R^2	0.6780

Note: *, **, *** denotes significance level at 10 %, 5% dan 1% respectively.
Standard errors are in parentheses

5. Data and Empirical Model

The efficiency of smallholder cocoa farmers in Malaysia could be improved by understanding the sources of efficiency for these farmers. Results from Tobit regression show that factors such as ratio of

labor per land size (RATIO) , farmers' experience (EXP), record keeping (RECORD) , basic knowledge about cocoa farming (KNOW) and status of farmers who are involved in cocoa plantation (STATUS) are significant determinants of efficiency among smallholder cocoa farmers in Malaysia. Based on the findings, formulation of policies and programs from governing agencies such as MCB should factor in these elements. These would ensure the cocoa farmers could benefit and ultimately increase their efficiency and output level.

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