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The Production of Thailand's Sugarcane: Using Panel Data Envelopment Analysis (Panel DEA) Based Decision on Bootstrapping Method

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Abstract

This study examine the statistical properties of technical efficiency (TE) was estimated by Data Envelopment Analysis in the panel data setting (Panel DEA) using collected data for sugarcane farming households in major regions of Thailand. The information about sugarcane in during period of 5 crop from 2008-2012 to analyse technical efficiency. A Panel Bootstrap Method is conducted to indicate statistical exactness of Panel Data Envelopment Analysis. Bootstrapping DEA panel data approach was used in empirical analysis despite being an important statistical tool for improving the estimation accuracy. Technical efficiency is modelled as a function of sugarcane yield and production factors. The results from the deterministic, indicate that the statistical properties, technical efficiency in term of sugarcane yield per rai* is significantly influenced by Area planted per rai and Rainfall (mm Lilit) as rainfall regional factors. In addition, scale efficiency analysis shows that for two ordinarily long years, the technical efficiency analysis of farm households involved in sugarcane production can be adopted for policy recommendation based on bootstrapping DEA panel data approaches because the mean of bootstrapping Panel DEA approach equal to the mean of DEA approach in the panel data setting in both 2008 and 2011 only. This is the contribution of this paper whenever the scholars want to estimate the DEA panel data approaches the results of these Simulations (resampling based) confirm these theoretical results by bootstrapping Panel DEA approach.

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Keywords: **Panel DEA approach, Efficiency, Sugarcane, bootstrapping DEA panel data approaches, Thailand.**

* 1 hectare in rai = 6.25 rai

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1. Introduction

Sugarcane farming policy can cause the quality of life of people in the country, including agriculture and non-agriculture. This research clarifies the statistical properties of technical efficiency influenced by a micro of factors efficiency levels in sugar cane industry obtained from both statistical methodologies of Data Envelopment Analysis in the panel data setting (Panel DEA) and bootstrapping Panel DEA approach. And information of cane in during the period of 5 crop years from 2008-2012 was conducted to analyse the statistical properties of technical efficiency. The results showed that estimate the DEA panel data approaches based on Simulations confirm these theoretical results by bootstrapping Panel DEA. The government must be support the transformation process policy to strengthen and build competitive advantage in this industry.

2. The objective of research

The aim of this study to examine the statistical properties of technical efficiency (TE) was estimated by bootstrapping panel data envelopment analysis can be used or not to evaluate the the panel DEA for sugarcane farming households in major regions of Thailand.

3. The research framework and methodology

The research framework and statistical methodology were applied to study the research namely is "*The Production of Thailand's Sugarcane: Using Panel Data Envelopment Analysis (DEA) Based Decision on Bootstrap Method"*. This research process is also demonstrated as follows the figure 1.

3.1 The research framework for production of Thailand's sugarcane based on decision by panel DEA bootstrapping approach

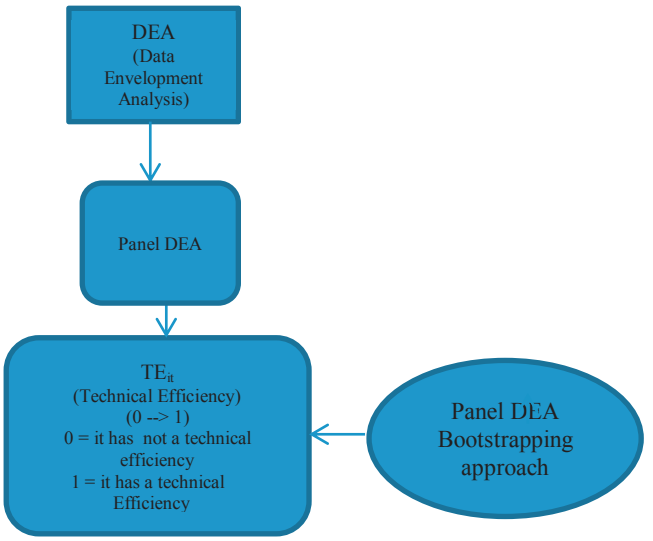


Figure 1 Presents the concept frame work of process based on Panel DEA bootstrapping approach

3.2 The methodology for of bootstrapping method for production of Thailand's sugarcane based on decision by panel DEA bootstrapping approach

a. Data Envelopment Analysis (DEA) and Panel Data Envelopment Analysis (Panel DEA)

The data envelopment analysis (DEA) is one amount of many nonparametric approaches and this approach can be employed to measure the technical efficiency (TE) for production function. The main idea of DEA approach was formulated by output divine by input (Output/Input (see more detail in equation 1).

$$TE_i = 0Q_i/0P_i \quad (1)$$

The TE_i is technical efficiency of firm (i=1,..,n) as well as the $0Q_i/0P_i$ was represented the ratio of TE belong to this firm. Moreover, the ratio of TE_i will be a value of between zero and one. The TE_i equate to zero is represented that firm has not a technical efficiency. On the other hand, the TE_i equate to one is represented that firm has a maximum technical efficiency (see more detail in Coelli, T.J,(1996)). The panel DEA is extension vision of DEA analysis and also the TE_{it} of panel DEA can be presented by equation (2).

$$TE_{it} = 0Q_{it}/0P_{it} \quad (2)$$

The TE_{it} is a technical efficiency of firm (i=1,..,n (number of firm) and t=1,..,n (number of time))as well as the $0Q_{it}/0P_{it}$ was represented the ratio of TE belong to this firm(i) at during period of time (t). Moreover, the ratio of TE_{it} will be a value of between zero and one. The TE_{it} equate to zero is represented that firm (i) at during period of time (t) has not a technical efficiency. On the other hand, the TE_{it} equate to one is represented that firm (i) at during period of time (t) has a maximum technical efficiency (see more detail in Coelli, T.J,(1996)). Based on this method was employed to estimate the production of Thailand's sugarcane based on panel DEA analysis.

b. Bootstrapping Panel Data Envelopment Analysis

A panel bootstrapping method is conducted to indicate statistical exactness of panel data envelopment analysis (Vu Hoang Linh, (2012)). In 1979, the bootstrapping method was first proposed by Bradley Efron and after that this method is very powerful for improvement of statistics estimation especially for the data is not normal distribution. For bootstrapping panel data envelopment was used in this research will be described from equation (3).

$$\bar{y}^*_{bit} = \sum_{it}^{n} y^*_{bit} / n \quad (3)$$

The $\bar{y}^*_{bit}$ is represented that the TE_{it} belong to the sugarcane produce of Thailand each area and these TE_{it} were generated by the method of bootstrapping until will be satisfied for the good properties of bootstrapping approach(Bradley Efron,1997).

$$\widehat{\emptyset}_{it(Lower*)} < \theta_{it} < \widehat{\emptyset}_{it(Upper*)} \quad \text{Logical Expression} \quad (1a)$$

The confident interval of a panel bootstrapping method can be presented the logical expression (1a) and where Lower* is the lower of mean ($\widehat{\emptyset}_{it(Lower*)}$) from bootstrapping method and Upper* is the upper of mean ($\widehat{\emptyset}_{it(Lower*)}$) from bootstrapping method respectively.

4. Data description

Table 1: By using information about the cane during the period of 5 crop years from 2008-2012 to analyse the statistical properties of total factor productivity to know the advantage of the use of the cane farmers and sugar cane industry policy and economic development plan demonstrate in term of Sugarcane yield per rai[†](**Y**) is efficiently influenced by Area planted per rai (AREA) covering Central of Thailand, West of Thailand East of Thailand, North of Thailand and Rainfall (mm Lilit RAIN) from 2008-2012 by yearly data. Moreover, the table (1) demonstrate the descriptive statistics of Area planted per rai covering Central of Thailand, West of Thailand East of Thailand, North of Thailand and Rainfall (mm Lilit) from 2008-2012 by yearly data. And figure (1) demonstrates in term of Sugarcane yield per rai is influenced by Area planted per rai and Rainfall (mm Lilit) during period of the same time. In terms of these Sugarcane yield per rai have a process are confirmed by the production function of sugarcane of Thailand.

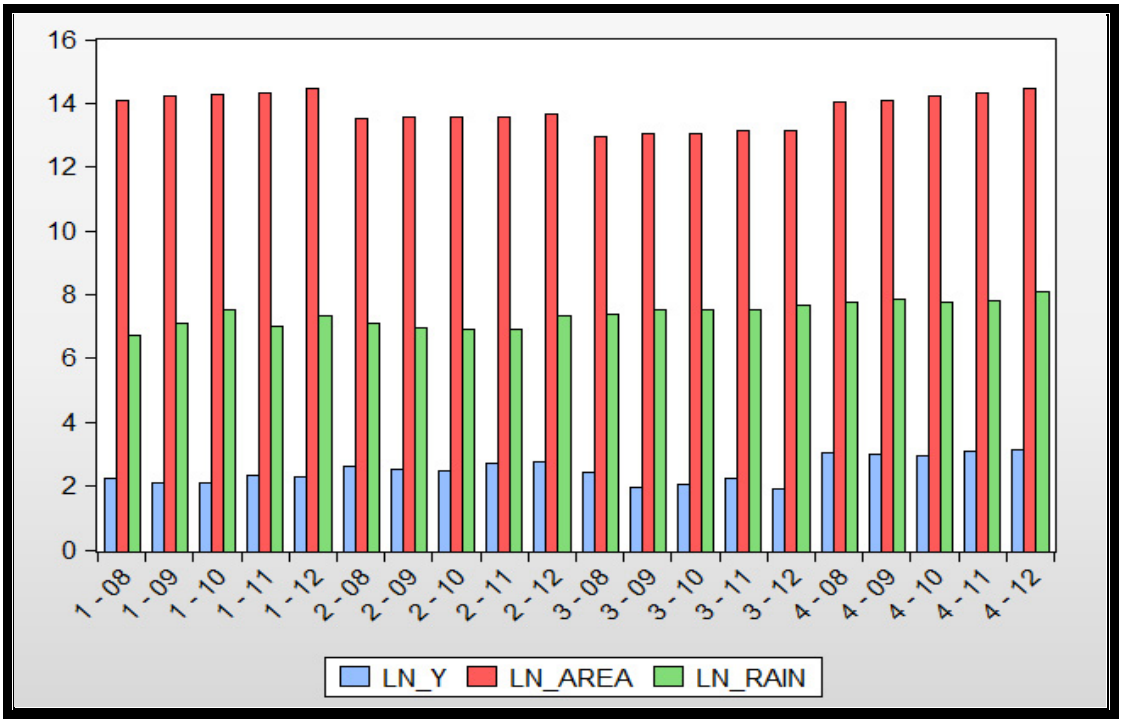
Table 1 Descriptive statistics of data were used estimated for during period of study (2008-2012)

	LN_Y	LN_AREA	LN_RAIN
Mean	2.496846	13.78423	7.388016
Median	2.440787	13.85665	7.444192
Maximum	3.147369	14.47226	8.071874
Minimum	1.923356	12.94142	6.735127
Std. Dev.	0.399227	0.527709	0.377268
Skewness	0.240999	-0.273677	-0.058010
Kurtosis	1.769204	1.614662	1.929688
Jarque-Bera	1.455984	1.848965	0.965857
Probability	0.482878	0.396737	0.616974
Sum	49.93691	275.6846	147.7603
Sum Sq. Dev.	3.028255	5.291058	2.704297
Observations	20	20	20

From: computed

[†] 1 hectare in rai = 6.25 rai, LN_Y is a natural logs of (sugarcane yield (ton/per rai)), LN_AREA is a natural logs of rai, LN_RAIN is a natural logs of Rainfall (mm Lilit).

Figure 2 Show the all of data was employed to estimate the production function of sugarcane of Thailand during period of 2008-2012



Note: i=1= Central of Thailand, ln_Y= Sugarcane yield per rai , ln_AREA= Area planted per rai ln_rain = Rainfall (mm Lilit).i=2=West of Thailand, i=3=East of Thailand, i=4=North of Thailand,

5. Results

The results indicated the Technical efficiency (TE) influenced by a micro of factor efficiency levels obtained from both Data Envelopment Analysis in the panel data setting (Panel DEA) using collected data for sugarcane farming households using cross such as central of Thailand, West of Thailand, East of Thailand, and North of Thailand. Based on information about the sugarcane during the period of five crop years from 2008-2012 to analyse the technical efficiency of the cane farmers and sugar cane industry policy and economic development plan. Technical efficiency results show in term of order by TE across the areas of studying as shown on Table 2. Panel Bootstrap Method is conducted to indicate statistical exactness of the panel data setting (Panel DEA). Bootstrapping DEA panel data approach was experimented in empirical analysis despite being an important statistical tool for improving the estimation accuracy. Technical efficiency is modelled as a function of sugarcane yield and production factors.

Table 2 Present the Technical efficiency (TE) results for sugarcane produce Thailand based on Panel DEA approach.

Areas	Year	TE	Order by TE
The Central of Thailand (1)	2008	0.85	4
The West of Thailand (2)	2008	0.95	2
The East of Thailand (3)	2008	0.86	3
The North of Thailand (4)	2008	1	1
Areas	**Mean**	**0.91**	**4**
The Central of Thailand (1)	2009	0.77	3
The West of Thailand (2)	2009	0.95	2
The East of Thailand (3)	2009	0.7	4
The North of Thailand (4)	2009	1	1
Areas	**Mean**	**0.86**	**4**
The Central of Thailand (1)	2010	0.72	4
The West of Thailand (2)	2010	0.93	2
The East of Thailand (3)	2010	0.75	3
The North of Thailand (4)	2010	1	1
Areas	**Mean**	**0.85**	**4**
The Central of Thailand (1)	2011	0.83	3
The West of Thailand (2)	2011	0.99	2
The East of Thailand (3)	2011	0.79	4
The North of Thailand (4)	2011	1	1
Areas	**Mean**	**0.9**	**4**
The Central of Thailand (1)	2012	0.79	3
The West of Thailand (2)	2012	0.95	2
The East of Thailand (3)	2012	0.67	4
The North of Thailand (4)	2012	1	1
Areas	**Mean**	**0.85**	**4**

In table 3, the Technical efficiency (TE) results for sugarcane produce of Thailand including areas, TE_boot_mean, TE_lower_boot, TE_upper_boot for Data Results of bootstrapping Panel DEA approach were information about the cane during the period of 5 crop years from 2008-2012. The results in sugarcane yields indicated that bootstrapping Panel DEA approach equal to the mean of Panel DEA approach in both 2008 and 2011 confirmed that there is statistical exactness.

Table 3 Present the Technical efficiency (TE) results for sugarcane produce of Thailand based on bootstrapping Panel DEA approach.

Areas	Year	TE	Mean	TE_boot_mean	_lower_boot	TE_upper_boot
The Central of Thailand (1)	2008	0.85	4			
The West of Thailand (2)	2008	0.95	2	**Equal**		
The East of Thailand (3)	2008	0.86	3			
The North of Thailand (4)	2008	1	1			
Areas	**Mean**	**0.91**	**4**	**0.91**	**0.85**	**0.98**
The Central of Thailand (1)	2009	0.77	3			
The West of Thailand (2)	2009	0.95	2	**Lower**		
The East of Thailand (3)	2009	0.7	4			
The North of Thailand (4)	2009	1	1			
Areas	**Mean**	**0.86**	**4**	**0.85**	**0.75**	**0.96**
The Central of Thailand (1)	2010	0.72	4			
The West of Thailand (2)	2010	0.93	2	**Lower**		
The East of Thailand (3)	2010	0.75	3			
The North of Thailand (4)	2010	1	1			
Areas	**Mean**	**0.85**	**4**	**0.84**	**0.72**	**0.96**
The Central of Thailand (1)	2011	0.83	3			
The West of Thailand (2)	2011	0.99	2	**Equal**		
The East of Thailand (3)	2011	0.79	4			
The North of Thailand (4)	2011	1	1			
Areas	**Mean**	**0.90**	**4**	**0.90**	**0.81**	**0.99**
The Central of Thailand (1)	2012	0.79	3			
The West of Thailand (2)	2012	0.95	2	**Lower**		
The East of Thailand (3)	2012	0.67	4			
The North of Thailand (4)	2012	1	1			
Areas	**Mean**	**0.85**	**4**	**0.82**	**0.7**	**0.94**

From: computed

6. Conclusion

This paper analyses bootstrap methods for producing good approximate confidence intervals. The goal is to improve by an order of amount upon the exactness of the usual intervals in a technique that allows routine application even to very complicated problems for sugarcane produce in transition. The contribution of this paper will be used only for policy recommendation based on bootstrapping Panel DEA approach because the mean of bootstrapping Panel DEA approach equal to the mean of Panel DEA approach. And as necessary condition to estimate the Panel DEA approach to be confirmed the results using the difference between values that researchers are confident of with upper or lower endpoint of this estimation by bootstrapping Panel DEA approach respectively.

The conclusion of this result indicated Thai Technical efficiency (TE) for sugarcane produce in transition, and therefore the transitional interval was so strong confirmed this finding as it an equal two years in both 2008 and 2011. This actually performs two tests recommend bootstrapping for estimation of internal validity of sampling according to the outcome.

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