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Technical Efficiency and Economies of Scale for Partnership-Based of Virginia Tobacco Farming in Buleleng, Bali, Indonesia: A Non-parametric Approach

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Abstract

In operating their farms, Virginia tobacco farmers establish partnerships with a number of companies, such as Company GG and Company BB. The level of tobacco production efficiency obtained is considered to be dependent on the experiences of the partner companies. This study aims to analyze the technical efficiency and the economies of scale of Virginia tobacco farming in Buleleng regency, Bali. Employing a survey method, census was conducted on a total of 87 respondents. Data was analyzed using a non-parametric approach, with a data envelopment analysis (DEA) model. Results show that based on planting location and acreage, the technical efficiency of Company GG partners is relatively higher than that of Company BB. The efficiency scale (SE = 1) revealed that farmers participating under the Company GG partnership is relatively more efficient compared to Company BB farmers. Further, the economies of scale score based on planting location show that the majority of Company GG farmers experience constant return to scale (CRS) category, while most Company BB farmers fall under the decreasing return to scale (DRC) category. A slightly different result is displayed by the economies of scale analysis based on acreage, where the majority of Company GG farmers with up to 4 ha of planting area is under the increasing return to scale (IRS), while farmers with >4 ha to 6 ha of planting area is under the decreasing return to scale (DRS) category. For Company BB farmers with up to 2 ha of planting area, 50% are experiencing constant return to scale (CRS) and 50% are experiencing increasing return to scale (IRS). Meanwhile, those who have >2 ha up to 6 ha, fall under the decreasing return to scale (DRS) category.

Keywords: efficiency, Virginia tobacco, partnership, data envelopment analysis, Bali

1. Introduction

Tobacco, as a strategic and prioritized commodity in Indonesia, has historically gained considerable attention since the Dutch colonialization. The tobacco planting policy has been continued by the Indonesian government through the state plantation company. Tobacco cultivation is fairly widespread both in Java and outside Java (Saptana *et al.*, 2001).

To date, the livelihoods of millions of Indonesians depend on the economy of tobacco. Tobacco farming has created employment for hundreds of thousands of farmers and agriculture laborers. The same is true for the tobacco processing industry. In the 2014 state budget (*Anggaran Pendapatan dan Belanja Negara - APBN*), the government received as much as IDR 100.7 trillion from tobacco taxes. The role of tobacco in the Indonesian economy is considered significant, in fact during the 1997-1998 economic crisis, the economy of tobacco continued to thrive and became a mainstay for the country's foreign exchange (Kinasih, 2012).

The Indonesian government remains to have a high expectation on tobacco, which is demonstrated by the increase in targeted income from tobacco taxes to IDR 120.5 trillion in the 2015 state budget. This implies that the government implicitly recognizes the potency of tobacco to play a major role in increasing the citizens' welfare. Ironically, although there is an increasing trend of revenue from tobacco in the state budget, the government has gradually issued a policy that is less conducive to the economy of tobacco.

The government policy that discontinued the provision of fertilizer subsidy for tobacco cultivation has forced tobacco farmers to purchase fertilizers at the market level price. This results in a significant increase in production costs, as tobacco cultivation requires a large amount of fertilizers. Tobacco farmers are also exposed to scarcity of fertilizers in the market. When tobacco farmers are faced with this issue, they are disadvantaged in two ways, first, farmers pay for fertilizers at a higher price, and second, farmers disregards the standard of fertilizer use which affects the quantity and quality of harvest.

The government policies that impose the conversion of kerosene to gas also increase the production cost of dried tobacco. Farmers that originally dry their tobacco leaves using subsidized kerosene, now have to use non-subsidized gas, which result in 50% of the production cost allocated for gas. This creates a significant obstacle for farmers to produce dried tobacco.

The issuing of Government Regulation No. 109 in 2012 on monitoring materials containing addictive substances, such as tobacco products, for public health has imposed a great pressure on the economy of tobacco. The broadcasting of cigarette advertisement has been limited and replaced a campaign that warns about the dangers of smoking. This is further compounded by the obligation for the tobacco industry to display gruesome

pictures of the effects of smoking on cigarette packages, which increase production costs. Moreover, the government has also limit public smoking areas through provincial and regency level regulations. These policies have systematically pressurized the existence of tobacco.

A real proof of the shift in the government's support for the development of national tobacco is demonstrated in the change of the Tobacco and Fiber Crops Research Broad to Sweetener and Fiber Crops Research Broad. The elimination of the word 'tobacco' from the research broad's name, demonstrates the decreasing government interest in developing national tobacco cultivation. The accumulation of less conducive government policies has resulted in the decreasing trends in tobacco production and planting areas. In 2000, the national tobacco planting area was 239,737 ha, with production of 204,329 tons. These has decrease to 209,454 ha and 185,619 tons respectively, in 2013.

In Bali, tobacco production and planting areas has also decreased during the 2000-2013 period, particularly for Virginia tobacco in Buleleng regency. In 2000, tobacco planting area was 867 ha, with production of 1685,273 tons. In 2013, this has decreased to 380 ha and 750 tons respectively. Apart from the decreasing trend in planting area and production, pressure from government policies has affected the production efficiency and economies of scale of Virginia tobacco production.

The achievement of production efficiency for Virginia tobacco farming is believed to be related to the experiences of the partner company. In operating their farm, tobacco farmers establish partnerships with companies, such as Company GG and Company BB. These companies provide farming inputs and monitor production process to ensure standard quality and quantity. The company strictly monitors and evaluates the production process. The intervention of the partner company is believed to contribute to the technical efficiency of Virginia tobacco farming in Buleleng, Bali.

At a global scale, the ASEAN and global free trade scheme provide a new challenge for Virginia tobacco farming to be more efficient and competitive in order to survive. Efficiency is deemed to be a prerequisite to successfully compete in the global market. Inefficient production process will lead to significant loss. As such, there is an urgency to analyze technical efficiency as one of the indicators of farm-level efficiency. Results from this analysis could be used to develop methods to strengthen the existence of Virginia tobacco production.

This study seeks to answer the following research questions:

1. What is the state of technical efficiency of partnership based Virginia tobacco farming in Buleleng regency, Bali province?
2. What is the state of economies of scale of partnership based Virginia tobacco farming in Buleleng regency, Bali province?

Based on the above research questions, the objectives of this present study are as follows:

1. To analyze the technical efficiency of partnership based Virginia tobacco farming in Buleleng regency, Bali province.
2. To analyze the economies of scale of partnership based Virginia tobacco farming in Buleleng regency, Bali province.

2. Research Methods

2.1 Location of Study

This study was conducted in Buleleng regency, Bali province, Indonesia. This location was determined purposively, considering the following:

1. Buleleng regency is the only regency in Bali where farmers cultivate Virginia tobacco.
2. Tobacco farmers in Buleleng regency have been cultivating Virginia tobacco for 3 years consecutively.

Further, this study is focused on three districts, with the largest acreage of Virginia tobacco plantation. Based on data from the Buleleng Regional Office of Plantation and Forestry, Sukasada, Buleleng, and Gerokgak are the three districts with the largest planting area in 2014.

2.2 Population and Sample

The population of this study is farmers who plant Virginia tobacco in Buleleng regency, where there are 87 farmers. A census method was employed, in which all farmers who cultivate Virginia tobacco were selected as respondents. These farmers comprised of 68 farmers participating under the partnership with Company GG, while 19 farmers participating under partnership with Company BB. Apart from farmers, this study also selected respondents from The Indonesian Association of Tobacco Farmers (*Asosiasi Petani Tembakau Indonesia-APTI*) in Buleleng regency, partner company, and Buleleng Regional Office of Plantation and Forestry.

2.3 Data Collection

Data was collected through surveys, collecting primary and secondary data. Primary data was collected through face-to-face survey with respondents, utilizing a set of questions that has been prepared prior to the survey.

Primary data collected, comprise of Virginia tobacco farmer characteristics, production costs, production data, and Virginia tobacco sale. Secondary data was collected from institutions related to this study, such as National Bureau of Statistics, Regional Office of Plantation and Forestry, partner company, publications, and on line media.

2.4 Data Analysis

Numerous studies have suggested a number of alternative approaches to estimate technical efficiency (Battese dan Coelli, 1995; Tadesse dan Krishnamoorthy, 1997; Ruggiero, 1999; Liu, 2000, Iraizoz, 2003; Binam *et al.*, 2004; Obwana, 2006; Bozoglu dan Ceyhan, 2007; Sadiq *et al.*, 2009; Tipi *et al.*, 2010; Kay and Yabe, 2011, Heidari *et al.*, 2011; Karimov, 2013). In general, the estimation of technical efficiency can be categorised into two major approaches, namely parametric and non-parametric frontier. Parametric models can be further categorized into deterministic and stochastic models. The deterministic model assumes that deviation from the frontier is caused by inefficiency, while the stochastic model allow the assumption of errors.

This study refers to the non-parametric data envelopment analysis (DEA) approach to estimate technical efficiency. This model is based on a mathematical programming technique. A major characteristic of the DEA model is that it does not require a specific assumption for the technology function, unlike the parametric model. The DEA model can be categorized into the deterministic model group. A number of studies have employed the DEA method to estimate technical efficiency, including Tipi *et al.* (2010); Heidari *et al.* (2011); Abatania *et al.* (2012); Jatto *et al.* (?); Mahjoor (2013); and Karimov (2013).

Data was analyzed using a data envelopment analysis (DEA) model. DEA model is commonly used to evaluate the efficiency of producers. Coelli (1995) identified two advantages of DEA model in estimating efficiency. First, the estimation does not require assumptions in the specific forms of the function between input and output. Second, it does not require assumptions on inefficiency distributions.

Technical efficiency is an optimal combination of input to achieve a certain amount of output (input oriented) or obtaining an optimal amount of output from a certain amount of input (output oriented). This analysis is input oriented, as tobacco farmers have greater control over input, compared to output. Coelli *et al.* (1998) asserts that the DEA constant return to scale (CRS) model is appropriate when all producers operate efficiently. The imperfect market and constraints in financing, may have cause farmers to be unable to produce at an optimal scale. Apart from that, in the case of the agriculture sector, when the volume of irrigation and fertilizer usage increase are not followed by proportional increase in plantation volume. Based on the aforementioned reasonings, this study utilize the DEA input oriented variable return to scale (VRS) model to estimate technical efficiency. The DEA model used to estimate technical efficiency under the assumption variable return to scale (VRS) was first developed by Banker *et al.* (1984), and was referred as the BBC (Banker, Chames and Cooper) model. Coelli *et al.* (1998) formulated the DEA input oriented variable return to scale (VRS) model, with N number of producers, producing M unit of output, using K amount of inputs, as follows:

$$\begin{aligned} & \min_{\theta, \lambda} \theta \\ \text{st } & -y_i + Y\lambda \leq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & N1' \lambda = 1 \\ & \lambda \geq 0 \end{aligned}$$

where θ is a scalar, λ is a $N \times 1$ vector constant and $N1$ is a vector 1. The estimated value of θ is the efficiency score of the decision maker i .

To determine whether CRS or VRS is implemented in the production process, the DEA technique is used to estimate and compare the efficiency score from both aforementioned assumptions. According to Coelli (1996), by comparing the DEA scores between the VRS and CRS assumptions, the producer's efficiency score can be estimated as follows:

$$SE = \frac{TE_{CRS}}{TE_{VRS}}$$

Where $SE = 1$ demonstrates that the producers are efficient, while $SE < 1$ shows that producers are inefficient. The DEA score is estimated using the DEA Frontier Software developed by Zhu (available at www.deafrontier.com).

3. Results and Discussion

Table 1 summarizes the descriptive statistics of input and output of this study. With regard to the output, all Virginia tobacco farmers sell their harvest in the form of dried tobacco. Fresh tobacco is dried using gas as fuel. On average, the output per hectare produced by Company GG farmers is higher than Company BB farmers. The same is true for the input usage, in terms of fertilizers such as KNO₃ and KS. The use of ZK and Agro fertilizers, labor, gas, and acreage per farmer is higher for Company BB farmers compared to that of Company GG.

Table 1. Descriptive Statistics of Input and Output

Variable	Unit	Company GG Farmers (n=68)				Company BB Farmers (n=19)			
		Mean	SD	Min	Max	Mean	SD	Min	Max
Output									
Dried Tobacco	kg/ha	2361.55	107.26	2031.50	2591.00	2166.13	78.76	1975.00	2266.67
Input									
Acreage	ha	2.93	1.07	1.75	6.00	3.63	1.14	1.50	6.00
ZK Fertilizer	kg/ha	75.54	34.71	21.46	121.46	77.12	13.77	58.96	121.46
KNO3	kg/ha	168.57	26.72	150.00	230.00	149.56	5.03	133.33	166.67
KS	kg/ha	191.64	27.87	148.15	250.00	151.32	7.39	133.33	166.67
Agro	kg/ha	546.18	45.08	480.00	600.00	554.32	30.73	500.00	600.00
Labor	Man-daysK/ha	520.24	3.94	510.67	528.77	532.63	5.97	522.63	540.63
Gas	kg/ha	1329.75	55.83	1125.00	1475.00	1411.42	171.05	1080.00	1666.67

3.1 Technical Efficiency

Table 2 displays the technical efficiency of partnership based Virginia tobacco farming in Buleleng, according to planting location and acreage (planting area). Producers participating under the Company GG partnership have a higher technical efficiency based on location and acreage compared to producers participating under Company BB partnership. The average TE_{CRS} score for Company GG partners in Buleleng, Sukasada, and Gerokgak districts is 0.97. This implies that Virginia tobacco farmers in Buleleng, Sukasada, and Gerokgak are able to reduce their input up to 3% and still maintain the same amount of output. The same TE_{CRS} score achieved in these three districts demonstrate that Company GG imposes a strict control over the production process.

By eliminating the inefficiency scale, Virginia tobacco farming in Buleleng and Sukasada district may increase the average of technical efficiency from 0.97 to 0.99. Meanwhile farmers in Gerokgak district may increase their technical efficiency from 0.97 to 0.98. This implies that with the elimination of inefficiency, Virginia tobacco producers in Gerokgak obtain a lower rate of technical efficiency compared to farmers operating in Buleleng and Sukasada.

Based on planting area, Company GG farmers with an average acreage of 2 ha are able to achieve higher TE_{CRS} and TE_{VRS} compared to farmers with larger acreage. Furthermore, farmers with 2 ha land will be able to reduce their input usage up to 2%, while maintaining the same amount of output produced. Furthermore, by eliminating the inefficiency rate, the technical efficiency can be increased from 0.98 to 0.99.

A different condition is observed in farmers with >2 ha to 4 ha and >4 ha to 6 ha acreage, that has a 4% inefficiency rate. This inefficiency rate is higher than that of farmers with 2 ha land. Farmers operating with aforementioned acreage will be able to reduce 4% of their input usage to produce the same amount of output. If farmers are able to eliminate efficiency, they would be able to increase their technical efficiency from 0.96 to 0.98. Farmers with larger acreage are exposed to larger constraints to achieve efficiency in input usage.

With regard to the Company BB partnership, farmers in Sukasada district obtained an average of 0.97 TE_{CRS} score, which is higher compared to farmers operating in Buleleng and Gerokgak district, with TE_{CRS} score of 0.95 respectively. This implies that the inefficiency of input usage is higher for farmers in Buleleng and Gerokgak. Further, farmers in Buleleng and Gerokgak have a larger opportunity to improve their efficiency in input usage. By eliminating inefficiency, farmers operating in Sukasada district will be able to increase their technical efficiency from 0.97 to 0.98, while farmers in Buleleng district will be able to increase efficiency from 0.95 to 0.97.

Table 2. Estimation of Technical Efficiency

	Company GG Farmers			Company BB Farmers		
	TE_{CRS}	TE_{VRS}	% farmers with $TE_{VRS}=1$	TE_{CRS}	TE_{VRS}	% farmers with $TE_{VRS}=1$
Location						
Buleleng	0.97	0.99	83.33	0.95	0.97	20.00
Sukasada	0.97	0.99	74.13	0.97	0.98	45.45
Gerokgak	0.97	0.98	75.00	0.95	0.97	33.33
Acreage						
≤ 2 ha	0.98	0.99	78.12	0.98	1.00	100.00
>2 - 4 ha	0.96	0.98	48.48	0.96	0.98	21.43
>4 - 6 ha	0.96	0.97	50.00	0.95	0.98	63.63

Virginia tobacco farmers under Company BB partnership with up to 2 ha land have the highest efficiency score ($TE_{CRS} = 0.98$) compared to farmers with larger acreage. The inefficiency rate of farmers operating with land between >4 ha and 6 ha is the highest among the partnership group, which reached up to 5%. This implies that to achieve the same amount of output, producers are still able to reduce their input usage up to 5%. This analysis also shows that 2 ha per decision making unit (DMU) is the most optimal land size for Virginia tobacco farming operation in both companies. Increasing land acreage from the optimum 2 ha may lead to greater inefficiency.

The average technical efficiency for Virginia tobacco farms in Buleleng district is 0.96, which implies a 4% inefficiency of input usage. The achievement of 96% technical efficiency in Buleleng district can be categorized to be high efficiency. This can be compared to a study conducted by Ilembo and Kuzilwa (2014) on technical efficiency analysis for tobacco farming in Tanzania. The study yield a technical efficiency score of 64%, concluding that the studies tobacco farm in Tanzania experience 36% inefficiency in input usage.

3.2 Economies of scale

Assessing the efficiency scale, displayed in Table 3, Company GG farmers are more efficient compared to Company BB farmers, based on farming location and land acreage. The efficiency score demonstrates whether efficiency can be obtained from improving the size of farming operation. Due to the high efficiency score of Company GG farmers, there is limited room for farmers to improve their scale of operation. Efficiency scores at the 0.98 and 0.99 level demonstrate that the farming operation is close to optimal.

Company GG farmers operating in Buleleng and Gerokgak district are mostly under the constant return to scale (CRS) category. While Company GG farmers in Sukasada district are mostly under the increasing return to scale (IRS) category. With regard to Company BB, the majority of farmers in Buleleng and Sukasada district are experiencing decreasing returns to scale (DRS) farming operation. Meanwhile, the majority (66.67%) of Company BB farmers operating in Gerokgak are experiencing increasing return to scale (IRS). Comparing the farming operation between the two partnerships, it can be concluded that the majority of Company GG farmers fall under the constant returns to scale category, while the majority of Company BB partners fall under the decreasing return to scale. A farm experiencing increasing return to scale will benefit from increasing their production scale, while the contrary is true for a farm that are experiencing decreasing return to scale. Similarly, when a farm is operating under the optimum scale, it does not require changing its production scale as the change may lead to loss.

Table 3. Estimation of Efficiency Scale

	Company GG Farmers				Company BB Farmers			
	SE	SE = 1	DRS	IRS	SE	SE = 1	DRS	IRS
			(% of farmers)				(% of farmers)	
Planting Location								
Buleleng	0.98	66.67	0.00	33.33	0.97	20.00	80.00	0.00
Sukasada	0.98	32.76	29.31	37.93	0.98	27.27	45.45	27.27
Gerokgak	0.98	50.00	50.00	0.00	0.97	33.33	0.00	66.67
Acreage								
≤2 ha	0.99	25.00	0.00	75.00	0.99	50.00	0.00	50.00
>2 – 4 ha	0.98	39.39	6.06	54.55	0.97	21.43	50.00	28.57
>4 – 6 ha	0.96	33.33	66.67	0.00	0.96	33.33	66.67	0.00

Assessing the return to scale score based on land acreage for Company GG, estimations show that most farmers with up to 4 ha land experience increasing return to scale, while the majority of farmers with >4 ha to 6 ha experience decreasing return to scale. A different condition is observed in the Company BB partnership. The majority of farmers with up to 2 ha of land experience increasing return to scale, while those with >2 ha to 6 ha land fall under the decreasing return to scale category. This implies that Company GG farmers with >4 ha to 6 ha and Company BB farmers with >2 ha to 6 ha should reorganize the combination of input usage to decrease inefficiency in their farming operation. However, according to Tipi *et al.* (2009), the cause of inefficiency is the inappropriate scale of operation and misallocation of resources. Inappropriate scale of operation restrict the farmers from receiving profits from economies of scale, while misallocation of resources demonstrate the inefficiency of input usage.

The inefficiency of Virginia tobacco farms in Buleleng district can be reduced through strictly following the recommended guideline for input usage provided by the company. A number of DMU used more inputs than recommended, which lead to inefficiency. These farming operations should be identified accurately. The company extension workers and the Regional Office for Plantation and Forestry officers should increase their effort in educating and assisting DMU to ensure appropriate input usage.

5. Conclusion

Based on both planting location and land acreage, the technical efficiency of Company GG farmers is relatively higher than that of Company BB. Technical efficiency score of $TE_{VRS} = 1$ is largely obtained by farmers participating under Company GG partnership. Based on the efficiency scale ($SE = 1$), Company GG farmers are relatively more efficient compared to Company BB farmers.

With regard to economies of scale based on planting location, the majority of Company GG farmers experience constant return to scale (CRS), while the majority of Company BB farmers experience decreasing return to scale (DRS). Assessing the economies of scale based on land acreage, the majority Company GG farmers with land up to 4 ha experience increasing return to scale (IRS), while most farmers with >4 ha to 6 ha land experience decreasing return to scale (DRS). Further, 50% of Company BB farmers operating with up to 2 ha of land fall under the constant return to scale (CRS) category, while the rest experience increasing return to scale (IRS). Meanwhile, the majority of farmers with >2 ha to 6 ha land fall under the decreasing return to scale (DRS) category.

To achieve a high technical efficiency and an optimal efficiency scale ($SE = 1$), DMU are recommended to operate their tobacco farms with 2 ha acreage. This will allow farmers (DMU) to employ good agriculture practices. It is also recommended that DMU follow strictly company guidelines in input usage, specifically for fertilizer dosage.

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