The Impact of Palm Oil Mills’ Capacity on Technical Efficiency of Palm Oil Millers in Malaysia

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ABSTRACT

The general purpose of this study is to evaluate technical efficiency of palm oil mills in Malaysia. Specifically, the study attempts to examine if large mills are more efficient than small mills as well as to compare technical efficiency between integrated and non-integrated mills. In order to fulfill the objectives, econometric approach was used whereby crude palm oil production function was estimated by using OLS least squared technique. The Cobb-Douglas production model was used and the model is satisfactory in terms of goodness of fit. This is shown by the values of $R^2$ (0.89) as well as F statistic (358.03). From the study, it was found that palm oil mills in Malaysia are technically efficient. In terms of processing capacity, large mills which have processing capacity more than 20 t/hr are more efficient than small mills. Integrated mills are also technically efficient as compared to non-integrated mills.

Keywords: palm oil, technical efficiency, FFB, processing, capacity.

INTRODUCTION

The Malaysian palm oil mill sector has developed successfully in parallel with the development of the oil palm plantation sector. The number of palm oil mills in operation has increased over time. In 1990, there were only 261 mills in operation with a total processing capacity of 42.8 million tonnes of fresh fruit bunches (FFB) per year (Table 1).

Two decades later, the number of palm oil mills had increased by 61.3% to 421 mills with a FFB processing capacity of 97.4 million tonnes per year. The increase in oil palm area is one of the factors that contributed to the increase in palm oil mills. Within that period, the oil palm planted area increased by about 138.9%, i.e. from 2.03 million hectares in 1990 to 4.85 million hectares in 2010. In 2013, there were 434 operating mills in Malaysia with a total processing capacity of 104 million tonnes. Out of the total, 247 mills were located in Peninsular Malaysia, 124 mills in Sabah and the remaining 63 mills in Sarawak (Table 2).

In Peninsular Malaysia, most of the palm oil mills were located in Pahang (71) and Johor (63) with a
combined total capacity to process about 32 million tonnes of FFB per year. These two states also have the largest area planted with oil palm in Peninsular Malaysia, 730 694 ha in Johor and 710 195 ha in Pahang.

Table 3 depicts the distribution by age of palm oil mills in Malaysia in 2013. Twenty-nine percent or 129 palm oil mills in Malaysia may be considered as new mills, and these mills are expected to be more efficient than the older mills. Palm oil mills which age 11 - 40 years old represented about 63.8% of the total and older mills (more than 40 years) represented about 7.2% of all the palm oil mills in the country.

Each palm oil mill was designed according to its ability to process a certain amount of FFB per hour or per year. This means that the capacity to process FFB per hour differs among the mills. In 2013, the lowest mill capacity was 10 t/hr whereas the highest was 96 t/hr. Based on capacity, palm oil mills in Malaysia can be grouped into two categories, namely, small and large mills. Mills which have FFB processing capacities of 20 t/hr and less are considered small, while the reverse is true. In 2013, there were 434 palm oil mills in operation in Malaysia. Out of this total, 5% were categorised as small mills and the rest as large mills.

Normally, integrated palm oil mills (i.e. mills located in the estate area) produce better quality crude palm oil (CPO) as well as a higher oil extraction rate (OER) as compared with non-integrated mills. This is because less time is needed to transport FFB from the estate to the mill. Therefore, FFB can be processed immediately, normally in less than 8 hr from harvest. This is very important because to achieve better quality CPO, FFB should be processed as soon as possible after harvest. Just as non-integrated mills, some integrated palm oil mills also buy FFB from other estates in order to fully utilise their capacity.

### TABLE 1. NUMBER OF OPERATING MILLS AND TOTAL CAPACITY IN MALAYSIA: 1990, 2010-2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of mills</th>
<th>Capacity (tonnes fresh fruit bunch per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>261</td>
<td>42 874 000</td>
</tr>
<tr>
<td>2010</td>
<td>421</td>
<td>97 380 600</td>
</tr>
<tr>
<td>2011</td>
<td>426</td>
<td>99 852 400</td>
</tr>
<tr>
<td>2012</td>
<td>432</td>
<td>102 342 400</td>
</tr>
<tr>
<td>2013</td>
<td>434</td>
<td>104 090 400</td>
</tr>
</tbody>
</table>


### TABLE 2. NUMBER OF MILLS IN OPERATION ACCORDING TO STATE, MALAYSIA: 2013

<table>
<thead>
<tr>
<th>State</th>
<th>Number</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johor</td>
<td>63</td>
<td>16 515 400</td>
</tr>
<tr>
<td>Kelantan</td>
<td>11</td>
<td>1 859 200</td>
</tr>
<tr>
<td>Negeri Sembilan</td>
<td>15</td>
<td>3 509 400</td>
</tr>
<tr>
<td>Pahang</td>
<td>71</td>
<td>15 452 200</td>
</tr>
<tr>
<td>Perak</td>
<td>44</td>
<td>10 158 800</td>
</tr>
<tr>
<td>Selangor</td>
<td>19</td>
<td>3 493 600</td>
</tr>
<tr>
<td>Terengganu</td>
<td>13</td>
<td>3 257 600</td>
</tr>
<tr>
<td>Other states</td>
<td>11</td>
<td>2 620 000</td>
</tr>
<tr>
<td>P. Malaysia</td>
<td>247</td>
<td>58 866 200</td>
</tr>
<tr>
<td>Sabah</td>
<td>124</td>
<td>3 228 100</td>
</tr>
<tr>
<td>Sarawak</td>
<td>63</td>
<td>14 943 000</td>
</tr>
<tr>
<td>Sabah &amp; Sarawak</td>
<td>187</td>
<td>47 224 200</td>
</tr>
<tr>
<td>Malaysia</td>
<td>434</td>
<td>104 090 400</td>
</tr>
</tbody>
</table>

The different processing capacities can result in a difference in unit cost of FFB processing. Generally, large mills (i.e. those which have a larger processing capacity per hour) produce CPO at a lower processing cost, enjoying economies of scale. Economies of scale could reduce variable costs per unit because of the opposite relationship between the quantity produced and per-unit fixed costs. It means that the higher the quantity of a good produced, the lower the per unit fixed cost. However, in terms of technical efficiency, are the large mills more efficient than the small mills? In other words, what is the economic size in processing capacity (tonnes FFB per hour) for palm oil mills in Malaysia?

Besides the difference in terms of processing capacity, as mentioned earlier, mills also differ in terms of being integrated or non-integrated. Integrated palm oil mills can lead to cost management efficiency. This is because greater integration may result in better control over the volume and quality of FFB delivered for processing. However, is it true that an integrated palm oil mill is technically more efficient when compared with a non-integrated palm oil mill?

**OBJECTIVES**

Generally, the objective of this study is to examine whether the palm oil mills currently producing CPO in Malaysia are technically efficient or not. Specifically, the study tends to calculate technical efficiency of large and small palm oil mills as well as to evaluate whether integrated mills are technically more efficient than non-integrated mills.

**LITERATURE REVIEW**

**Definition and Concept of Efficiency**

Economic efficiency which consists of technical efficiency (TE) and allocative efficiency (AE) is considered to be one of the most important issues in the production process due to resource constraint. TE is more on evaluating output that can be obtained compared with input used in producing the output and according to Kumbhakar and Lovell (2003), TE is defined as the capability of a producer to achieve maximum output using certain given input. Meanwhile a AE reflects the ability of the firm to use the input in optimal proportions, given their respective prices (Noel, 2001).

In measuring efficiency, the actually attained or realised value will be compared with what is attainable at the frontier. Generally, maximum TE can be achieved if output is maximised by using a certain quantity. In production process, a producer is considered TE if, and only if, it is impossible to produce more of any output without producing less of some other output or using more of some input (Koopmans, 1951).

In business, producers mostly aim at producing output at minimum costs. In other words, they will use their input to maximise output as well as profit so that they can achieve economic efficiency. There are two important factors in achieving economic efficiency, namely, cost and profit efficiency (Berger and Mester, 1997). Measures of efficiency provide economic policy-makers with the tools necessary to compare firms or industries in relation to their use inputs in the production of output.

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**TABLE 3. AGE DISTRIBUTION OF PALM OIL MILLS, MALAYSIA: 2013**

<table>
<thead>
<tr>
<th>Age of mills (yr)</th>
<th>Number of mills</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 &amp; below</td>
<td>127</td>
<td>33.3</td>
</tr>
<tr>
<td>11 – 20</td>
<td>70</td>
<td>18.4</td>
</tr>
<tr>
<td>21 – 30</td>
<td>128</td>
<td>33.6</td>
</tr>
<tr>
<td>31 – 40</td>
<td>47</td>
<td>12.3</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>9</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>381</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Efficiency measurement is one of the indicators for a producer's or industry's performance.

**Studies on Economic Efficiency (technical and allocative efficiency)**

In explaining the production behaviour of farmers or firm, many studies involve the concepts of economic efficiency make use of the restricted profit function. This is done by testing a certain behavioral rule such as profit maximisation. However, most studies that use the profit function are concerned with comparing groups of farmers. The most common comparison is between small and large farmers (Yotopoulos and Lau, 1973; Yotopoulos and Nugent, 1979; Junankar, 1980). These two groups of farmers are identified to have different production functions as a result of differences in their access to information and/or their managerial ability. It is also argued that even if they have identical production functions their market behaviour may differ.

Yotopoulos and Lau (1979) conducted a study on comparing TE for small and large farms in India and they found that the small farmers were more TE as compared with large farmers. Somel (1979) used a similar approach to compare improved and traditional methods of tillage for wheat production in Turkey. He found that the two methods showed that no significant differences in economic efficiency including TE as well as AE for small and large paddy farmers in Malaysia.

**METHODOLOGY**

This study concentrates only on palm oil mills in Malaysia and uses cross-section data which refer to activities of palm oil mills in 2007. To satisfy the objective of the study, palm oil mills were grouped into two categories, namely, small and large mills. As mentioned earlier, small mill capacity refers to those mills which have a processing capacity of more than 20 t/hr and vice versa. In order to measure efficiency, this study used the modern efficiency measurement which was established by Farrell in 1957. However, in this study efficiency of palm oil mill was measured based on only TE. For that, a model based on Cobb-Douglas production function for CPO production was used and the model was then estimated using ordinary least square (OLS). A production function which represents the transformation of input into output for group of homogenous mills is as follows;

\[ Y = f(X_1, X_2, ..., X_n) \]

where \( X_1, X_2, ..., X_n \) are the required input to produce an output and the relationship for the Cobb-Douglas production function is specified as;

\[ Y = AX_1^{b_1} X_2^{b_2} ... X_n^{b_n} e^\theta \]

where \( A \) is a constant, and \( b_1, b_2, ..., b_n \) define the transformation parameters for the level of input."
attractive characteristics, this study employed the function to estimate CPO production. It is believed that a model developed based on the Cobb-Douglas production function may be the best model to estimate CPO production.

In measuring the TE of palm oil mills, the model that Lau and Yotopoulos (1979) developed and used considered two palm oil mills with the following production functions:

\[ V^1 = A' f(X^1) \quad V^2 = A^2 f(X^2) \quad (1) \]

where \( V \) is the output and \( X \) is a vector representing a variable input. The natural differences in the production functions (\( A^1 \) and \( A^2 \)) will show the mill's specific TE. Two palm oil mills are equally TE if, and only if, \( A^1 = A^2 \).

In this study, two types of comparison were made. The first comparison examined the TE of small and large mills, while the second comparison determined whether or not integrated mills were more technically efficient than non-integrated mills.

Based on the function (1), a model was developed for this study as follows;

\[ Y = A X_1 + X_2 X_3 X_4 E^u \quad ........ (2) \]

where;

- \( Y \) = output (tonnes of CPO)
- \( X_1 \) = fresh fruit bunches (t)
- \( X_2 \) = labour (man-hour)
- \( X_3 \) = capital (RM)
- \( X_4 \) = age of palm oil mills (yr)
- \( u \) = stochastic disturbance term
- \( E \) = base of natural log

In addition, two dummy variables, DS and DI, were included in the model:

- DS = 0, for large mills
- DI = 1, for integrated mills
- DI = 0, for non-integrated mills

Therefore, the estimating equation [as suggested by Lau and Yotopoulos (1979)] was obtained as follows;

\[ \ln Y = \ln A + \delta_1 DS + \delta_2 DI + b \ln X_1 + c \ln X_2 + d \ln X_3 + e \ln X_4 + \varepsilon \quad .......... (3) \]

where \( A \) represents the TE parameter for small mills and for non-integrated mills. The TE parameters for large mills and integrated mills are represented by \( A + \delta_1 \) and \( A + \delta_2 \) respectively.

It is expected that large mills are technically more efficient than small mills while integrated mills are more technically efficient compared with non-integrated mills. It is also expected that all exogenous variables except for age of palm oil mill have positive correlations with endogenous variables.

RESULTS AND DISCUSSION

CPO Production Function

Estimates of the parameters of the CPO production Equation (3) are presented in Table 4. The values of the F statistic and \( R^2 \) show that the estimates are statistically acceptable. The coefficients of specified variables carry the expected signs. Overall, 89% of the variation in CPO production during the sample period is explained by the specified variables.

For the study period, the palm oil mills were found to be technically efficient. In other words, overall the palm oil mills in Malaysia produced maximum CPO from given input or minimised input used in CPO production. It was also found that FFB, labour and age of mills were significant in determining CPO production at the 1% probability level, while capital was also significant at the 5% level. FFB, labour and capital had positive correlations with CPO production. This means that an increase in FFB or labour or capital would increase CPO production. However, the age of the palm oil mills had a negative correlation with CPO production.

The coefficient parameter for large mills (0.0822) was greater than for small mills (0.0052). This indicates that large mills which had a processing capacity of more than 20 t/hr were technically more efficient than the small mills. Large mills could also exploit economics of scale and enjoy a lower cost of unit production. This factor was able to assist large mills in being more competitive than small mills. The coefficient parameter for integrated mills (0.0822) was also greater than for non-integrated mills (0.0155). In other words, integrated palm oil mills were technically more efficient than mills that were not integrated with an oil palm estate.

Elasticity

The estimates for elasticity of CPO production are shown in Table 5. The elasticity of production for FFB was the most dominant, at 0.76, compared with the elasticities of production for the other input. In other words, over the study period, holding all other input (labour and cost) constant, a 1% increase in FFB input led would on average bring about a 0.76% increase in CPO production. Similarly, by holding the other input (FFB and cost) constant, a 1% increase in labour input led on average a 0.19% increase in CPO production.

Economic of Scale

In terms of returns to scale, it was found that the sum of the
coefficients for FFB, labour and capital was 1.05. As this sum was greater than 1, there were increasing returns to scale. This means that an increase in all input by 1% would increase the output by 1.05%.

### CONCLUSION

From the study, it was found that palm oil mills in Malaysia are technically efficient. This is acceptable (and expected) because Malaysia is the pioneer in terms of CPO processing. Also as expected, large mills and integrated mills are more technically efficient compared with small and non-integrated mills. Large mills which have a processing capacity more than 20 t/hr can produce more CPO than small mills. Large mills can also enjoy economies of scale. In the year 2000, when the average price of CPO dropped to RM 850/t, many small palm oil mills stopped operations because their returns could not cover the cost of production. In terms of quality, integrated mills mostly produce a higher quality of CPO as compared with non-integrated mills. This is because FFB from the estates can be processed immediately as only a short time is needed to transport FFB from the estate to the mill. To obtain high quality CPO, FFB should be processed in less than 24 hr after harvest. Non-integrated mills sometimes receive FFB more than 24 hr after harvest. These FFB can be considered to be of lower quality and thus will affect the quality of CPO.

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