

THE EFFICIENCY OF LARGE AND MEDIUM SCALE OF THE FOOD AND BEVERAGE INDUSTRIAL PRODUCTION IN EAST JAVA: DATA ENVELOPMENT ANALYSIS (DEA) AND STOCHASTIC FRONTIER ANALYSIS (SFA) APPROACHES

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ABSTRACT

This study aims to estimate the technical efficiency of food and beverage industry in East Java in 2011 to 2013 using micro data at the company level. Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) are used to estimate technical efficiency. The output variable was the value of production, while input variables were capital, labor, raw material, and energy. The Likelihood Ratio test dictates that the Translog production function is more appropriate for use in this study. The estimation results show that the efficiency of food and beverage companies in East Java by using SFA has decreased significantly by 3.02%, whereas with the DEA method, the average technical efficiency has increased by 0.583% compared to the beginning of the year in 2011. In addition, there is difference in the efficiency value between SFA and DEA. The technical efficiency value of SFA calculation is greater than that of DEA. The dissimilarity is caused by the difference of specification in both methods related to the interaction between uncaptured variables in the DEA method. The results of this policy have implications on the government's obligation to pay attention to the food and beverage industry in order to suppress the company's various operating costs, such as maintenance for old machines, which has an impact on technical efficiency or improve the ability of labor in terms of machinery utilization. Therefore, in the following year, the performance of the food and beverage industry as the largest sub-sector in manufacturing is able to show the progress.

Keywords: Food and Beverage Industry, Efficiency, SFA, DEA, East Java

JEL Classification: D61, O47, L66

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ABSTRAK

Penelitian ini bertujuan untuk mengestimasi efisiensi teknis industri makanan dan minuman di Jawa Timur tahun 2011 hingga 2013 menggunakan data mikro di tingkat perusahaan. Stochastic Frontier Analysis (SFA) dan Data Envelopment Analysis (DEA) digunakan untuk memperkirakan efisiensi teknis. Variabel output adalah nilai produksi, sedangkan variabel input adalah modal, tenaga kerja, bahan baku, dan energi. Uji Likelihood Ratio menentukan bahwa fungsi produksi Translog lebih sesuai untuk digunakan dalam penelitian ini. Hasil estimasi menunjukkan bahwa efisiensi perusahaan makanan dan minuman di Jawa Timur dengan menggunakan SFA mengalami penurunan yang signifikan sebesar 3,02%, sedangkan dengan metode DEA rata-rata efisiensi teknis meningkat sebesar 0,583% dibandingkan awal tahun 2011. Selain itu, terdapat perbedaan nilai efisiensi antara SFA dan DEA. Nilai efisiensi teknis perhitungan SFA lebih besar dari DEA. Perbedaan tersebut disebabkan oleh perbedaan spesifikasi pada kedua metode terkait dengan inter-

aksi antar variabel yang tidak ditangkap pada metode DEA. Hasil dari kebijakan ini berimplikasi pada kewajiban pemerintah untuk memperhatikan industri makanan dan minuman dalam rangka menekan berbagai biaya operasional perusahaan, seperti perawatan mesin-mesin tua, yang berdampak pada efisiensi teknis atau peningkatan kemampuan tenaga kerja dalam hal pemanfaatan mesin. Oleh karena itu, pada tahun berikutnya, kinerja industri makanan dan minuman sebagai subsektor terbesar di bidang manufaktur mampu menunjukkan kemajuan.

Kata Kunci: Industri Makanan dan Minuman, Efisiensi, SFA, DEA, Jawa Timur

JEL: D61, O47, L66

Introduction

According to Wasiaturrahma and Ajija (2017), East Java is one of the provinces in Indonesia which has a higher rate of economic growth than the average national economic growth during the last five years. With an average growth of 6.7%, East Java is able to contribute to Indonesia's GDP of 15% per year. The contribution of East Java Gross Regional Domestic Product occupies the second highest position after Jakarta which contributes about 17% per year.

According to the data of Central Bureau of Statistic of Indonesia, Gross Regional Domestic Product (GRDP) of East Java has received a large contribution from the manufacturing sector. In 2014, the sector contributed to the Gross Regional Domestic Product (GRDP) 28.9 %. Compared to other sectors, such as agriculture which reached 13.56% by 2014, manufacturing industry has stabilized to become the largest contributor since 2000.

The manufacturing industry sector consists of various subsectors that will produce output from the production process. Central Bureau of Statistics noted that The East Java manufacturing industry output in 2014 reached 445 Trillion Rupiah. The amount was contributed by the food and beverage subsector of 27.41 percent to the total output of manufacturing industries in East Java. The contribution of the food and beverage subsector to the East Java manufacturing sector has continued to increase since 2010, which contributed 26%. Meanwhile the food and beverage subsector is stable as the largest contributor to the output of manufacturing industries in East Java. Therefore, the food and beverage industry has become one of the leading sub-sectors in East Java.

The food and beverage subsector is classified by the Central Bureau of Statistics based on the company scale, i.e., large and medium scale. The classification is based on the amount of labor used in each company. [The Central Bureau of Statistics \(2017\)](#) stated that by 2013, companies in the food and beverage subsector account for 31% of the total output of the manufacturing companies in East Java. These percentages indicate that the role of large and medium enterprises in the food and beverage subsector is vital in an effort to increase economic growth in East Java.

However, even though Food and Beverage industry of East Java become the leading sub-sector among the others, yet evidently, Food and Beverage industry as particular has fluctuate performance due to its large independency toward the price of input, notably labor, machine, and material. For instance, the data of Central Bureau of Statistic in 2013, Food and Beverage industry in East Java show the great decrease of labor productivity by 29 percent, much greater than the decreasing productivity in the 2015. Furthermore, external factor such as exchange rate also affected to the performance of this sub-sector in East Java. For instance, the depreciation in 2013 reached 24 percent, the greatest along 2010 to 2016. It implicates that, in 2013, there was great significant downward economic trend of Indonesia that might affect to the Food and Beverage industry of East Java performance.

The existence of a significant food and beverage subsector in improving the economic performance of East Java as well as its high independency performance toward various variables indicates evaluations need to be undertaken. Evaluations will provide insight for improvements on various factors in the food and beverage subsector, so the economic benefits of this subsector may improve. These evaluations can be done aggregately across large and medium-sized companies or even the micro size companies. In the end, the more detailed and thorough economic evaluation is the more efficient and effective the policy planning will be. In addition to spatial outreach, various calculation methods are also undertaken to ensure that the output produced is able to illustrate the industry condition more accurately as well as to provide key indicators that may affect industry performance (Lindberg, Tan, & Yan, 2015).

Currently, industry performance evaluation has evolved and varied as an effort to improve the benchmark indicators that have implications for development policies. One of the indicators used is technical efficiency that describes input contribution proportionally in generating output (Timothy J Coelli, O'Donnell, & Battese, 2005). The way in which technical efficiency evaluating the performance of entities is quite straightforward since there are considerable explanations of the correlation between input and output. Hence, this reason become the urgency of this study in evaluating the Food and Beverage Industry of East Java. The evaluation was conducted in various researches such as Saptana, Supena, & Purwatini (2004) which tested the efficiency and competitiveness of farming and sugarcane industry in East Java, as well as Susilowati & Tinaprilla (2012) which tested the technical efficiency of sugarcane farming in Indonesia. In addition, Cullinane, Wang, Song, & Ji (2006) examined the technical efficiency of ports in the world by expanding estimated output results with Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA).

This research attempts to calculate the efficiency score by using two methodologies, Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA). Two methods are utilized due to the comparison will be able to generate multi perspective and more accurate depiction of the Food and Beverage Industry of East Java and conducted policy afterwards. Furthermore, there are a few number of research which empowered both SFA and DEA. Hence, this study contributes in diversifying the use of performing estimator of the regional economy. In the end, following the result of calculation, Food and Beverage Industry as the largest contributor for East Java's economy will possess precise measurement and significantly encourage various positive sign, such as capital inflow and investment. udi ini. Pembahasan hasil akan didiskusikan pada bagian 4 dan bagian akhir akan ditutup dengan kesimpulan dan implikasi kebijakan.

Literature Review

Production Theory

The notion of production can be attributed to a functional illustration called the production function (Pindyck & Rubinfeld, 2001). Nicholson & Snyder (2008) define the function of production as a function that reflects the technical knowledge of the company about the utilization of inputs that have in producing the output. The definition, according to Bradley (2010) will aim to determine the level of output gained by the variation of factors of production.

The production function consists of various types. Two of them are the Cobb Douglas and Transcendental Logarithmic (Translog) production functions. The Cobb Douglas production function is understood as a linear homogeneous function with a substitution elasticity of

1 of each factor of production (Douglas 1976). Cobb's Douglas production function is illustrated as follows:

$$P(K, L) = bK^\alpha L^\beta \quad (1)$$

Where P is the total production, L is labor, K is capital (including machine, equipment, and building), α and β are the degree of elasticity in every factor of production. Based on equation 1, it is seen that the relationship of K and L is direct and non-existent interaction variables between variables that can affect production levels.

The production function of Transcendental Logarithmic (Translog) is a production function of Cobb Douglas generalization. This production function is more flexible in explaining the relationship between output and input (Boisvert, 1982 and Konishi & Nishiyana, 2002). This production function accommodates the interaction variables of the main variables that can not be applied to Cobb Douglas. The Translog production function is illustrated in equation 2.

$$\ln y = \ln \alpha_0 + \sum_{i=1}^n \alpha_i \ln x_i + \frac{1}{2} \sum_{j=1}^n \sum_{i=1}^n \beta_{ij} \ln x_i \ln x_j \quad (1)$$

Where y is the output, α_0 is an efficiency parameter, x_i is the input i , x_j is the input j , and \ln is the natural logarithm. Translog production function is often written in logarithmic equation to form a linear equation (Boisvert, 1982). Equation 2 shows that there are variables x_i and x_j as a form of interaction between variables in influencing the dependent variable. Therefore, this production function is referred to as a function flexible production.

Technical Efficiency

Efficiency is understood terminologically in the Oxford Dictionary as the maximum production condition obtained by the low cost. In addition, Koopmans (1951) defines the concept of efficiency in a more technical way that connects between the input and output that is the condition when the output increase reduces the output in the lowest quantity or the increment of at least one input. Timothy J Coelli, O'Donnell, & Battese (2005) define the concept of efficiency to be the technical efficiency illustrated in Figure 1.

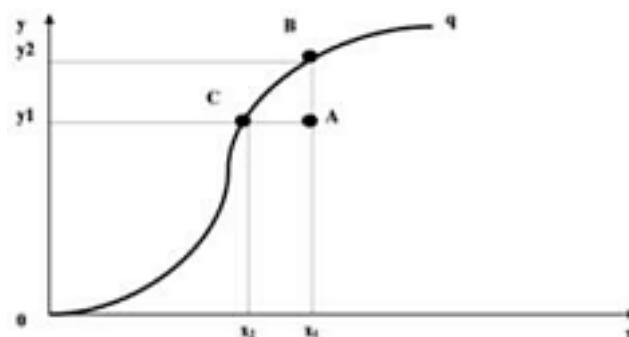


Figure 1: The Concept of Technical Efficiency

Source: Timothy J Coelli, O'Donnell, & Battese, 2005

Based on figure 1, the line q is the frontier line. The frontier line is derived from the optimum (efficient) production standard points, for example at points B and C. While at point A, production levels are not technically efficient because they are outside the frontier line. The firm at point A must reduce the quantity of input x to be efficient because with the input level of x_1 at point A, the firm can produce the same output (y_1) if the firm produces with input at x_2 (this condition is called technical inefficiency). This condition is called input ori-

ented. In addition, to achieve efficient conditions, the company at point A can also increase its output to the frontier line (point B). This is because, with the same level of input usage x_1 , the company can still increase its output from y_1 to y_2 (frontier line), thus, the company can achieve efficient conditions. This condition is referred to as output oriented.

Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA)

Estimation of technical efficiency is related to the method used. The method can be classified into 2 types namely parametric and non-parametric. In the parametric method, one of which is Data Envelopment Analysis (DEA). Data Envelopment Analysis (DEA) is a type of non-parametric method associated with productivity and was first discovered by (Charnes, Cooper, & Rhodes, 1978). This method requires modeling in a linear program derived from the specification of the variables used. Non-deterministic DEA modeling causes this model to measure efficiency without statistical noise (Sari, Khalifah, & Suyanto, 2016). The impact is that the specification used should be in accordance with empirical research so that the output calculations performed describe the actual conditions. The DEA illustration is shown in figure 2.

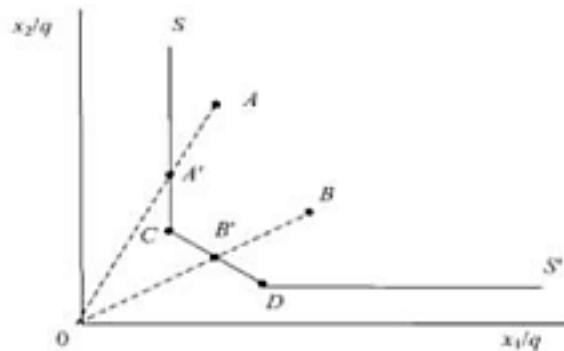


Figure 2: Efficiency Estimation Using DEA

Source: Timothy J Coelli, O'Donnell, & Battese, 2005

The DEA concept estimates the lag between the potential output and the actual output. In FIG. 2, points A', B', C, and D are the efficient production levels owned by each firm A', B', C, and D, while at points A and B are the production levels owned by each firm A and B. However, the problem occurs when at point A' which is an efficient point, similar to point C, in fact uses fewer x_2 inputs than firm C. In other words, firm C can produce the same output as firm A' using less x_2 input. This condition is called the slack input which can be found through the DEA approach (Timothy J Coelli, O'Donnell, & Battese, 2005).

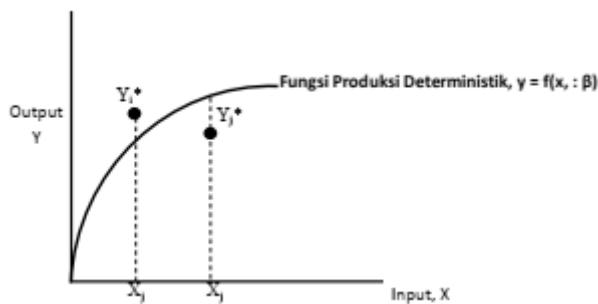


Figure 3: The Concept of SFA

Source: Battese (1992)

Stochastic Frontier Analysis (SFA) is a parametric method that also deals with productivity calculations. This method is proposed by (Aigner, Lovell, & Schmidt, 1977) and (Meeusen & Broeck, 1977). Similar to DEA, the SFA method estimates full production capacity (full capacity) or the so-called frontier (Lei, 2013). However, the difference with DEA is the presence of statistical noise as well as the parameters that appear as a benchmark of the significance of the specification used, so that in SFA the level of accuracy variables used can be measured. In addition, the SFA will distinguish the calculations between technical efficiency, technological progress, and total productivity factor (TFP) (Lloyd & Zhang, 2000). The SFA concept illustration is shown in figure 3.

Figure 3 describes the concept of SFA according to Battese (1992) illustrated in the production activity of two firms i and j. Company i uses the input with the value x_i and produces the output of Y_i , but the frontier of the output is in Y_i^* which exceeds its ideal value, so the value of V_i which is statistical noise is positive. Conversely, firm j uses inputs of x_j and achieves production Y_j with the ideal output position at Y_j^* , so V_j is negative. In the SFA approach, the value of V will be aggregated so that it will describe the statistical noise value of all firms under test.

Data and Methodology

Data and Variable

This study uses secondary data Manufacturing Industry food and beverage sub-sector derived from the Indonesian Central Bureau of Statistics (BPS). BPS defines the manufacturing industry as an economic field of activity that converts raw materials mechanically, chemically, or manually into finished / semi-finished goods. Therefore, in the presence of the process, the value of goods initially does not worth.

The classification of the manufacturing industry is divided by the number of workers. Large scale is a company that has a workforce of more than 100 people. Medium scale is a company that has a workforce of 20 to 99 people. The workforce is a group of workers with certain skills that work with predefined system.

The data of this research is taken from the annual survey of large and medium manufacturing industry companies (IBS) conducted by the Central Bureau of Statistics. The advantage of data used in this research is firm data (5 digits) Classification of Indonesian Business Standards (KBLI) so it will show the calculation output of each company in East Java. The number of observations used is 2433 with the details of 811 companies over a period of 3 years. This number is selected with the sorting company which have complete value in each variable. This study decide to eliminate the company which has empty value in certain variable. Since according to the data of BPS, the number of Food and Beverage companies in East Java in 2011- 2013 reached 1630, 1689, and 1724 respectively. Therefore, the number of sample of this study is quite representative for more than 50 percent of total Food and Beverage companies in East Java and this balance panel data is appropriately able to be analyzed.

The companies being tested are those that have been in the food and beverage industry for 3 years (2011- 2013) in East Java. Period of 2011 to 2013 is chosen as consideration of those period as the downward trend of national economy, notably in 2013. Moreover, the limited access of the national survey of industry for the forward years also become the limitation of this study. Hence, the performance of efficiency score trend will be viewed in 2011 and 2012 before the downward economy occurred.

The existence of the relationship between input and output on the SFA and DEA estimates requires that the corresponding variable be present. This research uses variable value of manufactured goods (in rupiah) as output, fixed capital (in rupiah) variable, amount of labor (per person), fuel used (in rupiah), and raw materials (in rupiah) as inputs. These variables according to [Evan & Hunt \(2009\)](#) are the development of a classical production function that initially consists only of capital and labor. These variables are also the core variables in the manufacturing production process according to the Central Bureau of Statistics in Indonesia. The descriptive statistics of the data used in this study are presented in Table 1 below.

Table 1: Descriptive Statistics of Observations

Variable	Unit	Year		
		2011	2012	2013
Output	Thousand	Mean	38354.75	40636.18
	Rupiah	Std. Dev	274372.48	225460.44
Fixed Capital	Thousand Rupiah	Mean	30248.35	22303.58
		Std. Dev	584048.44	293201.50
Labor	Person	Mean	99.47	112.89
		Std. Dev	251.42	295.66
Material	Thousand Rupiah	Mean	28067.63	27322.85
		Std. Dev	234202.18	180409.58
Energy	Thousand Rupiah	Mean	1138.58	919.01
		Std. Dev	11284.62	6455.04
Number of Observation		811	811	811

Note: Std. Dev: Standard Deviation

Source: Statistic Central Bureau

Method

The method used in this research is Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) used to estimate the technical efficiency level of food and beverage companies in East Java. The first method to be used is SFA as determinants of the suitability of variables used significantly affect the output. Then, the DEA method is used as a computation of the calculation results using the SFA method.

The SFA model specifications used in this study use research from [\(Battese & Coelli, 1995\); \(Kneller & Stevens, 2003\); \(Kumbhakar & Wang, 2005\); \(Margono & Sharma, 2006\); \(Wu & Lin, 2015\); \(Sari, Khalifah, & Suyanto, 2016\)](#) using the Transcendental Logarithmic (Translog) production function. The model specification used is in equation 3.

$$\begin{aligned}
 \ln(Y)_{it} = & \beta_0 + \beta_1(\ln(K)_{it}) + \beta_2(\ln(L)_{it}) + \beta_3(\ln(M)_{it}) + \\
 & \beta_4(\ln(E)_{it}) + \beta_5(\ln(K_{it}))^2 + \beta_6(\ln(L_{it}))^2 + \beta_7(\ln(M_{it}))^2 + \\
 & \beta_8(\ln(E_{it}))^2 + \beta_9(\ln((K)_{it}(L)_{it})) + \beta_{10}(\ln((K)_{it}(M)_{it})) + \\
 & \beta_{11}(\ln((K)_{it}(E)_{it})) + \beta_{12}(\ln((L)_{it}(M)_{it})) + \\
 & \beta_{13}(\ln((L)_{it}(E)_{it})) + \beta_{14}(\ln((M)_{it}(E)_{it})) + \beta_{15}(t) + v_{it} - u_{it}
 \end{aligned} \tag{3}$$

Where Y is the value of the goods produced, K is the value of fixed capital, L is the amount of labor, M is the raw material, E is the energy used, t is the time period (year), v is the statistical

noise of the equation, u is the inefficiency parameter, i is the i -th observation, and \ln is the natural logarithm. This research uses technical efficiency effect (TE effect) method which will describe the determinants of the technical efficiency level that is produced. Research by (Battese & Coelli, 1995); (Kneller & Stevens, 2003); (Kumbhakar & Wang, 2005); (Becerril-Torres, Alvarez Ayuso, & Moral-Barrera, 2010) is used for the TE effect specification. The TE effect specification is as follows.

$$U_{it} = \delta_0 + \delta_1 T + \delta_2 T^2 + W_{it} \quad (4)$$

Where U is technical efficiency, T is time, and W is statistical noise from the TE effect equation. Cobb Douglas production function is also used in this equation as an alternative to the production function of Translog. The Cobb Douglas production function is formed by ignoring the parameters $\beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}, \beta_{11}, \beta_{12}, \beta_{13}$, and β_{14} in equation (3). The production function of the Translog and Cobb Douglas will be tested with the Likelihood Ratio test in FRONTIER 4.1 application to determine the production function according to the data characteristic used. The LR test calculation formulation is as follows.

$$\lambda = -2[\lambda(H_0) - \lambda(H_1)] \quad (5)$$

Where $\lambda(H_0)$ and $\lambda(H_1)$ are log likelihood function values in the null hypothesis (Cobb Douglas) and alternative hypothesis (Translog). After the value is known, the parameter λ compared with χ^2 with degrees of freedom is equal to the number of parameters involved in the restriction. If the calculation of λ likelihood count is greater than χ^2 table then H_0 is rejected so as to accept H_1 (Translog production function is used).

The calculation of technical efficiency on the SFA method uses a formulation of (Farrell, 1957) with the following specifications.

$$ET_{it} = \exp(-U_{it}) = \exp[-(\delta_0 + \delta_1 T + \delta_2 T^2) - W_{it}] \quad (6)$$

Technical efficiency is calculated based on the level of production achieved relative to the maximum production level. The technical efficiency will be worth between 0 (very inefficient) to 1 (very efficient).

Specification Data Envelopment Analysis used in this study using the assumption of maximization ie each company is assumed aims to maximize its output. Therefore, DEA-BCC (Banker, Charnes, Cooper) output oriented was used in this study. In addition, DEA VRS (variable return to scale) is used in this study. The model is as follows.

$$\begin{aligned} & \text{Max} = \theta \\ & \text{Subject to: } \theta y + Y\lambda \geq 0 \\ & \theta \sigma z + Z\lambda = 0 \\ & x - X\lambda \geq 0 \end{aligned} \quad (7)$$

Where θ is the radial when the input reduction estimates the technical efficiency (parameter efficiency), λ is the matrix that describes each Decision Making Unit (DMU). (Banker, Charnes, & Cooper, 1984) states that efficiency occurs when θ is worth 1 and all positive and negative slacks are zero.

Result and Analysis

Selection of Production Function and Technical Efficiency Calculation

Selection of production function is performed to select the appropriate production

function. The selection is done by using Likelihood Ratio test according to the formulation in equation (5) by using application FRONTIER 4.1. The LR test decides the production function of Translog as an appropriate production function because the value $\lambda = 1982.38$ (greater than χ^2 table) and significant at 1% level. The results of the calculation of the two production functions using Maximum Likelihood are presented in Table 2.

Table 2: The calculation results of Maximum Likelihood Estimation (MLE)

Parameter	Production Function			
	Translog		Cobb Douglas	
	Coefficient	SE	Coefficient	SE
β_0	4.532***	0.45	2.610***	0.13
β_1	0.253***	0.05	0.116***	0.01
β_2	0.863***	0.11	0.358***	0.02
β_3	-0.094***	0.05	0.535***	0.01
β_4	0.252***	0.06	0.153***	0.01
β_5	0.003**	0.00	-	-
β_6	0.061***	0.01	-	-
β_7	0.086***	0.00	-	-
β_8	0.026***	0.00	-	-
β_9	0.036***	0.01	-	-
β_{10}	-0.042***	0.00	-	-
β_{11}	0.014***	0.00	-	-
β_{12}	-0.112***	0.01	-	-
β_{13}	0.004	0.01	-	-
β_{14}	-0.065***	0.00	-	-
β_{15}	0.056***	0.01	0.057***	0.01
δ_0	-18.453***	2.85	-0.02	0.58
δ_1	8.459***	1.41	-0.06	0.66
δ_2	-1.813***	0.32	0.00	0.15
σ^2	2.164***	0.28	0.359***	0.01
γ	0.9526***	0.01	0.00	0.00
Log Likelihood	-1140.3154		-2134.007	

Note: ***: Significant at $\alpha 1\%$, ** : Significant at $\alpha 5\%$, * : Significant at $\alpha 10\%$.

Source : Author Calculation

Based on the calculations performed, the parameters on the Translog function are almost entirely significant at the 1% level except in beta13 (labor and energy interaction variables). The values of γ and σ^2 are 0.9526 and 2,164, respectively, which are defined as the variance distribution of V_{it} and U_{it} . The γ value of 95.26% indicates the proportion of error rate on U_{it} . The significant result of this parameter shows the variables can be used for SFA analysis and technical efficiency calculation.

Calculation of technical efficiency of food and beverage companies by SFA method is done with application FRONTIER 4.1. The calculation is presented in Table 3 (classified by district / city and in average).

Table 3: Technical Efficiency Calculation Result with SFA Method

No	Districts/ Cities	Number of Firm	2011	2012	2013
1	Pacitan	2	0.8605	0.8434	0.8785
2	Ponorogo	8	0.857	0.8034	0.8155
3	Trenggalek	22	0.8664	0.8529	0.8475
4	Tulungagung	31	0.8251	0.7783	0.7822
5	Blitar	11	0.7409	0.7763	0.7583
6	Kediri	39	0.8516	0.8119	0.8115
7	Malang	22	0.8627	0.7997	0.8089
8	Lumajang	31	0.8544	0.8312	0.7979
9	Jember	46	0.8453	0.8337	0.8031
10	Banyuwangi	86	0.841	0.817	0.8205
11	Bondowoso	20	0.856	0.8176	0.8379
12	Situbondo	30	0.8472	0.8253	0.8124
13	Probolinggo	13	0.847	0.847	0.8469
14	Pasuruan	43	0.8633	0.8372	0.8098
15	Sidoarjo	107	0.8645	0.8415	0.8428
16	Mojokerto	16	0.8748	0.8543	0.8578
17	Jombang	26	0.8716	0.8494	0.8299
18	Nganjuk	9	0.862	0.8395	0.8408
19	Madiun	3	0.8506	0.8049	0.8134
20	Magetan	2	0.8777	0.7901	0.8964
21	Ngawi	5	0.8549	0.7079	0.7043
22	Bojonegoro	4	0.8847	0.7748	
23	Tuban	27	0.8678	0.8286	0.8334
24	Lamongan	19	0.8737	0.8396	0.8436
25	Gresik	21	0.8799	0.8522	0.8407
26	Bangkalan	4	0.8072	0.8252	0.8486
27	Sampang	5	0.8692	0.8521	0.8233
28	Pamekasan	1	0.88133	0.88823	0.86193
29	Sumenep	25	0.8425	0.8319	0.8321
30	Kediri City	18	0.8651	0.818	0.8208
31	Blitar City	1	0.81562	0.78549	0.77577
32	Malang City	24	0.8736	0.8576	0.8396
33	Probolinggo City	9	0.8833	0.8092	0.8334
34	Pasuruan City	16	0.8533	0.7921	0.816
35	Mojokerto City	4	0.85633	0.8229	0.82637
36	Madiun City	10	0.8448	0.8283	0.8122
37	Surabaya City	46	0.8744	0.8365	0.8481
38	Batu City	7	0.87612	0.85778	0.84138
Mean			0.855879	0.822711	0.825662

Source: Author Calculation

Based on calculations by SFA method, Sidoarjo regency has the largest number of food and beverage companies in the observation of 107 companies. This number means that the company has survived for 3 years in a row, so it can be recorded in this research. The average technical efficiency score in the food and beverage industry in East Java for 3 years decreased. In 2011 the average reached 85.58% with the highest level of technical efficiency occurred in Bojonegoro Regency of 88.47%, while the lowest efficiency is owned by Blitar regency which is equal to 74.09%. In 2012, the average technical efficiency decreased by 3.31% to 82.27% with the highest technical efficiency in Pamekasan Regency of 88.83%, while the lowest technical efficiency of 70.79% was by Ngawi Regency. In the following year, there was an average technical efficiency of 0.29%. This year, Magetan Regency had the highest technical efficiency of 89.64%, while Ngawi Regency still has the lowest technical efficiency of 70.43%. The technical efficiency level of the above 33 districts is summarized in Table 4.

Table 4: SFA Technical Efficiency Rating

No	Region	2011	2012	2013
1	Pacitan	20	10	2
2	Ponorogo	21	30	26
3	Trenggalek	14	5	8
4	Tulungagung	35	35	35
5	Blitar	38	36	37
6	Kediri	27	27	30
7	Malang	18	31	32
8	Lumajang	25	18	34
9	Jember	31	16	33
10	Banyuwangi	34	26	24
11	Bondowoso	23	25	16
12	Situbondo	29	21	28
13	Probolinggo	30	9	9
14	Pasuruan	17	14	31
15	Sidoarjo	16	11	11
16	Mojokerto	7	4	5
17	Jombang	11	8	20
18	Nganjuk	19	13	13
19	Madiun	28	29	27
20	Magetan	5	33	1
21	Ngawi	24	38	38
22	Bojonegoro	1	37	4
23	Tuban	13	19	18
24	Lamongan	9	12	10
25	Gresik	4	6	14
26	Bangkalan	37	22	6
27	Sampang	12	7	22
28	Pamekasan	3	1	3
29	Sumenep	33	17	19
30	Kediri City	15	24	23

No	Region	2011	2012	2013
31	Blitar City	36	34	36
32	Malang City	10	3	15
33	Probolinggo City	2	28	17
34	Pasuruan City	26	32	25
35	Mojokerto City	22	23	21
36	Madiun City	32	20	29
37	Surabaya City	8	15	7
38	Batu City	6	2	12

Source: Author Calculation

Based on Table 4, districts/municipalities that have consistent food and beverage companies in the top 10 within 3 years are Mojokerto and Pamekasan districts. Sidoarjo Regency which has the largest number of companies in this study in fact has the greatest efficiency level of the 16th in 2011 and 11 in the next 2 years. The city of Surabaya, as the capital of East Java province in 2011 was ranked the 8th largest, but decreased in 2012 to rank 15 and increased again to become the 7th largest. The changes that occurred at the level of efficiency shows the level of great competition between companies described in the operational policies of each company to improve efficiency. As a comparison, the calculation of technical efficiency with Data Envelopment Analysis (DEA) was also done. The results are presented in Table 5.

Table 5: Technical Efficiency Calculation Result with DEA Method

No	Region	Number of Firm	2011	2012	2013
1	Pacitan	2	0.5475	0.5525	0.551
2	Ponorogo	8	0.576375	0.57525	0.57525
3	Trenggalek	22	0.562864	0.563273	0.562273
4	Tulungagung	31	0.483452	0.488742	0.496355
5	Blitar	11	0.372	0.452	0.373455
6	Kediri	39	0.631333	0.638667	0.637564
7	Malang	22	0.670273	0.670955	0.672455
8	Lumajang	31	0.332032	0.33271	0.33329
9	Jember	46	0.552391	0.559087	0.558652
10	Banyuwangi	86	0.422023	0.43086	0.43343
11	Bondowoso	20	0.6128	0.6143	0.6153
12	Situbondo	30	0.3255	0.328733	0.337
13	Probolinggo	13	0.450769	0.454231	0.450769
14	Pasuruan	43	0.507512	0.512419	0.508837
15	Sidoarjo	107	0.536729	0.543804	0.538308
16	Mojokerto	16	0.580571	0.577786	0.576643
17	Jombang	26	0.590038	0.596038	0.5975
18	Nganjuk	9	0.711222	0.713889	0.715889
19	Madiun	3	0.677	0.677	0.677333
20	Magetan	2	0.7765	0.7835	0.7765
21	Ngawi	5	0.5684	0.641	0.6314

No	Region	Number of Firm	2011	2012	2013
22	Bojonegoro	4	0.6945	0.69475	0.6945
23	Tuban	27	0.436667	0.437185	0.436519
24	Lamongan	19	0.599895	0.596105	0.595789
25	Gresik	21	0.698762	0.702048	0.701238
26	Bangkalan	4	0.5575	0.59225	0.55
27	Sampang	5	0.6678	0.6678	0.6682
28	Pamekasan	1	0.646	0.646	0.646
29	Sumenep	25	0.66136	0.65764	0.64636
30	Kediri City	18	0.312556	0.313056	0.313278
31	Blitar City	1	0.558	0.559	0.589
32	Malang City	24	0.303958	0.306458	0.308542
33	Probolinggo City	9	0.525556	0.527667	0.527222
34	Pasuruan City	16	0.295125	0.29875	0.296938
35	Mojokerto City	4	0.2975	0.2975	0.2975
36	Madiun City	10	0.5427	0.5469	0.6247
37	Surabaya City	46	0.418652	0.407087	0.408022
38	Batu City	7	0.738	0.737429	0.740429
Mean			0.537943	0.544589	0.543775

Source: Auuthor Calculation

Based on Table 5, the technical efficiency of beverage and food companies in East Java with DEA method has increased slightly. In 2011 the average reached 53.79% with the highest level of technical efficiency occurring in Magetan Regency which amounted to 77.65%, while the lowest efficiency was by Pasuruan at 29.51%. In 2012, there was an average increase of technical efficiency by 0.66% to 54.45% with the highest technical efficiency occurring in Magetan Regency of 78.35%, while the lowest technical efficiency was 29.75% in Mojokerto City. In the following year, the decline occurred at an average of technical efficiency of 0.081%. This year, Magetan Regency is still the district with the highest technical efficiency of 77.65%, while Pasuruan has the lowest technical efficiency at 29.69%. The technical efficiency level of 33 districts / cities with the DEA method above is shortened in Table 6.

Table 6: DEA Efficiency Rating

No	Region	2011	2012	2013
1	Pacitan	22	22	22
2	Ponorogo	16	18	19
3	Trenggalek	18	19	20
4	Tulungagung	27	27	27
5	Blitar	32	29	32
6	Kediri	11	12	11
7	Malang	7	7	7
8	Lumajang	33	33	34
9	Jember	21	20	21
10	Banyuwangi	30	31	30
11	Bondowoso	12	13	14

No	Region	2011	2012	2013
12	Situbondo	34	34	33
13	Probolinggo	28	28	28
14	Pasuruan	26	26	26
15	Sidoarjo	24	24	24
16	Mojokerto	15	17	18
17	Jombang	14	15	15
18	Nganjuk	3	3	3
19	Madiun	6	6	6
20	Magetan	1	1	1
21	Ngawi	17	11	12
22	Bojonegoro	5	5	5
23	Tuban	29	30	29
24	Lamongan	13	14	16
25	Gresik	4	4	4
26	Bangkalan	20	16	23
27	Sampang	8	8	8
28	Pamekasan	10	10	10
29	Sumenep	9	9	9
30	Kediri City	35	35	35
31	Blitar City	19	21	17
32	Malang City	36	36	36
33	Probolinggo City	25	25	25
34	Pasuruan City	38	37	38
35	Mojokerto City	37	38	37
36	Madiun City	23	23	13
37	Surabaya City	31	32	31
38	Batu City	2	2	2

Source: Author Calculation

Based on Table 6, the districts / cities consistent with the top 10 highest technical efficiency scores are Magetan Regency, Batu City, Nganjuk Regency, Gresik Regency, Bojonegoro Regency, Madiun Regency, Malang Regency, Sampang Regency, Sumenep Regency and Pamekasan Regency. The results show that the technical efficiency calculation with DEA shows the stability of the technical efficiency level in each district / city. This stability is due to the limited specification of the DEA compared to the SFA which uses many specifications and interactions on the variables (see equation 1), so that any changes to the variables will affect the technical efficiency. While in the DEA method, the specification is only done on the main variables without any interaction between the variables, so the efficiency is more stable but lower. As a comparison of the technical efficiency spreads of the SFA and DEA methods, Figures 4 and 5 show the range of technical efficiency values for both methods.

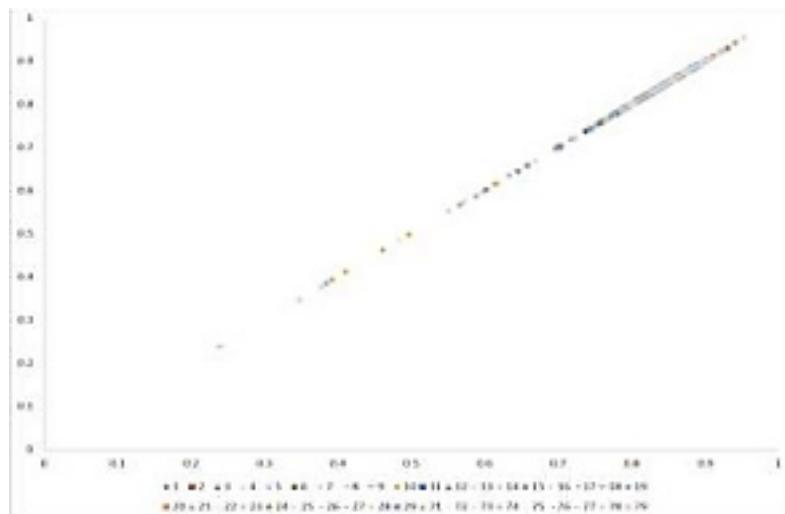


Figure 4: Scatter Plot of SFA Technical Efficiency

Note: Number on Description Represents Each District Code

Source: Author Calculation

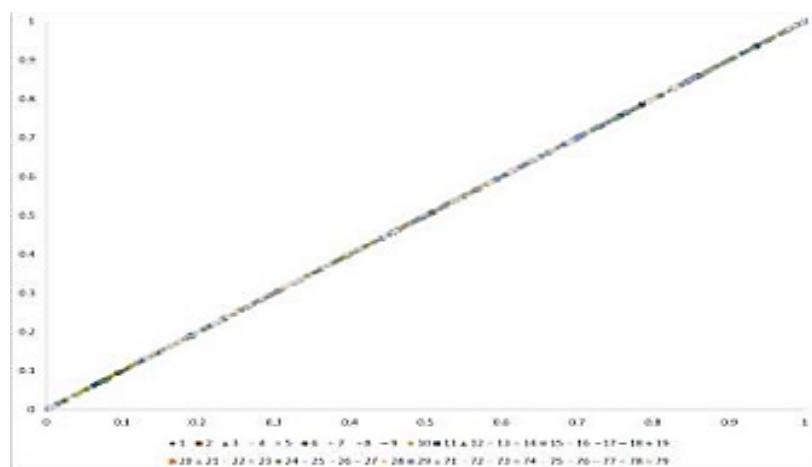


Figure 5: Scatter Plot of DEA Technical Efficiency

Note: Number on Description Represents Each District Code

Source: Author Calculation

Based on Figures 4 and 5, the technical efficiency level of beverage and food companies in East Java with the SFA method is larger at the 70% to near 100% efficiency range. There is only one company that has technical efficiency of less than 30%. When using the DEA method, the spread of technical efficiency values tends to be more evenly in the range of 0 to close to 100%. This diffusion difference is caused by differences in specifications in both methods resulting in higher technical efficiency in SFA. There is interaction between the main variables on the SFA method impact on higher technical efficiency because there are more variables that can explain and contribute to the level of technical efficiency. While in the DEA, the specification is used only on the main variable, so the number of explanatory variables is less, so the technical efficiency is not as big as the SFA method.

The technical efficiency of the food and beverage industry in East Java based on the SFA method shows a significant decrease in 2011 to 2013. The decrease is similar to that of Darmawan (2016) which found that there was a negative growth trend in the food and bev-

erage industry in East Java in 2009 to 2010, so the negative growth trend was expected to continue until 2013.

[Puspitasari \(2011\)](#) mentioned that the negative trend of efficiency was caused by the cost of procurement input, so the cost is not proportional in generating output. This has implications for large and medium scale food and beverage industry research in East Java. Increasing competition among food and beverage producers demands every producer to produce various product variants. However, limited production machinery or old machinery, for example, has an impact on the increasing cost issued for input ([Suyanto, 2009](#)); ([Bank Indonesia, 2006](#)). Therefore, technical efficiency trends allegedly continue to occur prior to the government's revitalization policy ([Yasin, 2017](#)).

Study of [Minh et. al. \(2011\)](#) found that the exchange rate influence the rate of efficiency score. As mentioned in the introduction section in this study, Indonesia had large depreciation of exchange rate in 2013 which might implicate to the performance of Food and Beverage industry in East Java. Since some raw materials of Food and Beverage industry require to be imported, such as salt and flavor, the great depreciation might also affect the rate of efficiency score.

The results of technical efficiency calculations using DEA show different trends with the use of SFA methods. It is indicated that SFA trends occurring in SFA are derived from interactions between Translog variables not found in the DEA method. For example, the interaction between capital and labor in generating output which in the empirical production process must occur, but the interaction is unable to be quantified by the DEA method. These induced interactions resulted in a downward trend in efficiency of the SFA method. This is seen in the technical efficiency level of the smaller DEA method compared to the SFA method due to differences in assumptions and specifications on both methods ([Cullinane, Wang, Song, & Ji, 2006](#)).

The different trend of efficiency score is a salient finding of this study. As aforementioned justification, the different trend occurred due to DEA is unable to capture the interaction between main variable, such as labor and capital, since this interaction may create the negative trend of efficiency score which captured by SFA. Hence, it is important to revolve around the interaction of labor and capital in conducting policy. For instance the use of machine involving the labor that might have downward performance compared to a machine which produce by itself in generating a product that have upward performance may implicate into the large amount of firing. As consequence, improving ability of labor in the use of machine is a must and become the appropriate policy following the result of this study.

Conclusion

The results show that the SFA method produces a greater efficiency level than DEA. Both methods also show different technical efficiency trends. These results have implications for the existence of interaction allegedly occurred between variables which have a greater contribution in generating production output than the main variable used in the DEA method. In addition, the limitations of the specifications on the DEA method also have an impact on the low technical efficiency, although these variables have been confirmed in significance with the SFA method. However, the

diffusion of technical efficiency in the DEA method is more even compared to the SFA whose technical efficiency is dominated in the range above 70 %.

Based on the calculation of technical efficiency, there are some policy implications related to the evaluation of the food and beverage industry development in East Java. There are extreme changes in some districts / cities in East Java which showed that the companies are not stable in maintaining its efficiency. To overcome this, an annual evaluation is required by each company in the form of technical efficiency calculation to measure ensure the level of achievement of the current year. The evaluation result can also be used for the next year's planning. In addition, the interaction between variables, such as capital and labor, also should be of concern to every company. This variable is indicated to have a major contribution in improving the technical efficiency of each company. For example, improving the ability of the workforce in the operation of machinery and advanced technology used in the producer process will have an impact on technical efficiency derived from the interaction between variables.

The huge potential of the food and beverage industry in East Java demands that the government be able to prioritize and pay attention to this sub-industry. One of them is through the subsidization of machinery or fixed assets for large and medium-sized companies in East Java, so that the subsidy will further lower production costs and improve technical efficiency.

Future research is expected to expand the time period studied so the positive and negative trends can be described. Therefore, this result will have implications on the evaluation of the success of government policy towards the manufacturing industry. If in any given period there is an upward trend, it can be said that government policy has been effective in improving the performance of the manufacturing industry in Indonesia.

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