INDONESIAN
CAPITAL MARKET REVIEW

Performance Measurement Model for the Consumer Industry Listed on Indonesia Stock Exchange: DEA and SFA Approaches

T.Handono Eko Prabowo* and Emilyn Cabanda†

This research attempts to provide performance measurement model for the consumer industry listed on Indonesia Stock Exchange (IDX) by using the data envelopment analysis (DEA) and the stochastic frontier analysis (SFA). There were 36 panel firms analyzed over the period of 2000-2005 or 216 pooled observations. The output variable was total sales and input variables were labor, inventory, fixed assets and capital. Z-variables are age of the firm, size of the firm, market share and time period. Empirical findings reveal that the average technical efficiency (mean TE) for consumer industry was 0.6630. The study indicates the existence of output slacks (output deficits) and input slacks (input wastages) in the consumer industry's operation. The study also shows that the joint effect of four z-variables on the technical inefficiencies of the consumer industry was significant although the individual effects of one or more variables might not be statistically significant.

Keywords: *performance measurement, consumer industry, data envelopment analysis (DEA), stochastic frontier analysis (SFA), Indonesia Stock Exchange (IDX)*

Introduction

The consumer industry in this study refers to manufacturing firms listed on Indonesia Stock Exchange (IDX) that produce such goods as foods and beverages, tobacco products, pharmaceuticals, cosmetics, and fabricated metal products. Most of the production is done in Java and Sumatera. There were 349 listed firms up to December 2005. In the consumer industry, there were 36 firms listed on Jakarta Stock Exchange (JSX) (*Kompas*, Dec 21, 2006). The JSX changed its name into Indonesia Stock Exchange (IDX) in December 2007.

The consumer industry is one of the most important industries listed on IDX. The study attempts to have significant and original contributions to the performance measurement field by

[1] Correspondence to : T.Handono Eko Prabowo, Faculty of Economics, Sanata Dharma University,Yogyakarta – Indonesia Phone: +62274513301 ; Fax: +62274562383, E-mail: thep_phd@yahoo.com
† Associate Professor, School of Global Leadership & Entrepreneurship Regent University, 1333 Regent University Drive, Suite 102 Virginia Beach, VA 23464 USA Phone: 757.352.4357; Fax: 757.352.4634; E-mail: ecabanda@regent.edu

providing performance measurement model for IDX-listed consumer industry. In Indonesia, there were previous studies using either DEA (Data Envelopment Analysis) or SFA (Stochastic Frontier Approach) method only but on different sectors such as on Indonesian agriculture in West Java (Daryanto, Battese, and Fleming, 2002); Viverita and Ariff (2004) on Indonesia's Public and Private Sector; Jacob and Los (2006) on labor productivity growth in the Indonesian manufacturing sector; and Abidin and Cabanda (2006) on Indonesia's commercial banks. However, most of the previous studies on Indonesia manufacturing to the best of the authors' knowledge mainly focused on SME (small-medium enterprises): Hill and Kalirajan (1993) on Small Enterprise and Firm-Level Technological Efficiency in the Indonesian Garment Industry; Hill (2001) on Small and Medium Enterprises in Indonesia; Mojo (2006) on Total Factor Productivity in Indonesian Manufacturing. This study, therefore, aims to fill the gap and serves as additional contribution to the literature on performance measurement and to try to introduce these models as alternative tools in measuring performance to the SEC (Securities and Exchange Commission), stockholders (investors), managers, bankers and other members of Indonesia business community.

The main aim of this study is to provide performance measurement model for the consumer industry listed on Indonesia Stock Exchange (IDX). To achieve this, ,the author raised the following specific objectives: (1) to provide model performance based on the DEA model on evaluating efficiency using firm's traditional inputs and an output; (2) to determine the stochastic frontier association of total sales to labor, inventory, fixed assets, and capital; and (3) to test whether age, size, market share, and time period affect the technical inefficiency of the consumer industry.

Literature Review

Modern manufacturing industries have undergone massive technological changes and most organizations have become larger and more complex. As a result, sophisticated technologies and production processes have led to a demand on companies' performance measurement. In this regard, performance measurement is essential for business as the basis for continuous improvement and for designing an adequate information system. Zairi (1995) states "performance measures (measurements?) are the life blood of organizations, since without them no decisions can be made". Performance measurement is the process of assessing progress toward achieving predetermined goals, including information on the efficiency with which resources are transformed into goods and services (outputs), the quality of those outputs and outcomes, and the effectiveness of companies' operations in terms of their specific contributions to program objectives.

Data Envelopment Analysis (DEA) was originally developed to measure the relative efficiency of peer decision making units (DMUs) in multiple-input multiple-output settings. The DEA models can use both input-oriented and output-oriented it. it may be operating under CRS (constant returns to scale) or VRS (variable returns to scale) assumptions. According to Coelli *et. al* (2005) the constant returns to scale (CRS) DEA model is only appropriate when the firm is operating at an optimal scale. Some factors such as economic and social conditions, imperfect competition, constraint in finance, labor strikes etc may, in practice, cause the consumer industry not to operate at an optimal level. To consider all these environmental factors that may affect the consumer industry performance, this study adopted Chen and Khan (2004) variable returns to scale (VRS) DEA model.

The stochastic frontier production model was originally defined (designed?) for an analysis of cross-sectional data, but various models to account for panel data have also been introduced by Kumbhakar (Kumbhakar and Lovell, 2000). In the estimation of stochastic frontiers models, using panel data has some advantages over using cross-sectional data. The application of panel data increases the number of degrees of freedom in the estimation procedure. It also makes it possible to investigate both technical change and technical efficiency change over time simultaneously (Coelli, 1995; Coelli, Rao, and Battese, 2005).

Methodology

Data Envelopment Analysis (DEA)

DEA is a linear programming-based tool for measuring the relative productive efficiency of each unit in a set of comparable organizational units using theoretical optimal performance for each organization (Khan, *et al*., 2008). The relative efficiency by which the consumer firms utilize their inputs is reflected on the output factors they have produced. Chen and Khan (2004) reported that DEA models with small number of input variables perform well in large samples. The advantages of DEA are that it works particularly well even with small samples, and it does not require any assumption about the distribution of inefficiency, nor does it require a particular functional form on the data in determining the most efficient decision making units.

In this study, input-oriented estimation is more appropriate than the output oriented alternative because one of the objectives of the study is to determine the efficiency of input use for the production of a given output and to find ways to minimize input use. The VRS assumed that each consumer industry - firm was compared with consumer firms with similar size(Please clarify this sentence). The VRS DEA model (input-oriented) can be written as: (Chen and Khan, 2004)

Minimize: θ_0 (1)

Subject to: $\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta_{io}$ $\quad i=1,2,.....,m$

$\sum_{j=1}^{n} \lambda_j y_{ij} \geq y_{io}$ $\quad i=1,2,.....,s$

$\sum_{j=1}^{n} \lambda_j = 1$ $\quad i=1,2,.....,m$

$\lambda j \geq 0$ $\quad j=1,2,.....,n$

Where:
x_{io} and y_{io} are are respectively the *i*th input and *r*th output for a DMU_o under evaluation. Each DMU has a set of *s* output measures, $y_{rj}(r=1,2,.....,s)$, and a set of m input measures, $x_{ij}(i=1,2,.....,m)$.

Stochastic Frontier Analysis (SFA)

This study adopts a trans-log production function to characterize the production frontier facing the consumer industry listed on IDX. Empirically, the equation (2) can be expressed in log-linear form to give:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln I_{it} + \beta_2 \ln F_{it} + \beta_3 \ln K_{it} + \beta_4 \ln L_{it} + \beta_5 \ln (I_{it})^2 + \beta_6 \ln I_{it} (\ln F_{it}) + \beta_7 \ln I_{it} (\ln K_{it}) + \beta_8 \ln I_{it} (\ln L_{it}) + \beta_9 \ln (F_{it})^2 + \beta_{10} \ln F_{it} (\ln K_{it}) + \beta_{11} \ln F_{it} (\ln L_{it}) + \beta_{12} \ln (K_{it})^2 + \beta_{13} \ln K_{it} \ln (L_{it}) + \beta_{14} \ln (L_{it})^2 + V_{it} - U_{it} \quad (2)$$

where:

Y_{it} represents total sales of the consumer industry-firm *i*-th at the *t*-th year of observation.

I_{it} represents inventory of the consumer industry-firm *i*-th at the *t*-th year of observation.

F_{it} represents fixed assets of the consumer industry firm *i*-th at the *t*-th year of observation.

Kit represents capital of the consumer industry-firm *i*-th at the *t*-th year of observation.

L_{it} represents labor of the consumer industry-firm *i*-th at the *t*-th year of observation.

β_1 represents the natural logarithm of inventory(L_{it});

β_2 represents the natural logarithm of fixed assets (F_{it});

β_3 represents the natural logarithm of capital (K_{it});

β_4 represents the natural logarithm of labor (L_{it});

β_5 represents the natural logarithm of inventory $(I_{it})^2$;

β_6 represents the natural logarithm of (I_{it}) x the natural logarithm of (F_{it});

β_7 represents the natural logarithm of (I_{it}) x the natural logarithm of (K_{it});

β_8 represents the natural logarithm of (I_{it}) x the natural logarithm of (L_{it});

β_9 represents the natural logarithm of fixed assets $(F_{it})^2$;

β_{10} represents the natural logarithm of (F_{it}) x the natural logarithm of (K_{it});

β_{11} represents the natural logarithm of (F_{it}) x the natural logarithm of (L_{it});

β_{12} represents the natural logarithm of capital $(K_{it})^2$;

β_{13} represents the natural logarithm of (K_{it}) x the natural logarithm of (L_{it});

β_{14} represents the natural logarithm of labor $(L_{it})^2$;

V_{it} s assumed to be iid $N(0,\sigma_v^2)$ random error, independently distributed of the U_{it};

U_{it} is non-negative random variable.

The technical inefficiency effect of the Battese and Coelli's (1995), U_{it} , in the stochastic frontier model could be specified in the equation (3):

$$U_{it} = \delta_0 + \delta_1(Age_{it}) + \delta_2(Size_{it}) + \delta_3(Marketshare_{it}) + \delta_4(Timeperiod) + W_{it} \qquad (3)$$

where:

Age_{it} represents the number of operation years of the consumer industry firm i-th at the t-th year of observation.

$Size_{it}$ represents the total assets of the consumer industry firm i-th at the t-th year of observation.

$Marketshare_{it}$ represents sales of the consumer industry firm i-th at the t-th year of observation divided by total sales of the consumer industry.

Timeperiod represents the time period (from 2000 – 2005) of the consumer industry firm i-th at the t-th year of observation.

W_{it} is defined by the truncation of the normal distribution with zero mean and variance.

Data Description

The study covers thirty six (36) firms in the consumer industry listed on Indonesia Stock Exchange (IDX) from 2000 – 2005. Thus, a pooled data of 216 (36 firms over 6 years) financial statements were gathered, representing the panel data. Data for this study were gathered from audited annual financial reports of the consumer industry-firms from Securities and Exchange Commission (SEC/BAPEPAM) and IDX (http://www.idx.co.id). These data were adjusted for inflation, using Consumer Price Index (CPI) with base year as 1993 prices, to obtain real values.

Variables

The relative efficiency by which the consumer industry-firms utilize their inputs is reflected on the output factors they have produced. In choosing output and input variables (table 1), this study considered the previous studies. These variables were

Table 1. Variables and Definitions

Variables	Definitions
Input Variables	
Labor	Salaries and wages are a proxy for labor
Inventory	Inventory includes raw materials, work-in-process, auxiliary materials, finished goods, and spare parts.
Fixed assets	Fixed assets include plant, property and equipment, land, transportation equipment, office equipment.
Capital	Stockholders' equity as proxy to capital is the amount received from investors in exchange for stock.
Output Variable	
Total sales	Total sales indicate the total amount of sales received by the firm for the sale of its products.
z-variables	
Age	Age is the length of period a firm has been in operation
Size	Total assets as proxy to size.
Market share	Market share is the ratio of firm sales to total sales of the consumer industry.
Time period	Time period is from the year 2000 to 2005

analyzed through the input-oriented DEA and SFA approaches. In evaluating the consumer industry's technical efficiency, the study used four inputs: (1) labor, (2) inventory, (3) fixed assets, and (4) capital (Kathuaria,2001; Weh Koh, Tahman and Tan,2004). The study used one output: total sales (Nakajima, 1998 and Chirwa, 2001).

The study also tests if there is an effect of age (Lundvall and Battese, 2000), size (Viverita and Ariff, 2006), market share (Tybout, 2000; Diaz and Sanchez, 2008), and time period (Chirwa, 2001) to the technical inefficiency of consumer industry. These variables were chosen based on the assumption that firms' performance is multidimensional in nature and that there exists a various indicators of firms' performance.

Result and Discussion

DEA Results: Efficiency Summary

Technical efficiency is defined as the maximum quantity of output attainable from given inputs. A firm is operating efficiently if it maximizes output with a given level of inputs and that is considered as "technically efficient" (Khan, *et al.*, 2008). The multistage DEA model was utilized to compute the total efficiency scores. This study adopted Chen and Khan (2004) variable returns to scale (VRS) DEA model. Therefore, technical efficiency in this study was calculated using the input-oriented VRS DEA model.

Table 2 shows the efficiency summary using DEA method of the consumer industry for the period 2000-2005. Fifteen out of 36 companies (41.67 percent) in consumer industry obtained a decreasing return to scale. Thirteen out of 36 companies (36.11 percent) in the consumer industry obtained an increasing return to scale. Eight out of 36 companies (22.22 percent) in the consumer industry obtained a constant return to scale. This finding implies while 22.22 % of firms are scale efficient (i.e. CRS), the majority, 77.78 percent are scale inefficient (i.e. DRS and IRS). The average crste, vrste and scale in the consumer industry were: 0.517, 0.591 and 0.883 respectively. This result suggests that to become fully efficient, the consumer industry possibly has to reduce their inputs by 1.0 -0.517 = 0.483, 1.0 - 0.591 = 0.409 and 1.0 – 0.883 = 0.117, respectively without reducing their outputs.

Input and Output Slacks

The amount of input that can be reduced is referred to as excess input or input slack (Sharma *et al.*, 1999). According to Gurgen (2006), input slacks refer to surpluses (input wastages) in the consumer industry operation. Table 3 shows of input slacks (percent) of the consumer industry for the

Table 2. Efficiency Summary-Consumer Industry (2000-2005)

Firm	Code	crste	vrste	scale	RTS
1	ADES	0.603	0.620	0.973	drs
2	AQUA	1.000	1.000	1.000	crs
3	CEKA	0.284	0.352	0.809	irs
4	DAVO	1.000	1.000	1.000	crs
5	FAST	0.708	0.722	0.980	irs
6	INDF	0.341	0.646	0.529	drs
7	MYOR	0.226	0.227	0.995	irs
8	MLBI	0.650	1.000	0.650	drs
9	PTSP	0.355	0.376	0.946	irs
10	PSDN	1.000	1.000	1.000	crs
11	SHDA	0.314	0.328	0.955	drs
12	SKLT	0.357	0.358	0.998	irs
13	STTP	0.319	0.332	0.962	irs
14	SIPD	0.338	0.339	0.998	irs
15	SMAR	0.598	0.621	0.963	drs
16	SUBA	1.000	1.000	1.000	crs
17	TBLA	0.530	0.538	0.985	irs
18	ULTJ	0.213	0.230	0.925	irs
19	BATI	0.560	0.723	0.775	drs
20	RMBA	0.348	0.478	0.728	drs
21	GGRM	0.686	1.000	0.686	drs
22	HMSP	0.357	0.760	0.470	drs
23	DVLA	0.308	0.316	0.978	irs
24	INAF	0.237	0.240	0.984	drs
25	KAEF	0.347	0.358	0.970	drs
26	KLBF	0.566	0.611	0.927	drs
27	MERK	0.626	0.688	0.909	irs
28	PYFA	0.104	0.363	0.288	irs
29	SCPI	1.000	1.000	1.000	crs
30	SQBI	1.000	1.000	1.000	crs
31	TSPC	0.355	0.390	0.910	drs
32	TCID	1.000	1.000	1.000	crs
33	MRAT	0.265	0.267	0.992	drs
34	UNVR	0.625	1.000	0.625	drs
35	KICI	0.131	0.149	0.883	irs
36	KDSI	0.261	0.261	0.999	crs
	Mean	**0.517**	**0.591**	**0.883**	

Notes:

crste = technical efficiency from CRS DEA
vrste = technical efficiency from VRS DEA
scale = scale efficiency = crste/vrste
irs = increasing return scale
drs = decreasing return scale
crs = constant return to scale

period of 2000-2005. The table shows that the companies' input of labor (L), 19 out of 36 companies (52.78 percent) obtained slacks and 17 firms did not obtain slacks. This means that these firms (19 firms) spent too much for labor for the period of 2000 – 2005 while the remaining companies (17 firms) properly used their capital. For input inventory (I), 12 out of 36 companies (33.33 percent) in the consumer industry obtained slacks. For input capital (K), 25 out of 36 companies (69.44 percent) in the consumer industry obtained slacks and 11 firms (30.56 percent) did not obtain slacks. This means that these companies (24 firms) spent too much for capital. For input fixed assets (F), 16 out of 36 companies (44.44 percent) in the consumer industry obtained

Table 3. Input and Output Slacks-Consumer Industry (%) Year 2000-2005

Firm	Code	INPUT SLACKS				OUTPUT SLACKS
		(L)	(I)	(F)	(K)	Total Sales
1	ADES	10.66	0.63	7.81	2.97	0.00
2	AQUA	0.00	0.00	0.00	0.00	0.00
3	CEKA	0.00	0.00	0.00	4.46	0.00
4	DAVO	0.00	0.00	8.14	0.00	0.00
5	FAST	44.73	0.00	0.00	0.00	0.00
6	INDF	15.51	5.33	2.13	0.00	0.00
7	MYOR	0.00	0.00	0.00	0.64	0.00
8	MLBI	15.32	0.00	0.00	3.76	0.00
9	PTSP	28.02	0.00	4.24	1.43	0.00
10	PSDN	0.00	0.00	0.96	8.53	0.00
11	SHDA	0.09	0.00	0.00	7.36	0.00
12	SKLT	7.17	0.00	0.49	0.00	0.00
13	STTP	0.00	0.00	0.00	1.19	0.00
14	SIPD	14.79	3.58	3.16	2.34	0.00
15	SMAR	28.27	3.04	25.76	0.00	0.00
16	SUBA	0.00	0.00	9.78	22.52	0.00
17	TBLA	0.00	0.00	3.68	3.08	0.00
18	ULTJ	0.00	0.00	0.73	2.32	0.00
19	BATI	0.00	9.45	0.00	4.76	0.00
20	RMBA	6.01	0.77	0.00	3.06	0.00
21	GGRM	0.00	0.19	0.00	9.47	0.00
22	HMSP	0.00	0.00	0.00	9.65	0.00
23	DVLA	2.40	0.24	0.00	0.00	0.00
24	INAF	0.00	4.25	0.00	1.98	0.00
25	KAEF	7.27	0.00	0.37	0.00	0.00
26	KLBF	20.35	0.00	8.83	0.36	0.00
27	MERK	1.88	0.92	0.00	11.53	8.31
28	PYFA	0.00	1.87	12.58	14.77	8.14
29	SCPI	3.29	0.00	0.00	0.00	0.00
30	SQBI	0.00	4.80	0.00	6.86	0.00
31	TSPC	0.12	0.00	0.28	5.75	0.00
32	TCID	0.25	0.00	0.00	0.00	0.00
33	MRAT	0.00	0.00	0.00	0.88	0.00
34	UNVR	0.39	0.00	0.00	4.47	0.04
35	KICI	0.00	0.00	0.00	4.62	0.00
36	KDSI	0.47	0.00	6.18	0.00	0.00
	Mean	**5.75**	**0.97**	**2.64**	**3.85**	**0.46**

slacks. These results imply that they spent too much for fixed assets. For input capital (K), 25 out of 36 companies in the consumer industry obtained slacks while the remaining companies properly used their capital. Among four input variables in the consumer industry operation, the most input slack was capital (25 firms) and the least input slack was inventory (12 firms). Table 3 also presents output slack (percent) in the consumer industry for the period 2000 – 2005. Based on further finding for output (total sales), only 3 companies (8.33 percent) in consumer industry obtained slacks, namely: MERK, PYFA, and UNVR. It shows that only three (3) companies experienced output sale deficit in the manufacturing sector-consumer industry's operation while the remaining companies were all efficient.

SFA Results

This section presents new findings on firms' technical efficiency and the relationship between firms' specific variables and technical efficiency of the consumer industry. The maximum likelihood estimation of the parameters in the Cobb-Douglas and translog stochastic frontier production function model was obtained using the software package Frontier Version 4.1. Hypothesis tests based on the generalized Likelihood Ratio (LR) test were conducted to select the functional form and to determine the presence of technical inefficiencies.

Table 4 presents the value of the generalized likelihood-ratio (LR) statistics for the parameters in the stochastic production function for sales–consumer industry. The first test was to select the functional form for sales-consumer industry. The first null hypothesis was that the Cobb-Douglas functional form is a correct functional form to represent the data in the manufacturing sector was rejected. Because the LR value of 175.78 was greater than the critical value of 18.30 based on a chi-square distribution table at 5 percent probability level, the translog model was chosen. The second test was the test of the null hypothesis that there was no technical inefficiency effect in the model, which could be stated as: $\gamma = \delta_1 = \delta_1 = \delta_1 = \delta_1 = \delta_1 = 0$. The LR test value was 356.91 and the critical value at 5 percent level was 13.40. The null hypothesis that γ was zero was rejected, suggesting that inefficiency was present in the model.

Panel A Results:

Table 5 on panel A shows the estimation of the parameters for panel data of 36 firms with a total of 216 observations in the consumer industry. A total of five (5) coefficients out of 14 were significantly different from zero at the 5 percent level, indicating the importance of some of the interaction and non-linearities among variables. Two direct effects, two squared terms and one cross product had coefficients which were significantly different from zero. All four inputs, labor, inventory, fixed assets, and capital, appeared to be the major determinants of consumer industry growth. Fixed asset remained the single most important input with an input elasticity of 1.5083.

The estimated β coefficients of the firms' four explanatory variables of the consumer industry for technical efficiency effects had some implications. Constant (β_0) was 0.4983 (0.2570). It indicates that the joint effect of four explanatory variables of the consumer industry was positive and insignificant although the individual effects of one or more variables may be statistically significant. The result showed a positive sign of the estimated coefficient for labor (0.4694) in this sector. The finding was consistent with the study of Mojo (2006) that the manufacturing sector firms' efficiency increases as they use more labor inputs. The estimated inventory coefficient of the stochastic frontier (0.0998) had a positive sign and insignificantly associated with efficiency. The estimated coefficient for fixed assets (1.5083) had a positive sign and significantly associated with efficiency. It implies that the firms' efficiency increased as they used more fixed assets. Finally, the estimated coefficient for capital (-0.8851)

Table 4. Generalized Likelihood-Ratio Test of Null Hypotheses for Parameters in the Stochastic Frontier Production function for Total Sales (2000 – 2005)

Null Hypotheses, Ho	LR Value	Critical value*	Decision
= 0,1,2,3,4 (Cobb-Douglas function)	175.78	18.30	Reject
$\gamma = \delta_1 = \delta_1 = \delta_1 = \delta_1 = \delta_1 = 0$ (no inefficiency effects)	356.91	13.40	Reject

** Critical values are obtained from the appropriate chi-square distribution, except for the test of hypothesis involving for technical inefficiency effects (Kodde and Palm, 1986)*

Table 5. The Maximum-Likelihood Estimates of Parameters of the Stochastic Frontier Production function for Total Sales (2000 – 2005)

	Variables	Parameters	Coefficient Estimates	t-ratio
A. Production Frontier	Constant	β_0	0.4983	0.2570
	ln L (Labor)	β_1	0.4694	0.8185
	ln I (Inventory)	β_2	0.0998	0.2394
	ln F (Fixedassets)	β_3	1.5083	2.9793 *)
	ln K (Capital)	β_4	-0.8851	-2.4639*)
	$(\ln L)^2$	β_5	0.0573	1.5997
	ln L x ln I	β_6	-0.0373	-0.7163
	ln L x ln F	β_7	-0.2336	-3.5831*)
	ln L x ln K	β_8	0.1713	0.2686
	$(\ln I)^2$	β_9	0.0661	2.1222*)
	ln I x ln F	β_{10}	-0.0235	-0.3533
	ln I x ln K	β_{11}	-0.0662	-0.9725
	$(\ln F)^2$	β_{12}	0.1080	1.7509
	ln F x ln K	β_{13}	-0.0864	-1.3387
	$(\ln K)^2$	β_{14}	0.0412	2.3270*)
B. Inefficiency Effects	Constant	δ_0	-25.3856	-4.5741**)
	Age	δ_1	0.2700	3.5776*)
	Size	δ_2	0.1415E-05	7.1981**)
	Market share	δ_3	-2.9890	-8.9438**)
	Time	δ_4	0.1161	0.5577
C. Variance		$\sigma^2_s = \sigma^2_v + \sigma^2_u$	11.0766	6.0148 **)
		$\gamma=\sigma^2_v/\sigma^2_v$	0.9960	918.3193**)
Log-likelihood ratio			356.9056***)	
Mean TE (Technical Efficiency)			0.6630	

**) Significant at 5 percent level (p< 0.05)*
***) Significant at 1 percent level (p < 0.01)*
****) Critical value is 13.40 for 7 d.f as for Table 1 of Kode and Palm (Coelli and Battese, 1998) for technical inefficiency effects.*

was negative and significantly associated with efficiency. The result implies that the firms' efficiency decreased as they used more capital which was consistent with the study of Lundvall and Battese (2000) and Mojo (2006).

Panel B Results:

Panel B shows the non negative technical inefficiency effects which were a function of age, size, market share, and time. The estimated δ-coefficients of the firms' specific explanatory variables in the model for technical inefficiency effects had important implications. Constant (delta 0) was (-25.3856). It indicates that the joint effect of four z-variables on the technical inefficiencies of the consumer industry was significant although the individual effects of one or more variables might not be statistically significant. The estimated coefficient associated with age (0.2700) was positive. The result was in line with the study of Lundvall and Battese (2000) that older firms are technically inefficient than younger firms. The estimated coefficient associated with size (0.1415E-05) was positive. Larger firms are technically inefficient than smaller firms. This finding was consistent with the study of Biggs *et al.* (1996). The estimated coefficient associated with market share (-2.9890) was negative. Market share had a negative effect on technical inefficiency and it was significant. The result was parallel with the study of Diaz and Sanchez (2008) that firms with higher market share (market power) is technically efficient compared to lower market shares. The estimated coefficient associated with time (0.1161) was positive. This finding was consistent with the study of Chirwa (2001) that inefficiencies of the consumer industry tends to increase throughout the six-year period.

Panel C results:

The parameters $\sigma^2_s=\sigma^2_v+\sigma^2_u$ and $\gamma=\sigma^2_u/\sigma^2_s$ were associated with the variance of the random variables, v_{ij} and u_{ij} . σ^2_s (sigma-squared) is 11.0766 and gamma (γ) is 0.9960. The results showed that the estimate for the γ-parameter was close to unity, which indicated that the inefficiency effects were likely to be highly significant in the analysis of the value of output of the consumer industry. This result was supported by the LR test of hypothesis that technical inefficiency effects were not simply random errors was significantly rejected. The average technical efficiency (0.6630) indicates that on average the consumer industry produced 66.30 percent of the output that could be theoretically produced with the same bundle of inputs by a technically efficient firm. Therefore, to become fully efficient, consumer industry firms need to increase their output by 33.70 percent.

Conclusion

This study assessed the extent of efficiency of the consumer industry listed on Indonesia Stock Exchange (IDX) using both (DEA) and (SFA). First, the study showed that technical efficiencies of the consumer industry firms were constant and that the returns to scale performance of each firm were the same over the test period was rejected. It indicated some factors such as economic and social conditions, imperfect competition, constraint in finance, labor strikes might cause consumer industry, in practice, not to operate at an optimal level. Secondly, there was source of inefficiencies identified in the slack performance of the consumer industry. The study also indicated the existence of output slacks (output deficits) and input slacks (input wastages) in the consumer industry's operation. The result showed that it had very low deficits (deficiencies) of output (total sales) in the consumer firms' operation. Thirdly, the results from the application of SFA (Stochastic Frontier Approach) indicated that for total sales, a total of five coefficients out of 14 are significantly different from zero at the 5 percent level, indicating the importance of some of the interaction and non-linearities among variables. The average technical efficiency (mean TE) for the consumer industry was 0.6630. Fourthly, the study found that the joint effect of four z-variables on the technical inefficiencies of the consumer industry was significant although the individual effects of one or more variables might not be statistically significant.

This study fills the gap and serves as additional contribution to the literature on performance measurement and provides these models as alternative tools in measuring performance to the SEC (Securities and Exchange Commission), stockholders (investors), managers, bankers and other members of Indonesia business community. The combined approaches of parametric and non-parametric may lead to robust and bias-free analysis of the consumer industry performance. Therefore, the limitation of each model is avoided.

References

Abidin, Zaenal and Cabanda, Emilyn C. (2006), Financial and Production Performance of Domestic and Foreign Banks in Indonesia in Pre and Post Financial Crisis, *Usahawan,* 6, 3 – 9.

Battese, G.E. and Coelli, T.J. (1995), A Model for Technical Inefficiency Effects in A Stochastic Frontier Production Function for Panel Data, *Empirical Economics,* 20, 325-332.

Biggs, Shah and Srivastava. (1996), Technological Capabilities and Learning in African Enterprises, *RPED Case Study Series*, World Bank , Washington DC, 29 – 62.

Chen, Yao and Khan, Riaz. (2004), Using Super Efficiency DEA to Evaluate Financial Performance of E-business Initiative in the Retail Industry, *International Journal of Information Technology and Decision Making,* 3(2), 337 – 351.

Chirwa, Ephraim W. (2001), Privatization and Technical Efficiency: Evidence from the Manufacturing Sector in Malawi, *African Development Review*, 13 (2), 276 – 307.

Coelli, T. (1995), Recent Developments in Frontier Modelling and Efficiency Measurement, *Australian Journal of Agricultural Economics*, 39(3), 219-245.

Coelli,Timothy J, Rao, D.S Prasada, and Battese, George E. (2005), *An Introduction to Efficiency and Productivity Analysis*, 2nd Ed., Springer Science Business Media, 41– 81.

Daryanto, H., G. E. Battese, and E. M. Fleming. (2002), Technical Efficiencies of Rice Farmers under Different Irrigation Systems and Cropping Seasons in West Java, *CEPA Working Paper* No 1/2002, Univ. of New England, NSW, Australia, 1-27.

Diaz, M Angeles, and Sanchez, Rosario. (2008), Firms' Size and Productivity in Spain: A Stochastic Frontier Analysis*, Small Business Economics,* 30(3), 315-323.

Gurgen, Ender. (2006), Regulatory Effect on Efficiency and Efficiency Measurements of Power Generating Companies: A Data Envelopment Analysis (DEA) Application, *Nisan,* I (1), 39 – 60.

Hill, H and Kalirajan, K.P. (1993), Small Enterprise and Firm-Level Technological Efficiency in the Indonesian Garment Industry, *Applied Economics*, 25(9), 137-144.

Hill, H. (2001), Small and Medium Enterprises in Indonesia: Old Policy Challenges for a New Administration, *Asian Survey*, 41(2), 248 – 270.

Jacob, Jojo and Los, Bart. (2006), *International Technology Spillovers and Manufacturing Performance in Indonesia*, Eindhoven Centre for Innovation Studies, Eindhoven University of Technology, 141-171.

Kathuria, Vinish. (2001), Foreign Firms, Technology Transfer & Knowledge Spillovers to Indian Manufacturing Firms: A Stochastic Frontier Analysis, *Applied Economics* , 33, 625 – 642.

Khan, M.S., Mahapatra, S.S., Sreekumar. (2008), Service Quality Evaluation of Technical Institutions Using Data Envelopment Analysis*, International Journal of Productivity and Quality Management*, 3(1), 127 – 143.

Kodde, DA and Palm, FC. (1986), Wald Criteria for Jointly Testing Equality and Inequality Restrictions, *Econometrica*, 54, 1243-1248.

Kompas Daily, Indeks harga saham Bursa Efek Jakarta (BEJ), December 21, 2006, 13.

Kumbhakar, S. and C.A.K. Lovell. (2000), *Stochastic Frontier Analysis*, Cambridge University Press.

Lundvall, Karl and Battese, George E. (2000), Firm Size, Age, and Efficiency: Evidence from Kenyan Manufacturing Firms, *Journal of Development Studies*, 36 (3), 146 – 163.

Mojo, Mohamad Ikhsan. (2006), Total Factor Productivity in Indonesian Manufacturing: A Stochastic Frontier Approach, Monash University., *ABERU Disc. Paper 28*, 1-18.

Nakajima, Takanabo*, et. al.* (1998), An Index Number Method for Estimating Scale Economies and Technical Progress Using Time Series of Cross Section Data: Source of Total Factor Productivity Growth For Japanese Manufacturing 1964 – 1988, *The Japanese Economic Review*, 49 (3), 310 – 334.

Sharma, Khem R., Leung, PhingSun., Zane Lynn. (1999), Performance Measurement of Hawaii State Public Libraries: An Application of Data Envelopment Analysis (DEA), *Agricultural and Resource Economics Review,* 28(2), 190 – 198.

Tybout, J. R. (2000), Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?, *Journal of Economic Literature*, 38(1), 7-40.

Viverita, Rita and Ariff, Mohamed. (2004), Corporate Financial Performance and Production Efficiency: A Study on Indonesia's Public and Private Sector, *4th International Symposium of DEA*, Aston University, UK, 88 -93.

Viverita, Rita and Ariff, M. (2006), Firm Size, Age, and Technical Efficiency of Indonesian Firms, *Usahawan,* 09, 16 – 20.

Wei Koh, Soo, Tahman Shahidur, and Tan, Randolph. (2004), Stochastic Frontier Analysis of Singapore Manufacturing Industries, *The Singapore Economic Review*, 49 (1), 85-103.

Zairi, M. & Sinclair, D. (1995), *Effective Process Management through Performance Measurement,* Publisher: Emerald. A, 75 – 88.