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STOCHASTIC FRONTIER ANALYSIS OF INDONESIAN FIRM EFFICIENCY: A NOTE

T. Handono E. Prabowo and Emilyn Cabanda
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Abstract

This research attempts to model performance measurement for the firms listed on Indonesia Stock Exchange (IDX) using the stochastic frontier approach. There are 121 firms analyzed over the period of 2000-05 with 726 pooled observations. We also test whether firm's age, size, market share, manufacturing classifications and time period have effects on the technical inefficiency of the manufacturing sector. Our findings reveal that the average technical efficiency of the tested firms is 0.7149, which is below the efficiency frontier: factors that affect inefficiency are found and explained. Our research has offered notable original contributions to performance measurement and provides insights on managerial decision making on operational performance of listed firms in an increasingly competitive Indonesian economy.

Keywords: Stochastic Frontier Analysis, Performance measurement, Efficiency, Manufacturing sector, Indonesia Stock Exchange

JEL Classification: G21

1. Introduction

Prior research on the Indonesian economy used stochastic frontier analysis (SFA) for evaluating a firm's performance but on other than manufacturing sectors: agriculture (see Daryanto, Battese, and Fleming (2002)) on technical efficiencies of rice farmers in West Java; Public and Private Sectors (Viverita and Ariff (2004); Viverita and Ariff (2006)); commercial banks (Abidin and Cabanda (2007); electronics manufacturing plants (Palangkaraya and Yong (2006); manufacturing sector's labor growth (Jacob and Los (2006)); and consumer industry (Probowo and Cabanda (2010). However, those few studies on Indonesian manufacturing firms are not

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This research attempts to fill the gap in existing performance literature on the behavior of listed manufacturing firms in a highly volatile emerging stock market namely Indonesia. This paper can also serve as an added contribution to the literature on performance measurement by introducing a frontier model as an alternative measure to a widely-used conventional accounting model to measure firm's performance. In addition, this research also provides significant empirical contributions to the performance literature in general, and offers specific managerial implications that can be helpful in the decision making of these firms.

This research is also prompted by the competitive environment putting pressure on the manufacturing industry in much more open emerging economy: Indonesia's is a case in point as this economy was restructured by the IMF and World Bank in 1998-2001, and is responding to competition. Some firms sought to acquire others to consolidate resources and, through merger, some firms rose to the status of global corporations. To survive in such increasingly competitive environments, manufacturing firms seek to continuously improve their efficiency and productivity performance to sustain long-term growth and profitability.

The sector studied is one of the most important sectors listed on Indonesia Stock Exchange (IDX). In this new reformed era of high competition, it is important to determine the operational performance of this sector as one of the paramount factors that contributes to the growth of Indonesia's economy. Scholars and practitioners alike have been looking for the right measurement tools to evaluate the overall performance of any industries.

Several studies had been conducted using the SFA approach on performance measurement for manufacturing sectors in other countries. Wei, Tahman and Tan (2004) examined an alternative measure: the rate of technical efficiency change in Singapore manufacturing sector. Rodriguez and Mini (2000) in their study on the manufacturing sector of the Philippines found that efficiency and size of firms are positively correlated, and larger establishments are more efficient. Lundvall and Battese (2000) examined efficiency of Kenyan manufacturing firms. Kathuria (2001) conducted an efficiency analysis of Indian manufacturing firms. Kim and Han

(2001) applied a stochastic frontier approach to Korean manufacturing industries and showed that technical efficiency had a significant positive effect on its productivity growth. In another study, Söederbom and Teal (2001) examined three dimensions of the performance of firms in Ghana's manufacturing sector. The findings of these previous studies will be later compared to the new empirical findings derived in this research.

Our research attempts to model performance measurement for the firms listed on the IDX. This research has three specific objectives: (1) Determine the stochastic frontier measures on labor, inventory, fixed assets, and capital on total sales; (2) Test whether firm's age, size, market share, manufacturing classifications, and time period have effects to the technical inefficiency of the sector; and (3) Test whether there is a significant difference among technical efficiency (TE) scores of classifications. New findings will offer significant and new empirical contributions to the performance management field.

The rest of the paper is structured as follows. Section 1 discusses the state of the Indonesia's manufacturing sector. The economic and regulatory environment is described in section 2. Data, variables and the model are presented in Section 3 as part of the methodology. Section 4 presents new findings and our discussion while the conclusion and managerial implications research is in the last section.

2. Overview of Sector Studied

From the late 1970s, Indonesia experienced a rapid economic growth which was sustained over the next three decades. The economy was transformed from highly dependent on agriculture in 1960s into one in which this sector's contribution was more than a quarter of the gross domestic product (GDP) in the mid-1990s. From 1973 to 1980, the value of Indonesian export was dominated by oil/gas and timber (60 per cent). Later on, as more and more processing plants developed domestically, the share of semi-processed goods in total exports rose steadily and the in the mid 1990s became one of the most important foreign exchange earners. The 1997 financial crisis turned the economic miracle into shambles. By January 1998 the currency had depreciated by 80 per cent, while the economy contracted sharply to 51 per cent of GDP at its trend growth. With the loss of valuable times, as the confidence of public and investor continued to evaporate, the crisis that was relatively mild in October 1998 continued to deepen when financial crisis led to political one. The currency continued to slide and the crisis had serious consequences; output contracted by 51 per cent of GDP, and US $ 238.60 billion estimated cost of the crisis (Widianto *et al*., 2000).

The severe economic contraction in 1998 was slightly reversed in 1999, when the economy grew again, though at a miniscule rate of 0.8 per cent. Rupiah was stabilized around Rp 9,000 per US dollar since November 2002 – a far cry from its 3,000 rupiah to dollar during pre-crisis times. The appreciation of Rupiah from around 15,000 rupiah along with the availability of food supply has held inflation in check. Measured by consumer price index (CPI), inflation reached its peak in 1998 at 82 per cent per annum. The inflation rate in 2001 was 11.2 per cent, 10.0 per cent (2002), 5.1 per cent (2003), 6.4 per cent (2004), 17.1 per cent (2005), and less than 10 per cent (2011). The inflation rate was higher in 2005 due to government decision to increase gas and oil prices by 100 per cent in 2005 (BPS Statistic Indonesia, 2006).

From 2000 through 2003, economic growth was mainly driven by private and public consumption, while fixed investment, just like in the preceding years after the crisis, remained sluggish. As a result of sluggish investment growth, the investment to GDP ratio in 2003 dropped to 17.8 per cent in 2003, the lowest level since the early 1970s. During the late Soeharto era, the investment to GDP ratio was around 30 per cent. However, in 2004 for the first time after the Asian crisis, GDP growth just exceeded 5 per cent. This time growth was not only driven by consumption, but also by investment, the growth of which for the first time after the crisis grew at double digit at 15.7 per cent. Export growth at 8.5 per cent was also higher than in 2002 and 2003. During the first and second quarters of 2005 fixed investment continued its double-digit growth (Wie, 2006).

The manufacturing sector accounts for an increasing share of GDP. The manufacturing sector accounted for an estimated 27.6 per cent of GDP in 2001, 27.8 percent (2002), 28.0 per cent (2003), 28.36 per cent (2004), and 28.1 per cent (2005) of GDP: it is close to a third in 2011. The growth rates were 3.8 per cent (2001), 5.3 per cent (2002), 5.3 per cent (2003), 6.4 per cent (2004), and 4.6 per cent (2005). The sector contributes the highest contribution to Indonesian GDP growth from the year 2001 to 2005 (BPS-Statistic Indonesia, 2006). With this, the financial sector has responded well with its own rapid growth and rehabilitation to a healthy state.

In the late 1980s and the 1990s, Indonesia implemented policies designed to move toward a freer, more market-oriented financial system. Indonesia deregulated its financial sector in 1988-1989. There were 56 listed companies before the deregulation of the financial sector in 1988-1989. One year later (1990), there were 123. Subsequently, there were 349 listed firms as of December 2005. In the manufacturing sector, there are 127 firms listed on Jakarta Stock Exchange (JSX). The JSX changed its name to Indonesia Stock Exchange (IDX) in December 2007. These firms listed are categorized into three classifications: basic industry (48 companies), consumer goods industry (38 companies), and miscellaneous industry (41 companies).

3. Data, Variables and Methodology

2.1 Data Sample

This research covers 121 out of the total 127 manufacturing firms listed on IDX from 2000 to 2005: due to data unavailability for recent periods, 2005 financial reports are the latest available. A pooled data of 726 represent the panel data for the current analysis. Data were gathered from audited annual financial reports of manufacturing firms from Securities and Exchange Commission (BAPEPAM) and IDX. This research include all the three listed manufacturing classifications: basic industry (47 companies), consumer goods industry (36 companies), and miscellaneous industry (38 companies). All financial data were adjusted for inflation, using the Consumer Price Index (CPI) with a base year of 1993 prices.

2.2 Variables

There are four (4) inputs used: (1) labor, (2) inventory, (3) fixed assets, and (4) capital (see Probowo and Cabanda, 2010; Kathuria, 2001;Wei Koh, *et al*., 2004; and Mojo, 2007). The one output is total sales (Nakajima,1998; Chirwa 2001; Probowo and Cabanda, 2010). Other z-variables used are age, size, market share, manufacturing classifications, and time period (see Lundvall and Battese, 2000; Biggs and Srivastava,1996, Viverita and Ariff, 2006, Tybout, 2000, Diaz and Sanchez, 2008; and Probowo and Cabanda, 2010).

2.3 Stochastic Frontier Analysis Model

We attempt to propose a model for technical inefficiency effects in a stochastic frontier production function for panel data of the listed manufacturing firms to estimate the trans-log stochastic production function over the time period. Provided the inefficiency effects are stochastic, the model permits the estimation of both technical change in the stochastic frontier and time-varying technical inefficiencies.

Table 1: Variables and 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 operating to produce and sell products.
	Size	Total assets as proxy to size.
	Market share	Market share is the ratio of sales to total sales of manufacturing sector.
	Manufacturing Classifications	Manufacturing classifications are basic industry, consumer goods industry, and miscellaneous industry.
	Time period	Time period of 2000 to 2005

Source: Probowo and Cabanda (2010).

Battese and Coelli (1995) provided the stochastic frontier production function for panel data:

$$Y_{it} = \exp(x_{it}\beta + V_{it} - U_{it}) \qquad (1)$$

where Y_{it} denotes the production at the *t*-th observation (*t* = 1,2, …,T) for the *i*-th firm (i = 1,2, …,N); x_{it} is a $(1xk)$ vector of values of known functions of inputs of production and other explanatory variables associated with the *i*-th firm at the *t*-th observation; β is a $(1xk)$ vector of unknown parameters to be estimated; V_{it}s are assumed to be iid $N(0,\sigma_v^2)$ random errors, independently distributed of the U_{it}s; U_{it}s are non-negative random variables, associated with technical inefficiency of production, which assumed to be independently distributed, such that U_{it} is obtained by truncation (at zero) of the normal distribution with mean $z_{it}\delta$ and variance, σ^2; z_{it} is a $(1xm)$ vector of explanatory variables associated with technical inefficiency of production of firms over time; and δ is a $(mx1)$ vector of unknown coefficients (Battese and Coelli (1995).

To characterize the stochastic frontier production of the listed manufacturing sector firms, this research applies a trans-log stochastic production function. Applying the Battese and Coelli's (1995) model, Equation (2) presents the empirical log-linear form for this research:

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

where:

Y_{it} represent total sales of the manufacturing firm *i*-th at the *t*-th year of observation;
I_{it} represent inventory of the manufacturing firm *i*-th at the *t*-th year of observation;
F_{it} represent fixed assets of the manufacturing firm *i*-th at the *t*-th year of observation;
K_{it} represent capital of the manufacturing firm *i*-th at the *t*-th year of observation;
L_{it} represent labor of the manufacturing firm *i*-th at the *t*-th year of observation;
β_1 represents the natural log of inventory (I_{it});

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

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

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

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

β_6 represents the natural log of inventory (I_{it}) x the natural log of fixed assets (F_{it});

β_7 represents the natural log of inventory (I_{it}) x the natural log of capital (K_{it});

β_8 represents the natural log of inventory (I_{it}) x the natural log of labor (L_{it});

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

β_{10} represents the natural log of fixed assets (F_{it}) x the natural log of capital (K_{it});

β_{11} represents the natural log of fixed assets (F_{it}) x the natural log of labor (L_{it});

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

β_{13} represents the natural log of capital (K_{it}) x the natural log of labor (L_{it});

β_{14} represents the natural log 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}; and U_{it} are non-negative random variable.

Furthermore, Battese and Coelli (1995), specified the technical inefficiency effect, U_{it}, in the stochastic frontier model as shown in Equation (3):

$$U_{it} = \delta_0 + \delta_1(Age_{it}) + \delta_2(Size_{it}) + \delta_3(Marketshare_{it}) \tag{3}$$

$$+ \delta_4(Class_{it}) + \delta_5(Timeperiod) + W_{it}$$

where Age_{it} represents the number of operation years of the manufacturing firm *i*-th at the *t*-th year of observation; $Size_{it}$ represents the total assets of the manufacturing firm *i*-th at the *t*-th year of observation; $Marketshare_{it}$ represents sales of the manufacturing firm *i*-th at the *t*-th year of observation divided by total sales of the manufacturing sector; $Class_{it}$ represents the classification of the manufacturing firm *i*-th at the *t*-th year of observation; $Time\ period_{it}$ represents the time period of the manufacturing firm *i*-th at the *t*-th year of observation (2000 – 2005); and W_{it} is defined by the truncation of the normal distribution with zero mean and variance.

The stochastic frontier production function may investigate a firm's technical efficiency and may also identify factors for the technical inefficiency effects of the manufacturing sector firms. The computer software known as Frontier 4.1 by Tim Coelli was used to derive all empirical findings in this research.

4. Empirical findings

The value of the generalized likelihood-ratio (LR) statistics for the parameters in the stochastic production function for sales is shown in Table 2. The null hypothesis that that the Cobb-Douglas functional form is a correct functional form to represent the data in Indonesia's listed sector is significantly rejected. Therefore, the trans-log model is chosen based on the LR value of 155.59. This is greater than the critical value of 18.30 based on a Chi-square distribution table, tested at 5 per cent probability level. The null hypothesis that there is no technical inefficiency effect in the model is also significantly rejected, based on the LR value of 546.26, implying that inefficiency effect is present in the model.

Table 2: Generalized likelihood-ratio tests of null hypotheses for parameters in the stochastic frontier production function for sales

Null Hypotheses, Ho	LR Value	Critical value*	Decision
$\beta_{ij} = 0,1,2,3,4$ (Cobb-Douglas function)	155.59	18.30	Reject
$\gamma = \delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ (no inefficiency effects)	546.26	13.40	Reject

*Critical values are obtained from the appropriate chi-square distribution, except for the test of hypothesis involving $\gamma = 0$ for technical inefficiency effects (Kodde and Palm, 1986).

4.1 Panel I Findings

To determine the stochastic effects of labor, inventory, fixed assets, and capital on total sales, results are shown in Table 3. The estimated coefficients of four inputs for the sector are reported in Panel I. There are five coefficients out of 14 that are significantly different from zero at the 5 per cent probability level. One direct effect, three squared terms and one cross product have coefficients significantly different from zero. These findings support the rejection of the Cobb-Douglas model: this is not an adequate representation of the sector. Inventory, among the four inputs, remains the single most significant predictor of sales output (efficiency), with an estimated elasticity of 0.7182.

Table 3: The maximum-likelihood estimates of parameters of the translog stochastic frontier production function for sales a significant positive effect (0.7182) on technical efficiency. The positive effect implies that the manufacturing sector firms' efficiency increases as more inventory utilized.

	Variables	Parameters	Coefficient Estimates	t-ratio
I. Production Frontier	Constant	β_0	4.0894	4.464**
	ln L (Labor)	β_1	-0.2799	-1.256
	ln I (Inventory)	β_2	0.7182	3.573**
	ln F (Fixedassets)	β_3	0.1511	0.920
	ln K (Capital)	β_4	-0.0241	-0.123
	$(\ln L)^2$	β_5	0.1118	5.377**
	ln L x ln I	β_6	-0.1559	-4.488**
	ln L x ln F	β_7	0.0581	1.853
	ln L x ln K	β_8	-0.0448	-1.380
	$(\ln I)^2$	β_9	0.0521	2.862*
	ln I x ln F	β_{10}	-0.0085	-0.302
	ln I x ln K	β_{11}	0.0067	0.191
	$(\ln F)^2$	β_{12}	-0.0165	-1.013
	ln F x ln K	β_{13}	-0.0086	-0.404
	$(\ln K)^2$	β_{14}	0.0295	2.214*
II. Inefficiency Effects	Constant	δ_0	-24.6063	-12.757**
	Age	δ_1	0.1938	8.292**
	Size	δ_2	0.1854E-06	2.241*
	Market share	δ_3	-0.7265	-4.122**
	Classification	δ_4	3.0547	5.737**
	Time	δ_5	0.0893	0.520
III. Variance Parameters		$\sigma_s^2 = \sigma_v^2 + \sigma_u^2$	7.9012	6.849**
		$\gamma = \sigma_u^2 / \sigma_s^2$	0.9809	297.503**
Log-likelihood ratio		546.260 ***		
Mean Technical Efficiency		0.7149		

* 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 Kodde and Palm (Coelli and Battese, 1998) for technical inefficiency effects.

Overall, constant (β_0) is statistically significant (4.0894). This finding suggests that the joint effects of four predictors of technical efficiency in this sector are positive and significant, in general, while individual effects of one or more variables are not statistically significant. Labor shows a negative effect (-0.2799) but is statistically insignificant. This finding is consistent with the findings of Wei Koh *et al*. (2004) and Gholami, Moshiri, and Yong (2004); they found out that technical efficiency decreases as more labor inputs are used. Inventory coefficient has the estimated coefficient for fixed assets (0.1511), which is positive, but the effect is insignificant. Lastly, capital (-0.0241) is found to have a negative but insignificant effect on efficiency, suggesting that efficiency declines when more capital is injected. This result supports the finding of Lundvall and Battese (2000) on Kenyan industry. This results are indicative of the sector's lack luster productivity.

4.2 Panel II findings

To further test whether firm's age, size, market share, classifications, and time period have effects on technical inefficiency of the sector, and the findings are shown in Table 3, Panel II. Overall, the joint effect of five z-variables on the technical inefficiency is significant, where the constant is -24.6063. The estimated coefficient associated with age (0.1938) is positive and statistically significant, suggesting that older firms are technically inefficient than younger firms perhaps due to the latter adopting newer technology. Size is also found to have a positive significant effect on technical inefficiency, which is a normal results. This finding is consistent with the results of Biggs *et al*. (1996) that larger firms are technically inefficient than smaller firms.

Meanwhile, market share is found to have a negative effect on technical inefficiency and is statistically significant. This finding supports Tybout (2000) and Diaz and Sanchez (2008) that firms with higher market shares demonstrate market power and are technically efficient compared to firms with lower market shares. Moreover, classifications show a positive effect on technical inefficiency and the coefficient is significant. This finding suggests that basic and consumer classifications are technically inefficient than miscellaneous type. Lastly, time has a positive effect: an indication that technical inefficiency is present in production over time. This finding is in line with Chirwa (2001) on the manufacturing sector in Malawi that, on average, technical efficiencies decline over time.

4.3 Panel III findings

The variance parameters, $\sigma_s^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / \sigma_s^2$, are all positive and significant. The estimate for γ (gamma) is close to unity (0.981) and very high. This result indicates that much of the variation in the composite error term is due to inefficiency effects (and not simply random errors) in this sector's data. This finding supports the previous result of Hill and Kalirajan (1993) on small-scale Indonesian garment producers.

Lastly, the mean technical efficiency is 71.49 per cent for the sector. On average, this sector produces 71.49 per cent of the total sale output that could be theoretically produce with the same combinations of inputs by a fully-efficient firm: of course this is the theoretical limit, which is not possible, given firms in any economy operate with some slack because of cyclical changes in demand for their outputs. This further suggests that sector needs to increase their sale output by 28.51 per cent to attain the optimal efficiency level.

4.4 Technical Efficiency analysis

The 121 firms used in this analysis are classified into three (3) categories: basic industry, consumer industry, and miscellaneous industry. The companies' technical efficiency data (2000 – 2005) are provided in Tables 4 and 5. The average technical efficiency scores of basic industry, consumer industry and miscellaneous industry are 0.703, 0.705, and 0.739, respectively. The overall mean technical efficiency of the manufacturing industries is 0.715. The highest average of technical efficiency was obtained by TBMS (0.904) in the basic industry and the lowest average of technical efficiency was 0.375 (PYFA) in the consumer industry. The lowest average of standard deviation in technical efficiency was in miscellaneous industry (0.093).

Kruskal-Wallis test was used to test whether there is a significant difference among technical efficiency scores of manufacturing sector classifications. We found that there is no statistically significant difference (0.178) in technical efficiency scores of the three classifications (basic, consumer and miscellaneous). Table 5 presents the descriptive statistics of the three industry classifications.

Our SFA model appears to have the same statistical results for efficiency scores among three classifications. Therefore, basic, consumer and miscellaneous industry classifications seem to be operating at the same efficiency level.

Table 4: Firm average technical efficiency scores for manufacturing classifications

Basic		Consumer		Miscellaneous	
Firm	TE	Firm	TE	Firm	TE
INTP	0.560	ADES	0.533	ACAP	0.702
SMCB	0.573	AQUA	0.884	ASII	0.831
SMGR	0.700	CEKA	0.579	AUTO	0.790
ARNA	0.801	DAVO	0.844	BRAM	0.694
IKAI	0.445	FAST	0.819	GJTL	0.784
MLIA	0.610	INDF	0.766	GDYR	0.766
ALMI	0.782	MYOR	0.732	ADMG	0.809
BTON	0.706	MLBI	0.644	HEXA	0.790
CTBN	0.672	PTSP	0.771	INDS	0.686
INAI	0.766	PSDN	0.685	INTA	0.727
JKSW	0.580	SHDA	0.728	LPIN	0.685
JPRS	0.830	SKLT	0.785	NIPS	0.784
LMSH	0.826	STTP	0.762	PRAS	0.800
LION	0.563	SIPD	0.822	SMSM	0.694
PICO	0.655	SMAR	0.779	TURI	0.910
TBMS	0.904	SUBA	0.709	UNTR	0.809
TIRA	0.645	TBLA	0.805	PAFI	0.700
AKRA	0.887	ULTJ	0.595	HDTX	0.746
BUDI	0.815	BATI	0.644	RDTX	0.611
CLPI	0.820	RMBA	0.808	MYTX	0.789
LTLS	0.780	GGRM	0.767	DOID	0.732
SOBI	0.793	HMSP	0.766	ESTI	0.611
UNIC	0.775	DVLA	0.692	INDR	0.816
AKPI	0.756	INAF	0.682	BIMA	0.487
AMFG	0.719	KAEF	0.723	RICY	0.686
APLI	0.735	KLBF	0.744	SRSN	0.734
BRNA	0.760	MERK	0.507	BATA	0.724
DYNA	0.662	PYFA	0.375	KBLI	0.743
FPNI	0.734	SCPI	0.754	JECC	0.771
LMPI	0.610	SQBI	0.729	KBLM	0.563
LAPD	0.784	TSPC	0.745	VOKS	0.834
SIMA	0.781	TCID	0.725	KOMI	0.814
SMPL	0.604	MRAT	0.610	INTD	0.813
TRST	0.747	UNVR	0.689	MDRN	0.814
BRPT	0.529	KICI	0.415	KONI	0.646
DSUC	0.704	KDSI	0.746	ASGR	0.514

SULI	0.656	MLPL	0.789
SUDI	0.601	MTDL	0.882
TIRT	0.661		
FASW	0.754		
INKP	0.627		
TKIM	0.637		
SPMA	0.702		
SAIP	0.712		
DPNS	0.505		
EKAD	0.787		
INCI	0.796		

Table 5: Descriptive statistics of technical efficiency scores for manufacturing classifications

	Basic		**Consumer**		**Miscellaneous**
Firm	TE	Firm	TE	Firm	TE
Mean	0.703		0.705		0.739
Std Deviation	0.102		0.113		0.093
Min	0.445		0.375		0.487
Max	0.904		0.884		0.910
Number of firms	47		36		38

5. Conclusion and Managerial Implications

This research has modeled a performance measurement for an important sector that is drving the economic recovery in this vast country: the selected firms are listed on the Indonesia Stock Exchange. We apply a stochastic frontier analysis. New findings derived from this study have offered notable original contributions to performance measurement and provides insights relevant to the managerial decision making on the operational performance of firms.

First, our research provides new findings on the predictors of firms' technical efficiencies and inefficiencies in the sector, using six years of combined firm-level accounting-financial and market data as well as other firm's specific variables. The finding indicates that the Cobb-Douglas functional form was rejected for the Indonesia's manufacturing sector. This finding further suggests that the trans-log functional form is a more general functional form, which is used as would be an appropriate model in representing the data for the sector listed.

Second, this research helped to reject the null hypothesis that there is no inefficiency effect in the sector model. Findings demonstrate that inefficiency effects are likely to be highly significant and are not simply random errors in the analysis of the value of output. This finding affirms previous studies covering different economies.

Lastly, our research has provides results relevant for managerial actions. The stochastic frontier model can be an alternative measure to the traditional ratio analysis when it comes to measuring performance of any firm: in banking this measure has been widely used for some 15 years to-date. The results from this model will be useful as a guide on corporate factor efficiency for stockholders (investors), managers, bankers and stakeholders of the Indonesia's business community in the evaluation of the operational performance and the behavior of listed firms as well as in identifying a specific factor that can affect the technical efficiency of firms. For the management of firms, this research also serves as a guide in making the right decisions based on the reported association of inputs and other firm's specific variables to the firm's technical efficiency as well as the inefficiency effects. For the investors, analysis and evaluation of a firm's efficiency would provide better quality appraisal tool in making a business decision to either invest or not in a given sector, and to either buy or not to buy shares to maximizing their returns on investment. Lastly, for creditors, the new empirical findings on a firm's efficiency may provide insights for analyzing and evaluating a loan application to minimizing risks. For bankers, these results provide a clear means of identifying the level of risk from inefficiency of the firms in this sector so that correct credit decisions could be based on objective facts about inefficiency.

A future extension of this research could be to analyze the sector as well as the financial firms listed on all ASEAN stock exchanges to evaluate how technical efficiency has changed over time. In redesigning future studies, variables such as market capitalization and other market data may need to be considered. These are the present limitations of our research due to data unavailability at this time. Other performance measurement tools such as linear programming techniques can also be utilized in future research for benchmarking performance.

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References

Abidin, Z. and Cabanda, E., (2007). Frontier Approaches to Production Efficiency of Commercial Banks in Indonesia. *Manajemen Usahawan Indonesia,* XXXVI (6): 9-14.

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, S., and Srivastava, H., (1996). *Technological Capabilities and Learning in African Enterprises*. RPED Case Study Series, Washington, D.C, USA: The World Bank.

BPS (2006). *Statistic of Indonesia*. BPS, Jakarta: Biro Pusat Statistik.

Chirwa, E. W., (2002). 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,T., Rao, D.S. P., O'Donnell, C.J., and Battese, G. E., (2005). *An Introduction to Efficiency and Productivity Analysis*, (Second edition). New York, NY: Springer Science.

Daryanto, H., Battese, G.E, and Fleming, E.M., (2002). *Technical Efficiencies of Rice Farmers Under Different Irrigation Systems and Cropping Seasons in West Java*. Paper presented at the 2002 Asia conference on efficiency and productivity growth, School of Economics, University of New England, Australia.

Diaz, M. A., and Sanchez, R., (2008). Firms' size and productivity in Spain: A Stochastic Frontier Analysis, *Small Business Economics*, 30 (3): 315-323.

Gholami, R., Moshiri, S., Yong T. L., Sang (2004). ICT and Productivity of the Manufacturing Industries in Iran. *EJISDC*, 19 (4): 1 – 19.

Hill, H., and Kalirajan, K.P., (1993). Small Enterprise and Firm-Level Technological Efficiency in the Indonesian Garment Industry. *Applied Economic,* 25: 1137-1144.

Jacob, J., and Los, B., (2006). *International Technology Spillovers and Manufacturing Performance in Indonesia*. Doctoral Thesis, Eindhoven University of Technology, Eindhoven, Netherlands.

Kathuria, Vinish., (2001). Foreign Firms, technology transfer and knowledge spillovers to Indian manufacturing firms: A Stochastic Frontier Analysis. *Applied Economics,* 33: 625-642.

Kim, S., and Han. G., (2001). A Decomposition of Total Factor Productivity Growth in Korean Manufacturing Industries: A Stochastic Frontier Approach. *Journal of Productivity Analysis*, 16, 269-281.

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

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

Mojo, M. I., (2007). Total Factor Productivity in Indonesian Manufacturing: A Stochastic Frontier Approach. *Global Economic Review*, 36 (4): 321-342.

Nakajima, T., (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.

Palangkaraya, A., and Yong, J., (2006). Entry, Exit and Productivity of Indonesian Electronics Manufacturing Plants, accessed December 15, 2008, available at: http://melbourneinstitute.com/wp2006n08.pdf

Probowo, T.H.E., and Cabanda, E., (2010). Performance Measurement Model for the Consumer Industry Listed on Indonesia Stock Exchange: DEA and SFA Approaches. *Indonesian Capital Market Review*, Vol. II, No. 1: 51-62.

Rodriguez, E., and Mini, F., (2000) Technical efficiency indicators in a Philippine Manufacturing Sector. *International Review of Applied Economic*, 14 (4): 461-473.

Söederbom, M., and Teal, F., (2001). Are African Manufacturing Firms Really Inefficient? Evidence from Firm-Level Panel Data. Center for the Study of African Economies, University of Oxford, UK, *WPS 2001*, 14, 1-25.

Tybout, J. R., (2000). Manufacturing Firms in Developing Countries: How Well Do They Do, and Why? *Journal of Economic Literature,* 38(3): 11- 44.

Viverita, R., and Ariff, M., (2004). *Corporate Financial Performance and Production Efficiency: A Study on Indonesia's Public and Private Sector.* Paper presented at the 4th International Symposium of DEA, Aston University, UK.

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

Widianto, Bambang, Choesni, Tb, Choesni, A., (2000). Indonesia: The Impact of the Economic Crisis on Industry Performance. National Development Planning Agency, BAPPENAS, Indonesia.

Wie, Thee Kian., (2006). Policies for Private Sector Development in Indonesia. ADB Institute *Discussion Paper* No. 46.

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

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