Accountancy Business and the Public Interest
ISSN: 1745-7718

Volume: 36
Issue Number:03

TECHNICAL EFFICIENCY AND ITS DETERMINANTS OF THE STATE-OWNED ENTERPRISESIN THE INDONESIAN MANUFACTURING INDUSTRY

MAMAN SETIAWAN[1*] and ERNIE TISNAWATI SULE[1]

[1]Faculty of Economics and Business, BUMN Center of Excellence, Universitas Padjadjaran, Indonesia.

ABSTRACT

This research investigates technical efficiency and its determinants of the state-owned enterprises (SOEs) in the Indonesian manufacturing industry. This study applies bootstrapped data envelopment analysis to calculate the technical efficiency score at the firststage and panel data technique to estimate the effects of the determinants on the technical efficiency at the second stage. This research uses firm-level survey data classified at the five-digit International Standard Industrial Classification (ISIC) level to estimate the technical efficiency score. This research finds that the SOEs in the Indonesian manufacturing are technically inefficient. The technical efficiency is affected by the firm size, the location, the level of technology, the export engagement and the economic and financial crisis.

Keywords: Indonesian state-owned enterprises: manufacturing industry: technical efficiency: bootstrapped data envelopment analysis

INTRODUCTION

Indonesian state-owned enterprises (SOEs) operating in the manufacturing industry have a significant contribution to the Indonesia economy. Data from Bureau of Central Statistics (2015) revealed that the enterprises contribute more than 10% to the total output of the Indonesian manufacturing industry in the period 1980-2015, on average. The output contribution of the enterprises decreased from about 17% in the period 1980-1990 to about 9%, 7% and 5% in the periods 1991-2000, 2001-2010 and 2011-2015, respectively. Besides the increase of the private enterprises contribution to the manufacturing industry, low technical efficiency can alsobe the cause of the declining of the contribution of the SOEs in the industry (see Setiawan and Oude Lansink, 2018). Indonesian government periodically injects funding to the SOEs as an equity participation to increase their performances, but most of the injected SOEs including SOEs in the manufacturing sector still have low performances (Setjen DPR-RI, 2016). This inefficiency might make the SOEs in the industry could not competewith the private enterprises (Phi et al., 2019). Therefore, an investigation about the technical efficiency of the SOEs in the manufacturing industry is important.

The number of SOEs operating in the Indonesian manufacturing industry is only 1% of the total numberof the enterprises in the industry (Bureau of Central Statistics, 2015). With this small number of SOEs in the industry, the output of SOEs contributed significantly about 3.5% to the total output of manufacturing industryin 2015. Also the number of SOEs operating in the manufacturing industry was about 25% of the total numberof SOEs in Indonesia in 2015. Therefore, improving the technical efficiency of the SOEs in the industry may improve the contribution of the SOEs to the economy.

Research about the technical efficiency of the SOEs in the manufacturing industry was rare in the previous literature. Bozec and Dia (2007) calculated the technical efficiency of Canadian state-owned enterprises for some sectors excluding manufacturing industry. Athanassopoulos and Giokas (1998) estimated technical efficiency of the state-owned enterprises in the Hellenic telecommunications organization in Greece. Also Huang and Kalirajan (1998) investigated technical efficiency of China's state owned enterprises without specifically investigated the manufacturing sectors. Only Vu (2003) investigated the technical efficiency of the SOEs in the Vietnam manufacturing sector. Therefore, research investigating the technical efficiency of the SOEs in the manufacturing industry is still relevant.

Also, research about technical efficiency of the SOEs operating in the Indonesian manufacturing industry is sparsely found[1]. Setiawan et al. (2012, 2013, 2018) investigated only the technical efficiency of the Indonesian food and beverages industry. Although the samples might include the SOEs, the research did not specifically investigate the SOEs. Moreover, Sukmadilaga et al. (2014; 2017) only estimated the technical efficiency for SOEs in general comparing the average technical efficiency of the SOEs and average technical efficiency of the family owned enterprises. Therefore, the investigation of the technical efficiency of the SOEs in the Indonesian manufacturing industry has a contribution to the literature.

This research investigates technical efficiency and its determinants of the SOEs in the Indonesian manufacturing industry. This research grouped the SOEs based on the subsectors in the Indonesian manufacturing industry. The technical efficiency of the SOEs is also compared between the technical efficiency of the SOEs located in Java and outside Java. The impact of the location is important to be investigated since Indonesian infrastructures are different significantly between the two regions[2]. Besides the location, this research also investigates the effect of the export engagement, the level of technology and the economic and financial crisis on the technical efficiency as suggested by Huang and Kalirajan (1998), Vu (2003) and Elliott and Zhou (2013). Finally, this research uses other private enterprises of non-SOEs as the benchmarks in estimating the technical efficiency of the SOEs in each subsector, which is different from the previous research. This is important because comparing the performance of the SOEs with other private firms of non-SOEs will give more picture on whether the performance of the SOEs is still far or close from the best practices.

This research has policy implications to improve inefficient SOEs in each subsector. The differences of the technical efficiency of the SOEs between different regions and different levels of technology will support and suggest the government to improve the infrastructures and business environment including technologies in whole regions in Indonesia. Furthermore, the SOEs can be supported to engage in the export strategy if this can be a market discipline to increase the efficiency. The knowledge about the effect of the economic and financial crisis on the technical efficiency will also give a recommendation to the government to strengthen fundamental economic aspects of the SOEs.

The paper is organized as follows. Section 2 provides the literature review. Next, the methods to estimate technical efficiency and its determinants are described. This is followed by the description of data in section 4 and the presentation of the empirical model and results in Section 5. The last section summarizes the results and draws conclusion from the research.

---

[1] Efficiency can be measured using either technical efficiency or economic efficiency.

Technical efficiency is related to minimizing inputs to produce given outputs (or maximizing outputs using given inputs) while the economic efficiency is related to minimizing costs to produce outputs (Setiawan et al., 2012; 2013). Technical efficiency is mostly applied for the measure of efficiency including in this research, instead of economic efficiency because of unavailability of price data of input variables in most of the economic sectors.
[2] The two regions also have differences in history, culture, religion, language, politics, and economics (see Dana, 2014; Setiawan, 2018).

LITERATURE REVIEW

Research investigating technical efficiency of the state-owned enterprises has been found previously. Vu (2003) investigated the technical efficiency of the industrial state-owned enterprises in Vietnam. Being benchmarked with state-owned enterprises, the research found that industrial state-owned enterprises in Vietnam had a rather high level of technical efficiency. There was also an improvement of the technical efficiency from the period of1997 to 1998. Other research in other sectors was also conducted by Bozec and Dia (2007) and Athanassopoulosand Giokas (1998). Bozec and Dia (2007) calculated technical efficiency of Canadian state-owned enterprises (SOEs). They used 14 Canadian SOEs as a sample in the period 1976-2001. The data envelopment analysis (DEA) was applied to estimate the technical efficiency. The samples included SOEs from oil and gas producers, transportation, telephone utilities, gas and electrical utilities and beverages. The research found that the Canadian SOEs has technical efficiency more than 0.8. Also, Athanassopoulos and Giokas (1998) estimated technical efficiency of the state-owned enterprises in the Hellenic telecommunications organization in the period1971-1993. The results show that technical efficiency of the SOEs was high in the period of estimation. The average technical efficiency score in the production was more than 0.9 using the data envelopment analysis. Moreover, Xue et al. (2018) investigated the technical efficiency of the state-owned forest enterprises in the Northest China. They found that there was an increasing pure technical efficiency score in the profit maximization framework. However, Abramov et al. (2017) found that the higher size of direct government ownership tended to reduce the efficiency and productivity in 114 largest companies in Russia. Also, Yin et al.(2018) and Walheer and He (2020) investigated the efficiency of the SOEs of Chinese industrial enterprises. They found that the state-owned enterprises had lower technical efficiency compared to other ownership typesof companies. Furthermore, Bach (2019) also investigated the efficiency and productivity of Vietnamese manufacturing industry. The research suggested that the private enterprises had better efficiency and productivity than the state-owned enterprises. Regarding the research on technical efficiency of the SOEs in Indonesia, Sukmadilaga et al. (2014; 2017) estimated technical efficiency of the SOEs in Indonesia and Malaysia in general analysis using the limited data from Indonesian and Malaysian Stock Exchange Market without estimating the technical efficiency specifically for each subsector of the SOEs in the manufacturing sector. The research also only compared the difference of the technical efficiency between SOEs and family owned enterprises.
The previous research sparsely estimated technical efficiency score by using other non-SOEs or private companies as benchmarks in each subsector. There is a limited benchmark as a best

practice when using only the SOEs as a sample. Therefore, the technical efficiency score could be much higher when the estimation only includes SOEs in the estimation. Thus, estimating technical efficiency of the SOEs by using other non-SOEs as benchmarks has contributions to the empirical literature as well as policy implication.

Regarding the determinant of technical efficiency of the SOEs, Vu (2003) found that location and export engagement were the important factors explaining the level of technical efficiency. The research suggested that better infrastructure and business environment would increase technical efficiency. The research also suggested that it is necessary to invest in new technology for industrial SOEs in Vietnam, since this could increase the efficiency in the production. Moreover, Huang and Kalirajan (1998) and Bozec and Dia (2007) supported the finding of Vu (2003) who found that the SOEs engaged in the export activities would have higher technical efficiency than the SOEs with no export engagement. The export engagement can be a market discipline for the SOEs because the SOEs are exposed to competition in the world market. Moreover, this research also uses the firm size that may affect the technical efficiency as used by Bozec and Dia (2007). The higher firm size is expected to increase the efficiency because of the economies of scale (see also Setiawan et al., 2016 and Setiawan, 2018). Furthermore, the period of economic and financial crisis can affect the technical efficiency, since the crisis can affect the cost of inputs given the same outputs (see Effendi et al., 2018; Setiawan and Oude Lansink, 2015; Kapelko and Oude Lansink, 2015). Fu et al. (2008) also found that the technical efficiency improves in the period of strong systematic reform and prosperous economy.

Summarizing the theoretical background, it is hypothesized that the effects of the firm size, location, technology level, export engagement and economic and financial crisis on the technical efficiency can be written as:

$$TE=f(Size, Loc, Tech, Export, Crisis)$$

where $\frac{\partial TE}{\partial Size} > 0$, $\frac{\partial TE}{\partial Loc} > 0$, $\frac{\partial TE}{\partial Tech} > 0$, $\frac{\partial TE}{\partial Export} > 0$, and $\frac{\partial TE}{\partial Crisis} < 0$. TE is the technical efficiency, Size is the firm size, Loc is the firm location, Tech is the level of technology, Export is the export engagement, and Crisis is the economic and financial crisis.

MODELLING

This research uses the bootstrapped data envelopment analysis (DEA) to estimate the technical efficiency. The data envelopment analysis is a mathematical linear programming to measure the efficiency which requires very few assumptions about the properties of the production possibilities set (Setiawan et al., 2012; Setiawan and Oude Lansink, 2018 and Setiawan, 2019). As stated by Setiawan et al. (2019), the DEA applies a frontier approach to calculate the technical efficiency score of firms by projecting the inefficient firms to this frontier directly. Following that approach, DEA uses the most efficient firms as the frontier for calculating technical efficiency score for other firms[3] (Setiawan et al., 2012). The technical efficiency scores estimated by this method are assumed not to bring too much noise when the score is used to estimate the determinants of the technical efficiency. This is because the technical efficiency can be calculated in every single year separately by the DEA without having detrimental consequences for the estimates. The technical efficiency is estimated together for both SOEs and non-SOEs in each subsector. Including non-SOEs as the benchmarks in estimating the technical efficiency of the SOEs will provide a truly condition on whether the SOEs are in the good condition compared to all firms in the subsector. For the final analysis, this research takes only the technical efficiency of the SOEs.

DEA calculates the technical efficiency score based on the transformation of N inputs into the M outputs for all I firms. The input and output for the i-th firm can be represented by the column vectors x_i and q_i, respectively. The data for all I firms are represented by the consecutive NxI input matrix, X, and the MxI output matrix, Q. The output-oriented DEA model[4] is applied in this research using the mathematical linear programming model as follows:

$$
\begin{aligned}
&max_{\theta,\lambda}\, \theta, \\
&st - \theta q_i + Q\lambda \geq 0, \\
&x_i - X\lambda \geq 0, \\
&I1'\lambda = 1 \\
&\lambda \geq 0,
\end{aligned}
\qquad (1)
$$

where θ represents a Farrell measure of technical efficiency (Farrell, 1957) with $\theta - 1$ measures the proportional increase in outputs that could be achieved by the i-th firm given the same amount of input quantities (see also Bogetoft and Otto, 2011; Setiawan et al., 2012; Tan et al., 2018; Effendi et al., 2018; Setiawan, 2019). This research applies a Farrell measure of technical efficiency to get an efficiency score which varies from 1 to infinity to avoid getting negative efficiency score in the next step estimation using a bootstrapping approach because of the high variability of input and output. λ is an Ix1 vector of constants and I1'λ=1 is convexity constraint with I1 as an Ix1 vector of ones. Imposing the convexity constraint implies that the variable return to

[3] The most efficient firms are marked to be 100% efficient.

[4] The output-oriented DEA defines the technical inefficiency by having a proportional increase in output, given the same inputs. This assumption can still be relevant in the Indonesian economy, since Indonesian firms may find rigidities in changes the inputs (see Setiawan et al., 2012).

scale (VRS) is applied to the the DEA. The VRS can be fit with the data because VRS can ensures that an inefficient firm will only be compared to firms with a similar size. The VRS assumption can also be relevant in Indonesia because the Indonesian manufacturing sector is characterized by many distortions that may cause the application of the constant returns to scale to be too strong assumption. Furthermore, this research uses the $1/\theta(\hat{\partial}(q, x))$ as a final technical efficiency score that assumes values in the unit interval as also applied by Setiawan et al. (2012). This research uses bootstrap technique of Simar and Wilson (1998) to get robust estimates of the technical efficiency score, which is firstly applied in the Indonesian SOEs. The bootstrap method uses a repeated simulation of the data generating process. The method uses a resampling method and applies it to the original estimator. Thus, the simulated estimates mimic the sampling distribution of the original estimator. As also applied by Setiawan et al. (2012), this research only uses the biased-corrected efficiency score from the bootstrapped method with the following formula:

$$\hat{\hat{\delta}}(q,x) = \hat{\delta}(q,x) - \text{bias}_Z[\hat{\delta}(q,x)] = 2\hat{\delta}(q,x) - Z^{-1}\sum_{z=1}^{Z}\hat{\delta}^{*}_{z}(q,x) \quad (2)$$

with the condition of sample variance

$$\hat{\sigma}^{2}_{z}(q,x) < \frac{1}{3}\left(\text{bias}_Z[\hat{\delta}(q,x)]\right)^2 \quad (3)$$

The $\hat{\delta}(q,x)$ and $\hat{\hat{\delta}}(q,x)$ are defined as the original and biased-corrected efficiency scores, respectively. The $\hat{\delta}^{*}(q,x)$ is bootstrap estimate of the efficiency score which is generated from Z samples with z=1,…,Z.

This research also applies panel data econometrics to investigate the effects of the determinants i.e. the firm size, location, level of technology, export engagement and economic and financial crisis on the technical efficiencies of the SOEs. The econometrics model is derived, as follows:

$$TE_{it} = \beta_i + \gamma_1 Size_{it} + \gamma_2 Loc_{it} + \gamma_3 Tech_{it} + \gamma_4 Export_{it} + \gamma_5 Crisis_{it} + e_{it} \quad (4)$$

where i and t index firm and year, respectively; TE is the logit of the technical efficiency score[5]; Size is the firm size measured by natural logarithm of value added as applied by Shalit and Sankar (1977) and Setiawan et al. (2012); Loc is location with the value 1 if the SOEs are located in Java and 0 otherwise; Tech is level of technology with the value 1 if the SOEs operating in the subsectors are classified as a high-tech industry and 0 otherwise[6]; Export is the dummy variable of export with the value 1 if the SOEs engage in the export activities and 0 otherwise; Crisis is the dummy variable for the economic and financial crisis that assumes the value 1 for the periods 1997-1998 and 2008-2009 and 0 otherwise[7]. The equation (4) is estimated using random or fixed effect model depending on the Hausman (1978) test. Also the correction of the standard error will be applied if the heteroscedasticity and autocorrelation problems are found in the model. The standard White test is applied to test the heteroscedasticity problem. Also, the Wooldridge (2002) test is implemented to test the autocorrelation problem in the panel data.

DATA

This research uses establishment-level data to estimate technical efficiency scores and then generates average technical efficiency score of the SOEs for each subsector of the Indonesian manufacturing industry based on the groups of the location, export engagement and level of technology. Moreover, the subsector average is

---

5 This research transforms the technical efficiency score to the logit transformation as to $TE = Ln(\frac{TE}{1-TE})$ to keep the predicted technical efficiency score in the interval between 0 and 1. This research applies the logit transformation because we find that the approach can produce more intuitive results using our data rather than another method such as the truncated regression.

[6] This research defines the high-tech industry as the industry with high and medium-high level of technology classified by OECD (2011). Originally, OECD classifies the industry into low, medium-low, medium-high and high level of technologies. Thus, the subsectors grouped into high-tech subsectors include aircraft and spacecraft, electrical, machinery and apparatus, n.e.c.; pharmaceuticals, motor vehicles, trailers and semi-trailers; office, accounting and computing machinery, chemicals excluding pharmaceuticals; radio, TV and communications equipment railroad equipment and transport equipment, n.e.c.; and medical, precision and optical instruments machinery and equipment, n.e.c.

[7] The period 1997-1998 is the Asian economic crisis and the period 2008-2009 is the global financial crisis. The effect of the crisis may last in more than the two years, but this research only sees the effect of the immediate shocks at the time when the crisis happened.

calculated only for the description of the technical efficiency of the SOEs in each subsector. The econometricsmodel still uses the establishment-level or firm-level data for the estimation. The data are obtained from the Annual Manufacturing Survey provided by the Indonesian Bureau of Central Statistics (BPS). The dataset covers the period from 1980 to 2015 in which the data of the SOEs can be obtained.

Regarding the technical efficiency estimation, this research uses 138 subsectors classified into five-digit International Standard Industrial Classification (ISIC) level in which the SOEs operate. Each subsector also includes more than 30 firms on average including both SOEs and non-SOEs in the period from 1980 until 2015. Few subsectors are combination of subsectors with fewer than 30 observations in the same digit of ISIC 4 (four)or 3 (three) level depending on the sufficiency of the observations[8]. Further, not all SOEs operated continuallyin the period of estimation, since some SOEs were privatized or even were terminated. Therefore, few subsectors have unbalanced panel data[9].

The Indonesian manufacturing industry uses labor, raw material, and fixed capital such as machines, equipment, etc. to produce the output (see Setiawan et al., 2012). The relevant inputs and output included in thetechnical efficiency estimation of the manufacturing industry were based on the common production function. Output is measured by the value of gross output produced by establishment every year and deflated by the wholesale-price Index (WPI). This research uses the labor efficiency unit to measure the labor[10]. Raw materialis represented by the total costs of domestic and imported materials[11] and is deflated by Wholesale-Price Index (WPI), respectively. Fixed capital is defined as fixed assets which is deflated by the WPI of machinery (excluding electrical products), transport equipment, residential, and non-residential buildings.

Table 1 shows the descriptive statistics of the input and output variables used for the technical efficiencyestimation using the DEA across firms and subsectors for the period 1980-2015. From the Table 1 it is shown that all variables had high variability, except for the size variable. The high variability of data was caused by the data averaging using long period of 1980-2015 and was calculated across firms and across subsectors. Moreover, capital had the highest variability among the other inputs and output variables. It has mean and standard deviation of $1.020*10^7$ and $6.300*10^9$, respectively. Since the technical efficiency is estimated every year in each subsector, the variability of data will not affect the estimation of the technical efficiency. Also, applying the variable return to scale (VRS) on the DEA estimation will also ensure that a firm will be benchmarked to the best practice of the firms with the similar sizes.

Table 1 Descriptive statistics of the variables across firms and subsectors, 1980-2015

Variable	Mean	Standard Deviation	Maximum	Minimum
Output (in thousands Rupiah)	386114.700	3691963.000	$7.950*10^{8}$	102.802
Labor (Person Index)	816.904	8618.203	174992.100	4.000
Capital (in thousand Rupiah)	$1.020*10^{7}$	$6.300*10^{9}$	$4.25*10^{12}$	100.000
Material (in thousand Rupiah)	287855.000	2391415.000	$6.440*10^{8}$	100.037
Size (unit of natural logarithm)	19.872	2.415	25.587	11.224
% of SOEs located in Java.	65%			
% of SOEs classified as high-technology level of industry.	12%			
% of SOEs engaged in export.	80%			

Source: authors' calculation

In addition, there were about 65% of SOEs located in Java and the rest was located outside Java. The composition is close to the condition in all manufacturing firms where more than 80% of the firms are located in Java. Also, 12% of the SOEs operating in the industries were classified as high-technology industries, according to OECD classification. Regarding the export engagement, 80% of the SOEs in the industry were engaged in the export activities during the period 1980-2015.

---

[8] For example, subsectors of 10110, 10120 and 10130 were combined into a new subsector of 10100 to have at least 30 observations in every single year.

[9] For example, subsector of 11060 was not reported since 2010.

[10] We define the labor efficiency units as used by Setiawan et al. (2012) to give an appropriate weight for the other workers who do not work in the production unit: L = Number of production worker + number of other worker*(Salary of other worker)

Salary of production worker

[11] The raw materials also include other costs related to the production such as electricity and fuel cost.

Table 2 Average technical efficiency score of SOEs across subsectors, 1980-2015

Period	Average technical efficiency score	Average technical efficiency score of SOEs located in Java	Average technical efficiency score of SOEs located outside Java
1980-1984	0.494	0.498	0.475
1985-1989	0.428	0.432	0.393
1990-1994	0.417	0.422	0.416
1995-1999	0.400	0.400	0.400
2000-2004	0.407	0.411	0.401
2005-2009	0.401	0.400	0.415
2010-2015	0.419	0.412	0.433
1980-2015	0.423	0.424	0.420

Source: Authors' calculation

RESULTS

Table 2 shows the trend of average technical efficiency of the SOEs in the period from 1980 to 2015. From Table 2 it is seen that there was a decreasing trend of the average technical efficiency of the SOEs in the periodfrom 1980 to 2015. The average technical efficiency of the SOEs was 0.494 for the period 1980-1984 and it decreased to 0.419 for the period 2010-2015. The average technical efficiency of the SOEs was 0.423 for the period 1980-2015. The technical efficiency score of 0.423 indicates that the SOEs can still increase the output by 57.7% given the same level of input, on average. The decreasing trend of the technical efficiency was the same for SOEs both operated in Java and outside Java. Furthermore, average technical efficiency of the SOEs located in Java was 0.424 or slightly higher than the average technical efficiency of the SOEs located outside Java which was 0.420 for the period 1980-2015[12]. The concentration of the infrastructure and better governmentadministrative and business environment in Java might increase the technical efficiency of the SOEs located in the region. Moreover, the average technical efficiency decreased in the period of economic crisis of 1995-1999for all the groups. The average technical efficiency also decreased for the period 2005-2009 when the financialcrisis period of 2008-2009 occurred, but only for the group of all SOEs and the group of SOEs located in Java.The financial crisis mostly happened in the center of economy in Java. This can support the finding of Fu et al.(2008) which suggested that the technical efficiency mostly improved in the period of prosperous economy andstrong systematic reform.

Table 3 shows 10 subsectors in which the SOEs had the highest and lowest average technical efficiencyscores during period 1980-2015[13]. The 10 subsectors in which the SOEs had the highest average technical efficiency scores had a range of the score from 0.521 to 0.771. The 10 subsectors in which the SOEs had the lowest average technical efficiency score had a range of score from 0.193 to 0.328. Based on the ANOVA test,the two groups also had a significant difference of the average technical efficiency scores at the 1% critical level(F-statistics=4.414). From Table 3 it is seen that there are three subsectors in the 10 subsectors with the highest technical efficiency score such as medical equipment, doctor, dentist and other industrial equipment; steel rolling and non-ferrous making classified as high-tech industries classified by OECD. There was no subsector in the 10 subsectors with the lowest technical efficiency score classified as high-tech industry as categorized byOECD. This can suggest that the level of technology has a role in improving the technical efficiency.

[12] The ANOVA test (F-statistics=59.60) using all observations indicated that there was a significant difference between the technical efficiency of the SOEs located in Java and outside Java at the 1% critical level.

[13] We cannot say that one subsector is better than other subsectors, instead this is an indication that the SOEs in each subsector consistently had a high or low technical efficiency during the period 1980-2015 compared to the technical efficiency of the private enterprises.

Table 3 Ten subsectors with the highest and lowest average technical efficiency (ATE) scores of SOEs, 1980-2015

10 subsectors with the highest average technical efficiency scoresof SOEs			10 subsectors with the lowest average technicalscores of SOEs		efficiency
ISIC	**Name of the subsectors**	**ATE**	**ISIC**	**Name of the subsectors**	**ATE**
20113	Inorganic	0.771	14111	Finished clothes from textile	0.193
24202	pigments Non-	0.632	17022	convectionBoxes, paper	0.295
32900	ferrous making Medical equipment, doctor, dentist and otherindustrial equipment.	0.610	16298	Other goods from woods, bamboo	0.299
24102	Steel	0.576	10745	Macaroni, noodles, processed food andbeverage	0.300
13113	rolling	0.567	23929	Porcelain prod, structural	0.311
22292	Threads	0.563	13121	Woven not gunny and other sacks	0.320
23941	Plastic prod, household (not furniture) Cement	0.539	28200	Machinery, agricultural, metal, wood, notmetal nor wood, electronic welding and other special purposes.	0.323
10793	Other food from soybean (not fermented soybean, *tempe*, *tahu*)	0.522	12091	Tobacco	0.326
10515	Fresh milk, cream, Powder milk and condensedmilk	0.522	16212	Laminated	0.328
10715	Cacao	0.521	16235	plywoodWoods utensil	0.328

Source: Authors' calculation

Table 4 shows the average technical efficiency of the SOEs based on the technology level classificationgrouped by the period intervals. From Table 4 it is seen that the average technical efficiency of the SOEs with high level of technology was relatively higher compared to the average technical efficiency of the SOEs with the low level of technology[14]. For example, the average technical efficiency of the SOEs with high level of technology level was 0.425 in the period 1980-2015. The coefficient was higher than the average technical efficiency score of the SOEs with low level of technology which reached 0.423 in the same period. Besides the decreasing trend, the average technical efficiency also fluctuated over the interval periods. The average technicalefficiency of the SOEs was relatively lower when there were economic and financial crisis in the periods 1997-1998 and 2008-2009 compared to the period of the pre- and post-crisis. For example, the SOEs with high levelof technology had average technical efficiency of 0.400 in the period interval of 1995-1999 when there was aneconomic crisis. The coefficient was lower than the average technical efficiency of the SOEs in the period interval of 1990-1994 which reached 0.421. The same condition also applied to the SOEs with the low level oftechnology. The shocks from the economic and financial crisis increased the cost of inputs given by the same outputs which turned into less efficiency of the SOEs (see also Setiawan and Oude Lansink, 2015; Effendi et al., 2018).

Table 4 Average technical efficiency score of SOEs across subsectors based on the level of technology, 1980-2015

Period	Average technical efficiency score of SOEs withhigh technology	Average technical efficiency score of SOEs with medium and low technology
1980-1984	0.494	0.493
1985-1989	0.405	0.441

1990-1994	0.421	0.414
1995-1999	0.400	0.400
2000-2004	0.415	0.404
2005-2009	0.410	0.397
2010-2015	0.420	0.420
1980-2015	0.425	0.423

Source: Authors' calculation

Table 5 provides the information about the the average technical efficiency of the SOEs based on the export engagement grouped by the period intervals. From Table 5 it is seen that the SOEs with export engagement had average technical efficiency of 0.428 during the period 1980-2015. The coefficient was slightlyhigher than the average technical efficiency of the SOEs with no export engagement which reached 0.426[15]. The average technical efficiency fluctuated between the period intervals and had a decreasing trend, especiallyfor the SOEs with no export engagement. The SOEs with export engagement had higher loss of the average technical efficiency than the SOEs with no export engagement when the economic and financial crisis happened. For example, the SOEs with export engagement had average technical efficiency losses of 0.020 and 0.005 during the period intervals of 1995-1999 and 2005-2009 when economic and financial crisis happened, respectively. The losses of the average technical efficiency of the SOEs with no export engagement reached 0.014 during the period interval of 1995-1999 and even the SOEs gained a higher technical efficiency score in the period interval of 2005-2009 when the financial crisis happened in 2008-2009. The exported products fromthe Indonesian manufacturing industry still used high proportion of the imported inputs. Thus, the shocks from the economic and financial crisis hitting the exchange rates could increase the cost of inputs significantly that reduced the technical efficiency.

[14] Using all observations, the ANOVA test suggested that there was a significant difference of the technical efficiency between the two groups at the 1% critical level (F-statistics=12.95).
[15] The ANOVA test using all observations suggested that there was a significant difference of the technical efficiency between the two groups at the 1% critical level (F-statistics=140.99).

Table 5 Average technical efficiency score of SOEs across subsectors based on the export engagement, 1980-2015

Period	Average technical efficiency score of SOEs withexport engagement	Average technical efficiency score of SOEs with noexport engagement
1980-1984	0.497	0.492
1985-1989	0.438	0.426
1990-1994	0.420	0.416

1995-1999	0.400	0.400
2000-2004	0.409	0.428
2005-2009	0.406	0.435
2010-2015	0.423	0.395
1980-2015	0.428	0.426

Source: Authors' calculation

Table 6 shows the regression estimation on the effects of size, location, level of technology, export engagement and economic and financial crisis on the technical efficiency. The eq. (4) was estimated using a random effect model since the Hausman test did not reject the hypothesis that the random effect model produced consistent estimators compared to the fixed effect model at the 5% critical level. The White test rejected the hypothesis of no heteroscedasticity at the 5% critical level. Further, the Wooldridge test did not reject the null hypothesis of no serial correlation at the 10% critical level. Also the standard errors of the parameters in the model were corrected by the White method, since only heteroscedasticity problem existed in the model.

Table 6 Results of the regression of the determinants of the technical efficiency

Independent variable	**Dependent variable: Logit of technical efficiency score (TE)**	
	Coefficients	**Marginal effects**
Intercept	-0.016 (0.135)	
Firm size (Size)	0.046*** (0.007)	0.002
Location (Loc)	0.196*** (0.037)	0.010
Level of technology (Tech)	0.092* (0.055)	0.003
Export engagement (Export)	0.138** (0.066)	0.005
Economic and Financial Crisis (Crisis)	-0.181***(0.048)	-0.010
Wald-statistics	85.030***	

Notes: *** denotes significance of the test statistic at the 1% critical level. ** denotes significance of the test statistic at the 5% critical level. * denotes significance of the test statistic at the 10% critical level. Standard errors in parentheses.

Source: Authors' calculation

From Table 6 it is seen that all variables had significant effects on technical efficiency score. The variable of firm size had coefficient of 0.046 and it was significantly affecting the technical efficiency at the 1% critical level. The marginal effect of the firm size variable was 0.002 indicating that every 1% increase of the firm size increases the technical efficiency by 0.002 unit or 0.2%, ceteris paribus. Higher firm size supports the firms to achieve the economies of scale reducing the cost of inputs relative to the outputs. This supports the finding of Setiawan et al. (2016) and Setiawan (2018) who found that higher firm size could increase technical efficiency.The variable of location had a coefficient of 0.196 and significant at the 1% critical level affecting the technical efficiency. The marginal effect of the location variable was 0.010 indicating that the average technicalefficiency score of the SOEs located in Java was greater by 0.010 or 1% compared to the technical efficiencyof the SOEs located outside Java, ceteris paribus. The better infrastructure, government administration and business environment in Java compared to outside Java make the SOEs located in Java get more competitive inputs and produce higher quality of the goods. This is in line with the finding of Vu (2003) and Setiawan et al. (2019) which found that the location with better administrative and business environment would increase thetechnical efficiency.

The variable of technology level had a coefficient of 0.092 and significant at the 10% critical levelaffecting the technical efficiency. The marginal effect of the technology level variable was 0.003 indicating thatthe average technical efficiency score of the SOEs with high level of technology was greater by 0.003 or 0.3%compared to the technical efficiency of the SOEs with low level of technology, ceteris paribus. The higher level of technology can minimize the waste of inputs and produce higher quality of outputs, thus increasing the efficiency of the firms in transforming the inputs into the output. This also support the finding of Vu (2003) who suggested that the SOEs should replace the old technology by modern technology to increase the efficiency.The variable of export engagement had a coefficient of 0.138 and significant affecting the technical efficiency at the 5% critical level. The marginal effect of the export engagement variable was 0.005 indicatingthat the average technical efficiency score of the SOEs with export engagement was higher by 0.005 or 0.5%compared to the technical efficiency of the SOEs with no export engagement, ceteris paribus. The resultsupported the hypothesis that the export engagement can be a market discipline for the SOEs (see Vu, 2003;

Huang and Kalirajan, 1998; Bozec and Dia, 2007).

Finally, the economic and financial crisis variable had coefficient of -0.181 and was significant at 1% critical level. The marginal effect coefficient of the economic and financial crisis variable of -0.010 indicates that the technical efficiency of the SOEs was lower of 0.010 or 1% in the period of economic and financial crisiscompared to the condition of the non-crisis, ceteris paribus. The higher cost of inputs caused by the exchange rate shock and other shocks coming from the economic and financial crisis can reduce technical efficiency of the SOEs. The result is in line with the finding of Setiawan and Oude Lansink (2015) and Effendi et al. (2018)who found that crisis can reduce technical efficiency. This also supports the finding of Fu et al. (2008) who shows that the technical efficiency improved only in the period of prosperous economy and a strong systematicreform.

CONCLUSION

This research investigates technical efficiency of the SOEs in the Indonesian manufacturing industry. This research uses bootstrapped data envelopment analysis to calculate technical efficiency score at the first stage. This research also investigates the effects of the determinants i.e. size, location, level of technology, export engagement and economic and financial crisis on the technical efficiency at the second stage. The panel data technique is applied to investigate the effects of the determinant factors on the technical efficiency.

This research found that the SOEs in the Indonesian manufacturing was relatively inefficient for the period 1980-2015. The average technical efficiency of the SOEs fluctuated with a decreasing trend. SOEs located in Java had higher technical efficiency compared to the SOEs located outside Java. SOEs with export engagement had higher technical efficiency compared to the SOEs with no export engagement. Also average technical efficiency of the SOEs with high-technology level was higher than the average technical efficiency ofthe SOEs with low-technology level. Further, the firm size, the location, the level of technology, the export engagement and the economic and financial crisis affected the technical efficiency significantly.

The results of this research implies that bigger size would increase the efficiency of the SOEs. Therefore, merger or holding strategies applied by the current ministry of the SOEs is an appropriate strategy to increase the efficiency of the SOEs. Also better technology and infrastructure would increase the efficiency in the transformation of inputs into the outputs. Therefore, the current government policy to boost the infrastructure and technology of the industry in the whole regions of Indonesia would help the SOEs and other firms to be more efficient. The government should also support the SOEs to have market exposure in the higher competitive environment to strengthen their economic fundamental aspects. Thus, the SOEs can sustain in the future economic and financial crisis.

REFERENCES

- Abramov A., Radygin, A., Entov, R. and Chernova, M. (2017) ‘State Ownership and Efficiency Characteristics’,
- Russian Journal of Economics, 3(2), pp. 129-157.
- Athanassopoulos, A.D. and Giokas, D. (1998) ‘Technical efficiency and economies of scale in stata-owned enterprises: The Hellenic telecommunications organization’, European Journal of Operational Research, 107, pp. 62-75.
- Bach, T.N. (2019) ‘State owned enterprises and capital misallocation in Vietnam’, Journal of the Asia Pacific Economy, 24(3), pp. 430-451.
- Bogetoft, P. and Otto, L. (2011) ‘Benchmarking with DEA, SFA, and R’, International Series in Operations Research & Management Science, 157.
- Bozec, R. and Dia, M. (2007) ‘Board structure and firm technical efficiency: Evidence from Canadian state-ownedenterprises’, European Journal of Operational Research, 177, pp. 1734-1750.
- Bureau of Central Statistics (2015) Survey of Medium and Big Enterprises Year 2015, BPS Press, Jakarta-Indonesia.Dana, L.P. (2014). Asian Models of Entrepreneurship: From the Indian Union and the Kingdom of Nepal to the Japanese Archipelago: Context, Policy & Practice, World Scientific, Singapore.
- Effendi, N, Setiawan, M, Indiastuti, R. (2018) ‘Technical efficiencies of Indonesian regional and non-regional bankspre- and post-financial crisis’, International Journal of Economics and Business Research, 16(3), pp. 355-366.
- Elliott, R. and Zhou, Y. (2013) ‘State-owned enterprises, exporting and productivity in China: A Stochastic dominance approach’, The World Economy, 36(8), pp. 1000-2018.
- Fu, F-C., Vijverberg, C-P. C. and Chen, Y-S. (2008) ‘Productivity and efficiency of state-owned enterprises in China’, Journal of Productivity Analysis, 29(3), pp. 249-259.
- Hausman, J.A. (1978) ‘Specification Tests in Econometrics’, Econometrica, 46(6), pp.1251–1271.

- Kapelko, M. and Oude Lansink, A. (2015) 'Technical efficiency and its determinants in the Spanish constructionsector pre- and post- financial crisis', International of Strategic Property Management, 19(1), pp. 96-109.
- OECD (2011) ISIC REV. 3 Technology Intensity Definition, OECD Directorate for Science, Technology and Industry,Economic Analysis and Statistics Division.
- Phi, N.T.M, Taghizadeh-Hesary, F., TU, C.A., Yoshino, N. and Kim, C.J. (2019) 'Performance differential betweenprivate and state-owned enterprises: An analysis of profitability and leverage', ADBI Working Paper 950, Tokyo: Asian Development Bank Institute.
- Setiawan, M. (2018) 'Technical efficiency and decision to exit: Evidence from the dairy farms in Sukabumi district, West Java, Indonesia', World Review of Entrepreneurship, Management and Sustainable Development, 15(4), pp. 428-440.
- Setiawan, M. (2019) 'Persistence of Price-Cost Margin and Technical Efficiency in the Indonesian Food and Beverages Industry', International Journal of the Economics of Business, 26(2), pp. 315-326.
- Setiawan, M. and Oude Lansink, A. (2015) 'Dynamic Inefficiency of Conventional and Sharia Banks Pre- and Post-Financial Crisis 2008', UNPAD Working Paper.
- Setiawan, M. and Oude Lansink, A. (2018) 'Dynamic technical inefficiency and industrial concentration in theIndonesian food and beverages industry', British Food Journal, 120(1), pp. 108-119.
- Setiawan, M., Effendi, N., Heliati, R. and Waskito, A. (2019) 'Technical efficiency and its determinants in the Indonesian micro and small enterprises', Journal of Economic Studies, 46(6), pp. 1157-1173.
- Setiawan, M., Emvalomatis, G., Oude Lansink, A. (2012) 'The Relationship Between Technical Efficiency and Industrial Concentration: Evidence from the Indonesian Food and Beverages Industry', Journal of Asian Economics, 23(4), pp. 466-75.
- Setiawan, M., Emvalomatis, G., Oude Lansink, A. (2013) 'Market Structure, Conduct, and Performance: Evidence from the Indonesian Food and Beverages Industry', Empirical Economics, 45(3), pp. 1149-1165.
- Setiawan, M., Indiastuti, R. Effendi, N. and Indrawati, D. (2016) 'Technical Efficiency and Environmental Factors of the Micro, Small and Medium Enterprises in Bandung City', International Journal of Globalization and Small Business, 8(1), pp. 1-17.
- Setjen DPR-RI (2016) Penyertaan modal negara kepada BUMN, Buku I Rancangan Undang-undang TentangAnggaran dan Belanja Negara Tahun Anggaran 2016, Jakarta.
- Shalit, S.S. and Sankar, U. (1977) 'The measurement of firm size', The Review of Economics and Statistics, 59(3), pp. 290-298.
- Simar, L., Wilson and P.W. (1998) 'Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Nonparametric Frontier Models', Management Science, 44(1), pp. 49-61.
- Sukmadilaga, C., Ramadili Mohd, S.M. and Shah, T.H. (2014). 'Performance of State Owned Enterprises in Indonesia and Malaysia', Global Journal of Business and Social Science Review, 2(4), pp. 9-17.
- Sukmadilaga, C., Shamsher, M., and Hassan, T. (2017) 'Ownership structure and productivity in Indonesia and Malaysia', International Journal of Monetary Economics and Finance, 10(3-4), pp. 322-340.
- Tan, K.M., Kamarudin, F., Noordin, B.A.A., Rahim, N.A. (2018) 'Firm Efficiency In Selected Developed And Developing Asia-Pacific Countries: Using Data Envelopment Analysis', International Journal of Economics and Management, 12(S2), pp. 431-442.
- Vu, Q.N. (2003) 'Technical efficiency of industrial state-owned enterprises in Vietnam', Asian Economic Journal, 17(1), pp. 87-101
- Walheer, B and He, M. (2020) 'Technical efficiency and technology gap of the manufacturing industry in China: Does firm ownership matter?', World Development, 127, 104769.
- Wooldridge, J.M. (2002) Econometric Analysis of Cross Section and Panel Data. Cambridge, MA: MIT Press.
- Xue, H, Frey, G.E., Yude, G., Cubbage, F.W. and Zhaohui, Z. (2018) 'Reform and efficiency of state-owned

forest enterprises in Northeast China as "socialfirms"', Journal of Forest Economics, 30, pp. 18-33.

- Yin, Z., Liu, L., Wang, H. and Wen, F. (2018) 'Study on the ownership balance and the efficiency of mixed ownership enterprises from the perspective of heterogeneous shareholders', PloS ONE, 13(4), pp.1-15.