Thesis for the Degree of Master of Management of Technology

Measuring the Efficiency of Indonesia's Leading Firms: Focused on Listed Company in Indonesia Stock Exchange

by

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(인도네시아 주요 기업의 생산성 분석 : 인도네시아의 상장 기업을 중심으로)

Advisor: Professor Dongphil Chun

by

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Measuring the Efficiency of Indonesia's Leading Firms: Focused on Listed Company in Indonesia Stock Exchange

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Abstract

This study examines the efficiency of Indonesia's Leading firms that listed in the Indonesian Stock Exchange using Data Envelopment Analysis (DEA) method in three industry sector, which are agriculture as the primary sector, manufacturing as the secondary sector and service as the tertiary sector. For each sector, we choose representative industry, plantation for agriculture, food and beverages for manufacturing and ICT sector for service. After measuring the efficiency then we conducted the comparative analysis using Kruskal-Wallis H test and post-hoc analysis using Tamhane test. The data was gathered from the company's financial report for the year 2016. The result indicates that the firms in agriculture sector as the primary sector has the lowest efficiency score among the other firms in the industry that has been analyzed, while the companies in the manufacturing and service sectors did not show any significant differences one with another. The empirical results may be useful and important for the companies nor the industries to improve their efficiency and performance. Also for Indonesia's government and policymakers to help them for making judgment and investment planning for the development of Indonesia's industry sector.

Keywords: Firm-level Efficiency, Industry Comparison, Indonesia, Data Envelopment Analysis (DEA).

인도네시아 주요 기업의 생산성 분석 : 인도네시아의 상장 기업을 중심으로

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요약

본 연구는 Data Envelopment Analysis (DEA) 방법론을 적용하여 인도네시아 증권거래소에 상장된 인도네시아 주요 기업의 경영 효율성 분석 및 비교를 진행하였다. 산업을 크게 3 개로 구분하여 1 차 산업 부문으로 농업, 2 차 산업 부문으로 제조업, 3 차 산업 부문으로 서비스업을 선정하였다. 각 부문별로 대표 산업을 뽑았으며, 농업에서는 작물재배업, 제조업에서는 식품 및 음료, 서비스업에서는 ICT 부문을 선택하였다.

경영효율성을 측정 결과를 기반으로 Kruskal-Wallis H 테스트와 Tamhane 테스트를 사용한 사후 분석을 사용하여 비교 분석을 수행하였다. 분석 데이터는 각 기업의 재무보고서를 통하여 수집하였다. 분석 결과, 1 차 부문인 농업 부문의 기업들이 분석대상 내 기업들 중에서 가장 낮은 효율성을 기록한 반면, 제조업과 서비스 부문의 기업들은 다른 기업들과 큰 차이를 보이지 않았다는 것을 보여준다. 본 연구의 실증 결과는 기업 또는 산업의 경영 성과를 향상시키는 데 유용한 정보를 제공할 것이다. 또한 인도네시아 정부 정책입안자의 인도네시아 산업 발전을 위한 자원배분 및 투자계획을 수립에 기여할 것으로 기대한다.

1. Introduction

Indonesia is the world's fourth most populous nation and member of the G-20. Indonesia is the largest economy in Southeast Asia that keep growing their economic. In 2017, Indonesia Economic growth expanded by 5.07 percent compared to 5.03 percent in 2016. It is considered as the strongest growth rate since 2013 (https://tradingeconomics.com/indonesia/gdp-growth-annual). The country's GDP per capita keep rising from $857 in 2000 to $3,603 in 2016 (http://www.worldbank.org/en/country/indonesia/overview). Over recent years Indonesia's economy keep growing, notwithstanding the sharp of economic contraction that occurred during the 1997-1998 Asian financial crisis, after that Indonesia keep increasing their economic growth and score higher GDP than the emerging market and developing economies countries (figure 1.1). The GDP per capita PPP (purchasing power parity)

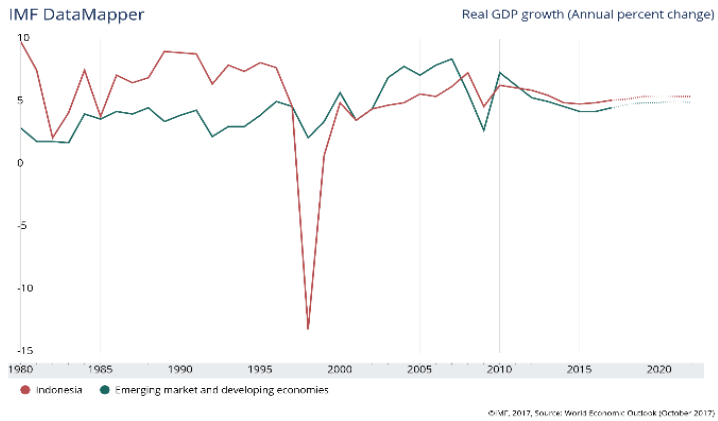

Figure 1.1 Indonesia's real GDP growth

of Indonesia is also rising and expected to continue to rise over the years ahead (figure 1.2).

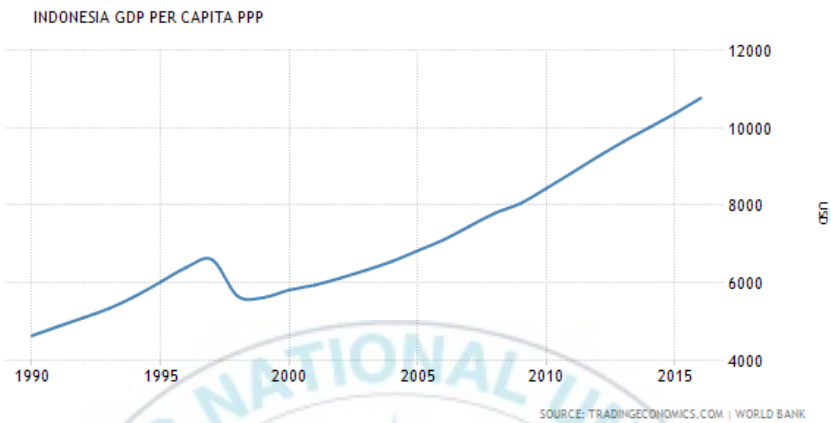

Figure 1.2 Indonesia's GDP growth per capita PPP

Industrial Sector take an important role in the economic activities of a country. In fact, countries with strong industrial sector have showed more economic growth. The development of industrial sector also shows improvement in national income and promote the living standard of population. In Indonesian case itself industrial sector has become the driver of economic growth. Industry accounts for the largest share of GDP (46.5 percent of total GDP). Within industry, services constitute 38 percent of total GDP, manufacturing which has been one of the main growth engines contributes 24 percent of total GDP and agriculture accounts for 15 percent (https://tradingeconomics.com/indonesia/gdp-growth-annual). According to BPS (Badan Pusat Statistik) or Statistics Indonesia said that

until quarter IV-2017 the most highest growth come from Information and communication sector which is 9,81 percent in terms of production.

Over the past 60 years, Indonesia's economy structure has undergo considerable transformation. In 1950s the economy has historically been heavily weighted towards the agricultural sector, reflecting the government agriculturally friendly policies and to promote agricultural self-sufficiency in 1960s (Reserve Bank of Australia, 2011). But, since 1970's the manufacturing and mining sector became the major pillars of the nation's economy, between 1967 and 2009, manufacturing as a share of GDP rose by 19%, while agriculture's contribution declined by 35% (Statistics Indonesia).

In RIPIN (Rencana Induk Pembangunan Industri National) or National Industry Development Masterplan 2015-2035, Indonesian government set the category of industrial sector to be the focus on growing the national Industry and divided it into three category: Mainstay or Backbone Industry, Supporting Industry and Upstream Industry. While the manufacturing and ICT industry included in the backbone industry category, and agriculture industry set in the upstream industry. The purpose of this RIPIN is to make Indonesia become a strong industrial country that based on innovation and technology.

Another Policy of Indonesian Government for industrial sector is about the tax holiday scheme that exempts certain business from paying corporate income taxes for up to ten years under Ministry of Finance Decree No. 130/PMK.011/2011, and government regulation No. 62 of 2008 that provides a tax incentive program. Priority is given to some pioneer sectors. On August 2015 the government of Indonesia updated the tax holiday incentives under the Ministry of Finance Decree No. 159/PMK.010/2015, they extended the time frame for the tax holiday facility to 5 to 15 years and expanded the coverage of pioneer sectors (https://www.export.gov/article?id=Indonesia-Industrial-Policies). Most of the pioneers sector that listed are from manufacturing industry and ICT is also one of the pioneer sector.

From the RIPIN and the policies that exist, we can see that Indonesian government is fostering the manufacturing and service or ICT industry development. So, regarding the government of Indonesia plan for the secondary and tertiary industry and the GDP growth of each industry that shifted from Agriculture based to the manufacturing and service, this study want to check the status of the leading firms of Indonesia in each industry sectors from the efficiency perspective whether the government plan and policies now is suitable when comparing with the efficiency status of the leading companies.

DEA (Data Envelopment Analysis) is well-known methodology that have been used to measure the efficiency of a set of decision making units (DMU) in many research area. One of them is measuring the efficiency and performance at firm-level. It also a helpful tools & technique for solving multi criteria decision making problem. DEA was introduced for the first time by Charnes, Cooper and Rhodes (1978) to evaluate nonprofit and public sector organizations, after that it is used by Banker, Charnes and Cooper in 1984. Since then, DEA has been used as a very powerful management tool for solving various type of multi-criteria decision-making problem in many studies.

The purpose of this study is to measure and check the efficiency status of Indonesia's leading firms that listed in the Indonesian Stock Exchange in three industry sector, which are agriculture (plantation) as primary sector, manufacturing (food and baverages) as secondary sector and service (ICT sector: telecommunication, computer and service) as service sector using DEA (Data Envelopment Analysis) methodology. After doing the DEA analysis, comparative analysis is conducted to know the significance differences and the efficiency status. It is hope that with the accurate measurement of this industry's firms efficiency, can help Indonesian firms and industries to improve their efficiency and performance. The results also may be useful and important for Indonesia's

government and policy makers to help them see the proper direction for investment planning and decision making for the development of Indonesia's industry sector.

The remainder of these paper proceed as follows. Section 2 discuss about the previous studies about Indonesia's industry sector, DEA methodology and its previous relative studies. In section 3 introduces the empirical model and resource of the data used. Section 4, shows the empirical results and the findings of this paper. Then in the section 5, presents the summary, implication and limitation.

2. Literature Review

2.1 Efficiency Concept

Many studies have been done about measuring the efficiency of an object in some field such as industry or firms, environment, medical, education, etc. Efficiency itself can be described as getting the greatest possible output from available inputs, with increasing the production or reducing the time needed. Or in other words, it indicates how well a company or organization uses its resources to produce goods and services. The concept of efficiency has been applied by humans since ancient time, we can say so when we see the historical evidences such as archaeology artifact that has been found. For example, the innovation that humans made in tool making from thousand years ago, they create it to make their way of living become more efficient. It is proof that since long time ago humans already applied the efficiency concept in their life and even until now human continuing to make innovation for more efficient life. The word of efficiency itself came into wide use in the nineteenth century, when scientists and engineers extended to human labor the physical idea of efficiency as useful work per unit of energy (Tenner, 2018).

Farrel (1957) proposed the modern efficiency concept measurement. He proposed that the efficiency of a firm consists of 3 components:

1. Technical efficiency that reflects the firm's ability to obtain maximum output.
2. Allocative efficiency that reflects the ability of firms to use inputs in optimal proportions, given their respective price.
3. Economic efficiency which is a combination of technical efficiency and allocative efficiency.

Some expert and scientist also describe the efficiency meaning by their own concept. Tenner (2018) define efficiency as producing goods, providing services or information, or processing transactions with a minimum of waste. In another side, Yampolskiy (2011) describe efficiency as the extent to which resources such as time, space, energy, etc. are well used for the intended task or purpose. While, Shubik (1978) indicates efficient if there are no alternatives that can produce greater benefit when all the costs are taken into account than the production processes and organization have been selected with the given goals and knowledge.

2.2 Previous Studies of Firms in Indonesia's Industry Sector

Firms in Indonesia's Industry sector has become study object for some researcher in the past years. There are some studies about Indonesia's industry sector had been done using some methodology. For example, Zuhdi et al. (2012) analyze about the role of the ICT sector to the national economic structural changes for 1990-2005 using input-output analysis. They find that ICT sector does not significantly influence national economic structural changes in that period, they conclude that in that period ICT sectors are not prioritized by the Indonesian government. Margono and Sharma (2006) evaluated about Indonesian manufacturing industries (food, textile, chemical and metal products) efficiency and productivity from 1993 to 2000 using stochastic frontier model. The findings show that the food, textile, chemical and metal products sectors are on average 50.79%, 47.87%, 68.65% and 68.91% technically efficient. The decomposition of TFP growth indicates that the growths are driven positively by technical efficiency changes and negatively by technological progress in all four sectors. Rohman and Bohlin (2013) evaluated about Indonesian telecommunication sector using input-output (IO) method for the time series of the investigation covers the period 1975-2008. They

found a lower ability of the telecommunications sector to build an inter-industry relationship with other sectors.

Moreover, there are also other studies about firms in Indonesia's industry sector were done based on DEA methodology. Halim (2010) evaluated the productivity and efficiency of manufacturing firms listed in the Indonesian Stock Exchange as results of their marketing activities for the time period of 2001-2007. The findings show that over the time periods, this industry experienced total productivity decline, mainly due to deterioration of managerial efficiency. Soetanto and Fun (2015) also did study about Indonesian manufacturing industry listed in the Indonesian Stock Exchange for periods 2010 to 2014. The result revealed that on average the highest output oriented super SBM efficiency is a miscellaneous industry while basic and consumer goods industry are not efficient on average. Setiawan et al. (2012) studied about Indonesian food and beverages industry sector to estimate the technical efficiency scores. The results show that the food and beverages industry characterized by high industrial concentration and the firms in the industry are inefficient. Another study come from Indonesian banking sector that have been evaluated by Hadad et al (2012), the study using data from 2003 to 2007 and shows that the most efficient bank grouping is generally found to be the 'state-owned' banks.

2.3 Data Envelopment Analysis (DEA)

There are a lot of methodologies that usually use for measuring efficiency and performance in firm-level. One of the most frequently used approaches is Data Envelopment Analysis (DEA) that first introduced by Charnes, Cooper and Rhodes (1978), it's a non-parametric method that use to evaluate the efficiency of decision-making unit (DMU's) and evaluate performance considering various inputs and outputs. According to Asimakopoulos and Whalley (2017), "DEA extends the traditional concept of productivity or efficiency analysis (input to output ratio) and makes it suitable for performance evaluation and benchmarking within the context of multiple performance measurements. DEA techniques use mathematical programming to calculate efficiency and their major advantage is that they do not require dealing with assumptions regarding the distribution of the variables included as inputs and outputs. Furthermore, another advantage of non-parametric techniques is that the calculation of efficiency scores based on a set of inputs and outputs are not supposed to have pre-specified relationships and the measurement of multiple inputs and outputs could be in different units. Importantly, the efficiency score of each decision-making unit (DMU) included in the

sample is determined relatively compared to the other DMU's included in the sample".

In 1978, Charnes, Cooper and Rhodes introduced the Data Envelopment Analysis with constant return to scale (CRS) model or also known as CCR model, it assumes that an increase in the amount of inputs results in a proportional increase in the amount of output. In their originating study, they described DEA as a mathematical programming model applied to observational data that provides a new way of obtaining empirical estimates of relations that are cornerstones of modern economics. Then in 1984, Banker, Charnes and Cooper proposed a variable return to scale (VRS) model (also known as BCC model) to overcome the limitation of the CRS model. This variable return to scale (VRS) model assumes that an increase in the amount of inputs results in a disproportionate increase of the amount of output. These two are the model of DEA based on the return to scale.

From the choice of orientation there are two well-known orientation choices in DEA, first is input oriented and second is output oriented. Input oriented models are where the aim is to minimize the inputs at the given output level. Output oriented models are where the aim is to maximize the output at the given input level.

According to Donthu et al (2005), DEA methodology mathematically compare the productivity of different DMU (decision-making units) based on multiple inputs and outputs. The ratio of weighted inputs and outputs produces a single measure of productivity called relative efficiency. DMUs that have a ratio of 1 are referred to as efficient given the required inputs and produced outputs. The units that have a ratio less than 1 are less-efficient relative to the most efficient unit. Because the weights for input and output variables of a DMU are computed to maximize the ratio and then compare to similar ratios of best-performing DMUs, the measured productivity is also referred to as relative efficiency.

In figure 2.1 give illustration about the difference of regression model and DEA. Regression models are quantitatively robust but they lack of the ability to include multiple inputs and outputs. The regression model also only provides an estimation of success of the model, with not offering feedback about possible improvements. On the other hand, DEA model produces an efficient frontier consisting of the set of most efficient performers, allowing direct comparison to the best performers who are opposed to the average. From Figure 2.1 we can see, that regression model produces an “average” line across all DMUs, but DEA produces an efficient frontier that encompasses the best performers. While DMUs above the regression line appear to perform better than average, they’re

not perform as well as the best or the most productive DMUs on the efficient frontier.

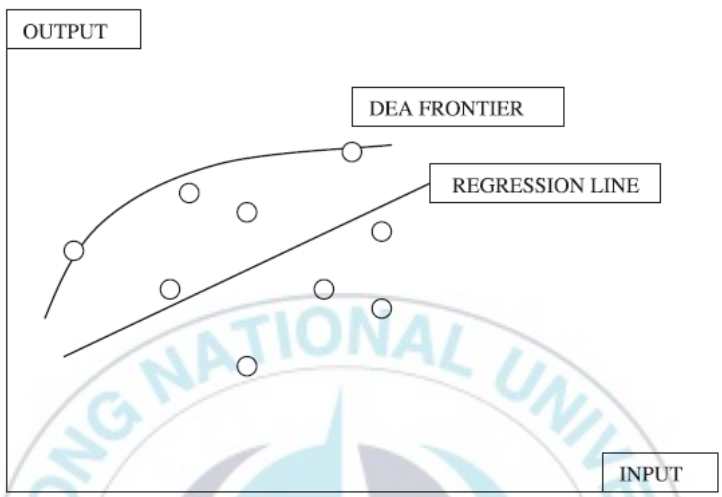

Figure 2.1 Regression versus DEA

The DMUs on the efficiency frontier is the best-performing peers that need to be replicated. Basically, the DMUs on the frontier are the most efficient industry leaders and use as role models. An inefficient DMU and inside the frontier can choose an efficient DMUs on the frontier that operates within its scope (or facet/cone) as a role model. Hence, depending on the size and scope of the DMU, each DMU will have a different set of role models. As an example, we can see in Figure 2.2, unit A can use units C and D as role models to be efficient. At the same time, for unit B, units E, F, and G are more appropriate role models. A DMU can be productive

by moving towards the frontier. For example, in Figure. 2.2, unit A can be efficient by moving towards the frontier by a distance *X* horizontally (reducing the input expended by X) or by moving towards the frontier by a distance *Y* vertically (increasing the output produced by Y) or a combination of both. In addition, because productivity is the ratio of output to input, a DMU can be productive by increasing output or reducing input. While this example has only one input and only one output for simple graphic illustrations, DEA can accommodate multiple inputs and multiple outputs (Donthu et al, 2005).

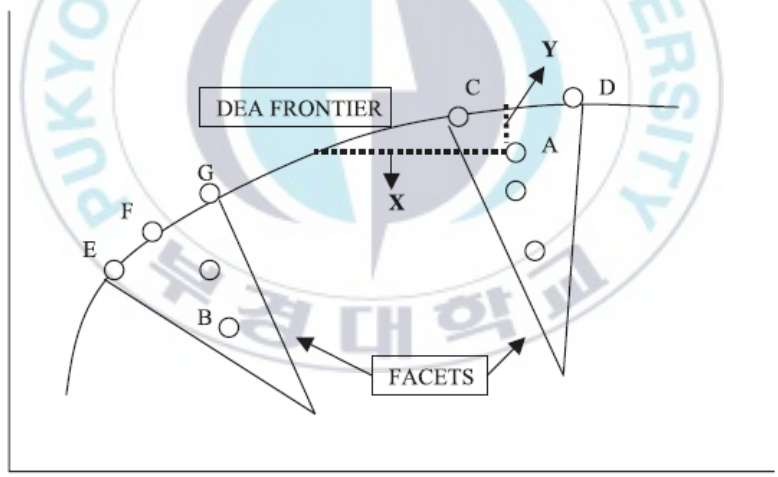

Figure 2.2 DEA facets

In this study we measuring the efficiency of each firm in three industry sectors based on the output-oriented VRS models. The VRS model can reflect the existence of economic of volume, while CRS cannot.

VRS model allow the benchmark production frontier to be convex, hence allowing other firms to moving towards the frontier as efficient firms even they are scale inefficient, in other words, the firms will be benchmarked against firms of similar size. The convexity constraint is used to impose variable returns to scale (VRS), which ensures that an inefficient firm will only be compared to firms with a similar scale. In the firm-level, the firm size and volume of investment or output is different, there is a gap between one and other company, which is why this study choose the VRS model. Setiawan et al (2012), also argued about the using of VRS model in his study about one of industry that use in this study which is food and beverages. They said "The assumption of VRS model is more relevant to be used because CRS seems a too strong assumption for the Indonesian food and beverages sector, as this sector is characterized by many distortions". For the choice of orientation, this study choose output oriented model regarding the condition of Indonesia firms that have limited resources as the input, that is why maximizing the output for the developing country seems to be more appropriate than minimizing the input.

The following DEA model is an output-oriented model where the output are maximized and the inputs are kept at their current levels (Banker et al. 1984) :

$$\max \phi + \varepsilon \left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \right)$$

subject to

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io} \qquad i = 1, 2, ..., m;$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = \phi y_{ro} \qquad r = 1, 2, ..., s;$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0 \qquad j = 1, 2, ..., n.$$

Where;

j = number of DMU being compared in the DBA analysis

y_{rj} = amount of output r used by DMU j

X_{ij} = amount of input i used by DMU j

λj = weight placed at DMU j

s_i^- and s_r^+ = input and output slacks

x_{io} and y_{ro} = ith input and rth output for DMU_o

i = number of inputs used by the DMUs

r = number of outputs generated by the DMUs

DMU_o is efficient if and only if $\phi^* = 1$ and $s_i^{-*} = s_r^{+*} = 0$ for all i and r.

DMU_o is weakly efficient if $\phi^* = 1$ and $s_i^{-*} \neq 0$ and (or) $s_r^{+*} \neq 0$ for some i and r.

2.4 Relative Studies using DEA

Many studies were done by researchers for measuring efficiency and performance at firm-level using data envelopment analysis since it first introduced by Charnes et al (1978). In service industry category, Yu and Ramanathan (2008) analyze the efficiency of retail industries in China between 2002 and 2003. The result indicates that 7 retailers in 2002 and 4 in 2003 are considered as efficient, and the average efficiency of retail firms in China was less than 45 percent in 2002 and 37 percent in 2003. Keh and Chu (2002) also provide an analysis for retail industry firms in the USA for the years 1988 through 1997 for 13 stores. They found that capital and labour contributes more effective in 3 stores that considered as "best practice" stores, while 2 stores become underperformance due to the distribution service problem.

In the manufacturing industry, some studies also provided using DEA approach. 220 Japan manufacturing firms that listed in Tokyo stock exchange were analyzed for their performance (Sueyoshi and Goto, 2010). Empirical result found three business implications related to the corporate strategy in the Japanese manufacturing industry. First, large manufacturing firms have technology and capital to enhance their environmental and operational performance. Second, Japanese manufacturing firms may have

a dynamic strategy along with their corporate sizes. Third, the two groups (A and C) with high operational efficiency lead to the improvement of financial performance. Similar studies also provide for measuring Turkey's manufacturing firm's performance by Duzakin and Duzakin (2006), they analyzed 480 major industrial enterprises using DEA. The result found a total of 65 firms were identified as efficient among the industries. Two hundred and seventy-eight firms were considered the most inefficient. Furniture industry companies were found to be more efficient in performance than other industries' companies. Firms in rock, soil and related industries also performed efficiently. Firms in food beverages and tobacco industry seemed to be performing poorly during 2003. Firms in mining did not seem to be performing efficiently. Chun et al (2015) also did an analysis using DEA to Korean manufacturing company for 1039 firms, and the findings show that firms show imbalanced R&D efficiency throughout the innovation and commercialization stages, also the R&D efficiency is different by firm size and industry type. Another study from Lin et al. (2005) identified about performance and efficiency of 14 Taiwanese shipping firms. The result shows that 4 firms are relatively efficient (U-Ming, YML, WAN HAI and Shanloong). These firms lay on the efficient frontier and hence had efficiency of 1, while all other firms lay inside the frontier and hence were inefficient. The inefficient firms can

effectively promote resource utilization efficiency by better handling labor and capital operating efficiency.

For the Agriculture industries, one of the previous studies was for measuring the productivity growth for Indian food industry using firm-level data (Kumar and Basu, 2008). They found that only 8 to 12 firms are technically inefficient. The high rate of growth in output in Indian food industry does not necessarily imply the high growth rate in productivity and efficiency. It is necessary to encourage imports along with R&D to ensure faster technological progress in Indian food industry. There is also a study about the comparison of three industries sector that measuring their productivity in China (Chen, 2002). These three Chinese major industry sectors that being analyze were Textiles, Chemicals and Metallurgy Industry. The result show that the textile, chemical and metallurgical industries are labor-intensive, capital-intensive and in-between, assume that (i) it is more important to reduce the amount of labor in the textile industry when improve the performance of the textile industry, because the textile industry is labor intensive, and (ii) it is more important to reduce the amount of capital in the chemical industry when improving the performance of the chemical industry, because the chemical industry is capital intensive. No preference over the two inputs is given in the metallurgical industry because the metallurgical industry is in between.

From all the studies that mentioned above, it is apparent that there is an increase in the use of DEA to evaluate firm-performance in recent years (see table 2.1). However, there seems to be no study on evaluating the performance of firms in Indonesia's three major industry sector that listed in Indonesia Stock Exchange and comparing the efficiency of firms in each industry one with another.

Table 2.1 DEA Previous Studies

Studies	**Analysis Level (Main Method)**	**Inputs**	**Outputs**
Wantao Yu and Ramakrishnan Ramanathan (2008)	61 retailers in China between 2000 and 2003 (DEA, Malmquist productivity index, bootstrapped Tobit regression)	Number of employees, total selling	Sales revenue, profit volume
Hean Tat Keh and Singfat Chu	13 chain grocery stores for the	Capital, Labor	Sales revenue.

Studies	Analysis Level (Main Method)	Inputs	Outputs
(2002)	years 1988 through 1997 based in the USA (DEA)		
D. Chun et al. (2015)	1039 Korean Manufacturing firms. (Two-stage DEA model)	Internal R&D expenditure, External R&D expenditure, R&D Employee	Sales, Operating Income
Toshiyuki Sueyoshi and Mika Goto (2010)	220 Japan Manufacturing firms listed in Tokyo Stock Exchange for period 2004-2007. (DEA)	Total assets, Number of employees, Total operation cost.	Total sale.

Studies	Analysis Level (Main Method)	Inputs	Outputs
Erkut Duzakin and Hatice Duzakin (2006)	480 major industrial enterprises of Turkey. (DEA)	Net assets, Number of employees	Profit before tax, Export revenue, Value Added
Mukesh Kumar and Partha Basu (2008)	Indian food processing industry by using the firm-level data from 1988-2004. (DEA)	Labour & Capital	Gross Value Added
Yao Chen (2002)	Three Chinese major industry sectors (Textiles, Chemicals and Metallurgy) during period 1966 to 1985. (DEA based non-	Capital, Labor	Annual Gross industrial output value (AGIOV)

Studies	Analysis Level (Main Method)	Inputs	Outputs
	radial Malmquist productivity index))		
Wen-Cheng Lin et al. (2005)	14 Taiwanese shipping firms (DEA)	Total assets, stakeholders equity	Operating Revenue, Net income

3. Research Design and Data Source

3.1 Research Model

Firms efficiency is calculated with DEA methodology using DEA application (DEA frontier), where the inputs are current assets, non-current assets, and number of employees of each firm in each industry, while net sales and net income of the firms are defined as outputs. The single output number then analyze using Kruskal-Wallis test to know the statistical significant differences between firms in 3 industries sector and then using post-hoc analysis to comparing these industries. (Figure 3.1)

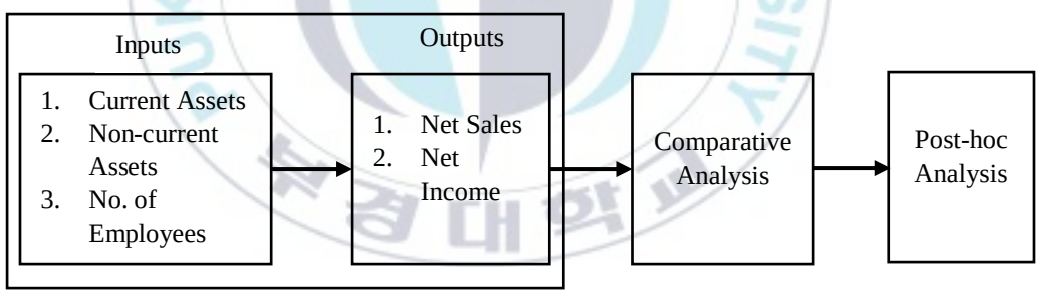

Figure 3.1 Research Model

Table 3.1 Description of variable for measuring efficiency using DEA model

Variable	Description	Unit of Measurement	Previous Study
Input	Current Assets	Indonesian Rupiah	Total assets (Sueyoshi and Goto (2010); Wen-Cheng Lin et al. (2005))
	Non-current Assets	Indonesian Rupiah	
	No. of Employees	Number	Yu and Ramanathan (2008); Sueyoshi and Goto (2010)
Outputs	Net Sales	Indonesian Rupiah	Yu and Ramanathan (2008); Keh and Chu (2002); Chun et al. (2015)
	Net Income	Indonesian Rupiah	Wen-Cheng Lin et al. (2005).

3.2 Data

We use data from every sample company's financial report for 2016 that they released in order to give their report to the Indonesian stock exchange, and also regarding the government regulation no. 64/1999 on amendment to government regulation no. 24/1998 about company's annual

financial information that needs to be reported to the Indonesian Ministry of Trade annually, and the regulations of the Capital Market Supervisory Agency (BAPEPAM) number: KEP-431/BL/2012 stating that public companies that already have websites, shall post their reports on the website. All the data are collected from the company's official website, and from Indonesian stock exchange website.

We analyze firms from three Indonesia's major economic sector and choosing representation from each industry. There are three classification sectors of industries in Indonesia based on Indonesia Stock Exchange called Jakarta Stock Industrial Classification (Jasica) index which are primary sector (Agriculture), secondary sector (Industry&Manufacturing) and tertiary sector (Service). The representative industries that used are plantation for agriculture, food and beverages for manufacturing and ICT industry (Telecommunication & Computer and Service) for service sector. The reason for choosing these sectors as representative are; for the agriculture and manufacturing, both plantation and food and beverages show the highest score of GDP among the other sub-sectors. And for ICT, this sub-sector showed the highest growth rate for Indonesia economy that accounts for 9.80 % of all economic growth by industrial origin in the third quarter of 2017 (Badan Pusat Statistik–Statistics Indonesia, 2017). Also regarding the RIPIN's

(Rencana Induk Pembangunan Industri National) or National Industry Development Masterplan 2015-2035 purpose to make Indonesia become a strong industrial country that based on innovation and technology, so it is important to analyze about the ICT sector as the representative of service industry.

The total number of firms is 44 firms. 16 firms for plantation, 16 firms for food and beverages, and 12 firms for ICT sector (telecommunication 5; computer and service 7). All the company's data used are shown in table 3.2.

Table 3.2 Company data

No	Industry Category	Industry Name	Company	Est. year	Net Sales	Net Income
1	Tertiary / Service Industry	Telecom unication	Indosat	1967	29,184,624	1,275,655
2			Smartfren	2002	3,637,386	(1,974,434)
3			TELKOM	1856	116,333,000	29,172,000
4			XL Axiata	1989	21,341,425	375,516
5			Bakrie Telecom	1993	172,005	(1,392,115)
6			Multipolar Technology	1975	1,927,503	130,166

No	Industry Category	Industry Name	Company	Est. year	Net Sales	Net Income
7			Anabatic Technologies	2001	4,127,443	73,214
8			Centratama	1987	140,668	(29,811)
9		Computer and Service	Astragraphia	1975	2,712,784	255,113
10			Metrodata Electronics	1983	10,048,153	322,877
11			Indoritel	1995	22,658	398,073
12			Limas Indonesia Makmur	1996	207,753	3,146
13	Secondary / Manufacturing	Food and Baverages	Indofood CBP Sukses Makmur	2009	34,466,069	3,631,301
14			Indofood Sukses Makmur	1990	66,750,317	5,266,906
15			Mayora Indah	1977	18,349,960	1,388,676

No	Industry Category	Industry Name	Company	Est. year	Net Sales	Net Income
16			Ultrajaya Milk Industry & Trading Company	1958	4,685,988	709,826
17			Nippon Indosari Corpindo	1995	2,521,921	279,777
18			Siantar Top	1972	2,629,107	174,177
19			Delta Djakarta	1932	774,968	254,509
20			Tiga Pilar Sejahtera Food	1959	6,545,680	719,228
21			Sariguna Primatirta	1988	523,933	39,263
22			Tri Banyan Tirta	1997	296,471	(26,500)

No	Industry Category	Industry Name	Company	Est. year	Net Sales	Net Income
23			Buyung Poetra Sembada	2003	816,213	29,336
24			Prasidha Aneka Niaga	1974	932,906	(36,662)
25			Sekar Bumi	1968	1,501,116	22,545
26			Wilmar Cahaya Indonesia	1968	4,115,542	249,697
27			Sekar Laut	1976	833,850	20,646
28			Multi Bintang Indonesia	1931	3,263,311	982,129
29	Primary / Agtriculture	Plantation	Astra Agro Lestari	1988	14,121,374	2,114,299
30			Sawit Sumbermas Sarana	1995	2,722,678	591,659

No	Industry Category	Industry Name	Company	Est. year	Net Sales	Net Income
31			Perusahaan Perkebunan London Sumatra Indonesia	1906	3,847,869	592,769
32			Salim Ivomas Pratama	1992	14,530,938	609,794
33			Tunas Baru Lampung	1973	6,513,980	621,011
34			Eagle High Plantations	2000	2,541,763	(391,367)
35			Dharma Satya Nusantara	1980	3,942,024	252,040
36			Sampoerna Agro	1993	2,915,225	459,356
			Austindo Nusantara Jaya	1985	1,771,371	121,205

No	Industry Category	Industry Name	Company	Est. year	Net Sales	Net Income
38			Provident Agro	2006	1,169,778	219,099
39			Jaya Agra Wattie	1921	590,138	(225,133)
40			Gozco Plantations	2001	544,884	(1,547,604)
41			Golden Plantation	2007	177,239	7,997
42			Bakrie Sumatra Plantation	1911	1,565,244	(484,669)
43			Multi Agro Gemilang Plantation	2005	30,535	(43,957)
44			Sinar Mas Agro Resources and Technology	1962	29,752,126	2,599,539

4. Empirical Results

4.1 Efficiency analysis

In Table 4.1 shows the descriptive statistic of the sample firm's variable. The total number of sample firms is 44 from 3 industry sector. From the results, we can see that regarding the negative value issue of DEA variable, one of the output that been used which is net income has negative values for some companies across these three industries. Since the DEA method that first developed by Charnes, Cooper and Rhodes (1978) required all input and output variable values to be positive, it means that this 'net income' variable is not suitable for DEA analysis. Therefore, to adjust the negative values of net income, based on Pastor (1996) studies about the translation invariance, we add the value of 1,974,435 to every net income sample of the firms.

Table 4.1 Descriptive statistic for firms' variables

N = 44	Min.	Max.	Mean	Std. Dev.
Current Assets	23,348	47,701,000	4,094,441	8,491,406
Non-Current Assets	137,191	131,910,000	10,961,498	22,540,714
No. of Employees	23	83,310	7,597	14,941
Net Sales	22,658	116,333,000	9,672,725	20,661,240
Net Income	-1,974,434	29,172,000	1,086,598	4,492,765

Table 4.2 presents the results of firm's efficiency across three industries that been analyzed. From that table, we can see that the mean and median of firms in the primary industry which is agriculture industry shows the lowest efficiency score compare to the other two industries. However, from this result we still don't know the real significant difference order, that's why we need to do the comparative analysis to see the significant differences.

Table 4.2 Firm's efficiency across three industries.

Industry Category	Min.	Max.	Mean	Median	Std. Dev.
Agriculture (Plantation)	0.4924794	1.0000000	0.7557668	0.7229077	0.160930043
Manufacturing (Food & Beverage)	0.7550355	1.0000000	0.9316245	0.9767971	0.087113136
Service (ICT sector)	0.4262214	1.0000000	0.9161263	1.0000000	0.167122149

4.2 Comparative Analysis

In order to do the comparative analysis to know the significant differences of firm's efficiency between these 3 industries, we used the

non-parametric statistical analysis method of the Kruskal-Wallis H test (Table 4.3). After that, a post-hoc analysis using Tamhane test were done to compare each industries significance differences (table 4.4).

Table 4.3 Results of Kruskal-Wallis H test.

Industry Category	N	Mean Rank
Agriculture (Plantation)	16	13.97
Manufacturing (Food & Beverage)	16	27.13
Service (ICT sector)	12	27.71

*Note: $x^2 = 11.919$, df = 2, ***p = 0.003*

Table 4.4 Results of Post hoc test.

Industry Category		Mean difference (I-J)	Std. Error	Sig. dif	95% Confidence Interval	
(I)	(J)				Lower Bound	Upper Bound
Agriculture	Manufacturing	-.1758577	.0457488	.002***	-.293595	-.058120
	Service	-.1603595	.0628183	.052*	-.321895	.001176
Manufacturing	Agriculture	.1758577	.0457488	.002***	.058120	.293595
	Service	.0154982	.0529318	.988	-.126108	.157104
Service	Agriculture	.1603595	.0628183	.052*	-.001176	.321895
	Manufacturing	-.0154982	.0529318	.988	-.157104	.126108

*Note: * = 0.1, *** = 0.01*

In table 4.3, we can see from the mean rank that primary sector (agriculture) scored the lowest result among these three industries sector. The result also shows that there is a quite large gap between primary (agriculture) and tertiary (service) sector, primary sector mean rank is 13.97 while tertiary sector mean rank is 27.71, which means tertiary sector have about two times higher score than primary sector.

Then from table 4.4, it shows that there is significant differences among the firms in these three industries. These significant differences can be seen both from the comparison of firms in primary sector (agriculture) with secondary sector (manufacturing) and the comparison of firms in primary sector (agriculture) and tertiary sector (service). In contrast, there is no significant difference can be seen when we compared the firms in secondary sector (manufacturing) and tertiary sector (service).

5. Conclusion

This study has evaluated and measured the efficiency of Indonesia's firms in three major industry sector which are primary (agriculture - plantation), secondary (manufacturing - food & beverage) and tertiary (service - ICT sector) industry. Data from 44 firms are used as the sample from three industry (primary 16, secondary 16, service 12) for the year 2016. Three inputs and two outputs are defined. Using Data Envelopment Analysis (DEA) for the methodology, applied Kruskal-Wallis H test for the comparative analysis and Tamhane test for post-hoc analysis to know the significant difference.

The results of this study indicate that the firms in primary (agriculture) sector shows a significant difference with the other two sectors and has the lowest efficiency score among the other firms in these three industries. While the firms in the other two sectors (manufacturing & service) did not show any significant differences, so we cannot rank which one have the highest efficiency. This shows a co-related result with the decreasing of agricultural share in Indonesia GDP for over the past 50 years. In 2016, the share of agriculture in Indonesia's gross domestic product was around 13.45 percent, industry sector contributed

approximately 39.32 percent and the services sector contributed about 43.66 percent.

From this perspective, we can say that from the result show that firms in primary (agriculture) sector has the lowest efficiency score, and regarding the low score of GDP share of agriculture industry, this study result can be related with that fact. Low efficiency of agriculture firms can be one of the reasons of decreasing the share of GDP score. Therefore, the government have to consider more about the agriculture sector and give attention for the growth of this sector by investment in R&D or make strategies for this sector to grow and improve their efficiency. While for the service and manufacturing sector, even though the GDP score is higher than agriculture sector and the firms in these two sectors scored higher and have a significant difference in efficiency than agriculture sector, however the government should invest more to this sector to increase their efficiency and help them grow more which automatically can help Indonesian economy to grow.

Regarding the research findings, it can be useful and important information for Indonesia's government and policymakers. For now, one of the policies that exist for supporting industrial competitiveness is about tax holiday and tax incentives. These regulation exempts certain businesses from paying corporate income taxes for up to ten years. Priority

is given to investment in some pioneer industry sector including some manufacturing industry and telecommunications information & communication, which is one of the sector discussed in this study. Also the RIPIN (Rencana Induk Pembangunan Industri National) or National Industry Development Masterplan 2015-2035, that focusing the industrial development of Indonesia based on the innovation and technology, the government of Indonesia put the manufacturing and ICT in the backbone industry. By this, we can see that the government fostering the secondary and tertiary industry. So, when we see from the efficiency perspective by the results of this study about the efficiency status of the leading company of Indonesia in three industry sector, the firms in manufacturing and service industry shows the highest efficiency score, means that these companies have a good efficiency now, and because the efficiency result is good, so we can conclude that the policy exist now is good and suitable with the condition and efficiency status. The government can also decide to invest more in the manufacturing and service industry by considering the result that shows a good efficiency score.

It is hoped that with the result of this research can help the Government of Indonesia in making judgement for the development of Indonesia's industrial sector, and for the investment plan in the future.

Finally, this research needs some additional work for the future, and this research have limitation about one of the input data, number of employees that provided by each firm differ in their reports. Some of the firms provide all the total number of employees (including permanent and contract), while other companies only provide the number of permanent employees. Therefore, for the future research it is hope to generalize all the data.

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