THE EFFICIENCY AND TOTAL FACTOR PRODUCTIVITY (TFP) IN THE MANUFACTURING INDUSTRY IN 33 PROVINCES OF INDONESIA

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ABTRACT

This study emphasizes the importance of controlling emittion's escalation in current decade. Furthermore, this study focuses on efficiency technique and the total factor productivity of manufacturing industry in 33 provinces Indonesia. This research was conducted by utilizing DEA. The input variables are labour, energy consumption and investment. While the output variables are GDP, SO2 and NO2. Malmquist-Luenberger (ML) productivity index was used to measure changes in productivity of observation data using undesireable variables as input or output. The result based of operational efficiency, at the end of the year there were 17 provinces observation in a state of inefficiency with the distribution of efficiency ranges between 0.750-0.999. Meanwhile, the result based of technical efficiency, there are the increasing trend in the technical efficiency of manufacturing industry in 19 provinces Indonesia. So, it can be concluded that the majority of manufacturing industries in Indonesia is efficient, but in fact only a few provinces that can increase their productivity by increasing desireable output while reducing growth rate of undesirable output production.

Keywords: efficiency, productivity, industry, DEA

INTRODUCTION

Energy use in the industrial sector contributed as emitters in many countries, especially developing countries. The greater use of energy, so that the greater the amount of emissions produced. At first, the relationship between the energy with the environment has not been a major concern. Environmental conditions are thus becoming its own demands for all countries to pay attention to energy utilization in the process of economic development in order to achieve economic sustainability. Energy utilization concept is to increase the process of industrialization, urbanization, and environmental issues, hence all of them can be regarded as a process unit, which implicitly will encourage growth in the production and consumption of energy

Sustain economic development itself is a balance between the growth of energy, economy, and environment. Among these three factors of energy is the most influential factor in economic growth, and economic growth also depends on the use of energy for economic development of the country . When economic growth is getting faster and maximize all possible energy sector, then in the process of economic growth was also natural resources, including energy resources that are used on a large scale creates emissions on a large scale as well. Therefore, the existence of a policy that takes into account environmental conditions are very necessary.

Previous studies about energy have been varied. One of which is efficiency measurement. Previous study attempt to measure the magnitudes of energy efficiency toward output produced. There are some research such as Korhonen and Luptacik (2004); Sueyoshi and Goto (2010); Sueyoshi et al. (2010) and Sueyoshi et al. (2013). However, this research have not covered particular province in some countries. Therefore, the study to measure efficiency of energy toward output in each province in a country need to be prolific.

This research focuses on what is operational efficiency and technique efficiency of manufacturing industry in 33 provinces in Indonesia. Analysis of an industry will be more adequate if analyzed also about the total factor productivity. This is executed by finding Malmquist-Luenberger (ML) Productivity Index to measure changes in productivity of observation data using undesireable variables as input or output. The input variables are labour, energy consumption and investment. The output variables are GDP, SO_2 and NO_2. By utilizing DEA, the problems will be solved. Therefore, this research formulates the following research problems viz. What are the operational efficiency level, technical efficiency level, and the Total Factor Productivity of manufacture industries in 33 provinces in Indonesia when undesireable output exist?

RESEARCH METODOLOGY

Operational Efficiency

Operational efficiency (OE) is designed using a non-radial measurement models. Thus the level of inefficiency is determined through the slack of each DMU (Decision Making Unit). OE ignore the undesireable output in the measurement (Sueyoshi, 2013). Then the non-radial mathematical model used in the measurement of OE as follows:

$$
\begin{aligned}
\text{Maximize } & \sum_{i=1}^{m} R_i^x d_i^x + \sum_{r=1}^{s} R_r^g d_r^g \\
\text{s.t. } & \sum_{j=1}^{n} X_{ij}\lambda_j + d_i^x = X_{ik} \ (i = 1, \ldots, m), \\
& \sum_{j=1}^{n} g_{rj}\lambda_j - d_r^g = g_{rk} \ (r = 1, \ldots, s), \\
& \sum_{j=1}^{n} \lambda_j = 1, \\
& \lambda_j \geq 0 \ (j = 1, \ldots, n),\ d_i^x \geq 0 \ (i = 1, \ldots, m), \\
& d_r^g \geq 0 \ (r = 1, \ldots, s) \qquad \ldots\ldots(1)
\end{aligned}
$$

after calculating model (1), the OE can be obtained by calculation

$$OE = 1 - \left(\sum_{i=1}^{m} R_i^x d_i^{x*} + \sum_{r=1}^{s} R_r^g d_r^{g*} \right) \qquad \ldots\ldots(2)$$

So that the slack of each DMU OE measurements can be obtained by calculating model (1). This model calculates the input and output desireable but does not include undesireable. Output variable

Technical Efficiency Change (TEC) and Total Factor Productivity Change (TFPC)

The approach used in this research is quantitative approach using Data Envelopment Analysis (DEA). Determining Total Factor Productivity Change (TFPC) and Technical Efficiency Change (TEC) of input and output in each country using the Malmquist - Luenberger Index, which is the

measurement of productivity and technical efficiency when DMU produce undesireable output. Chung et al. (1997) found Malmquist-Luenberger (ML) productivity index to measure marginal productivity of observational data which is use undesirable variable as input or output. If ML> 1 means that efficiency increase and DMU evaluated desireable output and reducing the undesireable output production. If ML = 1, the productivity is constant and there is no change, whereas if ML <1, it indicates declining levels of DMU productivity (Aparicio, Pastor, and Zofio. 2013). Based on the model of previous research, the authors use the model reference to Aparicio, Pastor, and Zofio (2013) by slightly modifying their model . The change is by putting

$$Y^{1,b}\lambda \geq y^{2,b}{}_o - \beta y^{2,b}{}_o$$

To the model. So the Malmquist model used in this study are:

Max β, λ

S.t $X^1\lambda \leq X^2{}_O$

$Y^{1,g}\lambda \geq y^{2,g}{}_o + \beta y^{2,g}{}_o$

$Y^{1,b}\lambda \geq y^{2,b}{}_o - \beta y^{2,b}{}_o$

$Max\{ y^{t,u}{}_i \} \geq y^{2,b}{}_o - \beta y^{2,b}{}_o$

$\lambda \geq 0$

where max {yt, ui} is the maximum number of observations of each undesireable output (SO_4 and NO_2 during the observation period (Aparicio, Pastor, and Zofio. 2013) (Aparicio, Pastor, and Zofio. 2015).

RESULT OF RESEARCH

Attachment 1 (Table 1) shows the distribution of operational efficiency score of the manufacturing industry for 33 provinces in Indonesia. That table show name of province which get efficiency score 1 (=1) means in operationally efficient condition and which provinces that show inefficiency means the score is less than one (<1) assuming the VRS (Variable Return to Scale).

In Attachment 1 (table 1) shows that in 2012 there were 12 of the 33 provinces in Indonesia in operational efficient condition, while 17 of the 33 provinces in Indonesia are in optimal efficient condition to the production of manufacture industry. From the table shows that 17 provinces have not utilized their resources both capital and human resources to achieve operational efficiency in their manufacture industry sector. While, in 2015, the number of provinces experiencing increased efficiency increased to 16 provinces from the number of efficient provinces in the previous year. While the number of inefficient provinces in 2015 remains at 17 provinces.

Attachment 1 (Table 2) shows the distribution of the changes of technical efficiency (index of technology) for 2012-2013 from the manufacturing sector of 33 provinces in Indonesia. In table above, classification of efficiency is divided into three, namely efficient, inefficient, very inefficient. It can be seen that there are 14 provinces classified to efficient group for 2012 to 2013, and increased to 19 provinces in 2013-2015. On the other hand, the number of provinces to

inefficient and very inefficient group showed a declining trend in the year of observation 2012 - 2015. For example, in the category of inefficient (0.750-0.999) there were declining number of provinces from 10 provinces to 9 provinces. While, the level is very inefficient (0.5 - 0.7499) also experienced a declining trend too, which means that several provinces in the manufacture industry sector manage to improve their technical efficieny score.

In 2012 - 2013 there were 9 provinces with technical inefficient conditions in manufacturing industry sector, but managed to reduce the number of provinces inefficient technically in 2013-2014 into 4 provinces and continued to decrease until the end of the observation being the only 2 provinces which is inefficient in manufacturing industry sector.

North Sulawesi in the observation year 2012-2013 experiencing technical inefficiency, but successful to increase the efficiency score in observation 2013-2015 become the full efficient technically by improving efficiency score to 1. Aceh also indicate similar trend, in 2012-2013 Aceh experienced a very inefficient condition with 0.5964 efficient score, but can massively improve its technical efficiency scores in 2013-2014 score to 1.1632 and 1.3793 in 2014 - 2015. The increasing trend in technical efficiency was experienced by several provinces in Indonesia, the member of inefficient or very inefficient group to be efficient as the years of observation, some of which are DI Yogyakarta, North Sumatra, North Maluku, Sumatra Barat, East Java, West Kalimantan, and Papua.

Other provinces seem be able to increase their technical efficiency in the manufacture industry sector, but unfortunately that changed is not significant so that the province remains an inefficient province technically. Some of them are South Kalimantan, Central Kalimantan and Central Sulawesi. However, even so, some provinces experienced decreasing score of their technical efficiency in the manufacture industry sector. For example, North Sumatra in Observation year 2012-2013, extremely inefficient with efficiency score 0.5015 and could feel the condition of efficient techniques in the years 2013-2014 with efficiency score 1.6275, but should be classified in very inefficient for 2014 - 2015 with score 0.6479. This is indicates that North Sumatra in the manufacturing industry production process had not had a policy that remains in determining the combination of the optimum input-output. Had experienced an increasing score in 2013-2014 indicates that in these observations North Sumatra had managed to combine the use of input - output in the manufacturing industry sector so it can be achieve efficient technically. But unfortunately, in the years 2014 - 2015, a policy change by the managerial system in the use of input - output so actually get the highest technical inefficiency. The same thing experienced by the province of Maluku.

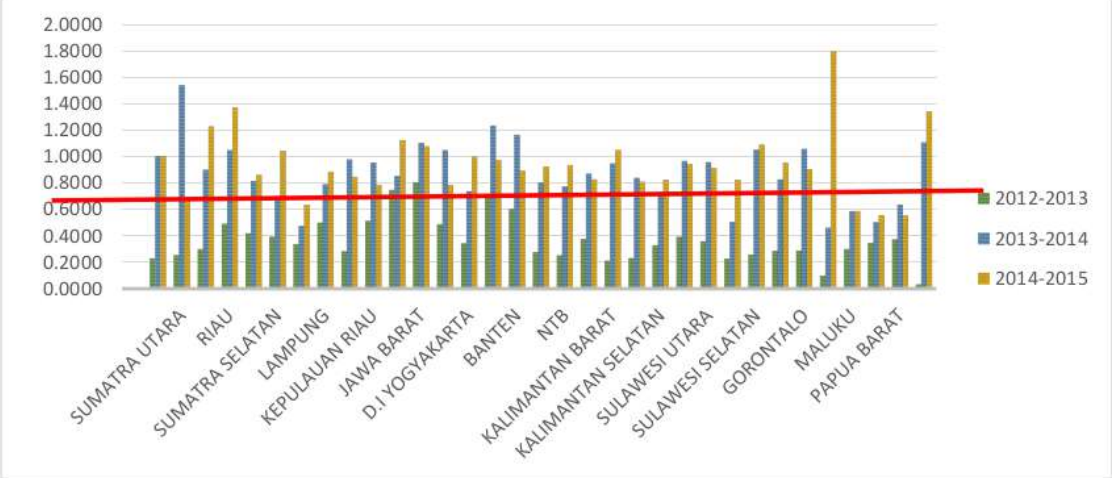
The Changes in Total Factor Productivity (TFPC) of Manufacturing Industry for 33 provinces in Indonesia

The first TFP measurement result is technical efficiency change (TEC). TEC is a growth rate of efficiency of Decision Making Unit (DMU) of the current year (t) to next year (t+1) as measured from the change in technical efficiency assuming constant returns to scale (CRS). However on

Malmquist models used by the author, the results are divided into TFPC and the TEC. In this study the authors used Malmquist - Luenberger Index, which is the measurement of productivity and technical efficiency when DMU produce undesireable output Chung et al. (1997).

Graph 1 shows, the period 2012-2013 all provinces in Indonesia could not reach ML> 1. This means that during the period of Indonesian manufacturing industry degraded mainly in suppressing the production of emissions. This is caused by incorrect use of technology to optimize the proctivity in Indonesia's manufacturing industry. In the period 2013 - 2014, there were 8 provinces been able to increase its productivity by achieving ML> 1, one of which the highest is the North Sumatra with a score ML 1.5395. This is indicates that, North Sumatra in these observations have managed to increase productivity by suppressing the production of emissions and improve good output in the manufacturing industry. But unfortunately, in the period 2014-2015, there are 23 provinces in Indonesia degraded their productivity in the manufacturing industry sector. North Sumatra is one of them, experienced a drastic reduction in the ML with a final score of 0.6677. In contrast to Sumatera, West Sulawesi experienced a significant productivity improvement. In the period 2012 - 2013 West Sulawesi only achieve 0.0966, and rise in the period 2013-2014 to 0.4605, and increase rapidly with the highest productivity scores 1.7978. This indicates that the West Sulawesi has been precise in the use of technology in the production process of manufacturing industry sector, it is supported by the high index of ML indicating the province succeeded in increasing desireable and undesireable output along with reduced production output.

Graph 1. Total Factor Productivity (TFP) change of Manufacturing Industry for 33 provinces in Indonesia.



CONCLUSION

There were 17 provinces observation in a state of inefficiency, the ranges between 0.750-0.999. This indicate less optimal control of governments toward manufacturing sector, in synergy to define policies in the production process, to achieve operational efficiency. Although, technically, the majority of manufacturing industries are efficient, yet, in fact, only a few provinces can

increase their productivity by increasing desirable output, while reducing undesirable output. This indicates that the implementation and control (law enforcement) by the local government to the implementation of environmental policy against the perpetrators of the manufacturing industry need to be further improved. This suggests that technically majority provinces in Indonesia is on the sustainable industrial process. By means of it, the government can encourage the majority industries to achieve the efficiency in technical issues by increasing the use of proper technology and environmental friendly production process. Furthermore, investation of technology sphere is important. Nevertheless, capital insentive can eradicate number of labour due to dismissal, hence investation supposed to be balance between capital insentive and labour insentive. Eventually, productivity can be raised up as well as reduce unemployment.

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ATTACHMENT

Attachment 1

Table 1. Operational Efficiency of Manufacturing Industry for 33 provinces in Indonesia.

Operational Efficiency Score	2012	2013	2014	2015
1.00 (Efficient)	1. Riau 2. Bengkulu 3. Lampung 4. Jakarta 5. West Java 6. Central Java 7. East Java 8. Banten 9. East Nusa Tenggara 10. North Sulawesi 11. Gorontalo 12. West Sulawesi 13. Maluku 14. North Maluku 15. West Papua	1. Riau 2. Jambi 3. South Sumatra 4. Bengkulu 5. Lampung 6. Riau Islands 7. Jakarta 8. West Java 9. Central Java 10. Special Region of Yogyakarta 11. East Java 12. Banten 13. West Sulawesi 14. Maluku 15. North Maluku 16. West Papua	1. Riau 2. Jambi 3. Bengkulu 4. Lampung 5. Riau Islands 6. Jakarta 7. West Java 8. Central Java 9. East Java 10. Banten 11. East Nusa Tenggara 12. Sulawesi Utara 13. West Sulawesi 14. Maluku 15. North Maluku 16. West Papua	1. West Sumatra 2. Riau 3. Bengkulu 4. Lampung 5. Jakarta 6. West Java 7. Central Java 8. East Java 9. Banten 10. East Nusa Tenggara 11. North Sulawesi 12. Gorontalo 13. West Sulawesi 14. Maluku 15. North Maluku 16. West Papua
0.750 – 0.999 (Inefficient)	1. Aceh 2. North Sumatra 3. West Sumatra 4. Jambi 5. South Sumatra 6. Bangka Belitung 7. Riau Islands 8. Special Region of Yogyakarta 9. Bali 10. West Nusa Tenggara 11. West Kalimantan 12. Central Kalimantan 13. South Kalimantan 14. East Kalimantan 15. Central Sulawesi 16. South Sulawesi 17. Papua	1. Aceh 2. North Sumatra 3. West Sumatra 4. Bangka Belitung 5. Bali 6. West Nusa Tenggara 7. West Kalimantan 8. Central Kalimantan 9. South Kalimantan 10. East Kalimantan 11. Central Sulawesi 12. South Sulawesi 13. Sulawesi Tenggara 14. Papua	1. Aceh 2. North Sumatra 3. West Sumatra 4. South Sumatra 5. Bangka Belitung 6. Special Region of Yogyakarta 7. Bali 8. West Nusa Tenggara 9. West Kalimantan 10. Central Kalimantan 11. South Kalimantan 12. East Kalimantan 13. Central Sulawesi 14. South Sulawesi 15. Sulawesi Tenggara 16. Papua	1. Aceh 2. North Sumatra 3. Jambi 4. South Sumatra 5. Bangka Belitung 6. Riau Islands 7. Special Region of Yogyakarta 8. Bali 9. West Nusa Tenggara 10. West Kalimantan 11. Central Kalimantan 12. South Kalimantan 13. East Kalimantan 14. Central Sulawesi 15. South Sulawesi 16. Sulawesi Tenggara 17. Papua

Table 2. Technical Efficiency Change (TEC) of Manufacturing Industry for 33 provinces in Indonesia.

Operational efficiency Score	Year 2012 – 2013	Year 2013 – 2014	Year 2014 – 2015
1.00 (Efficient)	1. Riau 2. Jambi 3. Bengkulu 4. Lampung 5. Riau Islands 6. Jakarta 7. West Java 8. Central Java 9. Yogyakarta 10. Banten 11. EastNusa Tenggara 12. West Sulawesi 13. North Maluku 14. West Papua	1. Aceh 2. North Sumatra 3. Riau 4. Jambi 5. Lampung 6. Bangka Belitung 7. Riau Islands 8. Jakarta 9. West Java 10. Central Java 11. East Java 12. Banten 13. East Nusa Tenggara 14. North Sulawesi 15. South Sulawesi 16. Gorontalo 17. West Sulawesi 18. West Papua 19. Papua	1. Aceh 2. West Sumatra 3. Riau 4. South Sumatra 5. Lampung 6. Jakarta 7. West Java 8. Central Java 9. Yogyakarta 10. East Java 11. Banten 12. EastNusa Tenggara 13. North Sulawesi 14. South Sulawesi 15. Gorontalo 16. North Maluku 17. West Papua 18. Papua 19. West Kalimantan
0.750 – 0.999 (Inefficiency)	1. South Sumatra 2. East Java 3. Bali 4. West Nusa Tenggara 5. South Kalimantan 6. East Kalimantan 7. North Sulawesi 8. South east Sulawesi 9. Gorontalo 10. maluku	1. West Sumatra 2. Bengkulu 3. Jogyakarta 4. Bali 5. West Nusa Tenggara 6. West Kalimantan 7. Central Kalimantan 8. East Kalimantan 9. South east Sulawesi 10. maluku	1. Jambi 2. Bangka Belitung 3. Bali 4. West Nusa Tenggara 5. Central Kalimantan 6. South Kalimantan 7. East Kalimantan 8. Central Sulawesi 9. SouthEast Sulawesi
0.5 – 0.7499 (very inefficient)	1. Aceh 2. North Sumatra 3. West Sumatra 4. Bangka Belitung 5. West Kalimantan 6. Central Kalimantan 7. Central Sulawesi 8. South Sulawesi 9. Papua	1. South Sumatra 2. South Kalimantan 3. Central Sulawesi 4. North Maluku	1. North Sumatra 2. Maluku

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