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DOES EFFICIENCY CONVERGENCE OF ECONOMY PROMOTE TOTAL FACTOR PRODUCTIVITY? A CASE OF INDONESIA

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This study investigates the relation between the efficiency converging moment and Total Factor Productivity of Indonesia's economy. The intriguing finding is that although efficiency convergence was speeding towards the frontier as well as the catching-up patterns, the finding showed a negative productivity at a nearly zero level. Particularly, the negative productivities were mostly exhibited by Indonesia's eastern regions. Technical Change that experienced a statistical downturn seemed to have discouraged this productivity. Variables such as investment might have played a significant role in this case. This study recommends making regulations on investment spending in each province, so that regional productivities can be improved.

Keywords: Efficiency, Convergence, Total Factor Productivity
JEL Classification: O47, O40, O49

1. INTRODUCTION

For more than two decades since the Asian financial crisis, Indonesia has been attempting to stabilize and improve its economy. The Central Bureau of Statistics (BPS) noted that, post 1998 crisis, the economic growth improved from year to year from -13.13% in 1998 to 0.79% in 1999, and to 4.92% in 2000. However, the global economic turmoil had caused uncertainty that resulted in fluctuating growth trends. Although Gross National Product (GDP) growth once hit a peak of 6.35% in 2007, the US crisis occurred in 2008 and led to decreasing the growth to 4.63% in 2009.

This fluctuated performance might influence regional productivity in Indonesia. As Kumbhakar and Wang (2005) suggested, regions might fall short of producing maximum possible (frontier) output due to the incompetence of financial institutions or inapposite regulatory intervention, leading thereby to economic inefficiency. Although Indonesia's economic crisis in 1997 has been recovered through the growth improvement, with more than 25 provinces owned by Indonesia, there should be a different ability to recover its economy. As Barro and Sala-i-martin (1992) suggested, poorer countries might have a more rapid catching-up process than the wealthier ones; regions with slower development in a poor country could move into the frontier (convergence) which then leads to the economic improvement. Hence, the growth distribution issue and catching up moment have emerged and been an intriguing discussion that emphasizes the inequality growth that might happen after an economic turmoil in a country.

In the last two decades, Indonesia has attempted to implement various policies to recover from the 1997 crisis and improve its economic growth, for instance, by emphasising a greater role of investment spending. Investment has been encouraged continuously to contribute greater to the long-term benefits. This is because Indonesia relies on its domestic consumption as the largest contributor to the economic growth for more than 50% since 1994 (CEIC Data, 2019) although consumption can be easily impacted by the purchasing power, hence is vulnerable to global recession.

There are large number of studies which argue that investment promotes the growth of GDP in Indonesia (e.g. Sjafii, 2009; Nizar et al., 2013). Meanwhile, the neoclassic theory suggests that economic growth (when it comes to output per person) is not sustainable without prolonged increases in Total Factor Productivity (TFP). This is because factor accumulation shows decreasing returns that are ultimately self-defeating (Margono et al., 2011). Nevertheless, research on the TFP measurement for the case of Indonesia is still underdeveloped[1].

Research on the catching-up effects and TFP measurement specific to Indonesian economy, by far, has only been conducted by Margono et al. (2011). Other investigations on specific TFP cases were conducted by using different approaches such as in the research of Wibisono (2005) and Eng (2009). Meanwhile, this study contributes to some intriguing issues: (1) the efficiency convergence moment approach that would detect regional efficiencies move toward or away from the frontier; (2) the efficiency catching up moment approach that would highlight the catching-up effect induced by regions with lower efficiency on the regions with higher efficiency; (3) the efficiency dispersed convergence moment that would show the regions efficiency convergence to the average level; (4) the measurement of Total Factor Productivity to find whether the convergence moment has the same pattern with TFP (when efficiency convergence occurs, TFP growth will be positive).

Margono et al. (2011) contended that technical efficiencies contributed to the TFP growth of Indonesia from 1993 to 2000 in 26 provinces. However, our study aims at investigating whether the efficiency convergence moment has the similar pattern with Total Factor Productivity growth in 29 provinces in Indonesia from 2002 to 2017. As the use of a single country consisting of several regions increases the possibility of regions

[1] The most recent research date back to 2014, five years from now, and the dataset was collected in 2010. Examples of previous research include Eng (2009), Margono et al. (2011), Arsana (2014).

facing a similar production frontier (Margono et al., 2011), we use provincial data instead of cross-countries data, which also distinguishes this study from the prior ones (e.g. Kneller and Stevens, 2003; Kumbhakar and Wang, 2005). Indonesia consists of provinces with different economic and governmental policies; therefore, our study would be distinguished for its representation of a country's diversity comparable to the dataset at the cross-countries level.

This study offers many practical implications, one of which is informing policy making in economic development. It could also evaluate how the macroeconomic performances are expanded either in specific provinces by emphasizing productivities growth or in simultaneous analyses by highlighting the efficiency convergence moment, so that the proposed policies could be tailored following the condition of each province. Furthermore, the current policy of Indonesia, such as investment intensification, could be also highlighted following our result, so that Indonesia could be a role model for other developing countries in the world.

The rest of this study is divided into four section. Section 2 of this paper is a literature review of the previous research on the Indonesia's economy, the theory of efficiency linked to the production frontier, the convergence notion and the existing studies. Section 3 explains this study's methodology, data, model and technical analysis. Section 4 presents the results and discussion while Section 5 concludes the paper.

2. LITERATURE REVIEW

2.1. The Economy of Indonesia

Indonesia is a large country divided into 34 provinces as of 2019. There are five large islands of Indonesia namely Sumatera, Kalimantan, Sulawesi, Papua and Java. However, according to the 2010 census, 57% of the 250 million population of Indonesia is merely centralized in Java Island. This condition leads to the inequality of output (captured by Gross Domestic Regional Product) owned by each province. Although Java Island only has 6 provinces, one of which is the capital city, Jakarta, the Central Bureau of Statistics noted that Java Island has averagely more than 60% of the aggregate GDRP of the 29 provinces in Indonesia from 2002 to 2017. Hence, this condition indicates that the output inequality among regions continued to exist for the last 16 years.

Indonesia's economy is contributed to by several sectors. These sectors are captured in the expenditure of GDRP. There are six main expenditures that fostered Indonesia's economic growth: household consumption, non-profit institutions serving households consumption expenditure, general government consumption expenditure, gross fixed capital formation, changes in inventories and net export of goods and services. The data of the Central Bureau of Statistics (2017) illustrated that household consumption is the largest expenditure spending of Indonesian economy at 40% in 2017. Meanwhile, Gross Fixed Capital Formation (GFCF) capturing investment circumstance merely reached

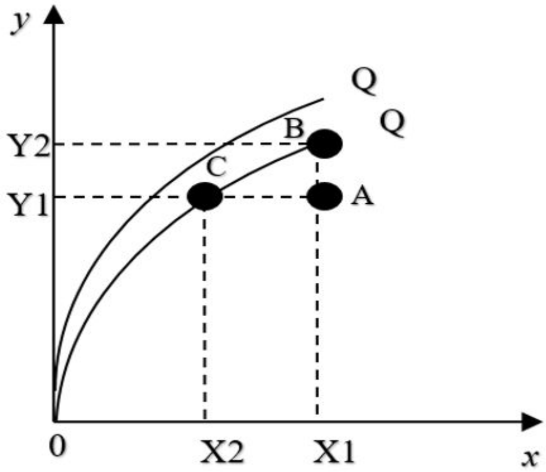
23% in 2017. This condition emphasized that Indonesian economy is still supported by household consumption, which is consumptive, instead of GFCF, which is more sustainably productive and lucrative for long-term economic stability. Whereas, Cohen and Leventhal (1989) suggested that capital formation is an essential indicator for any country to be self-sufficient, job opportunities expansive, and increase the standard of living of people. As could be seen, for instance, the Foreign Direct Investment (FDI) could foster economic growth through a spill-over effect such as transferring the knowledge of technology and growing capital formation (Budiharto et al., 2017).

As the population reached 250 million of whom more than 50% is labor (as of 2017), Indonesia's economy is labor intensive, which means that the use of labor is essential in the resulting output. Lubis (2014) maintained that the number of laborers significantly contributes to foster the growth of the Gross Domestic Regional Product of 33 provinces in Indonesia. Lubis (2014) also stressed the role of the government in developing human capital to boost productivity. There is also a side-to-side relation between economic growth and human capital, as mentioned by Lubis (2014). On one side, economic growth (supported by government spending for labor incentive) would provide any resources that can possibly foster human development in the sustainable term. While on the other, the good-quality human development would promote the agile economic growth. However, the Central Bureau of Statistics recorded that the domestic labor that works outside Java Island (for example, in Sumatera, Kalimantan) and the eastern region (like in Sulawesi, Maluku and Papua) reached 40.9% in 2017. This indicates that the human resources for labor are not well-dispersed along the region.

2.2. Theory of Efficiency and Production Frontier

Efficiency is a moment when an output increment leads to the diminishing of other outputs in the least amount and an escalation of at least one input (Koopman, 1951). Subsequently, Coelli et al. (2005) defined efficiency in a more specific context: technical efficiency is a moment when producers manufacture different products with minimal input or when they optimize input to produce more products. Technical efficiency will be measured and possibly not reach the optimal level. When this context occurs, technical inefficiency exists. The illustration of technical efficiency and other components is in Figure 1.

The concept of Technical Efficiency (Figure 1) is associated with the Production Possibility Frontier (PPF). Q1 as the frontier denotes the most optimal production rate with zero inefficiency. X is the input to produce Y. Points B and C represent the optimal production level. There are two possible movements of A to achieve efficiency. In the first case, inefficiency emerges at Point A because by using input at X1, point A is only able to produce output at Y1. Point A is still able to produce output up to Y2, which is the same output as point B by using a similar level of input. The second case is when point A utilizes more input than point C, point A produces an equal output at Y1. Hence, point A can reduce the use of input to reach efficiency. The second case is an instance of using scale economies to improve productivity. For more advanced cases, productivity needs to be compared over time, which is often referred to as technical change/technical progress (TP) capturing the role of technology as illustrated by the movement from Q1 to Q2 or the upward (progress) and downward (regress) shift of the production frontier.



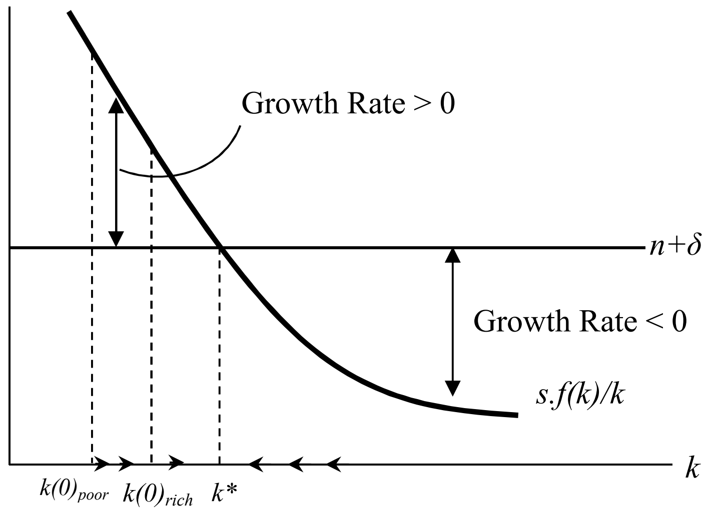
Source: Coelli et al. (2005).

Figure 1. Production Frontier, Technical Efficiency, and Technical Change

2.3. Theory of Convergence

The theory of convergence was originated from the Neoclassical Sollow growth model (Sollow, 1956), which assumes that growth is mainly determined by the physical capital factor such as saving and investment as well as labor (population growth), while Technological progress is considered as residual. The Neoclassical Theory postulates that a country's per capita economic growth has a negative correlation with the initial output level and income level (Ramsey, 1928; Sollow, 1956). This notion was then deriving the theory of income convergence in which a steady state might occur as the economic growth level decreases along with the income level surging.

Figure 2 provides the illustration of the Sollow Swan model showing how the growth trend eventually converges into a steady state. In the Sollow Swan model, the saving curve $(s.f(k)/k)$ and the effective depreciation line $(n+\delta)$ represent the growth of the capital ratio and labor (k). The lag between the saving curve and the effective depreciation line is noted as economic growth and is expected to decrease over time. Barro and Sala-i-martin (1992) then considered this theory in case of universal poverty in which the ratio of capital and labor of poor countries at the beginning period ($k(0)_{poor}$) is greater than that of the richer countries ($k(0)_{rich}$). This condition is recognized as convergence within the catching-up effect.



Source: Barro and Sala-i-martin (2004).

Figure 2. Convergence Theory

2.4. Existing Studies

The convergence trend consists of inflation convergence and efficiency convergence. Inflation convergence was mainly investigated from the experiences of the European Union being an economy with a single currency (see Kocenda and Papell, 1997; Motengua-Gomez, 2002; Lopez and Papell, 2012; Purwono et al., 2020). Meanwhile, efficiency convergence comprises two patterns, converging among the countries (Barro and Sala-i-martin, 1992) and converging into the frontier (Battese and Coelli, 1995; Kumbhakar and Wang, 1995). In both patterns, inefficiency occurs when production operates inside the frontier line that is the most optimal production rate because output can still be increased by using the same technology and input levels (Margono et al., 2011).

Further research on efficiency includes a decomposition of productivity growth factors (Orea, 2002; Kumar and Russel, 2002), which means investigating technological change/progress (TP) and scale economies. By doing so, the source of the TFP growth of a country should become identifiable. Research on efficiency in Indonesia mostly analyses TFP at the micro level (e.g. Suyanto et al., 2009; Sari et al., 2016; Yasin, 2020). Research at the macro level is still underdeveloped and only few studies have addressed this area (e.g. Margono et al., 2011). Other studies (e.g. Wibisono, 2005) consider technological transfer as the main driver of convergence in regional income and argue that government policies have a major influence on the technological diffusion among regions to achieve rapid and sustainable regional economic growth.

3. METHODOLOGY

3.1. Data

This study's data was collected from the Central Bureau of Statistics of Indonesia (BPS). The output was Gross Domestic Regional Product (GDRP) in the 29 provinces in the period 2002-2017. This was as a proxy for the Gross Domestic Product (GDP) in the studies of Kneller and Stevens (2003) and Kumbhakar and Wang (2010). The input was investment by empowering the data of the Gross Fixed Capital Formation (GFCF) (Becerril-Torres et al., 2010) defined by BPS as the expenditures for capital goods with a service life of more than a year and that are not consumer goods. GFCF includes residential and non-residential buildings, other facilities such as roads and airports, as well as machinery and equipment. Another input is the number of laborers (Becerril-Torres et al., 2010). To avoid data bias due to annual price change, we adjusted GDP and GFCF to Consumer Price Index (CPI) within the basis year of 2012. The descriptive statistic is displayed in Appendix 1.

3.2. Model and Technical Analysis

Regarding the efficiency convergence test, we employed two models: Translog (TL) production function (Model 1) by Kumbhakar and Wang (2005) and the model introduced by Margono et al. (2011) which was adapted from the cross-country panel data.

$$y_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 l_{it} + \beta_3 k_{it}^2 + \beta_4 l_{it}^2 + \beta_5 (k.l)_{it} + \beta_6 (k.t)_{it} + \beta_7 (l.t)_{it} + \beta_8 t + v_{it} - u_{it}, \quad (1)$$

$$u_{it} = \alpha_0 + \alpha_1(t) + \alpha_2\left(k_{it_0} - l_{it_0}\right) + \omega_{it}, \quad (2)$$

$$v_{it} \sim N(0, \sigma_v^2), \quad (3)$$

$$u_{it} \sim N^+(u_i, \sigma^2). \quad (4)$$

In the model above, i and t refer to provinces and year, y_{it} is the log of output, k_{it} is log of gross fixed capital formation, l is the log of number of workers. We also included a time trend (t) variable adhering what was conducted in the research of Kneller and Stevens (2003) and Kumbhakar and Wang (2005). v_{it} is the error distribution in the assumed normal distribution. u_{it} refers to the inefficiency index which is presumably distributed in a half-normal non-negative area. ω denotes a truncated normal random variable with zero mean and variance σ_u^2. We estimated those parameters by employing Stochastic Frontier Analysis (SFA) within Maximum Likelihood Estimator (MLE). We employed both models by Kneller and Stevens (2003) and Kumbhakar and Wang (2005) because they investigated efficiency convergence with specific parameters, namely $\underline{t}$ and capital labor ration at the beginning period $(k_{it_0} - l_{it_0})$. Both parameters were expected to depict the convergence moment along the frontier line. The model in Cobb Douglas (CD) production function was used as an alternative model that ignores $\beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ (Model 2). We tested both Model 1 and Model 2 to select the most appropriate one. The test was Log-Likelihood Ratio Test (LLR Test) with the following formula:

$$\lambda = -2[\lambda(H_0) - \lambda(H_1)], \tag{5}$$

where $\lambda(H_0)$ and $\lambda(H_1)$ are the value of Log Likelihood of null hyphotesis (Cobb Douglas) and alternative hypothesis (Translog). The Likelihood Ratio Test aims to choose the proper production function to calculate technical efficiency. This method views λ as a parameter by considering the Log Likelihood value in each production function. If λ is larger than χ^2 table, the null hypotheses are rejected, thus Translog should be accepted.

We also included efficiency convergence analysis with its β-convergence and σ-convergence. These views were initiated by Barro and Sala-i-martin (1992) who tested convergence based on economic growth. However, the convergence test in studies by Weil (2009), Wild (2016) and Carvallo and Kasman (2017) was conducted via the efficiency level. A study by Carvallo and Kasman (2017) employed the fixed effect model to estimate the convergence parameter, but this model was ruled out in the current research because of its potential endogeneity problem and explanatory variable omittance (Wild, 2016). As a final result, the Generalized Method of Moments (GMM) developed by Arellano and Bond (1991) was selected for testing the convergence. The equation of β-convergence (Eq. 6) and σ-convergence (Eq. 7) are specified below.

$$\ln(EFF_{it}) - \ln(EFF_{i,t-1}) = \theta_0 + \theta_1 \ln(EFF_{i,t-1}) + \varepsilon_{qt}, \tag{6}$$

$$\Delta W_{it} = \Phi_0 + \Phi_1 W_{i,t-1} + \varepsilon_{qt}, \tag{7}$$

where EFF_{it} is the technical efficiency of the province i in the year of t and $EFF_{i,t-1}$ refers to the technical efficiency of the province i in the year of $t-1$. θ_1 refers to the β-convergence parameter that will turn negative when efficiency converges. $MEFF_{it}$ is the mean of the Natural Logarithm (ln) of EFF_{it} in each period, $W_{it} = \ln EFF_{it} - MEFF_{it}$, $\Delta W_{it} = W_{it} - W_{i,t-1}$, Φ_1 is the σ-convergence parameter that will turn negative when efficiency converges. The test of specification is compulsory in GMM to ensure the appropriacy of the specified model. In this case, differentiated autocorrelation (AR) in the error term is appropriate (Gnangnon, 2019), so we termed AR(2) as an order of autocorrelation. This test decides that a p-value greater than 10% means no autocorrelation. The Sargan test was also used to ensure the validity, with the condition: if the probability of the chi-Square value is lower than its significance rate at 10%, the model is not valid.

Total Factor Productivity (TFP) growth was also calculated and decomposed to check if efficiency convergence brought a positive productivity. The decomposition is specified as below.

$$TFPg_{it,t-1} = TEC_{it,t-1} + TC_{it,t-1} + SEC_{it,t-1} \quad (8)$$

where $TFPg_{it,t-1}$ is the Total Factor Productivity growth between period t and $t-1$. TFP growth consists 3 components. The first component is $TEC_{it,t-1}$ denoting technical efficiency change of period t and $t-1$. The calculation is specified as follows.

$$TEC_{it,t-1} = \ln\left(\frac{TE_{it}}{TE_{it-1}}\right) \times 100, \quad (9)$$

where TE_{it} is the technical efficiency of period t and estimated from $\exp(-u_{it})$ in the Eq. (2). The second component is $TC_{it,t-1}$ that is Technical Change or Technological Progress and requires calculating the partial derivative of Eq. (1) with respect to time at each data point. The formula of $TC_{it,t-1}$ is specified as follows.

$$TC_{it,t-1} = 0.5[\partial y_{it-1}/\partial_t + \partial y_{it}/\partial_t] \times 100. \quad (10)$$

The third component is $SEC_{it,t-1}$ that is Scale Efficiency Change and requires calculation of production elasticity for each input at each data point, such as two equations as follows.

$$\epsilon_{nit} = \frac{\partial y_{it}}{\partial xn_{it}} = \beta_n + \frac{1}{2}\sum_{n=1}^{2}\sum_{m=1}^{2}\beta_{nm}xm_{it} + \beta_{nt}t, \quad (11)$$

$$\epsilon_{Tit} = \sum_{n=1}^{N}\epsilon_{nit}, \quad (12)$$

where ϵ_{nit} is the elasticity of each input and ϵ_{Tit} is the total elasticity. we can construct the scale factors at each data point from the Eqs. (11) and (12) as follows.

$$SF_{it} = (\epsilon_{Tit} - 1)/\epsilon_{Tit}, \quad (13)$$

$SEC_{it,t-1}$ between period t and $t-1$ is given by the summation of the average of the scale factor for the i-th province between the two periods multiplied by the change in the respective input usage. The formula is specified as follows.

$$SEC_{it,t-1} = \frac{1}{2}\sum_{n=1}^{N}[((SF_{it} \times \epsilon_{nit}) + (SF_{it-1} \times \epsilon_{nit-1}))(xn_{it} - xn_{it-1})] \times 100. \quad (14)$$

4. RESULTS AND DISCUSSION

The estimation results are provided in Table 1, showing the Maximum Likelihood Estimation (MLE) for Model 1 and Model 2. Since the Translog model parameter cannot be directly interpreted (Kumbhakar and Wang, 2005; Sari et al., 2016), we measured elasticity of each input by employing the equation: (11)-(14).

Table 1. MLE Estimation Results

	Translog		Cobb Douglas	
	Coefficient	Standard Error	Coefficient	Standard Error
Production Frontier				
β_0	21.242***	1.219	3.071***	0.194
β_1 (K)	-0.463*	0.267	0.727***	0.015
β_2 (L)	-0.881***	0.277	0.216***	0.020
β_3 (K^2)	0.022*	0.012	-	-
β_4 (L^2)	0.028	0.027	-	-
β_5 (KL)	0.023	0.038	-	-
β_6 (KT)	0.015***	0.006	-	-
β_7 (LT)	-0.022***	0.009	-	-
β_8 (T)	0.009	0.076	-0.003	0.006
Inefficiency Effect				
δ_0	1.230***	0.182	-0.072	0.145
δ_1 (T)	-0.163***	0.016	-0.198***	0.073
δ_2 (K_{t_0}/L_{t_0})	-0.228***	0.045	-0.467*	0.242
σ_u^2	0.108***	0.011	0.369***	0.118
γ	0.552***	0.071	0.820***	0.054
Log-Likehood Ratio	-35.26		-108.13	

Note: ***: significant at 1%, **: significant at 5%, *: significant at 1%.

The comparison between the results of Translog (TL) and those of Cobb-Douglas (CD) weighed heavily in the capital and labor influence towards GDRP. Most coefficients in the model of production are significant. The estimated parameter γ denotes the variance of the inefficiency components of the error term, σ_u^2 divided by the total variance, $\sigma_u^2 + \sigma_v^2$ (Margono et al., 2011). It could be concluded that about 55.2% (TL) and 82% (CD) of the variation came from inefficiency components, not a measurement error. Hence, the utilization of the stochastic frontier model was appropriate. The TL model shows negative signs of labor and capital variables. This is in line with the research of Margono et al. (2011) and Becerril-Torres et al. (2010). Conversely, the CD model shows negative signs for both capital and labor. This finding is supported by Kneller and Stevens (2003) and Kumbhakar and Wang (2005) - the convergence parameters are presented in Table 1. In terms of the speed of convergence, according to the γ-parameter, TL converges slower (55.2%) than CD (82%). The Log-Likehood Ratio for TL and CD were calculated to determine the proper production function. To achieve this, we employed the formula in equation (5). The result showed that the λ-statistic was 145.74, which was larger than the χ^2 table. Hence, the Translog production function was appropriate to use in further investigation. The result on Table 1 implicates that provinces in Indonesia experience efficiency convergence. This means that there is a trend of moving towards the frontier which is the optimal value of production. The role of investment spending, captured by capital formation, and human capital, captured by the number of laborers, are proportionally well contributing to the resulting Gross Domestic Regional Product of provinces.

Efficiency convergence parameters used by Kneller and Stevens (2003) and Kumbhakar and Wang (2005) showed negative signs. Therefore, we then used the efficiency scores to estimate the β-efficiency convergence (Barro and Sala-i-martin 1992; Weil, 2009; Wild, 2016; Carvallo and Kasman, 2017). By employing the dynamic panel regression, the result of the estimation is as follows:

Table 2. Test of β-Convergence Estimation Results

	Translog	
	Coefficient	Standard Error
θ_0	-0.000***	0.000
θ_1	-0.240***	0.002
AR(1)	0.013**	
AR(2)	0.116	
Sargan Test (χ^2: 90)	28.920	

Note: ***: significant at 1%, **: significant at 5%, *: significant at 1%. Estimates of *Lag-1* of Dependent Variable is not reported due to space limitation consideration.

In Table 2, the convergence parameter results showed similar negative signs which means that there was β-convergence. In the Translog model, efficiency convergence was observed in the period 2002-2017 with the convergence speed being 24%. This means that there was a negative correlation between the initial level of efficiency and the speed of convergence (see Table 1). It could then be concluded that provinces with a low initial level of efficiency experienced faster growth than the provinces with a high initial level of efficiency. We could see that even though there were some provinces that were probably left behind, due to the economic turmoil or crisis issue, there was still a catching-up effect of those provinces towards the well performing provinces. Hence, a β-Convergence of efficiency score exists.

We also calculated the σ-convergence to investigate the patterns of a cross-province dispersion. Convergence occurs when dispersion decreases over time. The σ-convergence captures each province's speed to converge towards the average provincial efficiency. The results are presented in the following table:

Table 3. Test of σ-Convergence Estimation Results

	Translog	
	Coefficient	Standard Error
θ_0	0.001**	0.001
θ_1	-0.312***	0.006
AR(1)	0.067*	
AR(2)	0.243	
Sargan Test (χ^2: 90)	24.680	

Note: ***: significant at 1%, **: significant at 5%, *: significant at 1%. Estimates of *Lag-1* of Dependent Variable is not reported due to space limitation consideration.

The analysis showed that there was a σ-Convergence of efficiency over the period 2002-2017. This means that the provinces were converging towards the average level of efficiency. We corroborated the results by calculating the distribution of efficiency deviation (Montuenga-Gomez, 2002) as presented in Figure 3 below:

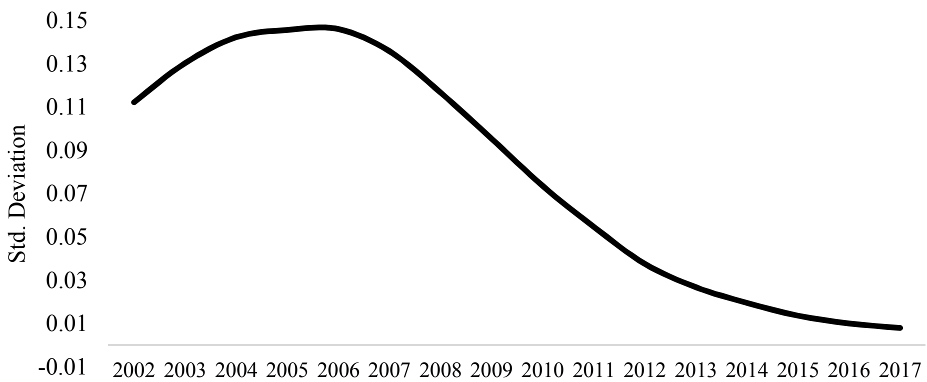


Figure 3. Technical Efficiency Dispersion

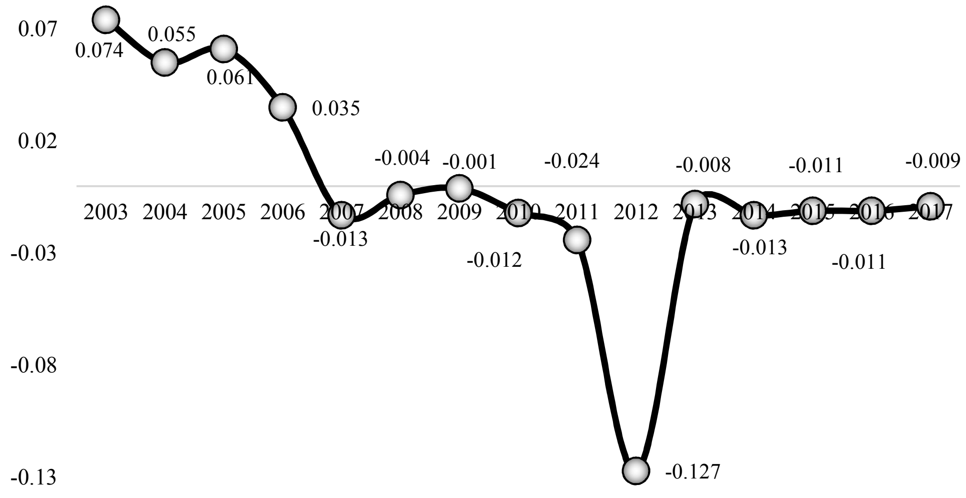
Figure 3 shows that the technical efficiency calculated by using Translog and Cobb-Douglas experienced a negative dispersion trend throughout 2006-2017 although in the first three years it experienced an increase. This means that the gaps in the efficiency level among provinces were reduced in the 15-year period. The movement speed towards the frontier was in line with the catching-up effect of the provinces with a lower efficiency score. Hence, we may assume that provinces not only successfully catch up for efficiency score, but also discourage the efficiency inequality among provinces by showing the efficiency score trend towards the average level.

To reveal whether technical efficiency contributed to economic productivity, we calculated TFP along with its individual component in both models. The estimation is presented in the Table 4.

Table 4. Total Factor Productivity (TFP) and its constituents

	Translog	
	Mean	Standard Deviation
EFF	0.778	0.212
TC	-0.033	0.022
TEC	0.065	0.069
SEC	-0.034	0.084
TFP	-0.0006	0.020

Note: TFP is the sum of TC, SEC, and TEC.



Source: Authors

Figure 4. Total Factor Productivity of Indonesia

Because Margono et al. (2011) only examined efficiency two years after the 1997 Asian Financial Crisis, the observed trend was mainly negative. This is because the magnitude of the disruption's impact on the economy was still the greatest. The current research examines the five-year period after the Asian Financial Crisis.

As shown in Figure 4, five years after the Asian Financial Crisis, TFP was at a positive level (7.4%), which was common in the post transition period (Firdausy, 2005). This finding confirms previous research findings (Arsana, 2014; Eng, 2009). However, the trend started to decline in 2005 until it reached its lowest point at -1.3% in 2007.

We performed a partial analysis focusing on each province to investigate the greatest contributor to the TFP decline. The result is provided in Appendix 2. All provinces experienced a negative TFP over the period 2002-2017. There were 15 provinces with a positive TFP and 14 provinces with a negative TFP. There were 14 provinces with a negative TFP in each year during the period of investigation. North Maluku was the region with the most frequent negative TFP (14 out of 15 years) and the lowest average growth at -13.3%. The same occurred in the years 1994-2000 (Margono et al., 2011). The lowest TFP in Maluku reached -106.4% in 2012, but in the following year it recovered to -1.3%. Meanwhile, Jakarta did not experience a negative TFP during the period 2002-2017. This calculation is similar to that presented by previous research showing that Jakarta had the greatest growth among 26 provinces over the period 1994-2000 (Margono et al., 2011). It is noteworthy that this finding is the opposite of the results found by Wibisono (2005) demonstrating that the largest TFP mostly came from the eastern regions of Indonesia. The results of our research might be a proximity for the more real developmental inequality i.e. infrastructure development that happens between the western and eastern regions of Indonesia (Rosmeli, 2015).

Jakarta showed the highest average TFP over the period 2002-2017. We obtained this result by comparing variables among provinces with the rank of technical efficiency. This summary is provided in Table 5.

Table 5. Share of Regions for Each Variable

Variables	Rank	Province	Share	Rank of Average Technical Efficiency
GDRP	1	Jakarta	17.28	4
	2	East Java	15.13	13
	3	West Java	13.90	8
	4	Central Java	8.93	18
	5	Riau	6.08	2
GFCF	1	Jakarta	23.62	4
	2	East Java	13.06	13
	3	West Java	10.81	8
	4	Central Java	8.29	18
	5	Riau	5.77	2
Labor	1	East Java	18.06	13
	2	West Java	16.48	8
	3	Central Java	15.53	18
	4	N. Sumatera	5.38	7
	5	Jakarta	4.07	4

Source: Tabulated by Authors

As shown in Table 5, Jakarta had the largest share of Gross Domestic Regional Product (GDRP) and Gross Fixed Capital Formation (GFCF) at more than 17%. The share of labor was the fifth largest among others (at 4.07%). Jakarta also had the fourth largest Technical Efficiency, at 86.4% on average over the period 2002-2017 (See Appendix 3 for the complete results of Efficiency Scores). This indicates that the level of GFCF might have played a considerable role in boosting the efficiency rate and inducing a positive TFP growth. Meanwhile, Table 6 shows that investments, e.g. Foreign Direct Investment (FDI), were mainly allocated in the western region of Indonesia, e.g. Java and Sumatera, and were concentrated largely in Jakarta. This condition has widened the gaps between the western and the eastern parts of Indonesia. It should also be highlighted that Central Kalimantan was a region with the largest average efficiency level (92.2%). Central Kalimantan had a moderately good amount of GDRP and GFCF. Among 29 provinces, it was the tenth highest for GDRP and the twelfth highest for GFCF. Labor in Central Kalimantan was merely 0.92% of the national labor, hence moderate level of input, but it managed to proportionally produce a high GDRP. Therefore, Central Kalimantan could be a good model for other regions to produce at an optimal level to reach a maximum efficiency.

Indonesia has experienced an increasing economic growth since the 1997 crisis. The disparity in efficiency amongst regions is also decreasing. However, referring to the Neoclassical model, economic growth may be non-sustainable if TFP is not considered. It is necessary to examine every TFP constituent, namely the downturn of Technical Change. Investment captured by GFCF is also important as it may significantly boost the economic growth. Manifestations of GFCF include infrastructure, machines, transportation, and intellectual property, and these have a greater multiplier effect compared to domestic consumption and will significantly boost operational efficiency in any given economic activity.

The distribution amongst the GFCF components is also important. We discovered that more than 70% of GFCF spending was for infrastructure development i.e. buildings, which might have caused technological regress in Indonesia. Decreasing trends of building development means reallocation for other GFCF components such as machinery and utilities, which may have caused a positive TFP in the following year. This phenomenon is yet to be investigated to gather sufficient evidence. Hence, future research is required to address this question.

The policy implication of this study emphasizes such variables of our study like Gross Fixed Capital Formation as a form of investment. Government could foster capital growth in each province, notably the eastern region, through attracting Foreign Direct Investment (FDI). As the long-term characteristic to operate in a country, FDI would be enormously lucrative for Indonesia as a developing country. As FDI comes from developed countries, there would be a transfer of knowledge among individuals, such as the transfer of knowledge on the sophisticated technology to boost labor productivity. The government should attract investors to establish projects in the eastern region by promoting various economic potencies. Nevertheless, this promotion should be followed by providing a good infrastructure for supporting accessibility and mobility, such as the establishment of roads and bridges. This notion is contended as the absence of such facilities not only could hamper the investment in the eastern region, but also enlarge the inequality growth issues due to the lack of accessibility.

Another variable is labor. Labor as human capital should be developed as early as possible to achieve a good quality of labor. For instance, the vocational and skill education system arranged by the government has functions to generate expert laborers in certain specialties. As the laborers have their own specialty in working, this policy would significantly increase the contribution of labor to foster economic productivity in Indonesia. However, the fact that each different region might own a different labor capability, there should be a labor policy that ponders the characteristic of each region. Regional governments play an essential role in dealing with this issue by arranging and adopting appropriate vocational and skill curriculum. Moreover, the transfer of knowledge for either the spatial dimension (from the western region such as Sumatera and Java-Bali to the eastern region) or the generation dimension (from old to young generations) is essential to ensure the occurrence of the equality of good human capital, so that economic efficiency could be equal among provinces (convergence) and productivity could show a positive trend.

5. CONCLUSION

The current research has shown that there is a similar pattern between efficiency converging and Total Factor Productivity. We found that provinces in Indonesia experienced efficiency convergence from 2002 to 2017 in all cases: convergence to the frontier, catching-up amongst regions, as well as convergence to the average level of efficiency score. However, TFP showed negative values at nearly zero, which is in contrast with what happened during the period 2002-2006 that showed a positive TFP. Statistically, Technical Change with its negative value played a significant role in the analysis, so it is suggested that spending allocation should be directed to machinery or technology. At the provincial level, the negative productivities were exhibited by the eastern regions. This finding contradicts with some prior studies that discovered the larger growth of the eastern regions. It is Jakarta that showed a positive value throughout the entire period. The contribution of its GFCF which is the largest among all regions might have improved Jakarta's performance in the last 16 years. Finally, the top five largest GFCF spending was in the west of Indonesia (e.g. Java and Sumatera), which means that investment spending has always been dominantly in the west, rather than the east, of Indonesia. Regulation is needed to address this issue to support equality through achieving, for example, an infrastructure development or a technological upgrade in the eastern regions, so that all provinces can experience a positive productivity. The limited tested period due to the lack of regional data is the main issue of this study. Therefore, future research is required to capture more measurement of Total Factor Productivity.

APPENDIX

Appendix 1. Descriptive Statistic

Variable	Unit		Years							
			2002	2003	2004	2005	2006	2007	2008	2009
GDRP	Billion Rupiah	Mean	28183.7	32689.3	41181.5	58281.2	72673.4	88282.6	120800.0	135200.0
		Std. Deviation	38657.1	45472.9	56955.2	80251.3	100900.0	121100.0	165200.0	185600.0
GFCF	Billion Rupiah	Mean	5983.3	6600.5	8626.5	12016.4	15069.2	19064.0	26341.9	30565.0
		Std. Deviation	10284.4	11323.6	15082.2	21101.1	25668.8	31876.4	41907.2	47067.9
Labor	Worker (in thousand)	Mean	3132.9	3171.5	3203.2	3193.9	3221.4	3372.0	3456.1	3533.8
		Std. Deviation	4433.0	4432.9	4518.4	4561.9	4588.5	4850.2	4838.6	4953.4
Variable	Unit		Years							
			2010	2011	2012	2013	2014	2015	2016	2017
GDRP	Billion Rupiah	Mean	164300.0	193800.0	287800.0	345300.0	421600.0	475300.0	532100.0	602000.0
		Std. Deviation	224400.0	264800.0	378300.0	456900.0	561100.0	640500.0	719200.0	814600.0
GFCF	Billion Rupiah	Mean	37833.4	45670.0	92568.6	108200.0	133400.0	151200.0	169200.0	191900.0
		Std. Deviation	57744.2	71263.3	135600.0	156900.0	191800.0	214900.0	236100.0	269500.0
Labor	Worker (in thousand)	Mean	3641.7	3614.8	3785.8	3794.9	3855.1	3850.5	3966.6	4057.1
		Std. Deviation	4878.9	4884.5	5161.3	5192.7	5208.6	5155.8	5153.4	5468.0

Note: Mean: arithmetic average, Std. Deviation: Standard Deviation

Appendix 2. Total Factor Productivity and the Decomposition in Each Province

Province	TFP Growth															Average				
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TFP Growth	TE	TEC	TC	SE
Aceh	0.304	0.032	-0.171	-0.057	0.006	-0.060	-0.028	-0.049	-0.026	-0.142	-0.012	-0.019	-0.020	-0.011	-0.017	-0.018	0.867	0.042	-0.032	-0.029
North Sumatera	0.078	0.095	0.106	0.066	-0.015	0.006	-0.002	-0.010	-0.007	0.004	0.007	0.009	0.008	-0.002	0.009	0.024	0.827	0.053	-0.036	0.005
West Sumatera	0.066	0.101	0.091	0.066	0.022	-0.009	-0.021	-0.041	-0.041	-0.094	-0.006	-0.028	-0.009	-0.018	-0.005	0.005	0.811	0.061	-0.032	-0.025
Riau	0.150	0.070	0.123	0.047	0.011	-0.010	-0.008	-0.004	0.001	-0.002	0.011	0.008	0.010	0.011	0.011	0.029	0.873	0.043	-0.013	-0.003
Jambi	0.053	0.053	0.085	0.056	-0.082	0.044	-0.043	-0.079	-0.047	-0.133	-0.032	-0.019	-0.018	-0.013	-0.021	-0.013	0.790	0.068	-0.034	-0.049
South Sumatera	0.069	0.086	0.133	0.039	0.039	0.034	-0.004	-0.008	-0.024	-0.037	0.014	0.006	0.001	0.006	-0.003	0.023	0.799	0.060	-0.031	-0.008
Bengkulu	0.042	0.032	0.035	0.041	-0.132	-0.006	-0.004	-0.069	-0.074	-0.637	-0.007	-0.020	-0.006	-0.014	-0.019	-0.056	0.741	0.077	-0.041	-0.094
Lampung	0.104	0.067	0.031	0.124	0.053	-0.011	-0.003	-0.015	-0.028	-0.082	-0.011	0.002	-0.017	-0.005	-0.011	0.013	0.779	0.069	-0.041	-0.017
Bangka Belitung	0.089	0.003	0.012	0.029	-0.233	0.000	0.007	0.001	-0.022	-0.059	-0.057	-0.061	-0.041	-0.035	-0.040	-0.027	0.768	0.068	-0.024	-0.073
Jakarta	0.127	0.062	0.093	0.071	0.050	0.046	0.024	0.036	0.019	0.084	0.039	0.051	0.030	0.037	0.037	0.054	0.864	0.037	-0.004	0.020
West Java	0.073	0.084	0.134	0.093	0.046	0.059	0.002	0.007	-0.007	0.066	0.009	0.027	0.010	-0.003	0.004	0.040	0.813	0.054	-0.045	0.030
Central Java	0.085	0.094	0.149	0.069	0.055	0.063	0.023	0.012	-0.003	0.060	0.012	0.029	0.010	-0.005	0.012	0.044	0.775	0.065	-0.050	0.027
Yogyakarta	0.032	0.059	0.057	-0.012	0.102	0.044	0.062	0.039	0.010	-0.019	-0.037	-0.034	-0.021	-0.029	-0.018	0.016	0.724	0.076	-0.035	-0.027
East Java	0.107	0.095	0.139	0.087	0.072	0.056	0.014	0.018	-0.003	0.084	0.016	0.024	0.013	0.018	0.010	0.050	0.798	0.060	-0.045	0.033
Banten	0.090	0.065	0.083	0.060	0.063	-0.027	-0.012	0.003	0.007	0.017	0.006	0.006	-0.005	-0.005	0.010	0.024	0.801	0.057	-0.032	-0.003
Bali	0.112	0.055	0.093	0.025	-0.132	-0.043	-0.006	-0.048	-0.031	-0.050	-0.004	-0.004	-0.021	-0.008	-0.014	-0.005	0.788	0.062	-0.036	-0.032
West Nusa Tenggara	0.064	0.117	0.069	0.087	0.006	0.042	0.036	-0.008	-0.010	-0.078	-0.015	-0.016	-0.021	-0.019	-0.023	0.015	0.754	0.071	-0.034	-0.023
East Nusa Tenggara	0.060	0.086	0.053	0.020	0.050	0.046	0.089	0.057	0.027	0.072	-0.029	-0.059	-0.027	-0.023	-0.016	0.027	0.678	0.087	-0.037	-0.025
West Kalimantan	0.072	0.099	0.043	0.037	-0.106	-0.094	-0.026	-0.024	-0.027	-0.141	-0.008	-0.007	-0.012	-0.008	-0.017	-0.015	0.794	0.060	-0.040	-0.037
Central Kalimantan	0.033	0.056	0.002	-0.036	-0.033	-0.042	-0.021	-0.017	-0.021	-0.009	-0.019	-0.018	-0.008	-0.017	-0.003	-0.010	0.922	0.021	-0.011	-0.021
South Kalimantan	0.054	0.072	0.062	0.009	-0.058	-0.032	0.040	0.041	-0.035	-0.063	-0.029	-0.029	-0.030	-0.016	-0.025	-0.003	0.736	0.076	-0.039	-0.041
East Kalimantan	0.040	0.063	0.032	0.066	0.056	0.033	-0.016	-0.041	-0.062	-0.269	0.013	0.004	0.010	0.008	0.020	-0.003	0.766	0.074	-0.028	-0.051
North Sulawesi	0.087	0.076	0.050	0.038	-0.037	-0.080	-0.038	-0.040	-0.025	0.011	-0.011	-0.024	-0.037	-0.025	-0.012	-0.004	0.861	0.043	-0.018	-0.031
Central Sulawesi	0.031	0.008	0.080	0.042	0.063	0.021	-0.026	-0.008	-0.021	-0.147	-0.011	-0.046	-0.002	-0.007	-0.001	-0.002	0.703	0.085	-0.031	-0.057
South Sulawesi	-0.057	-0.076	0.122	0.086	0.064	0.080	0.085	0.049	0.023	-0.211	0.036	0.028	0.018	0.019	0.011	0.019	0.550	0.132	-0.059	-0.058
Gorontalo	0.027	0.127	0.058	0.017	-0.032	-0.062	-0.043	0.011	-0.050	0.153	-0.057	-0.075	-0.049	-0.042	-0.029	-0.003	0.829	0.053	-0.015	-0.042
Maluku	0.016	-0.046	0.024	-0.010	-0.125	-0.055	-0.010	-0.114	-0.128	-1.064	-0.013	-0.039	-0.023	-0.046	-0.037	-0.111	0.714	0.084	-0.049	-0.148
North Maluku	0.159	-0.021	-0.307	-0.195	-0.064	-0.134	-0.118	-0.017	-0.066	-1.002	-0.015	-0.050	-0.053	-0.057	-0.062	-0.133	0.658	0.095	-0.048	-0.182
Papua	-0.025	-0.025	0.285	0.040	-0.079	-0.031	0.007	-0.035	-0.036	0.007	-0.025	-0.032	-0.012	-0.007	-0.016	0.001	0.799	0.059	-0.024	-0.036
INDONESIA	0.074	0.055	0.061	0.035	-0.013	-0.004	-0.001	-0.012	-0.024	-0.127	-0.008	-0.013	-0.011	-0.011	-0.009	-0.001	0.779	0.065	-0.033	-0.034

Appendix 3. Technical Efficiency Score in Each Province

Province	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Aceh	50.9%	69.1%	77.9%	78.6%	83.8%	88.2%	90.1%	91.5%	93.2%	94.6%	92.7%	94.3%	95.0%	95.4%	95.9%	96.4%
North Sumatera	43.9%	51.4%	60.0%	70.7%	80.4%	83.5%	87.0%	89.6%	92.3%	94.0%	92.7%	93.9%	95.0%	95.6%	96.1%	96.6%
West Sumatera	39.0%	45.4%	54.0%	64.8%	74.6%	82.4%	88.1%	90.8%	92.7%	94.0%	93.3%	94.6%	95.4%	96.0%	96.4%	96.8%
Riau	50.8%	59.8%	67.8%	80.3%	86.6%	90.9%	93.4%	94.0%	94.8%	95.7%	96.3%	96.7%	96.9%	96.9%	97.0%	97.2%
Jambi	34.7%	40.9%	48.5%	60.3%	70.1%	75.4%	86.2%	88.8%	91.3%	93.2%	94.0%	94.8%	95.7%	96.3%	96.8%	97.1%
South Sumatera	39.1%	45.4%	52.5%	64.8%	72.1%	79.3%	86.2%	89.1%	91.6%	93.1%	90.9%	92.7%	93.9%	95.2%	95.7%	96.2%
Bengkulu	29.8%	35.8%	43.1%	54.2%	63.6%	68.6%	79.3%	85.7%	90.2%	92.7%	82.5%	87.0%	90.0%	92.4%	93.6%	94.6%
Lampung	34.2%	40.6%	48.2%	55.4%	66.9%	76.7%	83.1%	88.3%	92.0%	94.0%	91.7%	93.4%	94.7%	95.5%	96.0%	96.4%
Bangka Belitung	34.5%	42.0%	49.4%	58.8%	67.5%	66.6%	75.6%	81.4%	87.5%	90.6%	94.1%	95.1%	95.7%	96.2%	96.5%	96.8%
Jakarta	56.4%	64.7%	70.4%	77.5%	83.3%	86.8%	90.3%	92.5%	93.6%	94.4%	93.8%	94.9%	95.6%	96.2%	96.6%	96.9%
West Java	42.6%	49.0%	55.7%	65.9%	75.4%	81.2%	86.7%	90.0%	92.0%	93.5%	92.1%	94.1%	94.8%	95.5%	96.1%	96.5%
Central Java	36.2%	42.3%	48.7%	59.6%	66.5%	74.0%	81.3%	85.7%	89.8%	92.6%	89.8%	92.3%	93.6%	94.5%	95.3%	95.8%
Yogyakarta	30.6%	35.3%	40.6%	47.5%	52.4%	61.2%	69.3%	77.0%	84.1%	88.9%	93.1%	94.3%	95.1%	95.7%	96.3%	96.6%
East Java	38.6%	45.6%	53.1%	62.7%	70.8%	79.1%	85.3%	89.2%	91.6%	93.1%	91.8%	93.3%	94.5%	95.3%	95.8%	96.2%
Banten	41.4%	47.7%	54.9%	64.0%	72.5%	81.1%	83.3%	85.2%	88.1%	90.9%	93.3%	94.9%	95.6%	96.1%	96.5%	96.8%
Bali	38.5%	45.9%	53.8%	65.6%	74.1%	75.1%	79.7%	84.8%	86.8%	88.8%	90.6%	93.2%	94.7%	95.5%	95.9%	96.4%
West Nusa Tenggara	33.1%	38.2%	46.3%	54.3%	62.7%	68.7%	77.5%	83.5%	88.2%	91.3%	90.3%	92.4%	93.9%	95.5%	96.0%	96.4%
East Nusa Tenggara	26.2%	30.5%	36.1%	42.1%	46.7%	53.1%	60.4%	68.8%	77.0%	83.2%	90.8%	92.9%	93.5%	94.4%	95.1%	95.8%
West Kalimantan	39.0%	46.3%	55.6%	66.1%	75.4%	77.7%	80.5%	84.9%	89.3%	91.9%	90.1%	92.4%	93.9%	94.7%	95.5%	96.1%
Central Kalimantan	70.9%	78.2%	87.5%	92.8%	94.0%	95.0%	96.3%	96.2%	96.7%	97.1%	92.6%	94.0%	94.9%	95.6%	96.2%	96.6%
South Kalimantan	30.9%	35.9%	42.9%	52.1%	58.5%	62.7%	69.1%	77.0%	84.8%	88.3%	93.9%	94.9%	95.7%	96.2%	96.6%	97.0%
East Kalimantan	32.0%	37.0%	43.9%	52.2%	60.6%	71.1%	81.9%	87.3%	91.0%	93.1%	95.0%	95.6%	95.9%	96.1%	96.5%	96.9%
North Sulawesi	51.0%	59.4%	68.9%	77.9%	85.8%	89.4%	91.4%	92.8%	94.0%	95.0%	93.1%	94.6%	95.6%	96.1%	96.5%	96.8%
Central Sulawesi	26.9%	31.2%	36.3%	44.8%	52.5%	61.4%	70.7%	76.5%	81.5%	86.2%	89.4%	91.5%	92.4%	93.9%	94.8%	95.7%
South Sulawesi	12.8%	14.6%	16.7%	22.1%	27.2%	32.6%	41.2%	49.8%	59.1%	67.7%	81.9%	86.1%	89.1%	91.3%	92.8%	93.9%
Gorontalo	44.0%	49.3%	61.3%	72.2%	79.3%	84.6%	87.6%	91.0%	93.7%	94.1%	92.4%	94.0%	95.1%	95.8%	96.4%	96.8%
Maluku	27.2%	31.9%	37.9%	47.5%	55.7%	63.1%	73.5%	82.5%	88.3%	91.9%	83.5%	88.2%	91.3%	93.1%	94.1%	94.9%
North Maluku	22.7%	28.0%	34.0%	38.5%	43.1%	50.2%	59.6%	67.9%	78.3%	84.9%	83.4%	88.2%	91.3%	92.8%	93.8%	94.6%
Papua	39.6%	43.5%	46.6%	68.7%	76.5%	78.6%	82.8%	88.2%	90.5%	89.7%	93.9%	94.8%	95.4%	96.0%	96.6%	96.9%

Appendix 4. Technical Efficiency Rank in Each Province

Province	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Aceh	4	2	2	3	4	4	5	5	6	4	13	12	14	19	19	19
North Sumatera	7	6	7	7	6	7	8	9	8	7	12	16	13	14	14	14
West Sumatera	13	14	11	12	11	8	6	7	7	8	9	9	9	10	10	8
Riau	5	4	5	2	2	2	2	2	2	2	1	1	1	1	1	1
Jambi	17	18	17	16	16	16	11	12	13	11	4	7	4	2	2	2
South Sumatera	11	13	14	13	14	11	10	11	11	14	19	21	20	21	21	21
Bengkulu	24	23	22	21	20	21	20	16	16	15	28	28	28	28	28	27
Lampung	19	19	18	19	18	15	14	13	10	9	18	17	18	16	16	18
Bangka Belitung	18	17	15	18	17	22	22	23	22	21	3	3	3	3	6	9
Jakarta	2	3	3	5	5	5	4	4	5	5	7	4	7	5	4	6
West Java	8	8	8	10	9	9	9	8	9	10	16	13	16	15	15	15
Central Java	16	16	16	17	19	18	17	17	17	16	24	24	23	23	23	23
Yogyakarta	23	24	24	24	26	26	25	24	25	23	10	11	12	12	12	12
East Java	14	12	13	15	15	12	12	10	12	12	17	18	19	20	20	20
Banten	9	9	10	14	13	10	13	18	21	20	8	6	8	6	9	11
Bali	15	11	12	11	12	17	19	20	23	24	21	19	17	17	18	16
West Nusa Tenggara	20	20	20	20	21	20	21	21	20	19	22	22	21	18	17	17
East Nusa Tenggara	27	27	27	27	27	27	27	27	28	28	20	20	24	24	24	24
West Kalimantan	12	10	9	9	10	14	18	19	18	17	23	23	22	22	22	22
Central Kalimantan	1	1	1	1	1	1	1	1	1	1	14	14	15	13	13	13
South Kalimantan	22	22	23	23	23	24	26	25	24	25	6	5	5	4	3	3
East Kalimantan	21	21	21	22	22	19	16	15	14	13	2	2	2	7	8	4
North Sulawesi	3	5	4	4	3	3	3	3	3	3	11	10	6	8	7	10
Central Sulawesi	26	26	26	26	25	25	24	26	26	26	25	25	25	25	25	25
South Sulawesi	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Gorontalo	6	7	6	6	7	6	7	6	4	6	15	15	11	11	11	7
Maluku	25	25	25	25	24	23	23	22	19	18	26	27	26	26	26	26
North Maluku	28	28	28	28	28	28	28	28	27	27	27	26	27	27	27	28
Papua	10	15	19	8	8	13	15	14	15	22	5	8	10	9	5	5

Appendix 5. 29 Provinces in Indonesia

Region of Sumatera		Region of Java-Bali		Regions of Kalimantan		Regions of Eastern	
1	Aceh	10	Jakarta	17	West Kalimantan	21	West Nusa Tenggara
2	North Sumatera	11	West Java	18	Central Kalimantan	22	East Nusa Tenggara
3	West Sumatera	12	Central Java	19	South Kalimantan	23	North Sulawesi
4	Riau	13	Yogyakarta	20	East Kalimantan	24	Central Sulawesi
5	Jambi	14	East Java			25	South Sulawesi
6	South Sumatera	15	Banten			26	Gorontalo
7	Bengkulu	16	Bali			27	Maluku
8	Lampung					28	North Maluku
9	Bangka Belitung					29	Papua

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