

Analysis of Efficiency and Change of Productivity in The Indonesian Banking Industry Using Data Envelopment Analysis (DEA) and Malmquist Total Factor Productivity

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Abstract. - This empirical study aims to identify differences in efficiency and productivity between state-owned banks, national foreign exchange private banks, and national non-foreign exchange private banks from 2010 – 2016. In the initial step, 43 banks listed on the Indonesia stock exchange were grouped into three groups. Then, we selected sampling using purposive sampling with the criteria of banks with an effective IPO date starts from 2010 onwards, and incomplete financial reports are excluded from sampling. The result was that 21 banks were selected as sampling and represented three bank groups. The research methods applied in this study were Data Envelope Analysis (DEA), Malmquist Total Productivity, and Paired Sample t-test. The outcomes suggest that: (1) national non-foreign exchange private banks have higher efficiency than two other bank groups, (2) change in the productivity of national foreign exchange private banks is powerfully vulnerable to the technological shift rather than changes in technical efficiency. The superiority of group national non-foreign exchange private banks was more efficient in reducing input costs such as labor costs and third-party funds. To cope with these problems, banks in Indonesia need to prompt innovations and advanced technology to improve efficiency and productivity.

Keywords: Banks, Efficiency, Productivity, DEA, Malmquist Total Indeks, Paired t-test

INTRODUCTION

Banks hold a critical role in the national economic system as they provide significant contributions in financing economic development. As an intermediation institution, banks mobilize saving and allocate them to the most productive and growth-promoting activities (Mahran, 2012). This is reflected through the market share size of the banking industry that dominates approximately 83% of Indonesian financial sector assets in the last quarter of the year 2016 (Bank Indonesia 2016). Indonesia's economic development, therefore, is greatly affected by the soundness of the banking sector.

Recent developments in the banking industry are confronted by a new challenge, that is, the implementation of the ASEAN Economic Community (AEC). The presence of AEC will automatically increase the banking competition between South-East Asian banks and potentially threaten domestic banks. On that account, local banks must continuously improve their operational efficiency to be able to compete with foreign banks from other South-East Asian countries.

Banks' credit growth was seen declining during the last four years. On the other side, the growth of third-party fund (TPF) remains above 10%.

Banks in Indonesia still capable of generating a high degree of net interest margin due to large spreads between loan rates and deposit rates. However, as soon as the AEC program starts being implemented, the foreign banks' appearance will pose a severe threat. In the light of this matter, banks in Indonesia must enhance their competitiveness level through efficiency improvements.

Given the previous discussions, the issue of banking efficiency has still become an interesting topic to study. Existing literature had used a wide variety of approaches in examining banking efficiency, either by linking the efficiency with capital level, ownership structure, or types of bank (Denizer et al., 2000; Altunbus et al.; Drake & Hall 2003; and Luciano & Regis 2007). In most cases, past empirical analysis regarding the banking efficiency in Indonesia only emphasized on the efficiency of individual banks and specific bank groups. Research conducted on individual banks' efficiency (Putri & Lukviarman 2008; Mulyadi 2015) found that only a small number of banks in Indonesia consistently performed efficiently. A study conducted by Purwokusuma (2012) showed that only 17 banks (2009), 16 banks (2010), and 13 banks (2011) out of the total sample studied, managed to achieve a full technical efficiency during 2009 to 2011. Hadad et al. (2002) examined



banking efficiency based on bank groups. They reported that the National Non-Foreign Exchange National Private Bank group was the most efficient bank compared to other bank groups

Based on the results of the existing literature, there are still problems that have not been discussed in the previous studies. In our study, we attempted to focus on the analysis of banking efficiency and changes in productivity on three different types of banks. Banks were grouped into the State-Owned Bank (SOB), National Foreign Exchange Private Bank (NFEPB), and National Non-Foreign Exchange Private Bank (NNFEPB). The results of this study are expected to identify precisely the problems of banking efficiency and productivity in Indonesia. Moreover, this research was a consideration with a thought to know the level of the competitiveness of the national banks. Data Envelope Analysis (DEA) and Malmquist Total Factor methods were utilized in this study.

1. Efficiency

Efficiency, as explained by Hadad et al. (2003), is one of the performance metrics which underlies all organizational performance. The ability to produce maximum output with existing inputs is the expected performance. Besides, a separation between units and prices allows the identification of technology efficiency, allocative efficiency, and total efficiency level. Further investigation on the allocation of inputs and outputs also can be done to see the causes of efficiency (Budi, 2010).

2. Productivity

Productivity is the state in which resources are being well-managed and utilized to their maximum in favor of achieving the optimal results. Any changes in the output and Input will consequently affect the level of productivity.

3. Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) was initially introduced by Charnes, Cooper, and Rhodes in 1978. Data Envelopment Analysis (DEA) is a nonparametric approach to the development of Linear Programming (LP). This approach serves to assess the efficient use of resources (input) to achieve results (output) whose purpose is to maximize efficiency. Likewise, it is used to empirically measure the production efficiency of the Decision-Making Unit (DMU).

4. Research Framework

Data Envelopment Analysis serves to assess the efficient use of resources (Input) to achieve results (output) whose purpose is to maximize efficiency. In this study, the use of the Thinking Framework as follows:

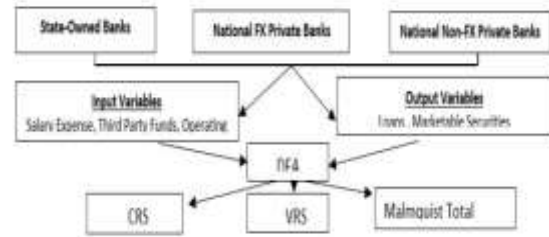


Figure 1. Research Framework Scheme

5. Hypothesis

Based on previous theoretical review, we develop the following hypothesis:

- Ha₁ : There is a difference in efficiency between national foreign-exchange private banks and state-owned banks.
- Ha₂ : There is a difference in efficiency between national non-foreign-exchange private banks and national foreign-exchange private banks
- Ha₃ : There is a difference in efficiency between national non-foreign-exchange private banks and state-owned banks.

Hypothesis for productivity

- Ha₄ : There is a difference in productivity between national foreign exchange private banks and state-owned banks.
- Ha₅ : There is a difference in productivity changes between national private foreign exchange banks and national non-foreign exchange private banks.
- Ha₆ : There is a difference in productivity between national non-foreign exchange private banks and state-owned banks.

RESEARCH METHOD

1. Population and Sample

The object of this study is all banks listed on the Indonesian Stock Exchange from 2010 to 2016. Purposive sampling was the technique we had selected by setting specific criteria, namely banks with an effective IPO date starts from 2010 onwards, and incomplete financial reports are excluded from sampling. The result was that 21 banks were selected as sampling and represented three bank groups.

2. Data Analysis Technique

Once we found out the Efficiency value and Malmquist Total Productivity value, we subsequently examined our assumptions by employing a paired sample t-test. This test is used to determine whether

there is an average difference between the two related groups.

a. Efficiency Measurement

It is already mentioned that DEA is a method to calculate the relative efficiency of a decision-making unit (DMU). Efficiency, Z , is a ratio between the total amount of output to the total number of inputs and mathematically expressed as:

$$Z = \frac{\text{Total Output}}{\text{Total Input}}$$

b. Constant Return to Scale

The Constant Return to Scale model is a basic form of DEA model that uses the constant return to scale assumption and has implications for an efficient linear set. Initially, developed by Charnar, Cooper dan Rhodes (i.e., CCR Model) in 1978, this model assumes an equal ratio between input and output addition.

c. Variable Return to Scale

This model assumes that the company does not or has not yet operated at an optimal scale. The ratio between the addition of input and output will present different results (Variable Return to Scale). That is, the amount of output increase will not adjust proportionally to the rise in input.

d. Measurement of the Malmquist Productivity Index

Malmquist Index is a DEA method that can be used to examine nonparametric panel data. It is often used to identify changes in the productivity level of a DMU. The index value generally can be derived from technological changes and efficiency changes. The productivity level is increasing when the Malmquist Index of a DMU shows a value higher than one (Increasing Return to Scale).

RESULT AND DISCUSSION

1. Banking Industry Efficiency

Descriptive statistics information provided in Table 1 exhibits that, on average, the level of technical efficiency of the overall banking industry in Indonesia declined from 2010 until 2012 before starting to fluctuate in the subsequent years. A significant increase in the efficiency of Indonesian banks occurred in 2016, rising to 87,3 percent from 82,80 percent in 2015.

Table 1. Average DEA Efficiency Value

Effisiensi	2010	2011	2012	2013	2014	2015	2016	2010 - 2016
Mean CRS TE	87,60%	83,90%	82,90%	85,10%	85,90%	82,80%	87,30%	85,10%
Mean VRS PE	96,10%	93,60%	89,90%	90,80%	92,40%	89,80%	94,00%	92,40%
Mean SE	91,30%	90,10%	92,90%	94,30%	93,50%	92,90%	93,10%	92,60%

Source: author's calculation using DEAP 2.1 software.

Notes: CRS TE : *Technical Efficiency Change*, VRS PE : *Pure Technical Efficiency*, SE: *Scale Efficiency*

Given the external factors that are likely to affect the national general banking industry, the decline in banking efficiency that occurred in 2015 may also be affected by macroeconomic conditions. Indonesian economy has been disrupted by the depreciation of the rupiah, mainly due to the uncertainty over the Fed's interest rate hike plans. The fluctuations in the Indonesian currency (Rupiah) exchange rate eventually can lead to an economic slowdown.

Table 2. DEA Efficiency Value

Bank Group		Efficiency	Min.	Max.	Mean	Std. Dev
National Exchange Banks	Foreign-Private	CRS TE	0.963	1.000	0.894	0.112
		VRS PE	0.889	1.000	0.985	0.034
		SE	0.623	1.000	0.908	0.109
State-Owned Banks		CRS TE	1.000	1.000	0.928	0.144
		VRS PE	1.000	1.000	1.000	0.000
		SE	0.713	1.000	0.928	0.144
National Foreign-Exchange Private Banks	Non-Private	CRS TE	1.000	1.000	1.000	0.000
		VRS PE	1.000	1.000	1.000	0.000
		SE	1.000	1.000	1.000	0.000

Source: author's calculation using DEAP 2.1 software.

Notes: CRS TE : *Technical Efficiency Change*, VRS PE : *Pure Technical Efficiency*, SE: *Scale Efficiency*

In the course of our research period, as can be seen in Table 2, the average value of national non-foreign-exchange private banks technical efficiency

in Indonesia was 100 percent. The research result above also shows that national non-foreign-exchange private banks had a better average efficiency value

than other bank groups. These national non-foreign-exchange banks could achieve a better efficiency result, probably due to well-managed input.

2. Banking Industry Productivity

Productivity analysis was carried out using the Malmquist Index Productivity (MPI) method or widely known as Malmquist Index (MI). Malmquist Index (MI) parameter regularly used to measure the productivity change of a decision-making unit (DMU).

Table 3. Average Malmquist Index for the period of 2010 – 2016

	Years	effch	techch	pech	sech	tfpch
NFEPB	2011	0,961	1,080	0,966	0,998	1,025
	2012	1,055	1,015	1,022	1,035	1,071
	2013	0,970	1,026	0,965	1,006	0,997
	2014	1,019	1,118	1,018	1,001	1,154
	2015	0,950	0,984	0,960	0,990	0,938
	2016	1,081	0,968	1,082	0,999	1,049
SOB	2011	0,950	1,049	1,000	0,950	0,992
	2012	1,048	0,999	1,000	1,048	1,047
	2013	1,042	1,037	0,989	1,055	1,081
	2014	0,979	1,049	1,012	0,968	1,027
	2015	0,992	1,029	0,996	0,996	1,021
	2016	1,031	0,953	1,000	1,031	0,982
NNFEPB	2011	1,000	1,461	1,000	1,000	1,461
	2012	0,539	0,911	0,539	1,000	0,442
	2013	1,012	1,296	1,012	1,000	1,307
	2014	1,046	0,771	1,058	0,988	0,822
	2015	1,000	0,935	0,987	1,013	0,932
	2016	1,005	0,985	1,011	0,994	0,990

Source: author's calculation.

Table 3 provides information about technical efficiency change in national non-foreign-exchange private banks with the largest figures and presents a score greater than 1 (Eff Ch > 1) three times. In 2011, 2014, 2015, the MI index equals to 1,000, 1,046, 1,000, respectively. In regards to pure efficiency change, the highest MI index score also happens to be drawn by national non-foreign-exchange private banks: 1,000 in 2011, 1,012 in 2013, and 1,058 in 2014. State-owned banks successfully secured the largest value for scale efficiency change category with scores equal to 1,048 in 2012, 1,055 in 2013, and 1,031 in 2016. National foreign-exchange private banks attained the highest productivity change value based on total factor productivity change four times with TFP value greater than 1 (tfpch > 1).

Refer to the results table above, and it can be concluded that national foreign-exchange private banks are more productive than other groups. Productivity change in technical efficiency occurred between 2011 and 2012, while from 2012 to 2016, there were shifts in the productivity due to technological progress. These findings are in line with the research outcome discovered by Suzuki et al. (2011).

3. Regression Test Results for Efficiency

To answer the hypothesis, a series of regression tests (paired sample t-test) was conducted to identify the difference in efficiency and productivity level between bank groups. The results are as follows:

Table 4. Efficiency Difference Between National Foreign Exchange Private Banks, State-Owned Banks, and National Non-Foreign-Exchange Private Banks

	t-stat	Sig.
NFEPB– SOB	8,542	0,000
NFEPB – NNFEPB	10,110	0,000
SOB – NNFEPB	12,328	0,000

Source: author's calculation using SPSS 22 software

Examination results for all bank groups presented in Table 4 above report that each pair is proven to have statistically significant t-stat value at all significance level (p-value < 0.05). Simply put, the outcomes tell us that there are differences in efficiency levels between bank group. Therefore, we accepted Ha1, dan Ha2 dan Ha3. The variation in the level of efficiency between banks allegedly was caused by differences in the input and output conditions of each bank group.

4. Regression Test Results for Productivity

Following the examination of productivity changes for each bank group, we later performed paired sample t-tests which outcomes are tucked in the table below

Table 5. Productivity Changes Difference Between National Foreign Exchange Private Banks, State-Owned Banks, and National Non-Foreign-Exchange Private Banks

	t-stat	Sig.
NFEPB– SOB	0,408	0,700
NFEPB – NNFEPB	0,850	0,434
SOB – NNFEPB	0,887	0,416

Source: author's calculation using SPSS 22 software

The regression test results in Table 5 show that there is no difference in the level of productivity between bank groups. This can be concluded from the

study results for productivity, which was proven to be statistically insignificant at all levels of significance (p value > 0.05). Therefore, Ha4, dan Ha5 dan Ha6, should be rejected. Regardless of the type of bank, banks in all groups may have put the same effort in managing efficiency and productivity while advancing their technology.

CONCLUSION

Our research's main objective is to study the differences in the level of efficiency and productivity between state-owned banks, national foreign-exchange private banks, and national non-foreign-exchange private banks. It can be concluded that national non-foreign-exchange private bank relatively has better efficiency than other groups. Minimizing input costs such as labor costs and third-party funds will improve efficiency and coupled with output maximization efforts (e.g., loans disbursed). Another finding suggests that there are no differences in productivity levels between banks listed on the Indonesian Stock Exchange during the research period of 2010-2016. Concerning the productivity, the bank's management is suggested to take a more significant concern on technological changes than inefficiency change. Technological evolution that happened is expected to enhance operational efficiency and productivity, which eventually improve bank performance. Parametric research methods such as using the Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA), or using the Distribution Free Approach (DFA) are strongly recommended in future studies.

As a consequence, banks in Indonesia need to prompt innovations and technological advancement to improve productivity. Based on the paired sample t-test results, there were differences in efficiency between each group of banks. Meanwhile, we found the absence of productivity level differences between each group of banks. A combination of efficiency, productivity, and technological innovation will enhance the competitiveness of the Indonesia banking industry.

Our study certainly poses some weaknesses. Firstly, we did not include non-listed banks in our empirical investigation. Therefore, it does not yet represent the efficiency and productivity of the overall banking industry in Indonesia. Secondly, research outcome analysis from testing the differences in efficiency and productivity level is only applied at the group level.

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