Banking Efficiency Analysis with Data Envelopment Analysis Method on Registered Commercial Banks on the Indonesia Stock Exchange

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Abstract. This study aims to analyze the efficiency level of commercial banks listed on the Indonesia Stock Exchange for the period between 2015 and 2019 and to analyze the efficiency level of commercial banks according to bank groups based on bank core capital. This type of research was quantitative research. This study used the Data Envelopment Analysis method with a Variable Return to Scale model using an intermediation approach. The results of this study indicated that the average banking efficiency score on the Indonesia Stock Exchange during the 2015–2019 research period was 0.949630. Of the 35 banks analyzed, there were only three commercial banks that were able to maintain a level of technical efficiency of 100 percent or 1 (efficient) in a row during 2015–2019, and thirty-two other banks that had not yet achieved 100 percent or 1 efficiency. The results of the study found that large banks were more efficient than medium and small banks.

Keywords: Commercial Banks · Data Envelopment Analysis (DEA) · Efficiency

1 Introduction

Banking as a financial institution needs to have a good performance. Moreover, the increasingly fierce competition in the banking business requires banks to improve their performance in order to attract investors before investing their funds. One of the indicators used to measure bank performance is efficiency. Efficiency measurement can provide information about the condition of bank performance that is relevantly needed in decision-making.

Efficiency in banking can be measured by the comparison between the output produced and the input it has. Banking can be said to be efficient compared to its competitors if it can produce a larger output with fixed inputs or produce a fixed amount of output using fewer inputs. Efficient commercial banks can certainly attract investors to invest where efficient banks indicate that banking performance is going well.

The term efficiency comes from the field of engineering, which is used to indicate the ratio between the outputs of a system to the input of the system. Measurements in exact science are always guided by an ideal situation where the quantity of output produced is

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exactly the same as the quantity of the given input or the ratio is exactly equal to 1 (one). Efficiency in this ideal state is called ideal (absolute) efficiency whose value is 100%. This means that the amount of output produced is the same as the number of inputs used while efficiency in non-ideal (normal) conditions can be less than 100%. In reality, these ideal conditions are very difficult to achieve due to many influencing factors. One of them is that the output produced is not proportional to the existing input because of the relative efficiency condition. In this case, the efficient value of an object is not compared to ideal conditions (100%) but to the efficiency value of other objects.

Companies including go public banking with good performance and more efficiency will increase the value of the company [1]. One common way to assess a bank's efficiency is the ratio of operating costs to operating income (BOPO). BOPO ratio is used for ease of calculation and use.

Based on annual report data from Financial Services Authority (Otoritas Jasa Keuangan, OJK) that the BOPO ratio in 2015 was 82.17% and increased in 2016 to 82.85%. Entering 2017 and 2018 the BOPO ratio decreased to 79.28% and 78.33% but in 2019 the BOPO ratio increased slightly to 79.18%. From this data, the BOPO ratio in 2015–2019 fluctuated. Where a decrease in the BOPO ratio indicates an increase in efficiency, on the contrary, an increase in the BOPO ratio indicates a decrease in efficiency. This is a problem for companies, so financial performance may reflect a company's ability to optimally turn a profit.

The measurement of banking efficiency using financial ratios, and in this case the BOPO ratio has the disadvantage that it is very difficult to interpret because cost reduction does not necessarily indicate efficiency [2]. According to Bauer, et al. [3] the approach using frontier analysis is superior to using the financial ratio analysis approach to assess the performance of companies including banking.

According to Grmanová & Ivanová [4], the most commonly used approach to measure efficiency in the banking sector today is the frontier analysis approach, one of which is the data envelopment analysis (DEA) method. Furthermore, Toci & Hashi [5] said that DEA is extensively used to degree performance in lots of industries, including inclusive of banking.

Data Envelopment Analysis (DEA) is a linear program-based method that measures the efficiency level of organizational units called DMUs (Decision Making Units) [6]. Choosing appropriate inputs and outputs is a very important step when applying DEA analysis. This is a reminder that there are many different approaches to DEA analysis. Different approaches to DEA analysis also imply different input and output variables for DEA analysis. Haddad et al. [7] stated that the concepts used to define the relationship between inputs and outputs in the behavior of financial institutions are three approaches: the asset approach, the production approach, and the intermediary approach.

This study used an intermediation approach because it pays consideration to the crucial work of the bank as a mediator institution. Berger and Humphrey [8] stated that the intermediation approach is defined as the main activity of a financial institution, namely as an intermediary between surplus units and deficit units. A good production approach is used to evaluate the efficiency of branches of a financial institution, while a good and appropriate intermediation approach is used to evaluate a financial institution as a whole.

Grmanová and Ivanová [4], who conducted research on banking efficiency in Slovakia, showed that there were 7 banks that were efficient in 2009 while there were 6 efficient banks in 2013. All banks that performed well in 2013 also performed well in 2009 for Slovak banks. A similar study was also carried out by Toci and Hashi [5], who conducted research on the efficiency of banking intermediaries in South-Eastern Europe showing the efficiency of intermediaries in the banking sector. The country had a 4-year average, where the lowest value in 2003 was 0.679 and the highest value in 2004 was 0.714. In general, in the period 2002–2005, the efficiency of banking operations increased insignificantly.

The purpose of this study is to analyze the efficiency level of commercial banks listed on the Indonesia Stock Exchange for the 2015–2019 period and to analyze the efficiency level of commercial banks according to bank groups based on bank core capital.

2 Methods

This research used a quantitative type of research. The sample in this study was all commercial banks that have been consistently listed on Indonesia Stock Exchange during the period from 2015 to 2019 with complete data. The number of research samples was 35 commercial banks. The analyzed data was from 2015 to 2019 so the number of analyzed DMUs was 175 DMUs. This study used secondary data from annual financial statements.

The study used the Data Envelopment Analysis (DEA) method to assess bank efficiency. Data Envelopment Analysis (DEA) is quite popular and has been widely used to analyze efficiency in the banking industry [2]. One of the advantages of DEA is that it is able to manage multiple inputs and outputs. The input indicators in this study consist of fixed assets, interest expense, non-interest expenses, liabilities, and capital, while the output indicators used consist of investment, credit, interest income, and non-interest income.

This research used the output-oriented VRS (Variable Return to Scale) model. The output orientation was chosen because it uses an intermediation approach. According to Toci and Hashi [5], in the intermediation approach where deposits are inputs and credits are outputs, conceptually, they must choose an output orientation. If the input orientation is chosen then it means achieving the same level of output (credit) by minimizing the input used (deposit), which is the opposite of what it should be. The assumption of VRS was chosen because the bank did not operate at an optimal scale. According to Coelli et al. [9], many industries, including the banking sector, face obstacles such as government regulations and high competition which causes banks to barely operate at an optimal scale.

3 Results and Discussions

DEA is a linear program-based technique that can be used to measure the efficiency level of an organizational unit called DMU (Decision Making Unit) [9]. DEA compares the efficiency level of DMU using various inputs and outputs with similar DMU. A DMU with a score of less than 1 is an inefficient unit and a score of 1 is an efficient unit.

Table 1 shows that in 2015 there were 16 banks (46%) that were not yet efficient (efficiency value < 1) and 19 banks (54%) were included in the efficiency category (efficiency value $= 1$) with an average banking efficiency level of 0,952510. In 2016, the number of banks that were not yet efficient increased to 23 banks (66%), and only 12 banks (34%) were included in the efficient category though the average banking efficiency increased by 0.962750. In 2017 there were 19 inefficient banks (54%) where inefficient banks decreased from 2016 and 16 banks (46%) were in the efficient category though the average efficiency decreased by 0.952810 or 95.28%. In 2018, the number of inefficient banks decreased to 16 banks (46%) and 19 banks (54%) which were categorized as efficient with an average efficiency of 0.941406 or 94.14%. In 2019 the number of banks that were not yet efficient increased to 19 banks (54%) and 16 banks (46%) which were included in the efficient category with an average efficiency of 0.938674 or 93.88%.

Table 2 provides information on efficiency by bank group, where it shows that in 2015, 2016, 2018, and 2019 large banks were more efficient than medium and small banks. Meanwhile, in 2017, medium-sized banks were more efficient than large and small banks. Based on the calculation results, the average efficiency during the 2015–2019 period for large banks was 0.994592, for medium-sized banks was 0.963454, and for small banks was 0.974763, so that the overall average efficiency during the 2015–2019 period shows that large banks were more efficient compared to the group of medium and small banks.

The results of the DEA analysis obtained allow for an analysis of the overall efficiency trend of the banking sector [10]. Based on the results of this study, it was found that the number of inputs and outputs of commercial banks during the 2015–2019 period has increased from year to year, while the achievement of average efficiency at commercial banks has fluctuated. The average score of efficiency and the number of efficient banks for 5 years which was quite volatile can be caused by external factors from the banking industry which indirectly affected the performance of 175 DMU (Decision Making Units) (35 commercial banks $\times$ 5 years) as an intermediary institution in managing the inputs and outputs used in this study.

Of the 35 banks analyzed, only three commercial banks were able to maintain a level of technical efficiency of 100 percent or 1 (efficient) in a row during 2015–2019, namely BBCA, BBHI, and BTPN. Furthermore, there were thirty-two other banks that had not yet reached the level of technical efficiency, which was less than 100 percent or 1 in a row during 2015–2019. The bank's consistent inefficiency every year means that the bank has not been able to achieve the maximum output in this study. This also indicates that the performance of commercial banks on the Indonesia Stock Exchange as intermediation institutions needs to be improved in order to survive in the increasingly fierce competition.

The consistent inefficiency of banks from 2015 to 2019 means that banks have not been able to convert inputs into outputs optimally. The results of research conducted by Yannick et al., [11] regarding the assessment of technical efficiency using Data Envelopment Analysis showed that applications in the Côte D'Ivoire banking sector faced several difficulties in converting its inputs (savings) into outputs (credit) and this study tried to discuss the problem of efficiently transforming savings into credit.

Table 1. The Calculation Results of the Efficiency of the Commercial Banks on Indonesia Stock Exchange during the Period from 2015 to 2019.

Bank name	Year					Mean
	2015	2016	2017	2018	2019	
AGRO	0,935076	0,940238	0,937722	1,000000	1,000000	0,962607
AGRS	0,915691	0,988355	1,000000	1,000000	0,870694	0,954948
BABP	0,921417	1,000000	0,878557	0,934014	0,976082	0,942014
BACA	0,896875	0,995568	1,000000	0,822020	0,888686	0,920630
BBCA	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000
BBHI	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000
BBKP	0,973854	1,000000	1,000000	0,419519	0,393478	0,757370
BBMD	1,000000	1,000000	1,000000	0,966380	1,000000	0,993276
BBNI	0,944428	0,957113	0,949401	1,000000	1,000000	0,970188
BBRI	1,000000	0,989004	1,000000	1,000000	1,000000	0,997801
BBTN	1,000000	0,952816	1,000000	1,000000	1,000000	0,990563
BBYB	1,000000	1,000000	1,000000	1,000000	0,944336	0,988867
BCIC	0,937475	0,883189	0,877225	0,936718	1,000000	0,926921
BDMN	0,892593	0,994498	1,000000	1,000000	1,000000	0,977418
BEKS	1,000000	0,905196	1,000000	1,000000	1,000000	0,981039
BINA	1,000000	1,000000	1,000000	0,883535	0,890890	0,954885
BJBR	1,000000	1,000000	1,000000	0,904733	0,935408	0,968028
BJTM	1,000000	0,977666	0,912176	0,941175	0,929265	0,952056
BKSW	1,000000	0,966464	0,811238	1,000000	1,000000	0,955540
BMRI	1,000000	0,969546	0,944674	1,000000	1,000000	0,982064
BNBA	0,863186	0,838883	0,851739	0,865937	0,883948	0,860739
BNGA	1,000000	0,998852	0,985024	1,000000	0,987662	0,994308
BNII	1,000000	0,892811	0,896203	0,925662	0,858776	0,914690
BNLI	1,000000	0,994685	0,926803	0,927986	0,935449	0,956985
BSIM	1,000000	1,000000	0,937509	1,000000	1,000000	0,987502
BTPN	1,000000	1,000000	1,000000	1,000000	1,000000	1,000000
BVIC	0,928985	1,000000	0,942775	0,814710	0,952586	0,927811
INPC	0,869252	0,878534	0,851215	0,770028	0,691081	0,812022
MAYA	1,000000	1,000000	0,990424	0,951465	0,994446	0,987267
MCOR	0,918958	0,877944	0,871531	0,946828	0,983676	0,919787

(*continued*)

Table 1. (*continued*)

Bank name	Year					Mean
	2015	2016	2017	2018	2019	
MEGA	0,712870	0,998510	0,948005	0,938486	0,773879	0,874350
NISP	1,000000	0,961352	1,000000	1,000000	0,986466	0,989564
NOBU	0,799369	0,879009	1,000000	1,000000	0,976789	0,931033
PNBN	0,917997	0,912149	0,897560	1,000000	1,000000	0,945541
SDRA	0,909830	0,943858	0,938585	1,000000	1,000000	0,958455
Mean	0,952510	0,962750	0,952810	0,941406	0,938674	0,949630

Table 2. The Calculation Results of the Efficiency of Commercial Banks on the Indonesia Stock Exchange by Bank Classification Based on the Core Capital.

Bank Classification	Year					Mean
	2015	2016	2017	2018	2019	
Large Banks	0,993635	0,993197	0,986251	1,000000	0,999876	0,994592
Medium Banks	0,977595	0,986690	0,993641	0,939142	0,920204	0,963455
Small Banks	0,973595	0,968668	0,971701	0,985067	0,974785	0,974763

The efficiency level of banks can be compared based on the bank group by the bank's core capital. In this study, banks were classified into three groups of banks, namely: large banks with core capital above Rp30 trillion, a group of medium-sized banks with a core capital of between Rp5 trillion and Rp30 trillion, and small banks with core capital below Rp5 trillion.

Based on the results of the study, the average efficiency scores according to bank groups based on bank core capital during the 2015–2019 period in large banks was 0.994592, in medium banks was 0.963454, and in small banks was 0.974763. Therefore, the overall average efficiency during the 2015–2019 period showed that large banks were more efficient than the middle and small bank groups. This is also in line with research conducted by Toci and Hashi [5] regarding the efficiency of bank intermediation in Southeast Europe which stated that larger banks were more efficient than small banks. Furthermore, Grammanová and Ivanová [4] calculated bank efficiency in Slovakia stating that the largest national bank category was the most efficient among other banks. However, in contrast to the results of Kurnia's [12] research on measuring the intermediation efficiency of the eleven largest Indonesian banks, large banks were more inefficient than smaller banks where large banks both in terms of assets and fundraising as well as lending were not always efficient in carrying out their intermediation function. According to Repková [13] who used the DEA analytical approach to study the efficiency of the Czech banking sector, the result of the study showed that large groups of banks had lower efficiency than other banks in the banking industry.

4 Conclusion

The average score of banking efficiency on the Indonesia Stock Exchange during the study period (2015–2019) was 0.949630, where in 2015 it was 0.952510, in 2016 was 0.962750, in 2017 was 0.952810, in 2018 was 0 .941406, and in 2019 was 0.938674. During the research period (2015–2019), there were only three commercial banks that were able to maintain a level of technical efficiency of 100 percent or 1 (efficient), namely BBCA, BBHI, and BTPN. There were thirty-two other banks that had not yet achieved a level of technical efficiency of 100 percent (inefficiency) or 1 in a row during 2015–2019.

The results of the study based on bank groups, namely large banks, medium banks, and small banks showed that the average efficiency during the 2015–2019 period at large banks was 0.994592, at medium banks was 0.963454, and at small banks was 0.974763 so that the overall average efficiency based on bank groups during the 2015–2019 period showed that large banks were more efficient than medium and small banks.

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