

DEA Window Analysis of Indonesian Banking Industry Efficiency During COVID-19

Ririn Riani¹

¹*Tazkia Institute Indonesia*

Pandemic conditions can result in a variety of issues that can eventually cause liquidity crises and inefficiency, particularly in the banking sector. As a result, policymakers need information comparing the efficiency of different types of banks so they can develop appropriate regulations. The purpose of this research is to measure and compare the intertemporal efficiency of Islamic and conventional banks in Indonesia using Data Envelopment Analysis and DEA window analysis. This study examines the stability and efficiency of the Indonesian Banking industry from 2015 to 2020, along with the years 2019 and 2020, which highlight the Covid-19 pandemic era. The results revealed that Islamic banking received a score of 0.66, higher than conventional banking's score of 0.59. However, both exhibit a similar pattern in which the average level of efficiency decreases during the Covid-19 pandemic. From the perspective of efficiency stability analysis through various summary statistics such as standard deviation (SD), Long Distance per Window (LDW), Long Distance per Period (LDP), and Long Distance per Year (LDY), BRI, BRI Syariah, and BTN have the most relatively stable efficiency values among Indonesian banks. This study found that from 2015 to 2020, BRI is the most stable and efficient bank in Indonesia. This study suggests that Indonesia's conventional and Islamic banking systems must maximize their available resources and advance their technological capabilities to increase productivity in special circumstances like the current Covid-19 pandemic.

Keywords: Banking Industry, DEA Window, Efficiency, Stability, COVID-19.
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*Correspondence:
Ririn Riani
ririnriani@tazkia.ac.id

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INTRODUCTION

The COVID-19 pandemic has caused a level of systemic economic disruption that has not been seen before on this scale. It simultaneously shook up a number of markets and rapidly spread to both public and private financial institutions (Dunz et al., 2021). In addition to this, its effects are anticipated to be long-lasting. The COVID-19 pandemic had a significant negative impact on the economy, which was reflected in a decline in a number of macroeconomic indicators, such as aggregate production, supply, savings, investment, trade flows, and employment. The presence of COVID-19 has a negative impact on a number of different industries, including the banking industry and the sector that includes financial institutions. The operations of banks have been impacted as a result of this pandemic (Hidayat et al., 2021).

Academics and policymakers alike are interested in the topic of what effect the COVID-19 pandemic will have on the world's financial markets. Lockdowns are imposed by governments in an effort to stop the spread of a disease, but this has the unintended consequence of causing individuals and businesses to run into financial and liquidity problems (Bartik et al., 2020). As a consequence of this, borrowers all over the world experienced a drastic and unnatural increase in their credit risk due to the pandemic. The decline in bank lending may have been caused by a combination of factors, including falling demand for loans as well as tighter credit market conditions (Rabbani et al., 2021).

The large number of business owner customers who had difficulty paying their obligations to banks, which resulted in bad loans, was the impetus for the impact that Covid-19 had on the various industry sectors that comprise the banking industry. The rise in the proportion of loans that are considered to be non-performing (NPL), as well as funding freezes, are two of the direct effects that Covid-19 has had on the banking industry (Baldwin & Weder, 2020). The banking industry is not immune to the effects of the pandemic, and it is suffering alongside its customers. This was especially noticeable during the second quarter of 2020, which was also the time that the stock market experienced a significant decline. On the other hand, in contrast to the Asian financial crisis that occurred in 1997 and 1998, the issue facing banks at the moment is not so much a lack of liquidity as it is a deterioration of their loan portfolios.

Because of recent rapid developments, even during the most recent global financial crisis, researchers and policymakers all over the world continued to make comparative evaluations of the different types of banking industries utilizing a wide variety of metrics to measure the effectiveness of banks. Their capacity to bring the COVID-19 epidemic under control will vary depending on the regulations, policies, and performance directions that are in place. As a consequence of this, it

is essential to have information regarding bank efficiency performances that compares the various types of banks, so that policymakers can develop regulations that are appropriate and suitable for each sector of the banking industry (Zaini & Karim, 2015).

Efficiency is a reflection of a company's performance and is regarded as a concerning factor for stakeholders in the process of formulating rational strategic decisions to lower the risk level of banking operation, the evaluation of the efficiency of banks will become increasingly important as a result of the conditions described above. Efficiency measurements are carried out in order to measure a bank's performance, particularly in the midst of the COVID-19 pandemic. Pandemic conditions can result in a variety of problems, some of which can result in financial distress and inefficiency.

In this era of the COVID-19 pandemic, when the majority of countries around the world are affected, various policies have been issued by governments in various countries to maximize the efficiency of banking so that it can be more optimal in realizing financial prosperity and economic equity. This is especially important because it can help realize financial prosperity and economic equity more quickly (Jamaruddin & Markom, 2020). The halt in economic activity came as a huge shock to the business world, which was forced to rearrange for cash to cover operating costs as a direct result of a shortfall in revenue caused by the halt in economic activity. It is anticipated that the financial sector, specifically banks, will play a significant role in mitigating the effects of the shock by providing sufficient funding (Acharya & Steffen, 2020; Borio, 2020).

The Bank is constantly working to improve its performance management in the terms of achieving a level of efficiency that will allow it to be more competitive (Buchory & Java, 2017). During times of economic uncertainty, competitive banking institutions will be of assistance to developing nations and will hasten the pace of economic recovery. Therefore, the level of economic growth that can be maintained in a nation will be highly dependent on the level of banking efficiency and stability in that nation. This is extremely important, particularly for developing countries that continue to rely on the performance of their banks to effectively route funds despite the ongoing pandemic. Using the DEA Window analysis method, the purpose of this study is to measure and compare the efficiency of Islamic and conventional banking in Indonesia, as well as to determine the impact that the COVID-19 pandemic has had on the various levels of banking efficiency.

A number of comparative studies of Islamic and conventional banks indicate that Islamic banking remains less effective than conventional banking in a

number of countries (Al-Khasawneh et al., 2012; Rozani and Rahman, 2013; Abbas et al., 2016). Sakti and Mohamad (2018), in contrast, demonstrate that Islamic banks in Indonesia were more efficient than conventional banks between 2008 and 2012. No previous studies utilizing DEA window analysis to compare the intertemporal efficiency of conventional and Islamic banks in Indonesia have been studied, except Hamidi & Rusydiana (2019). Charnes, Clark, Cooper, and Golany's (1985) introduce DEA window analysis to provide a more accurate method for measuring efficiency. In order to gain a more reliable understanding of efficiency, it is necessary to conduct a new study comparing the intertemporal efficiency of conventional and Islamic banks in Indonesia. So, this research aims to evaluate the effectiveness of 30 banks in Indonesia, both conventional and Syariah, during the time period between 2015 and 2020 (the period that includes the start of the COVID-19 pandemic).

The following will represent as the outline for the research: The background of the study and its objectives are discussed in the first chapter; the second chapter investigates the theoretical background that supports the theory of banking efficiency and summarizes the findings of previous studies; and the third chapter explains the data and research methodologies that were used in this particular study. Chapter 4 will contain a description of the analysis as well as the discussion of these findings. Then, the conclusion and recommendations based on the research findings are included in the last chapter.

LITERATURE REVIEW

In the past two years, the COVID-19 pandemic has affected both Islamic and conventional banking institutions. In this sustainable era, however, increasing efficiency is one of the objectives that banks must pursue. Numerous studies have focused on the efficiency of financial institutions, where efficiency is used as a metric to measure and evaluate bank performance. According to the KBBI, efficiency is the precision with which something is carried out (business, work) (by not wasting time, effort, and costs). In management theory, an organization's performance is measured by its ability to minimize expenses and maximize profits. The concept of efficiency derives from the microeconomic concept of the producer theory. From the manufacturer's vantage point, producer theory seeks to maximize profits or minimize costs. In the producer theory, the relationship between input and output of the production process is depicted by a production frontier curve (Ascarya and Yumanita 2007). The description of the Production Frontier Curve is as follows.

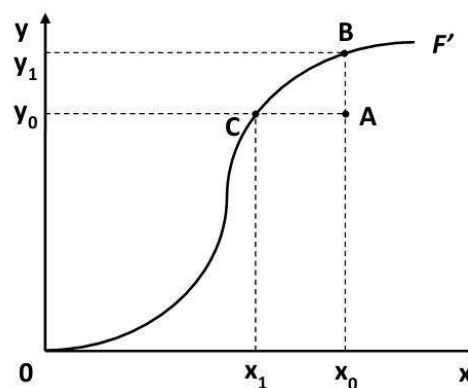


Figure 1: Production Frontier Curve

Efficiency can be broken down into two categories: technical efficiency and economic efficiency. The concept of microeconomic efficiency refers to technical efficiency, while macroeconomic efficiency refers to economic efficiency. Metrics of technical efficiency are applied in order to conduct an analysis of the operational relationships that exist between inputs and outputs. The term "Data Envelopment Analysis" refers, more specifically, to the definition of "technical efficiency," which is the relationship between input and output within a particular business unit (Rusydia 2013). Over the span of time, the model that is used to measure frontier efficiency has undergone developments in both theory and practice. In the following section, we will discuss how a successful frontier efficiency measurement model was developed.

The situation involving the COVID-19 outbreak has had a serious impact on all aspects of the industry, which has led to a decrease in revenue and issues with cash flow. In conclusion, COVID-19 has altered the banking behavior preferences of financial institutions, which will result in a lower demand for bank loans. This is because financial institutions will be more wary of defaults or substandard loans, both of which can make an already difficult situation even worse. The rapid expansion of Islamic banks even during the most recent global financial crisis has attracted the attention of a large number of academics, who apply a wide range of bank performance metrics in their research (Loong et al., 2017).

It is clear that Islamic banks are becoming an increasingly important part of the global banking industry, particularly for the recovery of the global economy following COVID-19. This is especially the case as the Islamic banking industry continues to expand (Boubaker et al., 2022). It has been discovered by Beck et al. (2013) and Farooq and Zaheer (2015) that Islamic banks are more resistant to the effects of financial shocks than their counterparts. To put it another way, it is anticipated that Islamic banks will recover more quickly than traditional banks. Islamic banks are less affected by the pandemic and are therefore better able to respond to the COVID-19 crisis than conventional

banks (Elnahass et al., 2021; Rehman et al., 2021; and Demirgüç-Kunt et al., 2021).

Numerous researchers have contributed to the body of knowledge by comparing the operational efficiency of conventional and Islamic banking systems. However, there are variations in the scope of the analysis, the method employed, and the input and output variables chosen. The following researchers have compared the efficiency of conventional banking to that of Islamic banking on a national and international level. The majority of these studies concentrate on a single nation (Aisyah & Hosen, 2018; Otaviya & Rani, 2020; Usman et al., 2019), whereas others take a broader view of the topic and examine it in relation to multiple nations (Rodoni et al., 2017; Johnes et al., 2018). During this pandemic era, research that examine the effectiveness of banking industry in a particular country has been carried out, leading to a variety of findings, particularly when contrasting the levels of success achieved by the two main different types of banks (Li et al., 2021; Loong et al., 2017; Nailah & Rusydiana, 2020a; Rani & Kassim, 2020; Rodoni et al., 2017).

Even though Data Envelopment Analysis within the standard form has been widely utilized by researchers, particularly in the context of comparing banking efficiency, it is suggested that another form of DEA be employed. Using the DEA Window method, periodic changes in the efficiency levels of Islamic and conventional banks can be observed (Charnes et al., 1985). Using DEA window analysis, Nailah and Rusydiana (2020) have measured the efficiency and stability of Islamic banking in ASEAN. This study analyzed twelve banks in Indonesia, Malaysia, Brunei Darussalam, and Thailand between 2013 and 2018. The results demonstrated that Malaysia has the highest average productivity across four distinct time periods. Overall, Islamic banks in ASEAN have achieved stable performance, despite the fact that the majority of them are still inefficient.

This study, in contrast to other research, seeks to measure and compare the efficiency of Islamic and conventional banking practices in Indonesia by utilizing the DEA Window analysis method. Additionally, the study investigates how the COVID-19 pandemic has affected the efficiency levels of banking institutions.

RESEARCH METHODS

This analysis uses a sample of 14 Islamic banks and 16 conventional banks in Indonesia from 2015-2020. All applicable data were obtained from the banks' annual reports, which are available on their respective websites. All essential data had to be available throughout a six-year period from 2015 to 2020 in order to choose the sample banks, resulting in a panel sample of 30 banks. The period of 2020, we took to capture the

extent to which COVID-19 could affect banking productivity and efficiency.

The input variables used in this study are fixed asset, labor cost, and third-party funds, whereas the output variable are total financing and operating revenues. Since one of the goals of this study to examine the banking efficiency, intermediation approach considered to be used. According to Ascarya et al., (2010), the intermediation model is more appropriate for Islamic banking than the production and modern approaches since it considers banks as intermediary entities. This concept describes banking's activity as a mediator in converting money from a third party into money lent to borrowers (Ascarya et al., 2010). Sufian and Kamarudin (2015), Rusydiana et al., (2019), Ascarya & Yumanita (2009), and Rusydiana & Marlina (2019) all recommended using input-output variables. The MAXDea 8 software is the analytical tool that is being used.

The score for the amount of efficient work should fall somewhere between 0 and 1. The radial distance that separates the projected production limit from the DMU that is being considered is taken into account in the efficiency score (Kamarudin et al., 2017).

Methods

The Data Envelopment Analysis was initially developed by Charnes et al., (1978), and it was later expanded by Banker et al., (1984) in order to measure the effectiveness of the Decision-Making Unit (DMU). In the literature on efficiency, Data Envelopment Analysis is a common method used to measure the technical efficiency, the efficiency of various institutions, including financial institutions (Sharma, et al., 2013; Rusydiana & Nugroho, 2017). The Data Envelopment Analysis method can also provide information about DMUs (which, for the purpose of this study, refers to Banking industry both Islamic and conventional) that do not use efficient inputs and the factors that contribute to inefficiencies, both in terms of input variables and output variables. In conclusion, this technique can provide information regarding the amounts of input and output that need to be modified in order to achieve the highest possible relative efficiency value. According to Wu et al. (2006), Data Envelopment Analysis is one of the methodologies that researchers frequently employ in their work. Scores of efficiency that take into account both input and output variables can be generated using this method (Yildirim, 2015).

The first step to using Data Envelopment Analysis is choosing the appropriate input and output variables used. Once the variables are identified for a set of DMUs, we begin to construct the production possibility set, within which the DMUs operate. The production possibility set contains all the correspondences of input and output vectors that are feasible. Let denote the set as T , so that:

$$\Omega = \{(x, y) \in \mathfrak{R}_+^{m+s} \mid x \text{ can produce } y\} \tag{1}$$

Then, an input set $L(y)$ is the subset of all input vectors $x \in \mathfrak{R}_+^{m+s}$, and a production set $P(x)$ is the subset of all output vectors $y \in \mathfrak{R}_+^{m+s}$, which are obtained from x . The input and output sets are therefore defined respectively as:

$$L(y) = \{x \mid (x, y) \in \Omega\} \text{ or } L(y) = \{x \mid y \in P(x)\} \tag{2}$$

$$P(x) = \{y \mid (x, y) \in \Omega\} \text{ or } P(x) = \{y \mid y \in P(x)\} \tag{3}$$

Suppose that n firm producing s outputs $(Y_i, i = 1, 2, \dots, s)$ with m inputs $(X_i, i = 1, 2, \dots, m)$. The shadow output and input prices are $(\mu_r, r = 1, 2, \dots, s)$ and $(v_i, i = 1, 2, \dots, m)$. So for the unit K , they use the input bundle $Xk = (Xk_1, Xk_2, \dots, Xk_m)$ to produce $Yk = (Yk_1, Yk_2, \dots, Yk_s)$. The linear “fractional” programming problems are set up as:

$$\max AP_k = \frac{\mu Y_k}{v Y_k} = \frac{\sum_{i=1}^s \mu_{rk} Y_{rk}}{\sum_{i=1}^m v_{ik} X_{ik}} \tag{4}$$

According to Campisi and Costa (2008), this method has a number of benefits, one of which is the capacity to evaluate efficiency in relation to benchmarks for a number of different businesses based on what constitutes optimal performance for each individual organization. This method is beneficial and contributes to an accurate estimation of the DMU's efficiency in a comparative sense (Shawtari et al., 2018). Moving averages are the foundation upon which DEA Window Analysis is built. These averages are then used to determine the performance trends of each unit as a function of time. Each DMU in a particular time period is treated as if it were a different kind of data. DMU performance during particular time periods in comparison to DMU performance during other time periods within the same DMU performance unit. This analysis can be used to increase the number of data points in the analysis, which enables it to be applied to analyses with smaller sample sizes. There are a few different ways that this DEA Window Analysis can be applied, the most notable of which is the number of time intervals that can be incorporated into the evaluation (in this study 5 years). This analysis can be used to conduct a period observation that spans the entire time period under consideration for the study.

The table of window analysis results can be used to analyze relative efficiency stability using a variety of summary statistics, such as standard deviation (SD), long distance per window (LDW), long distance per period (LDP), and long distance per year (LDY). This was suggested by Cooper et al., (2011). Utilizing these four measurements, one is able to ascertain the level of efficiency and stability possessed by each DMU. The value of the standard deviation provides an indication of the degree to which the average level of efficiency

achieved by the DMU for each window varies from one another. The value of the standard deviation indicates how consistent the efficiency value achieved by each DMU, which in this context refers to conventional and Islamic banks, is. A smaller value indicates greater consistency. The Long Distance per Window (LDW) model displays the greatest deviation from the efficiency figures for a single window due to the fact that it takes into account a longer distance between windows. The LDW value will drop to a lower level whenever an Islamic bank is able to maintain a more consistent efficiency value, and vice versa. The abbreviation "Long Distance per Period" (LDP) refers to the factor that indicates the greatest disparity between the various efficiency figures collected over the course of the entire observation period. The LDP value will be lower if each Islamic bank is able to maintain a higher efficiency value, and vice versa. The final factor is the long distance per year (LDY). The biggest disparity can be found between LDY and the annual efficiency rate. In a manner analogous to that of LDW and LDP, the value of LDY determines how stable the efficiency value attained by each DMU is, and vice versa: the lower the value, the greater the stability.

RESULT AND ANALYSIS

Indonesia Banking Efficiency Score

Using the DEA method, this discussion will demonstrate the level of efficiency achieved by 30 banks in Indonesia over the course of the period 2015-2020. The findings will be presented in the form of an efficiency score with a percentage range of one hundred to one hundred percent. The bank's ability to manage both their input and output variables to achieve maximum efficiency is represented by a score of one hundred percent. In the meantime, if the efficiency score is significantly lower than one hundred percent, it may be an indication that the bank is inefficient or that it has not managed its input and output variable in the most effective manner. The following table provides a look at the efficiency ratings obtained after the processing of the data:

Table 2:
Indonesian Banking Efficiency Score

DMU	VRS						RTS
	2015	2016	2017	2018	2019	2020	
Conventional Banks							
Mandiri	1,00	1,00	0,96	1,00	1,00	0,93	Decrease
Mega	0,81	0,79	0,77	0,73	0,72	0,86	Decrease
BTPN	0,93	0,81	0,86	0,90	1,00	0,95	Decrease
Islamic Banks							
CIMB Niaga	0,67	0,70	0,69	0,67	0,68	0,59	Decrease
DBS Bank	1,00	0,90	0,89	0,73	0,71	0,76	Decrease
BNI	0,94	0,91	0,89	0,96	0,97	1,00	Decrease
Panin	0,76	0,86	0,81	0,88	0,84	0,96	Decrease
BCA	0,96	0,94	0,94	0,97	0,99	1,00	Decrease
Maybank Indonesia	0,90	0,85	0,85	0,84	0,81	0,70	Decrease

Danamon	0,96	1,00	0,99	1,00	1,00	0,93	Decrease
Permata	0,83	0,70	0,71	0,64	0,80	0,89	Decrease
BTN	1,00	0,98	0,97	1,00	1,00	0,99	Decrease
OCBC NISP	0,80	0,71	0,75	0,77	0,76	0,78	Decrease
BRI	1,00	1,00	1,00	1,00	1,00	1,00	Decrease
HSBC	1,00	0,89	0,72	0,84	0,76	0,63	Decrease
DKI Bank	0,72	0,88	0,69	0,76	0,68	0,61	Decrease
Syariah Banks							
BSM	0,95	0,98	1,00	1,00	1,00	0,92	Decrease
BNI Syariah	0,84	0,77	0,80	0,73	0,68	0,58	Decrease
BRI Syariah	0,98	0,98	0,95	1,00	0,99	1,00	Decrease
BCA Syariah	0,57	0,55	0,58	0,60	0,63	0,58	Decrease
Aceh Syariah Bank	1,00	0,57	0,69	0,70	0,65	0,57	Decrease
Muamalat	0,86	0,72	0,79	0,62	0,59	0,60	Decrease
Bukopin Syariah	0,92	0,85	0,77	0,84	0,85	1,00	Decrease
BPD NTB Syariah	1,00	0,91	1,00	1,00	0,76	0,76	Decrease
Mega Syariah	0,68	0,76	0,77	0,71	0,78	0,80	Decrease
Panin Dubai Syariah	1,00	0,84	0,78	0,71	1,00	1,00	Decrease
Victoria Syariah	0,75	0,59	0,67	0,72	0,77	0,80	Decrease
Maybank Syariah Indonesia	1,00	0,99	0,85	1,00	1,00	0,77	Decrease
BTPN Syariah	0,92	0,89	0,60	0,66	1,00	0,94	Decrease
Jabar Banten Syariah Bank	0,86	0,77	0,70	0,70	0,72	0,70	Decrease
Mean	0,89	0,84	0,81	0,82	0,84	0,82	

According to Table 3, the value of the efficiency index for the VRS of Indonesian banking institutions experienced a relative decline during the period of 2015-2020. Between 2015 and 2017, the value of Indonesia's banking sector's efficiency suffered a decline. Following that, there was an increase in both 2018 and 2019, followed by another decline in 2020. The widespread dissemination of COVID-19 has already had an impact on banking activities in a number of countries, and it has prompted precautionary responses on the part of depositors (for example, increased withdrawal rates) and counterparties of financial intermediaries (for example, decreased market funding) (Baldwin et al., 2020). When COVID-19 began to spread throughout the country of Indonesia, overall banking performance began to decline (Nugroho et al., 2020). During the course of the research, there was only one financial institution that managed to achieve a perfect score: Bank Rakyat Indonesia (BRI). This institution had a relative efficiency value of one. According to the findings of Kristianto and Hendrawan's (2020) and Hendawan and Nasution's (2018) research, BRI was the most efficient bank compared to other banks during the time period of the

study. This result is consistent with those findings. Nevertheless, BCA Syariah has the worst score in terms of efficiency, with an average value of 0.59.

Comparative Analysis of Conventional and Islamic Banking Efficiency

In addition, a comparison will be made on the efficiency of banking based on the categorization of Islamic banks and conventional banks in order to determine which type of banking is more effective. The comparison is made by looking at the annual average efficiency value of Islamic banking versus conventional banking over the course of the five-year study period.

Figure 2: Comparative Analysis of Conventional and Islamic Banking Efficiency

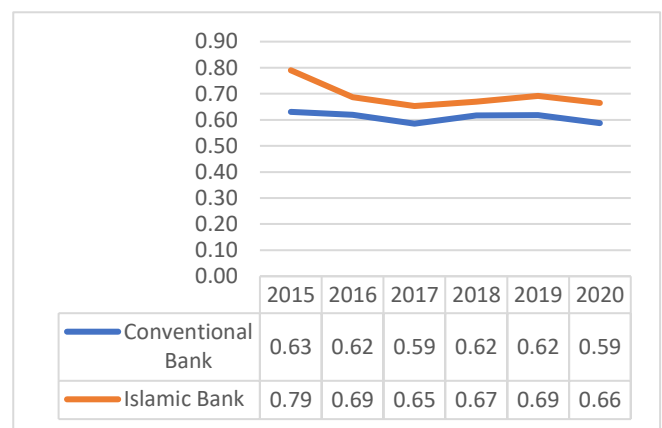


Figure 2 demonstrates that Islamic banking has a higher value of efficiency than conventional banking performs. This investigation's findings are in line with those found in Musa et al., (2020), as well as those found in Parsa (2020), which all state that Islamic banks are more efficient than conventional banks. However, the results of a number of other studies contradict the findings of this particular study in a significant way (Khalil & Siddiqui, 2019; Matar, 2017; Khan et al., 2018). During the course of the research period, however, conventional banks and Islamic banks generally followed a pattern that was quite comparable to one another on the whole.

During the course of the study, conventional banks and Islamic banks both exhibited a pattern that contains a remarkable similarity to one another. First, there was a drop in the average efficiency value between the years 2015 and 2017, then there was a slight increase between the years 2018 and 2019, and then there was another drop in the year 2020. During the course of the COVID-19 pandemic, conventional and Islamic banks alike experience a decline in their levels of productivity. This is in line with the findings of a study that was carried out by Shabib et al., (2020). In that study, they stated that developments in the banking industry indicate that the role of banks in the financial sector, as

well as the preferences and needs of customers, have changed significantly.

4.3 Window Analysis

The authors report the overall efficiency average for each bank in each window. This is due to the fact that the DEA window analysis method can capture a general picture or general development trend of banking industry in Indonesia. The "Mean" column represents the average of each bank's scores. The "SD" column provides an explanation of each bank's standard deviation. The "LDY" column displays the most

significant difference between banks' cores for the same year, measured across multiple time windows. The "LDP" column describes the greatest disparity between the cores of the various banks over the entire period. This metric is utilized to determine the DMU's level of effectiveness in maintaining stability. The lower the total number of the aforementioned four values, the more consistent the per-DMU efficiency (Nailah & Rusydiana, 2020). The table below presents the results of a DEA window analysis conducted on Islamic and conventional banks in Indonesia for the years 2015 to 2020. Each study is divided into four distinct time windows, with each window spanning three years.

Table 3:
DEA Window Analysis of Indonesian Banks in 2015-2020

Bank	window	2015	2016	2017	2018	2019	2020	Mean /window	MEAN	SD	LDW	LDP
Bank Aceh Syariah	W 1	1,00	0,60	0,72				0,77	0,71	0,05	0,40	0,43
	W 2		0,57	0,72	0,75			0,68				
	W 3			0,77	0,71	0,66		0,71				
	W 4				0,71	0,66	0,58	0,65				
	LDY	x	0,03	0,05	0,04	0,00	x					
BNI Syariah	W 1	0,86	0,79	0,85				0,83	0,78	0,07	0,18	0,30
	W 2		0,81	0,88	0,77			0,82				
	W 3			0,88	0,76	0,72		0,79				
	W 4				0,76	0,69	0,58	0,68				
	LDY	x	0,02	0,03	0,01	0,03	x					
BPD NTB Syariah	W 1	1,00	0,92	1,00				0,97	0,95	0,05	0,17	0,17
	W 2		1,00	1,00	1,00			1,00				
	W 3			1,00	1,00	0,84		0,95				
	W 4				1,00	0,84	0,83	0,89				
	LDY	x	0,08	0,00	0,00	0,00	x					
BRI Syariah	W 1	1,00	1,00	1,00				1,00	1,00	0,00	0,01	0,01
	W 2		1,00	0,99	1,00			1,00				
	W 3			1,00	1,00	1,00		1,00				
	W 4				1,00	1,00	1,00	1,00				
	LDY	x	0,00	0,01	0,00	0,00	x					
BCA	W 1	0,97	0,94	0,95				0,95	0,97	0,02	0,05	0,06
	W 2		0,95	0,97	1,00			0,97				
	W 3			0,95	0,98	1,00		0,98				
	W 4				0,98	1,00	1,00	0,99				
	LDY	x	0,00	0,03	0,02	0,00	x					
BTPN	W 1	1,00	0,97	1,00				0,03	0,07	0,05	0,14	0,14
	W 2		0,97	1,00	1,00			0,03				
	W 3			0,86	0,91	1,00		0,14				
	W 4				0,92	1,00	0,95	0,08				
	LDY	x	0,00	0,14	0,09	0,00	x					
CIMB Niaga	W 1	0,70	0,73	0,71				0,03	0,04	0,03	0,09	0,13
	W 2		0,72	0,71	0,69			0,04				
	W 3			0,72	0,70	0,70		0,02				
	W 4				0,69	0,69	0,61	0,09				
	LDY	x	0,01	0,01	0,01	0,00	x					
Danamon	W 1	0,96	1,00	1,00				0,99	0,99	0,01	0,04	0,04
	W 2		1,00	1,00	1,00			1,00				
	W 3			1,00	1,00	1,00		1,00				
	W 4				1,00	1,00	0,97	0,99				
	LDY	x	0,00	0,00	0,00	0,00	x					
DBS	W 1	1,00	0,91	0,89				0,93	0,86	0,08	0,27	0,28
	W 2		0,98	1,00	0,74			0,91				
	W 3			1,00	0,73	0,80		0,84				

	W 4				0,75	0,72	0,77	0,75			0,05		
	LDY	x	0,07	0,11	0,02	0,08	x			0,11			
DKI	W 1	0,78	1,00	0,76				0,85	0,78	0,09	0,24	0,25	0,38
	W 2		1,00	0,75	0,82			0,86			0,25		
	W 3			0,70	0,77	0,69		0,72			0,08		
	W 4				0,77	0,68	0,62	0,69			0,15		
	LDY	x	0,00	0,07	0,05	0,00	x		0,07				
HSBC	W 1	1,00	0,95	0,72				0,89	0,90	0,03	0,28	0,22	0,28
	W 2		1,00	0,78	0,91			0,90			0,22		
	W 3			0,78	0,91	0,92		0,87			0,14		
	W 4				0,92	0,98	0,91	0,94			0,07		
	LDY	x	0,05	0,06	0,01	0,06	x		0,06				
BJBS	W 1	0,95	0,83	0,76				0,85	0,78	0,05	0,19	0,19	0,23
	W 2		0,83	0,77	0,79			0,80			0,07		
	W 3			0,73	0,73	0,75		0,74			0,03		
	W 4				0,74	0,76	0,74	0,75			0,02		
	LDY	x	0,00	0,04	0,06	0,00	x		0,06				
Mandiri	W 1	1,00	1,00	1,00				1,00	0,99	0,01	0,00	0,07	0,93
	W 2		1,00	0,96	1,00			0,99			0,04		
	W 3			0,99	1,00	1,00		1,00			0,01		
	W 4				1,00	1,00	0,93	0,98			0,07		
	LDY	x	0,00	0,04	0,00	0,00	x		0,04				
Maybank	W 1	0,90	0,89	0,88				0,89	0,86	0,04	0,02	0,03	0,19
	W 2		0,88	0,88	0,87			0,88			0,02		
	W 3			0,88	0,87	0,86		0,87			0,03		
	W 4				0,86	0,84	0,71	0,80			0,15		
	LDY	x	0,01	0,00	0,01	0,02	x		0,02				
Mega	W 1	0,88	0,86	0,82				0,85	0,81	0,03	0,07	0,07	0,15
	W 2		0,81	0,79	0,75			0,78			0,06		
	W 3			0,83	0,77	0,82		0,81			0,06		
	W 4				0,74	0,73	0,88	0,78			0,15		
	LDY	x	0,05	0,04	0,03	0,08	x		0,08				
Mega Syariah	W 1	0,83	0,85	0,85				0,02	0,08	0,05	0,02	0,15	0,15
	W 2		0,86	0,86	0,77			0,09			0,09		
	W 3			0,81	0,75	0,81		0,07			0,00		
	W 4				0,75	0,81	0,90	0,15			0,15		
	LDY	x	0,01	0,05	0,02	0,00	x		0,05				
Muamalat Syariah	W 1	0,93	0,77	0,83				0,84	0,74	0,10	0,15	0,21	0,33
	W 2		0,78	0,85	0,68			0,77			0,17		
	W 3			0,88	0,70	0,66		0,75			0,21		
	W 4				0,62	0,59	0,60	0,60			0,03		
	LDY	x	0,01	0,04	0,08	0,07	x		0,08				
BNI	W 1	1,00	0,97	0,93				0,96	0,97	0,02	0,03	0,11	0,11
	W 2		0,92	0,89	1,00			0,94			0,11		
	W 3			0,93	1,00	1,00		0,98			0,07		
	W 4				0,99	0,98	1,00	0,99			0,02		
	LDY	x	0,04	0,03	0,01	0,02	x		0,04				
OCBC NISP	W 1	0,80	0,76	0,79				0,78	0,78	0,01	0,04	0,04	0,05
	W 2		0,75	0,78	0,79			0,77			0,04		
	W 3			0,78	0,79	0,80		0,79			0,01		
	W 4				0,78	0,76	0,78	0,77			0,02		
	LDY	x	0,01	0,01	0,02	0,03	x		0,03				
Panin	W 1	0,77	0,87	0,82				0,82	0,89	0,05	0,10	0,12	0,22
	W 2		0,89	0,83	0,90			0,87			0,06		
	W 3			0,90	0,97	0,93		0,93			0,07		
	W 4				0,91	0,87	1,00	0,93			0,12		
	LDY	x	0,01	0,08	0,08	0,06	x		0,08				
Panin Dubai Syariah	W 1	1,00	0,85	0,80				0,89	0,90	0,02	0,20	0,23	0,23
	W 2		1,00	0,86	0,82			0,89			0,18		
	W 3			0,87	0,80	1,00		0,89			0,20		
	W 4				0,77	1,00	1,00	0,92			0,23		
	LDY	x	0,15	0,06	0,05	0,00	x		0,15				
Permata	W 1	0,86	0,74	0,74				0,13	0,17	0,09	0,13	0,30	0,30
	W 2		0,73	0,75	0,66			0,09			0,09		
	W 3			0,75	0,67	0,84		0,17			0,17		

	W 4				0,65	0,84	0,95	0,30		0,30			
	LDY	x	0,00	0,01	0,01	0,00	x	0,00					
BRI	W 1	1,00	1,00	1,00				1,00	1,00	1,00	0,00	1,00	1,00
	W 2		1,00	1,00	1,00			1,00			0,00		
	W 3			1,00	1,00	1,00		1,00			0,00		
	W 4				1,00	1,00	1,00	1,00			0,00		
	LDY	x	0,00	0,00	0,00	0,00	x	1,00					
Syariah Bukopin	W 1	0,93	0,87	0,79				0,86	0,92	0,04	0,14	0,16	0,21
	W 2		0,96	0,84	0,94			0,91			0,12		
	W 3			0,84	0,94	1,00		0,93			0,16		
	W 4				0,95	0,96	1,00	0,97			0,05		
	LDY	x	0,09	0,05	0,01	0,04	x	0,09					
BSM	W 1	0,98	0,98	1,00				0,99	0,99	0,01	0,02	0,04	0,04
	W 2		1,00	1,00	1,00			1,00			0,00		
	W 3			1,00	1,00	1,00		1,00			0,00		
	W 4				1,00	1,00	0,96	0,99			0,04		
	LDY	x	0,02	0,00	0,00	0,00	x	0,02					
BTN	W 1	1,00	1,00	1,00				1,00	0,99	0,01	0,00	0,03	0,03
	W 2		0,99	0,97	1,00			0,99			0,03		
	W 3			0,98	1,00	1,00		0,99			0,02		
	W 4				1,00	1,00	0,99	1,00			0,01		
	LDY	x	0,01	0,03	0,00	0,00	x	0,03					
BTPN Syariah	W 1	1,00	1,00	0,66				0,89	0,82	0,07	0,34	0,40	0,40
	W 2		1,00	0,62	0,70			0,77			0,15		
	W 3			0,60	0,66	1,00		0,75			0,40		
	W 4				0,66	1,00	0,94	0,87			0,34		
	LDY	x	0,00	0,07	0,03	0,00	x	0,07					
Victoria Syariah	W 1	0,75	0,59	0,67				0,67	0,78	0,14	0,16	0,17	0,38
	W 2		0,60	0,71	0,77			0,69			0,17		
	W 3			0,71	0,77	0,84		0,77			0,13		
	W 4				0,95	0,99	0,98	0,97			0,03		
	LDY	x	0,01	0,04	0,18	0,15	x	0,18					
BCA Syariah	W 1	0,61	0,58	0,64				0,61	0,61	0,00	0,05	0,06	0,06
	W 2		0,58	0,59	0,63			0,60			0,05		
	W 3			0,58	0,60	0,64		0,60			0,06		
	W 4				0,60	0,63	0,59	0,61			0,04		
	LDY	x	0,00	0,05	0,04	0,00	x	0,05					
Maybank Syariah	W 1	1,00	1,00	1,00				1,00	0,96	0,03	0,00	0,18	0,18
	W 2		1,00	0,88	1,00			0,96			0,12		
	W 3			0,86	1,00	1,00		0,95			0,14		
	W 4				1,00	1,00	0,82	0,94			0,18		
	LDY	x	0,00	0,14	0,00	0,00	x	0,14					

The calculation results for the DEA window analysis carried out on 30 Indonesian banks over the course of the period 2015-2020 are presented in the table that can be identified above. The most consistent efficiency scores are found in BRI, followed by BRI Syariah and BTN. This is determined by conducting an efficiency stability analysis using multiple statistical summaries, such as standard deviation (SD), long-distance per window (LDW), long-distance per period (LDP), and long-distance per year (LDY). BRI received the highest score possible of 100 percent for its average efficiency value and the lowest score possible of 0.00 across all of the available statistics. Next, the statistical value for BRI Syariah is 0.00 for SD, 0.01 for LDY, 0.01 for LDW, and 0.01 for LDP. Its LDW value is also 0.01. Statistically speaking, the values for BTN are 0.01 for SD, 0.03 for LDY, 0.03 for LDW, and 0.03 for LDP. In addition, both BRI Syariah and BTN have an overall

efficiency value that is either 0.99 or higher, which is higher than the majority of other financial institutions.

Quadrant Category of Indonesian Banks

In addition, in order to evaluate the performances of Indonesian banks, the author attempts to categorize the banks into four different quadrants according to the level of efficiency and stability they maintain. Banks that operate at a consistently high level of efficiency are located in Quadrant 1, which contains these banks. In a nutshell, we consider the bank to be in the highest performance category. Quadrant 2 is made up of financial institutions that have a high level of efficiency but a lower level of stability. Quadrant 3 is made up of financial institutions that have low levels of both efficiency and stability. In Quadrant 4, there are financial institutions that have a high level of stability but produce a low level of efficiency. The efficiency column is obtained from the average efficiency level in the window

analysis results, and the stability of the efficiency column is generated from the Long Distance per Year (LDY) in the window analysis result. Table 4 is a representation of

the categories that form each quadrant and can be found in the table:

Table 4: Quadrant Category of Indonesian Banks

Banks		Efficiency		Stability	Quadrant
Conventional Banks					
BRI	1	High Efficiency	0	High Stability	I
BTN	0,994	High Efficiency	0,025	High Stability	I
Danamon	0,993	High Efficiency	0,002	High Stability	I
Mandiri	0,991	High Efficiency	0,039	High Stability	I
BCA	0,974	High Efficiency	0,025	High Stability	I
BNI	0,967	High Efficiency	0,042	High Stability	I
Bank BPD NTB	0,952	High Efficiency	0,081	High Stability	I
Panin	0,888	High Efficiency	0,079	High Stability	I
Maybank	0,859	High Efficiency	0,021	High Stability	I
HSBC	0,899	High Efficiency	0,638	Low Stability	II
DBS	0,857	High Efficiency	0,107	Low Stability	II
BTPN	0,068	Low Efficiency	0,136	Low Stability	III
Bank DKI	0,778	Low Efficiency	0,671	Low Stability	III
Mega	0,806	Low Efficiency	0,084	High Stability	IV
OCBC NISP	0,781	Low Efficiency	0,033	High Stability	IV
Permata	0,171	Low Efficiency	0,001	High Stability	IV
Islamic Banks					
Bank BRI Syariah	0,999	High Efficiency	0,011	High Stability	I
BSM	0,993	High Efficiency	0,015	High Stability	I
Syariah Bukopin	0,918	High Efficiency	0,092	High Stability	I
Maybank Syariah	0,963	High Efficiency	0,144	Low Stability	II
Panin Dubai Syariah	0,897	High Efficiency	0,145	Low Stability	II
Victoria Syariah	0,777	Low Efficiency	0,181	Low Stability	III
BTPN Syariah	0,821	Low Efficiency	0,066	High Stability	IV
BJBS	0,781	Low Efficiency	0,059	High Stability	IV
Bank BNI Syariah	0,779	Low Efficiency	0,032	High Stability	IV
Muamalat Syariah	0,741	Low Efficiency	0,076	High Stability	IV
Bank Aceh Syariah	0,705	Low Efficiency	0,045	High Stability	IV
BCA Syariah	0,606	Low Efficiency	0,054	High Stability	IV
Mega Syariah	0,082	Low Efficiency	0,046	High Stability	IV
CIMB Niaga	0,043	Low Efficiency	0,011	High Stability	IV

Based on the data presented in table 4 above, we can see that by type of bank, conventional banks with a total of 9 banks occupy the first quadrant, which shows a high level of efficiency and stability. The performance of these 9 banks is considered the best among all conventional banks for the 2015-2020 period. Bank BRI became the bank with the most efficient and most stable bank position, followed by Bank BTN and Bank Danamon. Quadrants 2 and 3 have the same number, namely there are 2 banks each, of which in quadrant 2 there are HSBC and DBS banks, while in quadrant 3 there are BTPN and DKI Banks. Furthermore, there are

3 banks in quadrant 4, namely Bank Mega, OCBC NISP, and Bank Permata. In general, conventional banks are dominated by banks in quadrant 1. This means that conventional banks are able to maintain stable efficiency.

It is interesting to note that Quadrant 4, which is characterized by low efficiency and stability, is the quadrant with the largest number of banks in Islamic banks with a total of 8 banks. Based on the research results, these 8 financial institutions are among the worst performers in terms of both efficiency and stability. In

the second position, there are banks in quadrant 1 with a total of 3 banks, namely: BRI Syariah banks, BSM, and Bukopin Syariah banks. Furthermore, the banks that enter Quadrant II are as follows: Panin Dubai Syariah, Maybank Syariah. Banks that fall into this quadrant are usually efficient, but the level of efficiency is prone to fluctuations. Quadrant III, on the other hand, consists of Victoria Sharia banks. Banks that fall into this quadrant have a low level of efficiency but are able to maintain stability throughout the 2015-2020 period. In general, Islamic banks must continue to strive to improve the efficiency and stability of their banks in order to maintain their performance, especially during the COVID-19 pandemic. Because of the presence of the COVID-19 pandemic, Islamic banks have been compelled to continue their pursuit of technological advancement and innovation.

During the pandemic, technological advancement in the banking industry can help customers overcome barriers to banking services caused by their inability to mobilize (Subanidja et al., 2022). Vergara and Aguado (2021) investigated the most important aspects of sustainable finance and fintech. According to their findings, fintech promotes the growth of financial businesses by fostering sustainable finance. According to the findings of Subanidja et al. (2022), the performance of banks can be affected by both fintech and competitive advantage. In addition, Legowo et al., (2020) proposed that the presence of fintech is to enhance the long-term performance of banks. According to Meiling et al., (2021), there is a strong suspicion that fintech promotes both long-term financial performance and financial development.

As a consequence of this, the challenge for Islamic banks industry in Indonesia is to continue to improve the quality of their technology in an effort to achieve higher levels of productivity in the future (Rani et al., 2017). It is possible that such a technological advancement could be contributed to by improved digital-based services, improved technologies for protecting customer data, and branchless banking. This will serve to encourage Islamic banks to maximize their output, which will ultimately allow them to function more efficiently.

CONCLUSION

This research on Indonesian banking efficiency has produced a number of findings that can be utilized by academic researchers and policymakers as a factor in policy formulation. During the study period, an analysis of efficiency scores reveals that Islamic banks have a higher score than conventional banks. During the COVID-19 pandemic, however, both conventional and Islamic banks led to a sharp decline in efficiency. The evolution of the banking industry demonstrates that

banks' roles in the financial sector have shifted significantly in response to alterations in customer preferences and expectations during the pandemic.

It was found that BRI, BRI Syariah, and BTN banks have a relatively stable efficiency value after conducting an efficiency stability analysis using several statistical summaries such as standard deviation (SD), long distance per window (LDW), long distance per period (LDP), and long distance per year (LDY). These statistical summaries were used to determine the level of efficiency stability. According to the results of the research conducted, BRI is the most reputable and productive bank in Indonesia from the years 2015 to 2020. According to the results of research that was carried out by Kristianto and Hendrawan (2020), BRI is the most efficient bank when compared to other banks over the course of the time period that was taken into consideration.

In order to achieve a higher level of productivity in special circumstances, such as the current Covid-19 pandemic, Indonesia's conventional and Islamic banking systems are required to maximize the use of their available resources and advance the level of sophistication of their technological capabilities. The management of Indonesian banks needs to conduct an analysis of the regulations that are currently in place so that they can boost productivity without compromising on performance or the quality of their services. In addition, the support of policymakers was necessary in order to enhance supervision and guidance in order to raise the bank's overall level of efficiency.

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