Intertemporal Social Efficiency on Indonesian Islamic Banks: DEA Window Analysis

Aam Slamet Rusydiana[1] and Mohammad Iqbal Irfany [2]
[1]Sharia Economic Applied Research & Training (SMART) Indonesia
[2]Faculty of Economics and Management, IPB University

Measurement of the efficiency level of Islamic banks in Indonesia is widely carried out, but almost no study has been conducted with the DEA window analysis approach, especially in the 'social efficiency' perspective. We try to measure the social efficiency of the Islamic banks in Indonesia employing both Data Envelopment Analysis (DEA) and the DEA window analysis. For certain cases the results of the DEA window analysis are relatively more stable and can illustrate the actual results of the efficiency value. The results show that the social efficiency of Islamic banks in Indonesia from 2011-2018 are relatively fluctuated but tend to increase. From the perspective of the stability of efficiency value, we found only 4 (four) out of 11 (eleven) Islamic banks that have relatively stable efficiency levels.

Keywords: Social Efficiency, Window Analysis, DEWA, Islamic Bank

OPEN ACCESS

*Correspondence:
Aam Slamet Rusydiana
aamsmart@gmail.com

Received: 11 March 2023
Accepted: 22 May 2023
Published: 2 June 2023

Citation:
(2023) Intertemporal Social Efficiency on Indonesian Islamic Banks: DEA Window Analysis
Faraid & Wealth Management 3.1.

INTRODUCTION

The development of the Islamic banking industry in Indonesia has been showing a positive trend, although the trend seems slow. Data for June 2019, according to sharia banking statistics, the number of sharia banking has reached 14 sharia commercial banks (BUS), 20 sharia business units (UUS) and 168 sharia rural banks (BPRS) with a total of 2,460 office networks throughout Indonesia (Indonesia Finance Authority (OJK), 2019).

Meanwhile, according to the 2017 *Global Islamic Finance Report*, the Islamic finance industry in Indonesia globally ranks seventh in the world after Malaysia, Iran, Saudi Arabia, UAE, Kuwait and Pakistan. In the same year, score index of the Indonesias´ Islamic financial industry was 24. 21 (out of 100) and ranks to 7th in the world (GIFR, 2017). Given its potential, Indonesia is relatively still not able to exploit the existing potential related to Islamic finance.

Islamic finance basically have objectives to help those who need help, especially for people who need business. It also always pay attention to the poor, education and other social as a form of application of Islamic sharia value that considers business is not everything but must always pay attention to the surrounding environment. Due to its objective that islamic banks do not only prioritize commercial profits but must carry out their non-commercial activities, this causes relatively higher costs and will reduce the level of efficiency compared to conventional banks.

Hence, measurement of the level of efficiency of Islamic banks from a 'social' perspective is also important to know because this industrial entity is essentially different from conventional commercial banks. It is then important for management and for other related stakeholders to investigate how the role of Islamic banking in Indonesia in providing benefits for the people more comprehensively and optimally. In other words, research must be conducted on efficiency through the 'social efficiency' approach, to investigate how the role of the Islamic banking industry in social functions and public benefit in general.

In assessing the efficiency rate, Data Envelopment Analysis (DEA) is widely employed. Technically, this approach measures the level of technical efficiency and economies of scale of the banking industry and other financial institutions. Previous studies have been conducted by employing this approach such as Ozdemir (2013), Shahreki (2012), Tsolas and Dimitris (2012), Rani et al. (2017), Kamarudin et al. (2016), Rusydiana & Firmansyah (2017), Rusydiana (2018a, 2018b), Ikhwan (2022), Riani (2022), Rusydiana & Sanrego (2018), among others.

However, in many cases the DEA efficiency results have relative properties. Meaning that when the data set increases, the measurement results will tend to be different. Therefore to overcome this problem, various studies such as Charnes et al. (1985) introduced the concept of DEA window analysis. This analysis, often also called DEWA, is an extension of DEA or DEA version with time dependence. To observe variations in the value of intertemporal efficiency, Charnes et.al (1985) proposed this window analysis technique in DEA, allows us to measure the performance of a decision making unit (DMU) over time or intertemporal by treating it as a different entity in each period.

This study has several objectives as follows. First, to measure the level of efficiency of Islamic banks in Indonesia, i.e. sharia commercial banks (BUS) from 2011 to 2018. Second, to analysis the intertemporal efficiency through DEA window analysis approach, by observing the standard deviation and the result of efficiency per year (Long Distance per Year). This measure is important to verify the efficiency results in DEA which are commonly relative and tend to change (inconsistent) in different data sets.

THEORETICAL BASIS

A process can be considered efficient if various efforts have been made to achieve maximum output, both in terms of quantity and quality. An activity can also be called efficient if with minimal input able to achieve certain outputs. Oscar (2008) then divides the efficiency into several parts, including technical efficiency, cost efficiency, scale efficiency, and allocation efficiency. Technical efficiency is the process of converting inputs into outputs. It means that this concept only applies to internal technical relationships between inputs and outputs. A company is considered economically efficient if it can minimize the cost of production in producing a specific output in certain technology and market price level (Farrell, 1957).

While financial efficiency is generally based on cost reduction (Berger and Humphrey, 1997), social efficiency is more directed towards market-based social aspects that can be used. It is at least to show social content based on social values entering the market (Gutierrez-Goiria et al., 2017). In our research, this concept is simply to show how Islamic banks also have a real social impact on customers, the environment and

society. Through social efficiency, we can calculate social function of financial institutions and focusing into their social performance. Tools for the assessment of social impact are currently being developed by conventional financial institutions under the Global Reporting Initiative (Gutierrez-Nieto et al., 2007). A framework of social performance indicators already exists with specific guidelines on how to calculate them (SPI, 2002). The other one is a model called by SROI (Social Return on Investment).

As Islamic economic and finance concepts have a relatively dual function of both serving social and economic/financial goals, there is a debate between those who focus on the financial side and those who focus on the social aspects. The 'institutionalists' generally focus more on the financial aspects and are relatively concerned with independence and sustainability. On the other hand, the 'welfarists' claims that the Islamic financial and banking industry must be 'pro poor' first, then profitability is the next target and concern.

To calculate the social efficiency of Islamic bank we use DEA window analysis. The main idea of the DEA window analysis is to consider each DMU as a different DMU from each data entered in the observation. Furthermore, each DMU is not compared to the whole data set but only compared to alternatives from a particular panel data subset. Window analysis is based on the assumption that what is 'feasible' in the past will remain 'feasible' forever. Therefore, the treatment of time in window analysis is more averaged over the time period covered by a window (Tulkens and van den Eeckaut, 1995).

DEA is commonly employed to analyze *cross section* data, where a DMU is compared to all DMUs over the same time period. In other words, the role of time is ignored. However, this case sometimes causes *misleading* because dynamic contexts can lead to excessive use of resources in the future. To overcome this problem, thus, one can employ panel data that is relatively superior to *cross section* data as it does not only allow a DMU to be compared with its counterparts but also the efficiency movements of a specific DMU can be traced over a certain period of time. Thus, panel data is better able to reflect the true efficiency of a DMU. For this reason, for certain cases the results of DEA window analysis are relatively more stable and can reflect the true results of the efficiency values (Rusydiana & As-Salafiyah, 2021; Marlina et al., 2023; Ikhwan & Riani, 2020).

Data Envelopement Analysis (DEA) is a mathematical and analytical technique used in operations research and management science to evaluate the relative efficiency of multiple decision-making units (DMUs). These DMUs could be organizations, departments, firms, or any entities that are performing similar tasks and can be compared in terms of their inputs and outputs.

DEA is particularly useful when you want to compare entities that have multiple inputs and outputs, and you're trying to determine how efficiently they are utilizing their resources to produce the desired outputs. The main objective of DEA is to find the optimal combination of inputs that will lead to the maximum possible outputs or to identify the most efficient entities among a set of entities.

There are different variations and models within DEA, such as input-oriented and output-oriented models, and radial and non-radial approaches. Some DEA models assume constant returns to scale, while others allow for variable returns to scale.

DEA has applications in various fields such as economics, finance, healthcare, education, manufacturing, and more. It helps organizations identify areas for improvement, resource allocation, performance evaluation, and strategic decision-making. Keep in mind that while DEA is a powerful tool, it's essential to carefully select the inputs and outputs and consider the context of the analysis to ensure meaningful and accurate results.

DEA assigns efficiency scores to each DMU. An efficiency score of 1 indicates that the DMU is on the efficiency frontier, while scores less than 1 indicate varying degrees of inefficiency. DEA evaluates the efficiency of each DMU by comparing its inputs and outputs with those of other DMUs in the dataset. The goal is to determine which DMUs are operating at the "efficiency frontier," meaning they are utilizing their resources optimally to achieve the maximum possible outputs or minimize possible inputs.

The development of DEA and efficiency in general is actually very dynamic, as evidenced by the many developing DEA extensions and models. Table 1 describes an overview and extension of the development of frontier efficiency measurement models that we have successfully identified and elaborated.

Table 1: Development of Analysis Model Measuring Efficiency Frontier

NO	MODEL	YEAR	AUTHOR	TYPE
1	Stochastic Frontier Approach als77	1977	Aigner, Lovell, Schmidt	Parametric
2	SFA Model mvb77	1977	Meeusen & van den Broeck	Parametric
3	CCR Data Envelopment Analysis	1978	Charnes, Cooper, Rhodes	Non parametric
4	SFA stev80 model	1980	Stevenson	Parametric
5	SFA mlti model	1981	Pitt & Lee	Parametric
6	Malmquist Productivity Index	1982	Caves, Christensen, Diewert	Non parametric
7	DEA BCC Model	1984	Banker, Charnes, Cooper	Non parametric
8	Free Disposal Hull [FDH]	1984	Deprins, Simar, Tulkens	Non parametric
9	SFA Model fe	1984	Schmidt & Sickles	Parametric
10	SFA Model Regls	1984	Schmidt & Sickles	Parametric
11	DEA Additive Model	1985	Charnes,Cooper,Golany,Seiford,Stutz	Non parametric
12	DEA Window Analysis	1985	Charnes, Clarke, Cooper, Golany	Non parametric
13	Assurance Region [DEA-AR]	1986	Thompson, Singleton, Thrall, Smith	Non parametric
14	DEA Cross Efficiency	1986	Sexton, Silkman, Hogan	Non parametric
15	DEA Facet Model	1988	Bessent, Bessent, Elam, Clark	Non parametric
16	SFA mlti model	1988	Battese & Coelli	Parametric
17	SFA fecss model	1990	Cornwell, Schmidt, Sickles	Parametric
18	SFA Model kumb90	1990	Kumbhakar	Parametric
19	DEA Cone Ratio	1990	Charnes, Cooper, Huang, Sun	Non parametric
20	TFA [Thick Frontier Approach]	1991	Berger & Humphrey	Parametric
21	SFA Model bc92	1992	Battese & Coelli	Parametric
22	Fuzzy DEA	1992	Sengupta	Non parametric
23	DFA [Distribution Free Approac]	1993	Berger	Parametric
24	SFA Model fels	1993	Lee & Schmidt	Parametric
25	DEA Super Efficiency	1993	Andersen & Peterson	Non parametric
26	SFA Model bc95	1995	Battese & Coelli	Parametric
27	DEA Network	1996	Fare & Grosskopf	Non parametric
28	Hierarchical / Nested Model	1998	Cook, Chai, Doyle, Green	Non parametric
29	Bootstrapped DEA	1998	Simar & Wilson	Parametric
30	DEA Russell Measure [ERM]	1999	Pastor, Ruiz, Sirvent	Non parametric
31	Imprecise Data [IDEA]	1999	Cooper, Park, Yu	Non parametric
32	DEA Parallel Model	2000	Cook, Hababou, Tuenter	Non parametric
33	Dynamic DEA	2000	Fare & Grosskopf	Non parametric
34	DEA Slack Based Measure [SBM]	2001	Tone	Non parametric
35	Meta Frontier	2003	Rao, O'Donnel, Battese	Non parametric
36	Context-Dependent DEA	2003	Seiford & Zhu	Non parametric
37	SFA Model gre03	2003	Greene	Parametric
38	SFA tfe model	2005	Greene	Parametric
39	SFA Model tre	2005	Greene	Parametric
40	Cross Efficiency Game	2008	Liang, Wu, Cook, Zhu	Non parametric

Source: Rusydiana (2018a).

Previous studies have been conducted that is relevant to our study. For instance, Shawtari et al. (2014), employing Data Envelopment Windows Analysis (DEWA), analyzed the efficiency of the banking industry in Yemen for the period 1996 to 2011. His findings indicated that the banking industry in Yemen generally experienced a downward trend and efficiency instability during the study period. It also found that the majority of conventional Yemeni banks are relatively more stable although inefficient. Meanwhile Islamic banks and foreign banks are more efficient overtime, whlie state owned and private banks are lagging behind in terms of efficiency level achievement.

Kamath (2007) argued that the banking industry is a business sector that is "intellectually intensive" as well as categorizes as one of service sectors, where customer service is highly dependent on the intelligence of human capital (Maisaroh, 2015). Hence, banking industry requires quality human resources to be able to increase efficiency and productivity in banking performance in general so that it can affect the level of profitability.

Other research, Kamau (2011), investigated the efficiency and productivity intermediation in the banking sector during the liberalization period in Kenya. This study uses non-parametric DEA to analyze the efficiency of intermediation in the banking sector and uses the Malmquist Productivity Index to measure the level of bank productivity in Kenya. The results show that banks that are not perfectly efficient can still run well during the research period by improving technology, skills, expanding operational scale. Based on the main conclusion, the policy encourages competition, diversification of products to increase credit, minimizing risk through increased capital regulation and privatization of several banks that are generally recommended.

In addition, Andries (2011) examines the determinants of bank efficiency and productivity growth in the Western and Eastern European bank systems. This study examines the determinants of the efficiency and productivity of the bank system from 7 Western and Eastern European countries during 2004-2008. Stochastic frontier analysis and DEA approaches are used to test the efficiency of the bank industry in Western and Eastern Europe. Input variables used are total deposits, fixed assets, total operational costs; And the output variables used are: total loans, total investment, other income. The results of the study showed that the average efficiency of banks in Western and Eastern Europe increased in the study period.

Studies related to social efficiency measurement have been conducted by several researchs. Some of them are done by Widiarto and Emrouznejad (2015), Demirci et al. (2013), Shahwan and Hassan (2013), and Gutierrez-Goiria et al. (2017), also Gutierrez-Nieto et al. (2007). The majority of the research is related to microfinance institutions.

Studies employing the DEA window model for banking research applications can be seen in research conducted by Asmild et al (2004), Bergendahl (1998), Kisielewska et.al (2005), Repkova (2014), and Sufian & Majid (2014), Sufian (2007) and Zimkova (2014). In addition, Shahooth and Battall (2006) used DEA and DEA Window Analysis methods to measure the relative cost efficiency of 24 Islamic bank institutions.

Not only in financial industry, the application of the DEA window method also widely carried out in other industries. For instance, in the health and hospital industry (Jia & Yuan, 2017; Weng et al., 2009), manufacturing industry (Mahadevan, 2002), port efficiency (Cullinane & Wang, 2010; Pjevcevic et al., 2012), stock market (Dastgir, 2012) and other industries (Chung et al., 2008; Hemmasi et al., 2011). Meanwhile more theoretical research can be found in the research of Maidamisa (2012), and Tatje & Lovell (1997).

METHODOLOGY

In our study, to monitor changes in the level of efficiency of Islamic banks over time, a Window DEA, as suggested by Charnes et al. (1985), was conducted. We used a five- year window analysis so that for each analysis, we obtain 55 (5 times 11) DMUs in which the same DMU for different periods of time was considered a different DMU. Therefore, *benchmarking is* not only carried out on peer DMU but also on its own performance. The total number of Islamic banks that have become the object of research are 11 Islamic banks including: 1) Bank Syariah Mandiri (BSM); 2) Bank Muamalat Indonesia (BMI); 3) Bank Rakyat Indonesia Syariah (BRIS); 4) Bank Negara Indonesia Syariah (BNIS); 5) Bank Mega Syariah (MegaS); 6) Panin Dubai Syariah Bank (PaninS); 7) Bank Jabar Banten Syariah (BJBS); 8) Bank Syariah Bukopin (BukopinS); 9) BCA Syariah (BCAS); 10) Bank Maybank Syariah Indonesia (MaybankS); and 11) Bank Victoria Syariah (VictoriaS). This selection of 11 Islamic banks is due to data availability as only those BUSs who have complete financial statements from 2011 until the end of 2018 .

Input and output data were obtained from the balance sheet and income statement of each bank. To measure bank efficiency, two inputs and two outputs are used. Input variables are the Third Party Funds (X1), labor costs (X2) and the administrative costs (X3) . Meanwhile output variables are the amount of financing provided for the Micro, Small and Medium Enterprises sector or MSME (Y1) and social funds including zakat and CSR (Y2). The selection of input-output variables, especially those related to social efficiency refers to research Gutierrez-Goiria et al. (2017) and Widiarto & Emrouznejad (2015), with our modification. The use of deposits and financing in input-output because this study uses an intermediation approach of DEA. In fact the intermediation approach is the most relevant approach to measure the level of efficiency of Islamic banks (Ascarya & Yumanita, 2008; Sufian, 2006).

Table 2: Input and Output Variables

Input variables	Third Party Funds (DPK) *(X1)*
	Labor Costs *(X2)*
	Administrative Costs *(X3)*
Output variables	Financing for MSMEs *(Y1)*
	Social funds *(Y2)*

Tools analysis used in this study is *MaxDEA 8 .1* to measure the efficiency of the entire DMU Islamic banks during the period 2011-2018. Efficiency measurements will be carried out in two steps. The first calculation of standard efficiency with the CRS or CCR approach as introduced by Charnes et al. (1978). The second calculation is measuring efficiency with window analysis. In general, for the analysis window DEA, we follow the following formula.

$$M_l = \frac{\sum_{t=1}^{M-K+1} \sum_{j=1}^{i+K-1} . E_{i,j}}{K \text{ x } (M-K+1)}, l = 1, L, N$$

where M is the average level of efficiency and K is the length of the window (window length) .

As recommended by Cooper et al. (2011), the results of *window analysis* calculations can be used to simultaneously check the stability of relative efficiency through several summary statistics such as standard deviation (SD), *Long Distance per Window* (LDW), *Long Distance per Period* (LDP) and *Long Distance per Year* (LDY). These four measurements can be used as an analysis of the stability efficiency achieved by each DMU.

Standard deviation measures the difference in the average level of efficiency DMU every window. The smaller the standard deviation value shows the more stable the value of efficiency achieved in each DMU (in this case Islamic banks). *Long Distance per Window* (LDW) shows the largest gap in efficiency figures in one window. The smaller the LDW value means the more stable the value of efficiency achieved by each Islamic bank, and vice versa.

Long Distance per all Period s (LDP) explains the largest gap in efficiency numbers of the entire period of observation. The smaller the LDP value indicates the more stable the value of efficiency achieved by each Islamic bank, and vice versa. Finally, *Long Distance per Year* (LDY) shows the largest gap in efficiency figures in one year. Similar to LDW and LDP, the smaller the LDY value indicates the more stable the value of efficiency achieved in each DMU, and vice versa. In our study on measuring the social efficiency of Islamic banks in Indonesia, we used standard deviation and LDY.

RESULTS AND DISCUSSION

DEA for the output oriented used the panel data of 11 BUS in Indonesia from 2011 to 2018. Thus the total number of observations to calculate the efficiency is about 88 observations. At the beginning, it was explained that the non-parametric method was divided into two based on the assumption of *Return to Scale* (RTS), namely *Constant Return to Scale* (CRS) and *Variable Return to Scale* (VRS). By estimating the *frontier* using the CRS and VRS approaches, it can decompose the *Technical Efficiency* on the CRS (TE_{CRS}) approach to *Pure Technical Efficiency* (TE_{VRS}) and *Scale Efficiency*. *Frontier* efficiency analysis is the *best practice* analysis of the entire data set used using the

input-output approach. CRS represent CCR model and VRS represent the BCC model.

The results, as shown in Table 3, illustrates the average summary of social efficiency scores of 11 Islamic Commercial Banks (BUS) in Indonesia. Technical Efficiency (*Technical Efficiency*) fluctuated during the study period, with the lowest and highest numbers are 2013 (36%) and 2015 (61%), respectively. In the initial observation period in 2011, the social efficiency value of Islamic banks was 47 % and then decreased to 42% and 36% in 2012 and 2013, respectively. Furthermore, the level of social efficiency of Islamic banks relatively experienced an increase to 49% and 61% in 2014 and 2015. Three years later, the level of social efficiency of Islamic banks tends to stagnate in the range of 59 % (2016), 60 % (2017) and 58 % (2018).

Table 3 also shows that overall *technical efficiency* of Islamic Commercial Banks in Indonesia throughout the study period was about 51% . It means that with the implementation of management practices with considering socially responsible input-output, Indonesian Islamic commercial banks can produce output with the same value (*identical volume*), with only used 51% of the total inputs. In this case, Islamic Commercial Banks have an average efficiency that is not so good, although it cannot also be called bad.

Table 3: Social Efficiency Level of BUS in Indonesia 2011-2018

SOCIAL EFFICIENCY	2011	2012	2013	2014	2015	2016	2017	2018	Mean
BSM	0.70	0.88	0.51	1.00	1.00	1.00	0.97	1.00	0.88
BMI	0.48	0.46	0.63	0.50	0.66	0.52	0.70	0.54	0.56
BRIS	0.16	0.24	0.33	0.35	0.98	1.00	1.00	1.00	0.63
BNIS	0.38	0.45	0.54	0.66	0.74	0.73	0.73	0.65	0.61
MegaS	0.35	0.25	0.46	0.57	0.71	0.92	1.00	0.89	0.64
PaninS	1.00	0.42	0.24	0.58	0.03	0.02	0.02	0.22	0.32
BJBS	0.13	0.07	0.03	0.37	0.49	0.23	0.14	0.20	0.21
BukopinS	0.47	0.40	0.29	0.15	1.00	1.00	0.71	0.49	0.56
BCAS	0.30	0.22	0.02	1.00	0.72	0.71	0.65	0.45	0.51
MaybankS	0.86	1.00	0.64	0.10	0.06	0.11	0.28	0.37	0.43
VictoriaS	0.33	0.22	0.26	0.07	0.33	0.29	0.36	0.59	0.31
Mean	0.47	0.42	0.36	0.49	0.61	0.59	0.60	0.58	0.51

Furthermore, as recommended by Cooper et al. (2011), and also Asmild et al. (2004), the results of *window analysis* can be used to analyze the stability of relative efficiency through several summary statistics, including SD, LDW, LDP and LDY. These four measurements can be used to analyze the the stability of efficiency achieved by each DMU (Islamic banks). The smaller the value of the four measurements above, shows the more stable the value of efficiency achieved each Islamic bank. Especially in this research, we just use two stability measurement that is the standard deviation (SD) and Long Distance per Year or LDY. Table 4 shows DEA *window analysis* for Islamic commercial banks in Indonesia during the period 2011 to 2018. Each analysis is divided into four windows, with each length per window is 5 years.

Table 4: *DEA Window Analysis* of BUS in Indonesia 2011 -2018

Bank	Window	SOCIAL EFFICIENCY SCORE								SUMMARY MEASURES		
		2011	2012	2013	2014	2015	2016	2017	2018	Mean/Window	MEAN	SD
BSM	Window 1	0.75	1	0.67	1	1				0.88	0.93	**0.05**
	Window 2		1	0.64	1	1	1			0.93		
	Window 3			0.62	1	1	1	0.97		0.92		
	Window 4				1	1	1	0.97	1	0.99		
	LDY	x	0.00	0.05	0.00	0.00	0.00	0.00	x	**LDY = 0.05**		
BMI	Window 1	0.66	0.66	0.89	0.71	0.85				0.76	0.69	0.07
	Window 2		0.61	0.8	0.71	0.73	0.59			0.69		
	Window 3			0.79	0.72	0.72	0.59	0.75		0.71		
	Window 4				0.51	0.66	0.52	0.7	0.54	0.58		
	LDY	x	0.05	0.10	0.21	0.19	0.07	0.05	x	LDY = 0.21		
BRIS	Window 1	0.25	0.39	0.53	0.56	1				0.54	0.72	0.14
	Window 2		0.35	0.49	0.51	0.98	1			0.66		
	Window 3			0.48	0.5	0.98	1	1		0.79		
	Window 4				0.35	0.98	1	1	1	0.87		
	LDY	x	0.04	0.05	0.21	0.02	0.00	0.00	x	LDY = 0.21		
BNIS	Window 1	0.57	0.61	0.81	0.81	0.93				0.75	0.79	**0.04**
	Window 2		0.62	0.81	0.8	0.90	0.89			0.81		
	Window 3			0.81	0.8	0.83	0.83	0.89		0.83		
	Window 4				0.72	0.84	0.83	0.83	0.65	0.77		
	LDY	x	0.01	0.00	0.09	0.09	0.06	0.06	x	**LDY = 0.09**		
Mega	Window 1	0.52	0.37	0.69	0.85	0.98				0.68	0.79	0.08
	Window 2		0.39	0.73	0.91	0.79	1			0.76		
	Window 3			0.72	0.88	0.72	0.92	1		0.85		
	Window 4				0.69	0.72	0.92	1	0.89	0.85		
	LDY	x	0.02	0.04	0.22	0.26	0.08	0.00	x	LDY = 0.26		
Panin	Window 1	1	0.48	0.3	0.7	0.04				0.50	0.30	0.15
	Window 2		0.47	0.25	0.62	0.04	0.03			0.28		
	Window 3			0.34	0.7	0.04	0.04	0.04		0.23		
	Window 4				0.74	0.03	0.03	0.03	0.02	0.17		
	LDY	x	0.01	0.09	0.12	0.01	0.01	0.01	x	LDY = 0.12		
BJBS	Window 1	0.16	0.08	0.04	0.43	0.54				0.25	0.27	**0.02**
	Window 2		0.07	0.04	0.41	0.53	0.26			0.26		
	Window 3			0.04	0.44	0.5	0.23	0.14		0.27		
	Window 4				0.37	0.5	0.23	0.14	0.2	0.29		
	LDY	x	0.01	0.00	0.07	0.04	0.03	0.00	x	**LDY = 0.07**		
BSB	Window 1	0.55	0.48	0.34	0.18	1				0.51	0.60	**0.07**
	Window 2		0.4	0.29	0.16	1	1			0.57		
	Window 3			0.29	0.16	1	1	0.71		0.63		
	Window 4				0.15	1	1	0.71	0.5	0.67		
	LDY	x	0.08	0.05	0.03	0.00	0.00	0.00	x	**LDY = 0.08**		
BCAS	Window 1	0.31	0.22	0.03	1	0.87				0.48	0.61	0.12
	Window 2		0.22	0.03	1	0.72	0.71			0.54		
	Window 3			0.31	1	0.78	0.74	0.66		0.70		
	Window 4				1	0.78	0.74	0.65	0.45	0.73		
	LDY	x	0.00	0.28	0.00	0.15	0.03	0.01	x	LDY = 0.28		
Maybank	Window 1	0.9	1	0.64	0.14	0.09				0.55	0.59	0.08
	Window 2		1	0.64	0.21	0.15	0.46			0.49		
	Window 3			0.90	0.35	0.35	0.69	1		0.66		
	Window 4				0.41	0.42	0.44	1	1	0.65		
	LDY	x	0.00	0.26	0.27	0.33	0.27	0.00	x	LDY = 0.33		
Victoria	Window 1	1	0.25	0.31	0.1	0.43				0.42	0.59	0.18
	Window 2		0.57	0.51	0.14	0.41	0.67			0.46		
	Window 3			0.61	0.21	0.71	0.92	1		0.69		
	Window 4				0.32	0.71	0.93	1	1	0.79		
	LDY	x	0.32	0.30	0.22	0.30	0.26	0.00	x	LDY = 0.32		

It can be seen, for example, BSM relatively fluctuated in the achievement of social efficiency level between 2011-2018 at the first window (with the efficiency of 75 %, 100 %, 67%, 100% and 100%), from year 2012 -2016 in the second window (with the efficiency of 100%, 64%, 100%, 100% and 100 %, respectively), as well as between 2013-2017 in the third window (with the efficiency of 62%, 100 %, 100%, 100% and 97%). Meanwhile BNIS slightly increased the value of efficiency in the fourth window of 2014-2018 with an efficiency value of 100 %, in addition to 2017 (97%). This DMU has the highest efficiency value of social of about 93% compared with other observed DMUs. With similar interpretion, we can interpret for the case of other Islamic banks.

Based on the DEA window analysis, Islamic banks with the highest average value of social efficiency during 2011-2018 was Bank BSM , with average value of an efficiency of 93%, followed by Bank BNI Syariah and Mega Syariah (both 79%) and BRI Syariah (72%), BMI (69%), BCA Syariah (61%), BSB (60%), Maybank (59%), Victoria (59%), Panin Syariah (30%) and BJBS (27%).

From the perspective of efficiency stability, we found that a relatively stable Islamic bank in its efficiency values such as BSM, BNI Syariah, Bank Bukopin Syaria and BJB Syariah. BSM has a statistical value of 0.05 for SD, and 0.05 for LDY. Bank BNI Syariah has a statistical value of 0.04 for SD, and 0.09 for LDY. Bank Bukopin Syariah has a statistical value of 0.07 for SD, and 0.08 for LDY. Meanwhile, BJB Syariah has a statistical value of 0.02 for SD, and 0.07 for LDY . The difference is, if BSM and BNI Syariah have a high average efficiency value of 0.9 3 and 0.79, Bank Bukopin Syariah is relatively included in the category of medium efficiency, which is the average efficiency value of 0.60. Bank BJB Sharia can be included in the category with a relatively low social efficiency value of 0.27. Table 5 summarizes of the categories of Islamic banks based on their level of efficiency and stability.

Table 5: The category of BUS Efficiency in Indonesia 2011-2018

BANK DMU	SOC-EFF	SD	LDY	CONDITION*
BSM	0.93	0.05	0.05	High-stable
BNIS	0.79	0.04	0.09	High-stable
MegaS	0.79	0.08	0.26	High-unstable
BRIS	0.72	0.14	0.21	High-unstable
BMI	0.69	0.07	0.21	High-unstable
BCAS	0.61	0.12	0.28	Medium-unstable
BukopinS	0.60	0.07	0.08	Medium-stable
MaybankS	0.59	0.08	0.33	Medium-unstable
VictoriaS	0.59	0.18	0.32	Medium-unstable
PaninS	0.30	0.15	0.12	Low-unstable
BJBS	0.27	0.02	0.07	Low-stable

Note: * Stable if the SD and LDY values are below 0.1

The issues related to efficiency especially on social efficiency for Islamic banks are very important. According to Schaeck and Cihak (2014) also Kasman and Carvallo (2014) the efficiency level become a channel between banking competition and generally affect banking stability and it is then important to be elaborated deeper.

Based on Farandy et al. (2017) Islamic banking industry in Indonesia are able to optimize their resource inputs to produce outputs as an intermediary institution. The other result, Ascarya and Yumanita (2007) proved that the Islamic bank's production approach has an increased scale efficiency because at that time the Islamic bank was quite aggressive in expanding the opening of new offices. As we know, Islamic banks have relatively higher financing portfolios for MSME compared to conventional banks. So that it is more pro poor and pro small business, in general.

CONCLUSION & RECOMMENDATION

Our results indicate that the average social efficiency score of all Indonesian Islamic Commercial Banks (BUS) observed during 2011-2018 fluctuated throughout the study period, but has an increasing trend. This figure can be explained by several things, ranging from a fairly high level of competition,

(internal) bank management, to micro and macro shocks both from domestic and internal shocks affecting the level of efficiency of Indonesian Islamic banks. Our results are slightly different from the findings of Nurfalah et al. (2018) which argued that Islamic banking is relatively more stable compared to conventional banking in the face of both internal and external shocks.

Based on DEA window analysis, Islamic commercial banks with the highest average values during the study period from 2011-2018 was BSM (with an average efficiency value of 93%), followed by BNI Syariah and Bank Mega (both have average efficiency of 79 %). These results are not significantly different from the measurement results with the standard CRS approach. The difference is that the average efficiency value of the DEA window analysis is relatively higher compared to the results of the standard CRS model. This can be understood as the more observations that are included, the efficiency value will be lower.

Among other advantages, of the DEA window analysis allows us to measure stability efficiency through several measurement statistics. Results show that Islamic banks that have relatively stable efficiency values are BSM, BNI Syariah, Bukopin Syariah and BJB Syariah. This means that the level of social efficiency of Islamic banks is still relatively fluctuating.

In the framework of Islamic finance development in Indonesia, increasing efficiency is one of the important things so that Islamic banks become more competitive. Our study is somehow relevant with Rusydiana (2016) that highlighted possible factors that are hampering the development of the Islamic banking industry in Indonesia, including: (i) insufficient capital of Islamic banks; (ii) weak understanding of practitioners of Islamic banks; (iii) lack of government support: and iv) trust and public interest in islamic banking is still low. Our findings, therefore, give message with respect to Islamic finance development in improving both capital and quality of human resources of Islamic banks, and no less important is the support of the government and related stakeholders. As we know, the integration of financial markets in the Asian Economic Community (MEA) necessitates intense competition between banks, also in South East Asia (Ajija et al., 2017). Not only conventional banking, Islamic banks will face the same challenges. Other recommendation, in the future, the framework for Islamic banking performance measurement can use this framework, especially in mapping and measuring the social performance of Islamic banks in Indonesia.

REFERENCES

Ajija, S.R., Yasin, M.Z., and Albra, R. (2017). Indonesian banking efficiency: Transmission to the financial stability confronting ASEAN economic community. *Jurnal Ekonomi Pembangunan*, 18(2), 183-193.

Andries, A.M. (2011). The determinants of bank efficiency and productivity growth in the Central and Eastern European banking systems. *Eastern European Economics*, 49(6), 38-59.

Ascarya and Yumanita, D. (2008). Comparing the Efficiency of Islamic Banks in Malaysia and Indonesia. *Bulletin of Monetary, Economic and Banking,* 11(2), 95-119.

Ascarya and Yumanita, D. (2007). Analisis Efisiensi Perbankan Syariah di Indonesia dengan Data Envelopment Analysis. *Tazkia Islamic Finance and Business Review*, 1(2), 1-32.

Ascarya, Yumanita, D., Achsani, N.A., and Rokhimah, G.S. (2008). Comparing the efficiency of conventional and Islamic banks in Indonesia using parametric and nonparametric approaches. Paper presented at University of Melbourne International Symposium and Conference on Islamic Banking and Finance: Ethics and Financial Practice in Global Perspective, Australia, November 19-20, 2008.

Asmild, M., Paradi, J.C., Aggarwall, V., and Schaffnit, C. (2004). Combining DEA window analysis with the malmquist index approach in a study of the Canadian banking industry. *Journal of Productivity Analysis,* 21, 67-89.

Bergendahl, G. (1998). DEA and benchmarks: An application to Nordic banks. *Annals of Operations Research,* 82, 233-249.

Chung, S.H., Lee, A.H.I., Kang, H.Y., and Lai, C.W. (2008). A DEA window analysis on the product family mix selection for a semiconductor fabricator. *Expert Systems with Applications,* 35, 379-388.

Cullinane, K. and Wang, T. (2010). The efficiency analysis of container port production using DEA panel data approaches. *Operational Research Spectrum,* 32, 717-738.

Dastgir, M., Momeni, M., Daneshvar, S., and Sarokolaei, M.A. (2012). Analyzing financial statements by using window data envelopment analysis model (output oriented BCC): Evidence from Iran.

Journal of Basic and Applied Scientific Research, 2(12), 49-55.

Demirci, A., Yakut, E., and Gunduz, M. (2013). Measurement of the economical and social efficiency of OECD countries by means of data envelopment analysis (DEA) and artificial neural network (ANN). *International Journal of Business and Social Science,* 4(16), 67-80.

Farandy, A.R., Suwito, D.A., and Dabutar, L.K. (2017). Efficiency of Islamic banks in Indonesia: Data envelopment analysis. *International Journal of Economics, Management and Accounting*, 25(2), 337-354.

Farrell, M.L. (1957). The Measurement of Productive Efficiency. *Journal of The Royal Statistical Society*, 120, 253-281.

Gutierrez-Goiria, J., San-Jose, L., & Retolaza, J.L. (2017). Social Efficiency in Microfinance Institutions: Identifying How to Improve It. *Journal of International Development*, 29(2), 259-280.

Gutierrez-Nieto, B., Serrano-Cinca, C., & Molinero, C.M. (2007). Social Efficiency in Microfinance Institutions. *Journal of Operational Research Society*, 60, 104-119.

Hemmasi, A., Talaeipour, M., Khadami, H.E., Farzipoor, R.S., and Pourmousa, S.H. (2011). Using DEA window analysis for performance evaluation of Iranian wood panels industry. *African Journal of Agricultural Research,* 6(7), 1802-1806.

Ikhwan, I. (2022). Islamic Banking Efficiency in The Covid-19 Pandemic Era and The Role of Digitalization. *Ekonomi Islam Indonesia*, *4*(1).

Ikhwan, I., & Riani, R. (2020). The Efficiency of Indonesian and Malaysian Sharia Bank in the Shadow of Covid-19 Pandemic: DEA Window Analysis. *Jurnal Ekonomi dan Perbankan Syariah (IQTISHODIAH)*, *2*(1), 1-9.

Islamic Banker Association. (2017). *Global Islamic Finance Report 2017*.

Jia, T. and Yuan, H. (2017). The application of DEA window analysis in the assessment of influence on operational efficiencies after the establishment of branched hospitals. *Health Services Research,* 17, 265.

Kamarudin, F., Sufian, F., and Nassir, A.M. (2016). Global financial crisis, ownership and bank profit efficiency in the Bangladesh's state owned and private commercial banks. *Contaduria y Administracion*, 61, 705-745.

Kamath, G.B. (2007). The intellectual capital performance of the Indian banking sector. *Journal of Intellectual Capital*, 8(1), 96-123.

Kamau, A.W. (2011). Intermediation efficiency and productivity of the banking sector in Kenya. *Interdisciplinary Journal of Research in Business*, 1(9), 12-26.

Kasman, A., and Carvallo, O. (2014). Financial stability, competition and efficiency in Latin American and Caribbean banking. *Journal of Applied Economics,* 17(2), 301-324.

Kisielewska, M., Guzowska, M., Nellis, J.G., and Zarzecki, D. (2005). Polish banking industry efficiency: DEA window analysis approach. *International Journal of Banking and Finance*, 3(1), 15-31.

Klopp, G. (1985). The analysis of the efficiency of production system with multiple inputs and outputs. Ph.D thesis at University of Illinois Chicago, Industrial and Systems Engineering College, USA.

Mahadevan, R. (2002). A DEA approach to understanding the productivity growth of Malaysia's manufacturing industries. *Asia Pacific Journal of Management,* 19, 587-600.

Maidamisa, A.A., Ahmad, R., and Ismail, A.A.M. (2012). A comparative analysis of window width selection technique in data envelopment analysis. *International Journal of Computer Applications*, 41(5), 21-26.

Maisaroh, Siti. 2015. Pengaruh Intellectual Capital dan Islamicity Performance Index Terhadap Profitability Perbankan Syariah Indonesia. *Jurnal Fakultas Ekonomi UIN Malang,* 7(1).

Marlina, L., Sudana, S., & Rusydiana, A. S. (2023). Intertemporal Efficiency Analysis on Indonesia Islamic Banks: A Window DEA Approach. *JURNAL EKONOMI SYARIAH*, *8*(1), 24-34.

Nurfalah, I., Rusydiana, A.S., Laila, N., and Cahyono, E.F. (2018). Early warning to banking crises in the dual financial system in Indonesia: The markov switching approach. *JKAU: Islamic Economics*, 31(2), 133-156.

Oscar, Yazar (2008). *Health Care Benchmarking and Performance Evaluation: An Assessment using Data Envelopment Analysis*. Springer, Newton MA.

Otoritas Jasa Keuangan. (2018). *Statistik Perbankan Syariah Indonesia,* June 2019.

Ozdemir, Asli. (2013). Integrating analytic network process and data envelopment analysis for

efficiency measurement of Turkish commercial banks. *Banks and Bank Systems, 8(2).*

Pjevcevic, D., Radonjic, A., Hrle, Z., and Colic, V. (2012). DEA window analysis for measuring port efficiencies in Serbia. *Traffic Management Review*, 24(1), 63-72.

Rani, L., Rusydiana, A., and Widiastuti, T. (2017). Comparative analysis of Islamic bank's productivity and conventional bank's in Indonesia period 2008-2016. In *1st International Conference on Islamic Economics, Business and Philanthropy (ICIEBP 2017),* 118-123.

Repkova, Iveta. (2014). Efficiency of the Slovak commercial banks applying the DEA window analysis. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering,* 8(5), 1342-1347.

Riani, R. (2022). DEA Window Analysis of Indonesian Banking Industry Efficiency During COVID-19. *Ekonomi Islam Indonesia*, *4*(1).

Rusydiana, Aam S. (2018a). Indeks malmquist untuk pengukuran efisiensi dan produktivitas bank syariah di Indonesia. *Jurnal Ekonomi dan Pembangunan LIPI*, 26(1), 47-58.

Rusydiana, Aam S. (2018b). Efisiensi dan stabilitas bank umum syariah di Indonesia. *Jurnal Akuntabilitas,* 11(2), 203-222.

Rusydiana, Aam S. (2016). Analisis masalah pengembangan perbankan syariah di Indonesia: Aplikasi metode analytic network process. *Esensi: Jurnal Bisnis dan Manajemen,* 6(2), 237-246.

Rusydiana, A. S., & As-Salafiyah, A. (2021). Dea Window Analysis Of Indonesian Islamic Bank Efficiency. *Journal of Islamic Monetary Economics and Finance*, *7*(4), 733-758.

Rusydiana, Aam S., and Yulizar D. Sanrego, (2018). Measuring the performance of Islamic banking in Indonesia: An application of Maslahah efficiency quadrant (MEQ). *Journal of Monetary Economics and Finance, 3(SI), 103-130.*

Rusydiana, Aam S., and Irman Firmansyah, (2017). Efficiency versus Maqasid sharia index: An application on Indonesia Islamic bank. *Shirkah Journal of Economics and Business, 2(2).*

Schaeck, K., and Cihak, M. (2014). Competition, efficiency and stability in banking. *Financial Management,* Spring 2014, 215-241.

Shahooth, Khalid & Battall, Hussien. (2006). Data envelopment analysis and window analysis in measuring and analyzing the relative cost efficiency of 24 Islamic banking institutions. *Scientific Journal of Administrative Development*, 4, 134-156.

Shahreki, Javad, Nazar Dahmardeh and Mohammad Ali Ghasemi. (2012). Efficiency Evaluation Bank Sepah Branches in Sistan and Baluchestan Province Using Data Envelopment Analysis. *Interdisciplinary Journal of Contemporary Research in Business, 4(2).*

Shahwan, T.M., and Hassan, Y.M. (2013). Efficiency analysis of UAE banks using data envelopment analysis. *Journal of Economic and Administrative Sciences*, 29(1), 4-20.

Shawtari, F.A., Ariff, M., and Razak, S.H.A. (2015). Efficiency assessment of banking sector in Yemen using data envelopment window analysis: A comparative analysis of Islamic and conventional banks. *Benchmarking: An International Journal*, 22(6), 1115-1140.

SPI. (2002). Social Performance Indicators for the financial industry. http://www.spifinance.com, accessed 8 September 2019.

Sufian, F. and Majid, M.Z.A. (2007). Deregulation, consolidation and banks efficiency in Singapore: Evidence from event study window approach and tobit analysis. *International Review on Economics,* 54, 261-283.

Sufian, F. (2007). Trends in the efficiency of Singapore's commercial banking groups: A non-stochastic frontier DEA window analysis approach. *International Journal of Productivity and Performance Management,* 56(2), 99-136.

Sufian, F. (2006). The Efficiency of Islamic Banking Industry in Malaysia: Foreign Versus Domestic Banks, Paper, INCEIF Colloquium, Malaysia, April.

Tatje, E.G., and Lovell, C.A.K. (1997). A DEA-based analysis of productivity change and intertemporal managerial performance. *Annals of Operations Research,* 73, 177-189.

Tsolas, Ioannis E. and Dimitris I. Giokas. (2012). Bank branch efficiency evaluation by means of least absolute deviations and DEA. *Managerial Finance, 38(8).*

Tulkens, H., and vanden Eeckaut, P. (1995). Nonparametric efficiency, progress and regress measures for panel-data: Methodological aspects. *European Journal of Operational Research,* 80(3), 474-499.

Weng, S.J., Wu, T., Blackhurst, J., and Mackulak, G. (2009). An extended DEA model for hospital

performance evaluation and improvement. *Health Service Outcomes Research Method,* 9, 39-53.

Widiarto, I., and Emrouznejad, A. (2015). Social and financial efficiency of Islamic microfinance institutions: A data envelopment analysis application. *Socio-Economic Planning Sciences*, 50, 1-17.

Zimkova, E. (2014). Window analysis of super-efficiency change: Case of the Slovak banking system. Proceedings of International Scientific Conference, Poland 27-31 August 2014, 294-300.