



BUSINESS PERSPECTIVES



LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine
www.businessperspectives.org

Received on: 24th of June, 2022

Accepted on: 8th of September, 2022

Published on: 6th of October, 2022

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Conflict of interest statement:

Author(s) reported no conflict of interest

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INDONESIAN ISLAMIC BANKS: A REVIEW OF THE FINANCIAL STATE BEFORE AND AFTER THE COVID-19 PANDEMIC

Abstract

Banking plays an important role in business and economic growth. However, since a couple decades ago, there have been issues with efficiency and performance. This paper aims to examine Indonesia's Islamic banking performance through non-parametric production efficiency analysis before and after the COVID-19 pandemic, 2010–2021. This study differentiated between different dimensions of Indonesia's Islamic banks (IIB) finance and non-finance aspects, as well as investigated the relationships between these dimensions of finance, including assets, deposits, equity, financing, and income, and non-financial variables, namely employees and offices. Non-parametric analysis, with the input-oriented variable constant return to scale (CRS) and returns to scale (VRS) models as a framework, data envelopment analysis (DEA) is used to calculate the IIB of overall, pure, and scale efficiency. However, the resources of technology IIB management are lacking, as well as macroeconomic and environmental effects. This study found that IIB operational needs to enhance investment in technology beyond the office. This means that the number of offices has a smaller impact on enhancing deposits and revenue. Technology investment has a crucial role in enhancing IIB equity, income, and innovation service. As a result, IIB managers and policymakers must improve their efficiency scores in order to increase competition and innovation. Furthermore, IIB needs to increase and spend their assets and experience to enhance technology, which significantly affects efficiency.

Keywords

DEA, efficiency, COVID-19 pandemic, Indonesian
Islamic bank

JEL Classification

C53, E32, G21

INTRODUCTION

The Islamic finance sector has expanded and is now present in almost every country in the world over the past 20 years. This sector includes banking, the capital market, and insurance. With over USD 260 billion in assets, it has developed more than 300 global Islamic funds and institutions across the region, with the majority of Muslim people and Western countries (Junaidi, 2022). The COVID-19 pandemic hurts the banks' finances and profitability. In most countries worldwide, the Central Bank attempts to solve economic downturns by enhancing the banking intermediary role to transfer funds from depositors and borrowers. It is crucial for the real economy and the financial stability of the area. However, borrowers (e.g., banks) need to be concerned about banking efficiency, price stability, financial structure, and operational system. Commonly, the efficiency concept refers to how the input variables stimulate the outcome variables. In the banking sector, the concept of efficiency is how the funds obtained from third parties are allocated to investment and financing. Besides contributing to bank profitability and performance, banking efficiency and financing have contributed to economic growth.

Efficiency is defined as the degree to which the input and output of variables are strongly correlated. Efficiency in the banking industry refers to the best use of resources, including internal resources and outside finances, offices, and expenses, to facilitate financing and income. It is crucial for increasing credit, economic growth, and lowering income disparity. Consequently, the effectiveness of the banking industry is used to verify their performance. Furthermore, the input and output variables have a strong relationship to technical efficiency as decision-making units (DMU) toward optimal inputs to obtain maximum output (Demirguc-Kunt et al., 2021). Indonesia implemented a dual banking system simultaneously for conventional and Islamic banks. The rapid development of Islamic banks has invited investors and researchers to examine their contribution to Indonesia's economic growth and performance toward efficiency analysis. With the research findings in this part, bank managers and the government can evaluate the input role to achieve maximum output. As a result, when Islamic banks operate efficiently, they help the economy by reducing income inequality and asymmetry in the financial market.

1. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

During the COVID-19 pandemic, banks need stability and efficiency to support the financial operation and system. The Islamic finance sector has expanded significantly over the past 20 years and is now present practically everywhere in the world. This sector includes banking, the capital market, and insurance. However, some studies concluded mixed result of Islamic bank efficiency.

The impact of return on financial performance on Islamic banking profitability was studied by Le et al. (2022). The result of this study is that banking profitability has decreased during the COVID-19 pandemic than before. It also indicates the relationship between the government, banking system, and resources on banking performance. Furthermore, Saleh et al. (2020) concluded that the financial performance and inflation play an important role in influencing non-performing loans in the GCC countries. Prior studies also recommended enhancing methods and research models such as social science and statistical methods (parametric and non-parametric) to provide useful information.

Previous research revealed that Islamic banks may endure a crisis. However, the Middle Eastern and Asian regions have also encountered the Islamic bank with a poor level of efficiency (Rosman et al., 2014). This means that profitability and capitalization play an important role in efficiency. Just like in Indonesia, in particular, three years ago, the rise

of deposits, workers, operating costs, and offices had a negative impact on the increase in income and financing (OJK, 2021). Although, Islamic banks are better than conventional banks, lack of product and service innovation has contributed to Islamic bank inefficiency (Johnes et al., 2014). Furthermore, high operational expenses and unproductive employees also have a significant contribution to Islamic bank efficiency (Wanke et al., 2019). The scale of Islamic banks in Southeast Asia allows for greater efficiency in producing tiny amounts of output from little amounts of input (Basri et al., 2018). Moreover, the efficiency of Islamic banks has improved with time. Despite operating at a size that is generally ideal, Islamic banks must improve their efficiency, particularly with regard to their ineffective managerial resources. Islamic banks should increase the quality of assets due to the positive effect on their efficiency (Kamarudin et al., 2017).

Chowdhury and Haron (2021) revealed that Islamic banks need to focus on enhancing efficiency to enhance their sources. Similarly, Junaedi et al. (2022) concluded that Islamic bank financial ratios suffered because of their low level of efficiency. Additionally, Shawtari et al. (2018) discovered that macro and micro variables significantly and favorably affect bank efficiency. Saâdaoui and Khalfi (2022) argue that Islamic bank efficiency measurement is worthwhile to provide accurate and timely information. Anouze and Bou-Hamad (2019) revealed that DEA is useful for examining bank performance. Similarly, Emrouznejad and Yang (2018) concluded that data envelopment analysis (DEA) is recognized as modern to validate private and public companies' application of inputs to

produce outputs. According to Sealey and Lindley (1977), there is a significant relationship between the technical characteristics of the production and operational processes and the input and output variables.

Data envelopment analysis (DEA), according to Henriques et al. (2020), is crucial for validating efficiency. Alandejani (2022) used DEA to assess the effectiveness of conventional and Islamic banks in GCC countries. This study discovered that banks' effectiveness has a significant impact on financial stability and economic growth. Furthermore, it demonstrates that Islamic banks are more effective than conventional banks. Additionally, Indonesia experienced same situation, where Islamic banks beat traditional banks (Junaidi, 2021; Hambali & Adhriani, 2022). The same tendency was discovered by Akram and Rahman (2018) in Pakistan, where Islamic banks perform and operate more efficiently than traditional banks. Contrarily, traditional banks performed better in Southeast Asian nations between 2006 and 2014 (Kamarudin et al., 2019) and Malaysia (Ling et al., 2020). Besides, financial ratios, banking leaders also play a crucial role in banking efficiency and performance in Ghana (Kyei-Frimpong et al., 2022). The mean of efficiency and financial turnover have an impact on bank efficiency (Parsa, 2022).

The DEA technique is used to assess the efficiency inputs and outputs of the decision-making units (DMUs) (Charnes et al., 1978). The main issue in the literature is the examination of the banking sector's return to scale (RTS) with a view of presenting the incremental return to scale (IRS) and continuous return to scale (CRS). The second type of PTE is known as global efficiency, and the third type of PTE is managerial and administrative capability. Using both the CCR and the BCC, SE determines the ratio of OTE and PTE after being linked to the operational scale level (Gulati & Kumar, 2017). Therefore, it was necessary to confirm the difference in their levels of efficiency. However, few applied studies on Islamic banks' efficiency and whether the efficiency of banks effectively influences their financial stability. Moreover, preliminary studies on Islamic banks have mixed results. This indicates that conventional banking has been utilizing the efficiency of information technology and electronic systems. In addition,

scale efficiency (SE) is an essential source of technical efficiency (TE) for conventional and Islamic banks (Dolgun et al., 2019). Furthermore, preliminary studies also confirmed that banking assets, deposits, employees, and offices are essential in enhancing their financing and revenue.

Moreover, Islamic banks' efficiency has improved with time. Although Islamic banks operate at a size that is generally ideal, their effectiveness, especially the managerial resources inefficient, is needed. Islamic banks should increase the quality of assets due to the positive effect on their efficiency. Mixed results of Islamic bank financial performance are needed to get clear confirmation as to which the main factor is to encourage economic efficiency. One of the solutions is to deeply understand the crucial input to the output process to increase financial performance. Furthermore, the scholars must focus on Islamic banking studies (Kamarudin et al., 2019). The use of DEA as a measurement technique is efficient when there are few data points. To prevent the data identifying and determining, it does not require a specified structure or a specific well-designed form. The evaluation of the banking sector's return to scale (RTS) toward presenting the return to scale (IRS) and steady return to scale, however, is the key topic in the literature (CRS). Its concepts are also called global efficiency with regard to administrative and managerial capability (Wanke et al., 2019).

As a result, this strategy suggests two distinct approaches to OTE, PTE, and SE: constant returns to scale (CRS), and variable returns to scale (VRS). The VRS model can also be used to quantify pure technical efficiency, which refers to the influence of size and technical efficiency. By comparing technical efficiency (TE), which is consistent with the CRS and VRS principles, scale efficiency (SE) is attained. It calculates financial and operational performance toward input and output configurations (Asmild et al., 2018). It also embraced the production system, the facility to consolidate, and an effective approach to employee surveillance in a firm to affect the decision-making process toward efficiency measurement scores (Sakti & Mohamad, 2018). The model confirms that each DMU is benchmarked at a similar size (Wanke et al., 2019). Mainly, the features of DEA are attractive and useful for bank regulators, especially how

to identify the best and worst practices within a financial institution group (Farrel, 1957). The PTE and SE provided material to ensure OTE results. The measurement of technical efficiency provided by SE in scale returns reflects an exceptional level of activity concerning observed performance and the situation of constant return to scale. The CRS prediction operates at the optimal scale when all the DMUs have good constant returns to scale and there is no correlation among scale efficiency. Hence, the OTE can be regarded in this study, which achieved the DMU operation in economies and diseconomies. As a result, it is advised to consider the consequences of the VRS theory and score. SE enables us to prove the transformation between two approaches to efficiency. This study aims to address this issue and add to the knowledge in both the financial and non-financial sectors, which influence bank performance toward examining Islamic banks' performance regarding economic (e.g., assets, deposits, equity, financing, and income) and non-financial fields (e.g., employees and offices) effects.

Despite Islamic banking have significantly grown worldwide, few studies have been given to the financial and operational performance. Specific research to evaluate banking efficiency has become crucial since the 1990s (Mateev et al., 2022). It is useful to managers, stakeholders, policy-makers, and regulators, as well as researchers. Through a review and summary of prior studies, which were correlated to the banking efficiency concept, the research hypotheses of the current study before and after the COVID-19 pandemic are set. In some parts, the COVID-19 pandemic has caused a banking performance downturn. Hence, Islamic banks' concerns about the operational efficiency. However, there is little empirical research on the effectiveness of Islamic banking operations in this environment, and the literature and earlier studies on bank efficiency are widely addressed in relation to the comparison between Islamic and conventional banks. The efficient frontier of banks will directly enhance profitability levels, and higher amounts of finance will be available, theoretically constrained by technical and allocative efficiencies. A bank will attempt to minimize the operational and service costs (cost-efficient), which is correlated to enhancing their income (revenue efficiency) and profit (profit margin).

The aims of this study are to examine Indonesia's Islamic bank (IIB) efficiency and performance with regard to economic (e.g., assets, deposits, equity, financing, and income) and non-financial fields (e.g., employees and offices) effects. The results from a recent study tend to help academicians, practitioners, and policy-makers obtain a better view of the effect of inputs on output bank performance. Additionally, it makes a number of theoretical and useful contributions. First, the data envelopment analysis (DEA) method is used to connect this study to the financial and operational context. Second, the field of Islamic banking is restricted, with the exception of literature and studies on the impact of deposits, workers, expenses, and offices on financing and income. The outcome of this study reveals the critical function of input variables and provides a thorough understanding of their impact on output variables, which has been overlooked in earlier studies.

H1: Islamic bank assets, deposits, employees, and offices positively influence total financing and revenue.

H2: Islamic bank assets, deposits, equity, and employees positively influence total financing and revenue.

2. DATA AND METHODOLOGY

Data were retrieved from the banks' databases. 14 Indonesian Islamic banks (IIB) (see Table 1) for 2010 to 2021 have been considered. This study was conducted using the input and output approach referred to by Demircuc-Kunt et al. (2021) to ensure a fair distribution of inputs and outputs in order to maintain the DEA. In this study, the inputs are the number of employees, offices, total deposits, and total operational expenses, and the outputs are total financing and revenue.

The production approach was pioneered by Benston (1965), who transformed banks into producers of loans, deposits, and other services by utilizing conventional inputs like labor, capital, and space. It just takes into account operating expenses and ignores interest costs. In this concept, the DMU applies employees and

Table 1. Indonesian Islamic Banks (IIB) data and indicators

Islamic bank	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SCB	11	11	11	11	12	12	13	13	14	14	14	12
SBU	23	24	24	23	23	22	22	21	20	19	19	21
SRB	150	155	158	163	163	163	166	167	165	164	167	164
Offices	2,101	2,101	2,663	2,990	2,922	2,747	2,654	2,664	2,724	2,917	2,034	2,035
Assets*	148.98	186.74	199.71	248.10	272	304	366	425	490	538	609	676
Financing*	105.33	118.95	151.06	188.56	201	220	256	287	330	366	396	435
Deposits*	117.51	126.70	150.46	187.20	222	236	285	342	380	425	476	521

Note: SCB = Shariah commercial banks, SBU = Shariah business units, SRB = Shariah rural banks, * in trillion rupiah (IDR).

capital as inputs to enhance deposits and assets. Hence, the recent study adopts the intermediation approach to generate revenue and assets. It helps evaluate a bank's efficiency (Berger & Humphrey, 1997; Wanke et al., 2019). The current study also refers to Xu and Zhou (2020), which use deposits as intermediate input and output. Furthermore, this study combines two prior studies by Bhatia et al. (2018), Chaffai and Hassan (2019), and Doumpos et al. (2017) as input and financing, non-interest income, interest income, and nonperforming loans as output. As the major function of banks is to move money between surplus and deficit units, the intermediation technique is more appropriate for analyzing bank efficiency (Bhatia et al., 2018). More significantly, the intermediation model takes interest costs into account, which make up a sizeable portion of any banking or financial institution's overall costs. As a result, this study chose to use financing and income as output variables in this paper's intermediation technique, and assets, deposits, personnel, and offices as input measurements.

Under these two presumptions, the DEA idea makes it possible to regulate efficiency score, namely, CRS and VRS. The inputs include the number of employees, branches, and deposit and operational expenses that are defined as a sum of bank premises and two intermediate outputs, income and financing, to measure the production efficiency. The inputs and outputs are assessed in monetary terms because the intermediation approach sees banks as financial intermediaries. In this respect, Indonesian

Islamic banks can be seen as financial intermediaries, with their main function being the acquisition of funds from depositors in order to make loans to other people. So, in this study, the intermediation strategy is employed.

By converting deposits into income-producing assets rather than service providers and lenders, the intermediation strategy is applicable to the interaction between investors and savers. Deposits, along with labor and physical capital, are classified as inputs, and the output measure is based on the sum of all loans, securities, and deposits. Xu and Zhou (2020) proposed the intermediation approach concerning total assets, workers, operating expenses as input, and deposits as intermediation productivity. This method defines output as interest revenue, non-interest income, and on-performing loans. When used to an Islamic bank, this strategy is more appropriate. In fact, it is sometimes asserted that an Islamic bank is a joint venture company, in which members share in the profit, loss, and risk. The participation in business and the use of finances based on profit-and-loss sharing principles are the fundamental tenants of the Islamic financial system. Furthermore, the intermediation strategy, according to Chen et al. (2023) and Xu and Zhou (2020), is the most pertinent bank context. The primary locations for bank services are branches, which also operate as a channel for communication with customers. Neglecting branch efficiency could lead to a number of problems with economies of scale, product mix, and efficiency (Aggelopoulos & Georgopoulos, 2017).

$$\text{Scale Efficiency}(SE) = \frac{\text{Overall Technical Efficiency}(OTE) \text{ under CRS}}{\text{Pure Technical Efficiency}(PTE) \text{ under VRS}}. \quad (1)$$

3. RESULT

This study shows the correlation between the input and output variables (see Table 2). Together with the Pearson's correlation coefficient between the input and the output, the averages of the ratios for various ranges show a positive correlation.

This study examines the effectiveness of Indonesian Islamic banks (IIB) under the CRS and VRS hypotheses. Table 3 shows that the mean OTE and SE scores have changed across all banks. Table 3 makes it evident that the IIB OTE's mean value over the study period was 82.13%. Overall findings indicate that all banks could have saved

17.87% by using comparable input resources to create the same number of outputs. As a result, the IIB management's resource decomposition is poor. The PTE can be evaluated using VRS technology, which allows for an average PTE assessment of 90.83%. This means that if IIB had adopted the most efficient technology, they could lower their input by 8.17% while maintaining a constant level of output.

Table 3 shows that IIB has very poor resource management based on current technologies. In fact, a small variation in this study indicates factors like macroeconomic and environmental variables that are out of the IIB's control. Table 3 further shows that the average SE index for all institutions is ap-

Table 2. Correlation and descriptive variables

Variables	Min	Max	Mean	Std	Deposit	Employees	Expense	Financing	Offices	Revenue
Deposit	17	87472	12270	17795	1	–	–	–	–	–
Employees	47	16945	3329	4376	747**	1	–	–	–	–
Expense	10	5316	804	1031	926**	837**	1	–	–	–
Financing	21	67753	10756	14578	993**	747**	915**	1	–	1
Offices	1	747	155	180	895**	810**	875**	903**	1	–
Revenue	7	7689	1438	1774	970**	842**	956**	972**	946**	910**

Note: ** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Descriptive statistics of annual efficiency score of IIBs

Year	Overall technical efficiency					Pure technical efficiency scores					Scale efficiency scores				
	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
Model 1															
2010	86.50	100.00	95.59	0.058	0.061	88.70	100.00	96.68	0.047	0.049	92.70	100.00	97.43	0.011	0.011
2011	67.00	100.00	93.94	0.117	0.125	78.50	100.00	95.99	0.080	0.083	85.30	100.00	97.52	0.051	0.052
2012	73.10	100.00	92.81	0.099	0.107	88.70	100.00	96.44	0.050	0.052	73.10	100.00	95.20	0.093	0.098
2013	81.70	100.00	96.16	0.064	0.067	96.00	100.00	99.48	0.008	0.008	91.70	100.00	96.67	0.065	0.067
2014	91.70	100.00	98.00	0.033	0.034	93.30	100.00	99.20	0.021	0.021	91.70	100.00	98.79	0.025	0.025
2015	96.90	100.00	94.75	0.052	0.055	87.00	100.00	97.24	0.045	0.046	90.40	100.00	97.47	0.037	0.038
2016	86.50	100.00	96.31	0.045	0.047	92.20	100.00	97.76	0.034	0.035	93.80	100.00	98.49	0.023	0.023
2017	81.90	100.00	92.99	0.060	0.065	89.70	100.00	97.38	0.044	0.045	81.90	100.00	95.55	0.056	0.059
2018	76.00	100.00	96.80	0.074	0.060	99.00	100.00	99.90	0.031	0.025	76.50	100.00	96.70	0.074	0.045
2019	87.10	100.00	98.80	0.051	0.030	88.30	100.00	98.80	0.038	0.040	88.10	100.00	97.90	0.038	0.060
2020	85.15	100.00	93.50	0.045	0.020	86.20	100.00	93.50	0.021	0.025	86.15	100.00	92.15	0.021	0.040
2021	87.25	100.00	95.58	0.065	0.035	88.50	100.00	98.95	0.045	0.048	88.75	100.00	98.25	0.040	0.065
Mean	–	–	95.15	–	–	–	–	97.27	–	–	–	–	97.41	–	–
Model 2															
2010	71.10	100.00	94.23	0.094	0.100	89.60	100.00	98.36	0.036	0.037	71.10	100.00	95.82	0.029	0.030
2011	70.40	100.00	95.91	0.070	0.073	75.80	100.00	95.91	0.071	0.074	76.70	100.00	95.54	0.076	0.080
2012	76.70	100.00	92.75	0.094	0.101	89.20	100.00	98.17	0.034	0.035	76.70	100.00	94.47	0.088	0.093
2013	80.90	100.00	95.35	0.070	0.073	94.30	100.00	99.01	0.019	0.019	80.90	100.00	96.31	0.068	0.071
2014	90.00	100.00	97.35	0.039	0.040	93.50	100.00	98.75	0.026	0.026	98.30	100.00	99.62	0.006	0.006
2015	87.10	100.00	94.92	0.053	0.056	87.20	100.00	97.42	0.045	0.046	90.50	100.00	97.46	0.037	0.038
2016	86.50	100.00	95.63	0.050	0.052	89.40	100.00	97.85	0.039	0.040	89.30	100.00	96.94	0.039	0.040
2017	82.90	100.00	93.18	0.057	0.061	89.80	100.00	97.45	0.043	0.044	82.90	100.00	95.69	0.054	0.056
2018	76.10	100.00	96.40	0.073	0.045	98.50	100.00	99.80	0.006	0.040	76.10	100.00	96.60	0.074	0.050

Table 3 (cont.). Descriptive statistics of annual efficiency score of IIBs

Year	Overall technical efficiency					Pure technical efficiency scores					Scale efficiency scores				
	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
2019	88.50	100.00	96.30	0.047	0.050	90.50	100.00	99.00	0.031	0.030	88.50	100.00	97.30	0.039	0.045
2020	85.25	100.00	96.20	0.031	0.041	90.20	100.00	98.88	0.025	0.025	88.55	100.00	96.50	0.031	0.040
2021	88.75	100.00	96.50	0.055	0.075	94.25	100.00	99.20	0.040	0.045	89.10	100.00	97.50	0.045	0.057
Mean	—	—	95.10	—	—	—	—	97.85	—	—	—	—	95.58	—	—
Model 3															
2010	61.10	100.00	92.66	0.132	0.142	86.50	100.00	97.85	0.047	0.048	70.60	100.00	94.37	0.105	0.111
2011	70.50	100.00	96.55	0.093	0.096	78.50	100.00	97.85	0.068	0.069	89.70	100.00	98.47	0.034	0.035
2012	73.50	100.00	94.17	0.099	0.105	89.20	100.00	98.55	0.035	0.036	73.50	100.00	95.56	0.093	0.097
2013	81.70	100.00	96.13	0.064	0.067	96.00	100.00	99.48	0.013	0.013	81.70	100.00	96.64	0.064	0.066
2014	91.70	100.00	97.45	0.032	0.033	93.60	100.00	99.23	0.02	0.020	91.70	100.00	98.22	0.028	0.029
2015	87.10	100.00	94.92	0.053	0.056	87.20	100.00	97.42	0.045	0.046	90.50	100.00	97.46	0.037	0.038
2016	85.00	100.00	96.02	0.050	0.052	92.20	100.00	98.34	0.029	0.029	87.80	100.00	96.85	0.014	0.014
2017	82.90	100.00	93.13	0.058	0.062	89.80	100.00	97.20	0.042	0.043	82.90	100.00	95.87	0.052	0.054
2018	74.50	100.00	94.60	0.089	0.050	88.60	100.00	98.70	0.038	0.020	84.50	100.00	95.70	0.063	0.030
2019	88.10	100.00	95.90	0.054	0.045	90.60	100.00	99.00	0.031	0.040	88.10	100.00	96.90	0.049	0.050
2020	85.50	100.00	95.85	0.050	0.040	90.45	100.00	98.85	0.025	0.035	88.25	100.00	96.50	0.025	0.047
2021	88.45	100.00	96.10	0.060	0.067	90.85	100.00	99.10	0.035	0.045	88.45	100.00	97.45	0.055	0.065
Mean	—	—	95.93	—	—	—	—	98.07	—	—	—	—	96.70	—	—
Model 4															
2010	51.80	100.00	86.39	0.194	0.225	67.90	100.00	93.70	0.132	67.90	51.80	100.00	92.22	0.153	0.166
2011	70.00	100.00	91.71	0.110	0.120	81.70	100.00	96.67	0.064	81.70	78.80	100.00	94.80	0.088	0.093
2012	73.30	100.00	93.24	0.103	0.110	89.20	100.00	98.59	0.035	89.20	73.50	100.00	94.57	0.098	0.104
2013	78.80	100.00	93.91	0.088	0.094	84.10	100.00	97.74	0.05	84.10	80.30	100.00	96.04	0.069	0.072
2014	92.00	100.00	98.09	0.030	0.031	93.60	100.00	98.61	0.026	93.60	97.10	100.00	99.46	0.009	0.009
2015	87.10	100.00	97.06	0.048	0.049	87.20	100.00	97.34	0.047	87.20	98.40	100.00	99.71	0.005	0.005
2016	90.50	100.00	97.40	0.037	0.038	90.80	100.00	97.60	0.035	90.80	98.50	100.00	99.78	0.005	0.005
2017	82.90	100.00	92.21	0.053	0.057	89.80	100.00	97.46	0.043	89.80	82.90	100.00	94.70	0.055	0.058
2018	84.80	100.00	90.00	0.280	0.025	92.20	100.00	99.00	0.025	92.20	84.20	100.00	96.70	0.053	0.050
2019	89.20	100.00	97.00	0.048	0.030	89.10	100.00	98.90	0.034	89.10	89.50	100.00	98.10	0.040	0.025
2020	89.10	100.00	97.15	0.055	0.038	89.05	100.00	98.85	0.025	89.05	88.75	100.00	98.06	0.035	0.020
2021	90.15	100.00	98.20	0.055	0.065	89.75	100.00	99.24	0.055	90.25	90.15	100.00	99.25	0.025	0.030
Mean	—	—	93.58	—	—	—	—	97.53	—	—	—	—	95.42	—	—

proximately 90.47%. This result clarified that, on average, IIB could earn 9.53% if they adopted the production structure to their optimal size.

The remaining technical inefficiency is said to be caused by the improper scale of banking activities. Additionally, the PTE scores' lower mean and higher standard deviation than the SE ratings point to a greater overall technical inefficiency caused by pure technical inefficiency. The IIB's efficiency decreased from 2015 to 2021 (however, there was an increase in OTE, PTE, and SE from 2013 until 2014). The remaining technical inefficiency is said to be caused by the improper scale of banking activities. Additionally, the PTE scores' lower mean and higher standard deviation than the SE ratings point to a greater overall technical inefficiency caused by pure technical inefficiency.

Table 4 shows that during the study period, IIB was effective at least once. According to the descriptive data, MBS, BPDN, and BTPNS have the highest scores in the big IIB category, with a perfect score of 100%. In the big category, BMI is the highest of OTE. In the PTE, BMI and BSM are the best. The BMS is the lowest in the OTE and PTE, with the average scores of 51.89% and 64.70%. The SE of BBS on average is 95.40%, which is the highest. In sum, it is deduced that BPS is the most efficient of IIB. The difference among the banks for all categories is quite significant.

Table 5 highlights a progressive drop for the three forms of efficiency, namely OTE, PTE, and SE, during the course of the study. From 2011 to 2021, the drop was significantly more pronounced, but between 2017 and 2018, there was an upward ten-

Table 4. Descriptive statistics of efficiency scores across banks

Banks	Overall technical efficiency scores				Pure technical efficiency scores				Scale technical efficiency scores			
	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
Model 1												
BSM	92.10	100.00	97.24	0.04	99.80	100.00	99.98	0.00	92.10	100.00	98.90	0.03
BNIS	87.70	100.00	96.63	0.04	89.20	100.00	98.50	0.04	92.70	100.00	98.11	0.03
BCAS	67.00	100.00	87.71	0.09	78.50	100.00	93.02	0.07	83.20	100.00	94.25	0.07
BJBS	87.70	100.00	96.70	0.05	89.40	100.00	97.70	0.04	92.70	100.00	98.96	0.02
BBS	88.60	100.00	96.13	0.04	89.80	100.00	97.37	0.04	92.70	100.00	98.75	0.02
BMS	87.90	100.00	98.04	0.04	89.70	100.00	98.95	0.03	92.00	100.00	98.27	0.03
BPS	82.50	100.00	99.25	0.02	98.50	100.00	99.85	0.01	93.90	100.00	99.39	0.02
BVS	73.10	100.00	90.32	0.10	99.80	100.00	99.98	0.00	73.10	100.00	90.34	0.10
BMI	90.40	100.00	97.74	0.04	95.10	100.00	99.21	0.02	90.40	100.00	96.75	0.45
BRIS	86.50	100.00	95.59	0.06	88.70	100.00	96.68	0.05	92.70	100.00	97.44	0.03
Model 2												
BSM	92.10	100.00	97.24	0.04	98.50	100.00	99.85	0.37	92.10	100.00	98.90	0.03
BNIS	87.50	100.00	93.84	0.05	89.10	100.00	96.03	0.05	93.90	100.00	97.70	0.02
BCAS	70.40	100.00	87.57	0.09	78.50	100.00	92.85	0.06	71.70	100.00	91.35	0.10
BJBS	92.50	100.00	99.25	0.02	98.50	100.00	99.85	0.01	93.90	100.00	99.36	0.02
BBS	88.60	100.00	93.11	0.03	89.80	100.00	95.18	0.04	93.90	100.00	97.85	0.04
BMS	88.30	100.00	98.08	0.04	89.90	100.00	98.84	0.03	92.00	100.00	98.41	0.03
BPS	92.50	100.00	99.25	0.02	98.50	100.00	99.85	0.01	93.90	100.00	99.39	0.02
BVS	71.10	100.00	90.11	0.11	98.50	100.00	99.85	0.01	71.10	100.00	87.92	0.11
BMI	87.30	100.00	94.32	0.05	95.10	100.00	99.21	0.02	90.00	100.00	95.05	0.04
BRIS	86.50	100.00	95.92	0.06	93.00	100.00	98.83	0.02	89.30	100.00	97.02	0.04
Model 3												
BSM	92.10	100.00	96.49	0.04	100.00	100.00	100.00	0.00	92.10	100.00	96.49	0.04
BNIS	87.00	100.00	95.11	0.05	89.20	100.00	97.15	0.05	94.60	100.00	97.90	0.02
BCAS	61.10	100.00	83.13	0.12	78.50	100.00	91.36	0.07	70.60	100.00	90.89	0.10
BJBS	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00
BBS	88.60	100.00	96.11	0.04	89.80	100.00	96.74	0.04	97.20	100.00	99.35	0.01
BMS	88.30	100.00	98.54	0.04	89.90	100.00	98.74	0.04	92.00	100.00	98.77	0.03
BPS	98.90	100.00	99.86	0.00	100.00	100.00	100.00	0.00	98.90	100.00	99.86	0.00
BVS	73.50	100.00	88.73	0.10	100.00	100.00	100.00	0.00	73.50	100.00	88.74	0.10
BMI	90.50	100.00	97.76	0.04	100.00	100.00	100.00	0.00	90.50	100.00	97.76	0.04
BRIS	85.00	100.00	95.55	0.06	93.00	100.00	98.41	0.03	87.80	100.00	97.04	0.05
Model 4												
BSM	92.10	100.00	98.81	0.03	100.00	100.00	100.00	0.00	92.10	100.00	98.81	0.03
BNIS	68.90	100.00	90.98	0.11	69.10	100.00	91.93	0.11	95.20	100.00	99.01	0.02
BCAS	58.30	100.00	81.60	0.12	67.90	100.00	90.91	0.09	70.60	100.00	90.89	0.10
BJBS	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00	100.00	100.00	100.00	0.00
BBS	88.60	100.00	94.18	0.04	89.80	100.00	96.51	0.04	89.90	100.00	97.62	0.04
BMS	88.30	100.00	98.54	0.04	89.90	100.00	98.74	0.04	92.00	100.00	99.77	0.01
BPS	78.80	100.00	94.84	0.08	84.10	100.00	97.26	0.06	86.10	100.00	97.45	0.05
BVS	51.80	100.00	83.14	0.16	100.00	100.00	100.00	0.00	51.80	100.00	83.14	0.16
BMI	89.00	100.00	97.98	0.04	96.20	100.00	99.53	0.01	89.00	100.00	98.45	0.04
BRIS	90.10	100.00	97.46	0.04	90.90	100.00	98.52	0.03	93.70	100.00	98.91	0.02

Note: Input = Total asset, deposits, equity, output = total revenue and financing.

dency. The OTE reached a minimum of 75.30% in 2016. Accordingly, for the same amount of output produced in 2016, Islamic banks might lower inputs by 24.70 percent in constant returns to scale. The PTE nearly followed evolution: the score was 95.10% in 2013 and 87.10% in

2017 at its lowest point. Scale effectiveness gradually decreased during the course of the investigation. The lowest performance was attained in 2015 with a score of 85.20%, while the best performance was attained in 2010 with an average score of 94.90%.

Table 5. Annual evolution of efficiency scores per category

Model 1												
Forms	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
OTE	96.50%	95.20%	92.80%	96.20%	98.00%	98.00%	94.80%	96.30%	93.00%	95.40%	96.80%	97.20%
PTE	98.70%	96.80%	97.50%	99.50%	99.20%	99.20%	97.20%	97.80%	97.40%	99.50%	98.90%	99.15%
SE	97.80%	98.00%	95.20%	96.70%	96.70%	96.70%	97.50%	98.50%	95.50%	96.90%	97.90%	98.30%
Model 2												
Forms	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
OTE	94.20%	94.00%	92.80%	95.30%	97.40%	97.40%	94.90%	95.60%	93.20%	96.70%	96.50%	97.20%
PTE	98.40%	95.90%	98.20%	99.00%	98.75%	98.70%	97.40%	97.80%	97.40%	99.90%	99.00%	99.15%
SE	95.80%	97.90%	94.50%	96.30%	98.65%	98.60%	97.50%	97.70%	95.70%	96.80%	97.50%	98.25%
Model 3												
Forms	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
OTE	92.70%	96.50%	94.20%	96.10%	97.55%	97.50%	94.90%	96.00%	93.10%	94.80%	96.10%	97.20%
PTE	97.80%	97.90%	98.50%	99.50%	99.60%	99.20%	97.20%	98.30%	97.20%	98.80%	99.00%	99.15%
SE	94.40%	98.50%	95.60%	96.60%	97.30%	98.20%	97.70%	97.60%	95.90%	84.00%	97.20%	98.25%
Model 4												
Forms	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
OTE	86.40%	91.70%	93.20%	93.90%	97.85%	98.10%	97.10%	97.40%	92.20%	84.00%	97.20%	98.25%
PTE	93.70%	96.70%	98.60%	97.70%	98.70%	98.60%	97.30%	97.60%	97.50%	99.10%	98.90%	99.35%
SE	92.20%	94.80%	94.60%	96.00%	99.60%	99.50%	99.70%	99.80%	94.70%	97.10%	98.20%	98.50%

Note: Input = Total asset, deposits, equity, output = total revenue and financing.

From 2010 through 2021, the annual evolution of average efficiency among nations for the three types of efficiency is further examined, namely OTE, PTE, and SE. Table 4 demonstrates that for the large IIB group, both BMI and BSM have the highest annual efficiency scores, while for the medium category, they are achieved by BMS and BTPNS, which have even succeeded in achieving 100% of PTE during the study. As BPDA, their PTE decreased slightly in 2015. These conclusions are based on PTE, which demonstrates a bank's capability to manage the organization and resources on its own without taking into account external factors whose impact is considered in SE. Looking into the SE of Indonesian Islamic banks reveals that only BTPNS and MBS were effective at all times. All scores of SE were, on average, changing. The BNIS for big IIB, BMS, and BPDA for the medium category were measured at their lowest values in 2011, 2015, and 2016. Although, financing and revenue were reduced during the COVID-19 pandemic, Islamic banks still existed through mobilization assets, deposits, employees, and offices. Interestingly, Islamic bank assets, deposits, equity, and employees also have a positive and significant effect on total financing and revenue.

4. DISCUSSION

This study confirmed that inputs (e.g., employees, offices, total deposits, and total operational expenses) have significantly and positively influenced outputs (e.g., total financing and revenue). Because of this, it is preferable to compare the profit efficiency of the Indonesian Islamic banking sector to cost efficiency in order to determine whether a full idea of revenue efficiency exists there. It discusses how to distinguish between the cost, revenue, and profit efficiencies, three main types of efficiency.

The recent study has shown that OTE, PTE, and SE average scores have declined since 2010. This outcome demonstrates Indonesia's Islamic banks' declining performance. The IIB's failure to operate at the appropriate scale was the primary cause of technological inefficiency. As a result, they had to cut back on their inputs to get the best scaling. It shows that, despite the scale effects, the banks' management was unable to effectively manage costs and leverage a variety of inputs to achieve outputs. The viability and creativity of IIB's products and services, specifically their ability to pur-

sue their roles as a middleman between depositors and borrowers, will be determined by their capacity to meet the efficiency and performance requirements. Due to their search for Sharia-compliant institutions, Indonesian Muslims' critical reasons have significantly influenced the growth of deposit banking.

The present study contributes to the theory of the non-parametric approach (DEA) in three ways. First, this study differentiated between different dimensions of IIB finance and non-finance aspects. It investigated the relationships between these dimensions of financial (e.g., deposits, expenses, financing, and income) and non-financial variables (e.g., employees and offices). The results of this study supported the relationship between input factors and output variables, illuminating the effectiveness of the IIB. Second, this research showed that, besides financial variables, employees and offices are the essential key points of IIB economic efficiency and performance. Past researchers did not investigate the relationships between these variables. The findings provide a theoretical basis for future research. Finally, this study reinforces the data envelopment analysis (DEA) to examine Islamic bank efficiency. It also strengthens the relationships between the variables observed and the Islamic banking system.

In conclusion, the research raises a number of suggestions for bankers and decision-makers to increase efficiency. First, although outperforming, the industry as a whole still has worse efficiency scores than IIB. Greater innovation and competition may result in increased efficiency. In order to operate more effectively, IIB must also expand and invest in its capabilities, resources,

and know-how. Instead of concentrating on SE, bankers should improve their PTE. It is directly governed by banks, and management is tasked with reviewing the operational side, cutting operating costs, and raising the caliber of staff based on hiring and training practices. However, previous studies have reported the role of DMUs' employees, offices, deposits, and operational expenses as antecedents of financing and income (Alqahtani et al., 2017; Hambali & Adhariani, 2022; Kamarudin et al., 2019; Le et al., 2022) were examined separately; the input variables are considered the most important to increase DMUs' financial performance. The significance of the input role indicates that the effectiveness of DMUs may have an impact on output. It is a consequence of the efficient activities, experience, skills, and knowledge of employees acquired by Islamic banks.

Second, by easing restrictions, officials should take significant action to facilitate the admission of foreign banks. It might increase competition, which would increase the banking sector's overall efficiency. Most notably, one of the crucial operational system indicators for improving the interaction between customers, staff, and this banking system is the role of the shariah supervisory board (SSB) and financial services authority (OJK). With well-defined regulation and supervision mechanisms, which can be employed as an operating system fundamentally distinct from conventional banking, regulators are expected to play a crucial role in this respect. Additionally, a thorough tool and diligent coordination are essential components that promote Islamic banking's viability and success in competing in both domestic and international markets.

CONCLUSION

This study's goal was to investigate the effects on Indonesian Islamic banks' assets, deposits, offices, and equity, as well as other input and output variables (e.g., financing and revenue). An analysis of the efficiency of Islamic banks during 2010–2021 using an intermediary approach showed that Islamic banking operations have a strong correlation with economic development in some regions. The efficiency and situational variables of the Islamic banking system, including businesses, investors, governments, and depositors or borrowers, take the stability of the system seriously. Investors and academics in both broad and narrow disciplines have therefore paid attention to Islamic bank capital and financing. The need to improve the financial efficiency of Indonesia's Islamic banks is becoming more and more urgent. Additionally, it demonstrated that Indonesian Islamic banks' operational efficiency has improved since

the COVID-19 epidemic compared to both before and during the pandemic. The operations of Islamic banks in Indonesia are also improved in terms of deposits, employees, expenses, and offices to decrease operating expenses while developing technology applications and investing in productive sectors.

The study does have certain restrictions. First, as this study was conducted inside the realm of Islamic banking, it is not necessary to generalize the findings. To support a better conclusion, future studies should use traditional banks, larger sample sizes, and additional regions and geographical locations. Second, it only considers the intermediation approach. Hence, future research needs to investigate the performance of DMUs under the intermediation and production approach and generate the inputs and outputs. It would provide a further understanding of the robustness of the results presented in the study. Finally, despite the fact that the research's proposed input variables were validated as useful, they were only applicable to Islamic banks with preliminary research. Future research must pay close attention to the interaction between financial and non-financial circumstances. To determine whether staff members and the number of offices have a good impact on bank performance, it is also necessary to find out whether Islamic bank management are aware of the significance of this relationship.

AUTHOR CONTRIBUTIONS

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