

Korespondensi Artikel

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Judul Artikel : *“Indonesian Islamic banks: A review of the financial state before and after the COVID-19 pandemic”*

Nama Jurnal : Bank and Bank Systems

Volume/Issue : 17 Issue 4

Halaman : 12-24

e-issn/p-issn : 1991-7074/ 1816-7403

Penerbit : LLC “Consulting Publishing Company “Business Perspectives”

Web Jurnal :

<https://www.businessperspectives.org/index.php/journals/banks-and-bank-systems/issue-418/indonesian-islamic-banks-a-review-of-the-financial-state-before-and-after-the-covid-19-pandemic>

URL Dokumen :

https://www.businessperspectives.org/images/pdf/applications/publishing/templates/article/assets/17141/BBS_2022_04_Lantara.pdf

Adapun alur korespondensi di mulai pada :

No.	Waktu	Keterangan
1.	24 Juni 2022	Submit artikel
2.	15 Juli 2022	Menanyakan status dari artikel
3.	15 Juli 2022	Balasan status artikel
4.	16 Juli 2022	Menanyakan status artikel pada editor jurnal “Bank and Bank Systems”
5.	23 Juli 2022	Revisi I (pertama)
6.		Balasan Revisi I (pertama) melalui website jurnal “Bank and Bank Systems”
7.	27 Juli 2022	Revisi II (dua)
8.		Balasan Revisi II (dua) melalui website jurnal “Bank and Bank Systems”
9.	9 Agustus 2022	Revisi III (tiga)
10.		Balasan Revisi III (tiga) melalui website jurnal “Bank and Bank Systems”
11.	30 Agustus 2022	Revisi IV (empat)
12.	2 September 2022	Balasan Revisi IV (empat) melalui E-mail
13.	8 September 2022	Pemberitahuan telah melewati tahap review dan konfirmasi terkait proses publikasi

14.	9 September 2022	Pemberitahuan kepada jurnal bahwa penulis setuju untuk proses publikasi
15.	9 September 2022	Pemberitahuan artikel telah diterima dan mengisi form “Publication Agreement”
16.	12 September 2022	Balasan penulis tentang “Publication Agreement” dan informasi pembayaran
17.	12 September 2022	Pemberitahuan jurnal terkait detail informasi pembayaran
18.	15 September 2022	Balasan penulis terkait konfirmasi telah melakukan pembayaran
19.	3 Oktober 2022	Konfirmasi pada jurnal terkait status artikel
20.	3 Oktober 2022	Balasan jurnal terkait proses persiapan publikasi
21.	4 Oktober 2022	Penyampaian hasil proofreading dari jurnal
22.	5 Oktober 2022	Balasan proofreading dari penulis
23.	5 Oktober 2022	Final proofreading dari jurnal
24.	6 Oktober 2022	Balasan final proofreading dari penulis
25.	6 Oktober 2022	Artikel Terbit
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Journal: Banks and Bank Systems

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Kind regards,

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2. 15 Juli 2022 Menanyakan status dari artikel



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- 4. 16 Juli 2022 Menanyakan status artikel pada editor jurnal “Bank and Bank Systems”**
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1 pesan

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16 Juli 2022 16.31

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5. 23 Juli 2022 Revisi I (pertama)

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the manuscript Indonesian Islamic banks (IIB): An analysis of financial performance before and during the COVID-19 pandemic, submitted to Banks and Bank Systems Journal, needs to be revised.

Comments:

Please revise your manuscript according to the Manuscript Submission Guidelines. - Please pay attention to the fact that the research paper, is a final report on the finished original experimental study (the structure is Abstract, Introduction, Literature review, Method, Results, Discussion, Conclusion). The length of the manuscript (maximum) should be up to 6000 words (not including the abstract, list of sources, and appendices). Attachments should not exceed 5 pages. The material should be correctly divided into sections. The purpose of the research should be clearly and concretely formulated.

The abstract (its volume is 150-250 words) should have the following sequence of presentation of the material - relevance, purpose, method, result, and conclusion. This is exactly the sequence it should be. Most of the volume of the abstract should be devoted to the result. Quantitative indicators of the demonstration of the research result should be given in the abstract. Keywords should be words and not repeat the title of the article. JEL Classification codes should be clarified.

The introduction should be devoted to the research topic's relevance and the problem's general formulation. This is half a page - a page of text. There should be 40-50 analyzed sources in the literature review. It should start with a few introductory sentences. The review should also be concluded with 2-3 summarizing sentences. Then the purpose of the research should be formulated. After that, you should state the hypotheses (right here, all together, and do not insert text between them). Then the Methods section. The results section is the main section of the manuscript. Then there should be a Discussion section. There should be a discussion of research results, a comparison with previous ones, a discussion of why the authors have such results, and a determination of prospects. The Conclusions should have the following logic - we indicate the purpose of the research, briefly demonstrate the obtained result, and indicate what conclusions should be drawn from it.

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Journal Banks and Bank Systems

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- 6. Balasan Revisi I (pertama) melalui website jurnal “Bank and Bank Systems”**
-

Indonesian Islamic banks (IIB): An analysis of financial performance

Abstract

Purpose – This study examines the Indonesian Islamic bank (IIB) by a non-parametric approach efficiency analysis during periods 2010-2020.

Design/methodology/approach - Non-parametric analysis, data envelopment analysis (DEA) is used to compute the IIB of efficiency (e.g., overall, pure, and scale) with the framework input-oriented variable constant return to scale (CRS) and returns to scale (VRS) model.

Findings - The resource of technology IIB management is lack, as well as macroeconomic and environmental effects. IIB managers and policy-makers need to improve their efficiency scores toward intensifying competition and innovation. Furthermore, IIB needs to increase and spend their assets and experiences to enhance technology, which significantly affects efficiency.

Research limitations/implications – The sample consist of all Indonesian Islamic bank (IIB). Hence, comparison study (e.g., conventional and Islamic bank) is needed.

Practical implications – The bank manager need to develop

Original value - This study differentiated between different dimensions of IIB finance and non-finance aspects, as well as investigated the relationships between these dimensions of financial (e.g., assets, deposits, equity, financing, and income) and non-financial variables (employees and offices).

Keywords: Overall technical efficiency, pure technical efficiency, scale efficiency, IIB

Paper type: Research paper

1. Introduction

Since two decades, the Islamic finance industry has overgrown and exists almost in all parts worldwide. This sector included banking, the capital market, and insurance. With over US\$260 billion assets, it has developed more than 300 global Islamic funds and institutions across the region with the majority Muslim people and Western countries (IMF, 2019). In contrary, prior studies found Islamic bank has been faced to low level of efficiency in Middle Eastern and Asian regions (Rosman, Abd Wahab, & Zainol, 2014), India (Gulati & Kumar, 2017), Jordan (Al-Rjoub, 2021); Malaysia (Ismail, Abd. Majid, & Ab. Rahim, 2013; Ling, Abdul-Rahim, & Said, 2020), GCC (Belanes, Ftiti, & Regaïeg, 2015), Pakistan (Majeed & Zanib, 2016). As well as in Indonesia, the growth of deposits, employees, operational expense, and offices are not positive effect on to increase of income and financing, primarily, three years latest (OJK, 2017). Despite Islamic banking has significantly grown up worldwide, few studies have been given to the financial and operational performance. The specific research to evaluate banking efficiency has become crucial since the 1990s (Kamarudin, Sufian, Nassir, Anwar, & Hussain, 2019; Sahyouni & Wang, 2020). It is worthy to managers, stakeholders, policy-makers, and regulators, as well as researchers.

Past studies revealed the low level of products and services standards (Johnes, Izzeldin, & Pappas, 2014), high operating expense, and unproductive employees (Wanke, Azad, Emrouznejad, & Antunes, 2019) are the essential factors of weakness the Islamic bank performance. However, the literature and prior studies on bank efficiency are widely discussed regarding the comparative study between Islamic and conventional banks and relatively little empirical research regarding the efficiency of Islamic banking operation context (Kamarudin, Sufian, Loong, & Anwar, 2017). The efficient frontier of banks will directly enhance profitability levels, and higher amounts of finance intermediated, theoretically constrained by technical and allocative efficiencies. A bank

will attempt to minimize the operational and services cost (cost-efficient), which is correlated to enhancing their income (revenue efficiency) and profit.

The efficiency measurement of the bank is determined by the objective, which is evaluated. Commonly, the concept of efficiency comprises two types (e.g., cost and revenue), it mobilized through input and output variables. It has been considered as an essential key to validate the firm level of efficiency. Cost efficiency is used to analyze the bank performance toward comparative results between the expenditure is used to achieve higher output under similar technological circumstances. Meanwhile, revenue efficiency aims to compare operational bank practice or functional toward applying the entirely efficient (maximize the profits). However, few works of literature and comprehensive study have examined these efficiencies simultaneously. Prior studies more concentration on comparative research between cost and revenue efficiency (Kamarudin, Sufian, Nassir, Anwar, & Hussain, 2019; Ling, Abdul-Rahim, & Said, 2020) and avoid validating the causes and how the inputs affect the outputs in practice (Paradi & Zhu, 2013) and one of the solution more focus on Islamic bank study (Kamarudin, Sufian, Loong, & Anwar, 2017; Yanıkkaya & Pabuçcu, 2017). It is an essential assignment in the organization to deep realize a firms' past activities and plan for its future direction (Kao, 2014; Sahyouni & Wang, 2019).

The performance of firms was dependent on truthful deal resolutions organism made. It shows that the study of decision-making units (DMU) performance is necessary to examine component processes, so the cause of any inefficiencies can be identified. It is, therefore, worth exploring the institution's financial effectiveness concerning the interaction between financial and non-financial aspects (e.g., employees and offices). Even with the rapidity of competition and development technology, bank employees and offices are also the central conduit and responsible for a large portion of efficiency, as well as provide customer services and bank operational expenses (LaPlante & Paradi, 2015) and specific banking model (Dolgun, Mirakhor, & Ng, 2019). Sahyouni and Wang (2019), and Ling, Abdul-Rahim and Said (2020), in their study, recommended future research to investigate relationship technical efficiency, as well as the financial performance of Islamic bank. It can help achieve a holistic view of the Islamic bank's performance toward combining financial and non-financial fields and insights into the industry players. It can assist in testing the generalizability of the components more comprehensively. Building upon earlier studies discussion on Islamic bank performance across the countries and combining this with insights from the financial literature, hence this study answer the following questions:

RQ1. Does the number of deposits, employees and offices, and operation expense positively affect Islamic bank financing and income?

RQ2. Among the efficiency scales, which is the best and the worst?

This study seeks to address these questions and contribute to the financial and non-financial literature aspects which influence bank performance. Hence, this study examines Islamic banks' performance regarding economic (e.g., assets, deposits, equity, financing, and income) and non-financial fields (e.g., employees and offices) effect.

The result from a recent study tends to help academicians, practitioners, and policy-makers obtain a better view of the effect of input to output bank performance. It also provides several theoretical and practical contributions. First, this study linked to financial and operational context with applying the data envelopment analysis (DEA) method. Second, except for literature and studies concerning the effect of deposits, employees, expenses, and offices on financing and income on the Islamic bank field is limited. The result from this analysis uncovers the crucial role

of input variables and offers a detailed view of their impact on output variables that have been neglected in preliminary studies.

This paper is organized as follows. Section 2 provides a review of the efficiency of Islamic banks across the region; it contributed to developing the technique in a recent study, describing the methodologies in section 3. Section 4 reports the results of the analysis, comprised of the OTE, PTE, and SE. Finally, section 5 offers some conclusions.

2. Literature Review

Data envelopment analysis (DEA) is a common and effective method to be measuring a firm financial and operation productivity toward apply inputs to produce outputs (Kao, 2014), specifically to examine efficiency in the banking sector (Emrouznejad & Yang, 2018). However, prior studies have had mixed results, such as the Islamic bank has become more prosperous than conventional banks. For instance, Johnes, Izzeldin and Pappas (2013) empirical study of 19 Muslim countries during 2004-2009 toward meta-frontier approach (MFA). Similarly, in Pakistan (Akram & Rahman, 2018; Majeed & Zanib, 2016). Contrarily, conventional bank performance is more efficient in GCC countries in 2005-2011 (Parsa, 2020); Southeast Asian countries during 2006-2014 (Kamarudin, Sufian, Loong, & Anwar, 2017), Malaysia (Ling, Abdul-Rahim, & Said, 2020), and Pakistan during 2008-2010 (Sardar, Azeem, Ahmed, & Zafar, 2011). It indicates conventional bank has been utilized the efficiency of information technology and electronic system. In addition, the scale efficiency (SE) is an essential source of technical efficiency (TE) for conventional and Islamic banks. However, the performance is denoting that the size (e.g., a total of asset, deposit, employees, and the number of branches) are essential in to improve their efficiency (Kao, 2014; LaPlante & Paradi, 2015; Paradi & Zhu, 2013).

The size of the Islamic banks in Southeast Asia is more efficient in the small scope to generate outputs from the inputs (Islam, Abd. Majid, & Ab. Rahim, 2013). Moreover, Islamic banks' efficiency has improved with time. Although the Islamic banks operated at a reasonably optimal operation scale, the efficiency of Islamic banks, especially the managerial resources inefficient is needed. Islamic banks should increase the quality of assets due to the positive effect on their efficiency (Sardar, Azeem, Ahmed, & Zafar, 2011). Mixed results of Islamic bank financial performance are needed to clear confirmation which the main factor to encourage economic efficiency. One of the solutions to deep understand the crucial input to the output process to increase financial performance. Furthermore, the scholars must focus on Islamic bank study (Kamarudin, Sufian, Loong, & Anwar, 2017; Yanıkkaya & Pabuçcu, 2017). With applied minimum assumption, DEA is an effective measurement tool when the number of data is low. Also, it does not entail a predetermined structure or specific well-designed form to avoid the data identifying and determining error (Rosman, Abd Wahab, & Zainol, 2014).

2.1 Data envelopment analysis (DEA)

DEA is the method to examine the efficiency inputs and outputs of the decision-making units (DMU) (Charnes, Cooper, & Rhodes, 1978; Sakti & Mohamad, 2018). The crucial issue in the literature is the evaluation of banking sector return to scale (RTS) toward presenting the return to scale (IRS) and constant return to scale (CRS). Hence, it necessary to validate the differentiation of their efficiency. The PTE also called global efficiency, while the second model of PTE are administrative and managerial capability. SE is linked to the operating scale level, then calculates the ratio of OTE and PTE toward using both the CCR and the BCC models (Rosman, Abd Wahab, & Zainol, 2014; Wanke, Azad, Emrouznejad, & Antunes, 2019).

2.1.1 Charnes–Cooper–Rhodes (CCR) model

Charnes, Cooper, and Rhodes (1978) were extended the financial and operation efficiency measurement concept, which assumed CRS to measure the efficiency of each DMUs. However, the difference of DMUs with operating at different scales was ignored in early studies. The CCR concept assumed no correlation between the scale of operations and efficiency by taking CRS and OTE. Meanwhile, the CRS concept is adopted when the DMU is operating on the expected scale. However, in practice, the DMU potency is affected by economies and non-economies factors, such as GDP, inflation, interest-rate, etc. With employed in line combination to convert the variables into single input and output, estimated efficiency of each DMU in CRS between 0 and 1. The score of the efficiency 1 pointed the level of efficient is good, otherwise is less efficient.

2.1.2 Banker–Charnes–Cooper (BCC) model

Banker, Charnes, and Cooper (1984) expanded the CCR concept and application scope into Farrell and CCR patterns. Therefore, this approach proposes two different strategies between OTE, PTE and SE, namely constant returns to scale (CRS) and variable returns to scale (VRS) (Belanès, Ftiti, & Regaïeg, 2015). The BCC procedures bridge across sections that enclose the data point is tighter than the CCR concept; therefore, the OTE score refers to CCR application, which is always larger than or equivalent to the value of the BCC model (Coelli, Rao, O'Donnell, & Battese, 2005; Mobarek & Kalonov, 2014). The VRS model can be applied to measure the pure technical efficiency, which designates the technical and scale efficiency effect. Scale efficiency (SE) is achieved by comparing technical efficiency (TE), which in line with constant returns-to-scale (CRS) and variable returns-to-scale (VRS) concepts. It calculates financial and operation performance toward input and output configuration (Belanès, Ftiti, & Regaïeg, 2015; Ismail, Abd. Majid, & Ab. Rahim, 2013). These models embraced the production system, the facility to consolidate, and an effective approach to employee surveillance in a firm to affect the decision-making process.

The scale efficiency (SE) provided the DMU technical and pure technical efficiency scores (Sakti & Mohamad, 2018). If the result between the technical efficiency and pure technical efficiency scores is different, it proves the firm's financial and operation is inefficient (Rosman, Abd Wahab, & Zainol, 2014). The model confirms that each DMU is benchmarked in a similar size (Wanke, Azad, Emrouznejad, & Antunes, 2019). Mainly, the feature of DEA is attractive and useful for bank regulators, especially how to identify the best and worst practices within a financial institution group. The PTE and SE provided material to ensure OTE results. The measurement of technical efficiency provided by SE in scale returns for an exceptional level of activity concerning observed performance and situation of constant return to scale.

The CRS prediction operates in the optimal scale when all the DMU have good constant returns to scale and no correlation among scale efficiency. Hence, the OTE can be considered in this study, which realized whether the DMU operation in economies and diseconomies. Therefore, it is recommended to assume VRS hypothesis and score implications. SE enables us to prove the transformation between two approaches of efficiency.

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

The DEA concept allows us to control efficiency score under these two assumptions, namely, CRS and VRS, with the following program:

$$\text{Min } \lambda_0 \theta_0 \quad (1)$$

$$\text{Subject to } \sum_{j=1}^n \lambda_{0j} y_{rj} \geq y_{r0} \quad (r = 1, \dots, s) \quad (2)$$

$$\theta_0 x_{i0} \sum_{j=1}^n \lambda_{0j} x_{ij} \quad (i = 1, \dots, n) \quad (3)$$

$$\sum_{j=1}^n \lambda_{0j} = 1 \quad (4)$$

$$\lambda_{0j} \geq 0 \quad (j = 1, \dots, n) \quad (5)$$

With θ_0 : OTE; y_{r0} : output r of DMU₀; x_{i0} : input I of DMU₀; y_{rj} : output r concerning the unit of references j ; x_{ij} : input I concerning the unit of references j ; λ_{0j} : the weight of references unit j ; s : number of outputs; n : number of DMU_s.

The first constraint (Eq. 2) requires the output must have at least the same level as the output of DMU₀. Furthermore, (Eq. 3) stipulates to adjust efficiency, input DMU₀ must be larger than (or equivalent to) the used output of DMU, (Eq. 4) is used to validate the VRS hypothesis. However, if the efficiency scores are below CRS assumption, this model is eliminated.

To maintain the bias issue, we chosen the methodology of Xue and Harker (1999), who applied the five stages of the bootstrap technique:

1. First, we determine the probability distribution of the sampling F with each observed DMU of the samples $(x_1, x_2, \dots, x_n)$, which has a probability of occurrence equal to $\frac{1}{n}$.
2. Select c random samples of size n to replace original samples $(x_1, x_2, \dots, x_n)$, such c is a constant: $S_k = (x_{k1}, x_{k2}, \dots, x_{kn})$; $k = 1, 2, \dots, c$ with $x_{ki} = (U_{ki}, V_{ki})$ for $i = 1, 2, \dots, n$; S_k is called the bootstrap sample. U and V respectively represent the inputs and outputs.
3. For each bootstrap samples $S_k, k = 1, 2, \dots, c$, we apply the DEA model and we recalculate the scores of efficiency for the n DMU: $\Theta_{ki} = \phi_i(U_k) \quad i = 1, 2, \dots, n$.
4. For each bootstrap sample $S_k, k = 1, 2, \dots, c$, we evaluate the bootstrap reproduction β_{kj} , with $k = 1, 2, \dots, c$ and $j = 0, 1, \dots, m$ according to the following regression model: $\Theta_{ki} = G(\beta_k, V_{ki}) + \varepsilon_{ki}$ with $i = 1, 2, \dots, n$; $\beta_{k0}, \beta_{k1}, \dots, \beta_{km}$.
5. Finally, we estimate the standard error $SE(\beta_i)$ by the standard deviation of the samples of reproductions bootstrap.

$$SE(\beta_i) = \left\{ \frac{\sum_{k=1}^c (\beta_{kj} - \beta_j)^2}{(c-1)} \right\} \text{ with } j = 1, 2, \dots, m \text{ and } \beta_j = \frac{\sum_{k=1}^c \beta_{kj}}{c}$$

3 Data and methodology

3.1 Data

Data retrieved from the bank database. We have been considering 10 Indonesian Islamic banks (IIB) (see table I) for 2010 to 2019. This study, conducted the input and output approach refers to Belanès, Ftiti, and Regaïeg (2015), Ismail, Abd. Majid, & Ab. Rahim (2013), Johnes, Izzeldin, and

Pappas (2013), Rosman, Abd Wahab, and Zainol (2014), Sakti and Mohamad (2018) to guarantee the number of inputs and outputs are equitable to preserve the DEA. In this study, the inputs are the number of employees, offices, total deposit, and total operational expense, and the outputs are total financing and revenue.

Insert Table I Here

3.2 Methodology

In the efficiency analysis, the most challenging task ahead of a researcher is selecting the relevant input and output observation. However, researchers have no agreement on establishing the input and output variables (Parsa, 2020). It is even more challenging in the banking industry with applied two approaches in preliminary studies to select the process. The production method, also known as the intermediation approach, is also called the asset approach (Wang, Huang, Wu, & Liu, 2014). Both ways apply to examine the specification of banking activities and performance.

Benston (1965) delights banks as producers of loans, deposits, and other services using traditional inputs-labor, capital, and space as a pioneer of the production approach. It considers operating expenditure only, not interest expenses. In this concept, the DMU is applying employees and capital as inputs to enhance deposits and assets. Hence, the recent study adopts the intermediation approach to generate revenue and assets. It helped evaluate a bank's efficiency (Berger & Humphrey, 1997; Wang, Huang, Wu, & Liu, 2014).

We refer to Xu and Zhou (2020) and Wang, Huang, Wu, and Liu (2014) are using deposits as intermediate input and output. Furthermore, we combine two prior studies and Bhatia, Basu, Mitra, and Dash (2018), Chaffai and Hassan (2019), and Doumpos, Hasan, and Pasiouras (2017) deposits, fixed asset, labor, equity, and overheads expense as input and financing, non-interest incomes, interest incomes, nonperforming loans as output. The intermediation approach is more applicable for examining the bank efficiency, as the primary activities of banks are the channeling of funds across surplus and deficit units (Bhatia, Basu, Mitra, & Dash, 2018). More importantly, the intermediation approach includes interest expenses that are a considerable part of the total cost of any banking and financial institution. Therefore, in this paper, using the intermediation approach, we preferred financing and revenue as output variables, and assets, deposits, employees, and offices as input measurements.

DMUs can be regarded as having a network structure to obtain better performance. The complicated process of the entire production can be divided into several sub-processes or sub-stages in which some intermediate products are considered outputs of one sub-stage, then treated as inputs of the other sub-stage. These intermediate outputs/inputs are further defined as intermediate measures (Chaffai & Hassan, 2019; Xu & Zhou, 2020). Thus, the efficiency scores obtained using these variables would capture the ability of the banks to generate loans and other earning assets using deposits, equity, fixed asset, and other operating expenses. The sample size used in this study is consistent with the standard rules of thumb in DEA literature. Cooper, Li, Seiford, and Zhu (2011) provide two rules of thumb as $[n \geq \max \{m \times s, 2(m + s)\}]$. Where n , m , and s are the number of banks, the number of input variables, and the number of output variables. The rules indicate that the sample size should be at least greater or equal to the product of the number of input and output variables or greater or equal to three times the sum of input and output variables. In the present study, the sample size is $n = 10$ banks with $m = 3$, and $s = 2$, thus, consistent with both the rules stated above.

The inputs include the number of employees, branches, 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 intermediation approach views banks as financial intermediaries; therefore, the inputs and outputs are measured in monetary terms. In this sense, Islamic banks in Indonesia are essentially financial intermediaries whose primary business is to borrow funds from depositors to lend to others (Kao & Liu, 2014). Therefore, the intermediation approach is used in this study.

3.3 Pearson correlation

Initially, all the input and output variables in DEA must be positively correlated. Therefore, this study was adopted the Pearson correlation to analyze the relationship between input and output variables. This method aims to reduce the possible number of output variables from the data bias exploration. If there are negative coefficient variables, the input and output variables need to be changed or removed.

3.4 Specification of inputs and outputs

Selecting input and output variables for estimating bank efficiency is still debatable among scholars (Humphrey, 1985). Berger, Hunter, and Timme (1993) suggest that the choice of variables in efficiency study significantly affects the result. In banking literature, three approaches are proposed to define inputs and outputs: the production approach, the intermediation approach, and the revenue approach. The production approach was first introduced by Benston (1965). He considered the bank as a producer of service for account holders. Therefore, the best measure of the output is the number of account transactions, and the input is measured through the number of employees and capital resources. Sealey and Lindley (1977) are the pioneers of the intermediation approach, which considers financial firm as an intermediary between savers and borrowers. The intermediation approach applied the relationship between investors and savers by transforming deposits into earning assets rather than producers of services and loans. The output measure is based on total deposits, loans, and securities, while deposits along with labor and physical capitals are defined as input. Xu and Zhou (2020) were proposed the intermediation approach concerning total assets, workers, operating expenses as input, and deposits as intermediation productivity. Under this approach, interest incomes, non-interest incomes, and on-performing loans are defined as output.

In a recent study, we adopt the intermediation approach for some reasons. Firstly, this approach is more suitable in the context of Islamic bank. Indeed, Islamic bank is often claimed as a joint venture firm in which shares the profit, loss, and risk. The principle of the Islamic financial system is the participation in enterprise and employing funds based on profit and loss sharing principles. Secondly, Henriques, Sobreiro, Kimura, and Mariano (2020) and Xu and Zhou (2020) suggest that the intermediation approach is the most relevant bank context. Branches are the main outlet of bank services and serve as an interaction mechanism with the consumers of banking services. Ignoring the branch efficiency could result in several issues related to efficiency, product mix, and economies of scale (Aggelopoulos & Georgopoulos, 2017).

4. Empirical findings

4.1 Pearson correlation and descriptive statistics result

In Table II we present the relationship between the input and output variables. The averages of the ratios for different ranges have a positive correlation, together with the Pearson's correlation coefficient between the input and the output.

Insert Table II Here

4.2 Descriptive statistic of efficiency scores of Indonesia' Islamic banks

We investigate Indonesia's (IIB) efficiency under two assumptions: CRS and VRS. According to table III, all the banks' mean of OTE and SE scores have experience fluctuated. It is clear from Table III that during the study period, the mean of the IIB OTE is 82.13%. The overall results suggest that all banks could have saved about 17.87% to produce the same amount of outputs by using the similar input resources. Therefore, the result decomposed the resource of IIB management is low. The frontier of technical efficiency is also measured under VRS technology, which enables assessing the PTE with an average of 90.83%, which implies that IIB can reduce their input by 8.17% by maintaining a constant output level if they had adapted the most efficient technology.

Insert Table III Here

It can be seen, from the table III, the resource management in IIB based on existing technology is very low. Indeed, a slight difference in this study reflects the variables are not under the control of the IIB, including macroeconomic and environmental variables. Besides, table VIII elucidate the average index of SE for all bank in whole is around 90.47%. This result clarified that, on average, IIB could earn 9.53% if they adopted the production structure to their optimal size.

The rest of the overall technical inefficiency appears due to the inappropriate scale of banking operation. Further, lower mean and high standard deviation of the PTE scores than SE scores indicate a more significant overall technical inefficiency due to pure technical inefficiency. The IIB's efficiency decreased from 2015 to 2019 (however, there is an increase in OTE, PTE and SE in 2013 until 2014). Overall, with the analysis of PTE and SE as a whole, the results revealed that the overall technical inefficiency of IIB is due to inadequate input utilization (i.e., pure technical inefficiency) and failure to operate the productive scale size (i.e., scale inefficiency).

Table IV highlight that IIB remain efficient at least once during the study period. Descriptive statistic elucidated that MBS, BPDN and BTPNS are the highest score of the big of IIB category with the perfect result 100%. In the big category, BMI is the highest of OTE, in the PTE BMI and BSM is the best. 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 95.40% which the highest. In sum, we deduced that BPS is the most efficient of IIB. The difference among the banks for all categories are quite significant.

Insert Table IV Here

Table V emphasizes a gradual decline during the study for the three types of efficiency, namely OTE, PTE and SE. However, the decline was relatively more intense from 2011 to 2016, and then an upward trend between 2017 and 2018. The OTE reached a minimum of 75.30% in 2016. This means that in 2016, Islamic banks could reduce inputs of 24.70% in constant returns to scale for the same level of output obtained. The PTE almost followed evolution: It peaked in 2017 and the minimum result in 2013, with the score at 95.10% and 87.10%. As for scale efficiency, it witnessed

a gradual decline during the study. The best performance was achieved in 2010 with an average score of 94.90%, while the lowest was obtained in 2015 with 85.20%.

Insert Table V Here

We further investigate the annual evolution of average efficiency across countries from 2010 to 2019 for the three kinds of efficiency, namely OTE, PTE, and SE. Table VI shows the annual highest scores of efficiency belong to both BMI and BSM for big IIB category, while for the medium category achieved by BMS and BTPNS which have even succeeded to achieve 100% of PTE during the study. As BPDA their PTE had slightly decreased in 2015. These findings are based on PTE that reveals a bank's own ability to manage the organization and the resource without considering external factors whose impact is taken into account on SE. Investigating SE of Indonesia Islamic bank reveal that no state was efficient except BTPNS and MBS for all periods. All scores of SE were on average, fluctuating. The lowest levels were observed in 2011, 2015, and 2016 for BNIS for big IIB, BMS and BPDA for the medium category.

5. Discussion

5.1 Key finding and conclusion

This study confirmed that input (e.g., employees, offices, total deposit, and total operational expense) has significantly and positively influenced outputs (e.g., total financing and revenue). Therefore, instead of focusing on the Indonesian Islamic banking sector's profit efficiency alone, it is better to compare it with cost efficiency to identify the existence of revenue efficiency comprehensively concept on the Indonesian Islamic banking sector. It addresses to distinguish between three different types of efficiency, namely cost, revenue, and profit efficiencies.

The recent study identifies a decrease in average scores of OTE, PTE and SE since 2010. This result reveals the reduction of Islamic banks' performance in Indonesia. The main source of technical inefficiency was due to the IIB operating at the wrong scale. Hence, they needed to reduce their inputs to achieve optimum scales. It indicates that the banks' management was unable to efficiently control the costs and use the mix of inputs to produce outputs regardless of the scale effects. To fight this fact on strategy is the ability of IIB to meet the efficiency and performance will determine their viability and innovation of products and services, specifically, to pursue their roles as an intermediary between depositors and borrowers. It is critical motivations of Indonesia Muslim who have contributed to the increase of deposit bankings due to looking for Sharia-compliant.

5.2 Academic implication

The present study contributes to the theoretical 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, expense, financing, and income) and non-financial variables (e.g., employees and offices). The findings of this research confirmed the effects of input variables on output variables, which elucidated the efficiency of the IIB. Second, this research portrayed that, besides financial variables, employees and offices involve the essential key point of IIB economic efficiency and performance. Past researchers did not investigate the relationships between these variables. Our findings provided a theoretical ground for future research. Finally, this study reinforces the data

envelopment analysis (DEA) to examine Islamic bank efficiency. It also strengthens the relationships between variables, which observed and the Islamic banking system.

5.3 Practical implication

To sum up, the finding suggests several implications for bankers and policy-makers to improve efficiency. First, although IIB outperforms, the industry still lags in terms of their efficiency scores. Intensifying competition and innovation could lead to better efficiency. Furthermore, IIB needs to increase and invest their resources and capabilities and introduce know-how technology to better efficiency. Bankers need to focus their efforts on improving their PTE, rather than SE. It directly under the control of banks and managements is charged by examining the managerial side, reducing operating expenses, and improving employees' quality based on job procurement and training activities. However, previous studies have reported the role of DMUs employees, offices, deposits, and operational expense as antecedents of financing and income (Alqahtani, Mayes, & Brown, 2017; Aggelopoulos & Georgopoulos, 2017; Kamarudin, Sufian, Nassir, Anwar, & Hussain, 2019; Paradi & Zhu, 2013). There were examined separately; the input variables are considered the most important to increase DMUs financial performance. The strength of the input role shows that output is possibly influenced DMUs performance. It is a consequence of efficient activities, experiences, skills, and knowledge of employees acquired by Islamic banks.

Second, the policymakers should take serious steps to allow for the entry of foreign banks by relaxing restrictions. It might improve competition and hence the overall efficiency of the banking industry. Most importantly, the role of the shariah supervisory board (SSB) and financial services authority (OJK) is one of the essential indicators of the operational system for strengthening the relationship between consumers, employees, and this banking system. In this regard, the regulators are expected to play a pivotal role with clearly established regulation and supervision mechanisms, which can be used as an operating system fundamentally different from conventional banking. Additionally, a comprehensive tool and intensive coordination are essential factors that support the sustainability of Islamic banking and its success to compete for both in the local and global market.

5.4 Limitation

There are some limitations to this study. First, this study was carried out on Islamic banking field; therefore the results need not be generalized. Future studies need to include conventional banks, more sample sizes, other regions, and geographical areas to encourage a better conclusion. Second, it only considered 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, although the input variables proposed in this research were proven positive, it was restricted and limited to Islamic banks with preliminary studies. Future studies also need to comprehensively focus on the relationship between financial and non-financial contexts. In addition, there is a need to ascertain whether Islamic bank managers understand the importance of this relationship because it aids in establishing when employees and the number of offices have a positive effect on bank performance.

We also observe that techniques to determine the values of the parameters based on the characteristics of the data set for any of the methods are not currently available in the literature; this is a valuable area for research. Future research needs to extend the sample by comparing the Shariah business bank, Shariah unit business bank, and Shariah rural bank or/and across the region

and simultaneously. With concerning different method such as panel data techniques, namely the general method moment (GMM), instead of static panel data techniques, which help to account for endogeneity problems.

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7. 27 Juli 2022 Revisi II (dua)

MA6236: Notification on Submission

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Indonesian Islamic banks (IIB): A review of the financial situation both 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 during the periods before and after the COVID-19 pandemic, 2010–2021. This study differentiated between different dimensions of 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. It means that the number of offices has less 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, Indonesia' Islamic bank

JEL Classification C53, F65, 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 US\$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, the bank managers and 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

Banking intermediary role play important role to support economic growth. However, 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. With over US\$260 billion assets, it has developed more than 300 global Islamic funds and institutions across the region with the majority Muslim people and Western countries (IMF, 2019). However, some studies concluded mixed result of Islamic bank efficiency.

The impact of return on financial performance on 43 Indonesian banking profitability was studied by Rohman 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. Similar, Sang (2021) used the Generalized Method of Moments (GMM) and discovered that Vietnam's banks' financial stability is positively and significantly impacted by the capital adequacy ratio. Furthermore, Msomi (2022) concluded that the financial performance and inflation play an important role in influencing non-performing loans in some African 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). It means that profitability and capitalization play an important role in efficiency. As well as 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, Islamic banks' efficiency 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, Junaidi 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. Hafez (2022) used DEA to assess the effectiveness of conventional and Islamic banks in Egypt. 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 (Sofilda et al., 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 have a crucial role in banking efficiency and performance in South Africa (Govender, 2022). As a financial institution, banking plays an important role in transferring capital to borrowers in Ukraine (Bukhtiarova et al., 2022) and Vietnam (Sang, 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 to 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. It indicates 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 for 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 fill 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 having 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 address these questions and contribute to the financial and non-financial literature aspects which influence bank efficiency 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 research 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, employees, and offices positively influence total financing and revenue
H2: Islamic bank assets, deposits, and offices positively influence total financing and revenue
H3: Islamic bank assets, deposits, and employees positively influence total financing and revenue
H4: Islamic bank assets, deposits, and equity positively influence total financing and revenue

2. DATA AND METHODOLOGY

Data retrieved from the bank's database. We have been considering 14 Indonesian Islamic banks (IIB) (see table 1) for 2010 to 2021. This study, 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.

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

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

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 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). We also refer to Sofilda et al. (2022) and Xu and Zhou (2020), which use deposits as intermediate input and output. Furthermore, we combine 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, we favored employing financing and income as output variables in this paper's intermediation technique, and assets, deposits, personnel, and offices as input measurements.

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

Under these two presumptions, the DEA idea enables us to regulate efficiency score, namely, CRS and VRS, with the following program:

$$\text{Min } \lambda_0 \theta_0 \quad (1)$$

$$\text{Subject to } \sum_{j=1}^n \lambda_{0j} y_{rj} \geq y_{r0} \quad (r = 1, \dots, s) \quad (2)$$

$$\theta_0 x_{i0} \sum_{j=1}^n \lambda_{0j} x_{ij} \quad (i = 1, \dots, n) \quad (3)$$

$$\sum_{j=1}^n \lambda_{0j} = 1 \quad (4)$$

$$\lambda_{0j} \geq 0 \quad (j = 1, \dots, n) \quad (5)$$

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 of 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 include 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 Govender and Maralack (2022) 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).

3. RESULT

This study shown the correlation between the input and output variables in 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.

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**

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

We examine the effectiveness of Indonesia's 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 Descriptive statistics of annual efficiency score of IIBs Model 1

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
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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 2

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
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
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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 3

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
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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 4

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
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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

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 approximately 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, we deduce that BPS is the most efficient of IIB. The difference among the banks for all categories is quite significant.

Table 4: Descriptive statistics of efficiency scores across banks Model 1

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
BSM	92.10	100.00	97.24	0.037	99.80	100.00	99.98	0.000	92.10	100.00	98.90	0.027
BNIS	87.70	100.00	96.63	0.040	89.20	100.00	98.50	0.035	92.70	100.00	98.11	0.025
BCAS	67.00	100.00	87.71	0.091	78.50	100.00	93.02	0.070	83.20	100.00	94.25	0.065
BJBS	87.70	100.00	96.70	0.049	89.40	100.00	97.70	0.042	92.70	100.00	98.96	0.023
BBS	88.60	100.00	96.13	0.042	89.80	100.00	97.37	0.039	92.70	100.00	98.75	0.023
BMS	87.90	100.00	98.04	0.043	89.70	100.00	98.95	0.033	92.00	100.00	98.27	0.032
BPS	82.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	73.10	100.00	90.32	0.102	99.80	100.00	99.98	0.000	73.10	100.00	90.34	0.102
BMI	90.40	100.00	97.74	0.042	95.10	100.00	99.21	0.016	90.40	100.00	96.75	0.450
BRIS	86.50	100.00	95.59	0.058	88.70	100.00	96.68	0.047	92.70	100.00	97.44	0.032

Input = Total asset, employees, offices, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 2

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
BSM	92.10	100.00	97.24	0.037	98.50	100.00	99.85	0.370	92.10	100.00	98.90	0.027
BNIS	87.50	100.00	93.84	0.047	89.10	100.00	96.03	0.050	93.90	100.00	97.70	0.024
BCAS	70.40	100.00	87.57	0.085	78.50	100.00	92.85	0.064	71.70	100.00	91.35	0.102
BJBS	92.50	100.00	99.25	0.023	98.50	100.00	99.85	0.005	93.90	100.00	99.36	0.019
BBS	88.60	100.00	93.11	0.030	89.80	100.00	95.18	0.036	93.90	100.00	97.85	0.036
BMS	88.30	100.00	98.08	0.042	89.90	100.00	98.84	0.032	92.00	100.00	98.41	0.030
BPS	92.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	71.10	100.00	90.11	0.111	98.50	100.00	99.85	0.005	71.10	100.00	87.92	0.114
BMI	87.30	100.00	94.32	0.048	95.10	100.00	99.21	0.016	90.00	100.00	95.05	0.041
BRIS	86.50	100.00	95.92	0.056	93.00	100.00	98.83	0.022	89.30	100.00	97.02	0.041

Input = Total asset, deposits, offices, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 3

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
BSM	92.10	100.00	96.49	0.038	100.00	100.00	100.00	0.000	92.10	100.00	96.49	0.038
BNIS	87.00	100.00	95.11	0.050	89.20	100.00	97.15	0.050	94.60	100.00	97.90	0.021
BCAS	61.10	100.00	83.13	0.118	78.50	100.00	91.36	0.068	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	96.11	0.042	89.80	100.00	96.74	0.041	97.20	100.00	99.35	0.010
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	98.77	0.028
BPS	98.90	100.00	99.86	0.004	100.00	100.00	100.00	0.000	98.90	100.00	99.86	0.004
BVS	73.50	100.00	88.73	0.104	100.00	100.00	100.00	0.000	73.50	100.00	88.74	0.104
BMI	90.50	100.00	97.76	0.041	100.00	100.00	100.00	0.000	90.50	100.00	97.76	0.041
BRIS	85.00	100.00	95.55	0.064	93.00	100.00	98.41	0.025	87.80	100.00	97.04	0.045

Input = Total asset, deposits, employees, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 4

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
BSM	92.10	100.00	98.81	0.028	100.00	100.00	100.00	0.000	92.10	100.00	98.81	0.028
BNIS	68.90	100.00	90.98	0.111	69.10	100.00	91.93	0.114	95.20	100.00	99.01	0.017
BCAS	58.30	100.00	81.60	0.122	67.90	100.00	90.91	0.090	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	94.18	0.041	89.80	100.00	96.51	0.041	89.90	100.00	97.62	0.036
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	99.77	0.006
BPS	78.80	100.00	94.84	0.080	84.10	100.00	97.26	0.056	86.10	100.00	97.45	0.051
BVS	51.80	100.00	83.14	0.163	100.00	100.00	100.00	0.000	51.80	100.00	83.14	0.163
BMI	89.00	100.00	97.98	0.039	96.20	100.00	99.53	0.013	89.00	100.00	98.45	0.038
BRIS	90.10	100.00	97.46	0.038	90.90	100.00	98.52	0.032	93.70	100.00	98.91	0.022

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

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 tendency. 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

	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%

Input = Total asset, employees, offices, output = total revenue and financing

Model 2

	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%

Input = Total asset, deposits, offices, output = total revenue and financing

Model 3

	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%

Input = Total asset, deposits, employees, output = total revenue and financing

Model 4

	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%

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

From 2010 through 2021, we further examine the annual evolution of average efficiency among nations for the three types of efficiency, 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.

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 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 pursue 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. Our 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; Kamarudin et al., 2019; Rohman et al., 2022; Sang, 2021, 2022; Sofilda 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 influences on Indonesia Islamic banks' assets, deposits, offices, and equity as well as other input and output variables (e.g., financing and revenue). By analyzing the efficiency of Islamic banks during 2010–2021 with an intermediary approach, it has proven that Islamic banking operations have a strong correlation to 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 operational of Islamic banks in Indonesia is also improved toward measures 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 off, because 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. In order 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.

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9. 9 Agustus Revisi III (tiga)
2022



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MA6236: Notification on Submission

1 pesan

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Dear Dirgahayu Lantara,

the manuscript Indonesian Islamic banks (IIB): An analysis of financial performance before and during the COVID-19 pandemic, submitted to Banks and Bank Systems Journal, needs to be revised.

Comments:

Such a beginning of an abstract is more suitable for a textbook or a lecture than for a scientific article - "Banking system play important role in financial system. The banking operational system and intermediary role. Indonesia applied dual-banking system (e. g. , conventional and Islamic bank) and Islamic bank has rapid development than conventional bank. " Abbreviations should not be entered in the abstract. Here the result of the research should be shown more thoroughly. What can this sentence mean "The literature study on it consists of two methods, namely accounting and economics-based study. "? There should be 40-50 analyzed sources in the literature review. It should start with a few introductory sentences. The review should also be concluded with 2-3 summarizing sentences. Then the purpose of the research should be formulated. After that, you should state the hypotheses (right here, all together, and do not insert text between them). Then the Methods section. Everything else should be taken into account from the previous recommendations

The deadline for revisions is 2022-08-16

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Kind regards,

Yaroslava Mospanova
Managing Editor
Journal Banks and Bank Systems

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- 10. Balasan Revisi III (tiga) melalui website jurnal “Bank and Bank Systems”**
-

Indonesian Islamic banks (IIB): An analysis of financial performance before and during the COVID-19 pandemic

Abstract

This paper aims to perform a non-parametric production efficiency analysis of Indonesia of Islamic banks (IIB) estimated during periods 2010-2020. Non-parametric analysis, data envelopment analysis (DEA) is used to compute the IIB of efficiency (e.g., overall, pure, and scale) with the framework input-oriented variable constant return to scale (CRS) and returns to scale (VRS) model. Although, the resource of technology IIB management is lack, as well as macroeconomic and environmental effects. This study found that IIB need to enhance investment in technology beside office. It has crucial role to enhance IIB equity and income. Hence, the IIB managers and policy-makers need to improve their efficiency scores toward intensifying competition and innovation. Furthermore, IIB needs to increase and spend their assets and experiences to enhance technology, which significantly affects efficiency. This study differentiated between different dimensions of IIB finance and non-finance aspects, as well as investigated the relationships between these dimensions of financial (e.g., assets, deposits, equity, financing, and income) and non-financial variables (employees and offices).

Keywords: DEA, overall technical efficiency, pure technical efficiency, scale efficiency, IIB

JEL Classification C53, E32, E44, F65

INTRODUCTION

Since two decades, the Islamic finance industry has overgrown and exists almost in all parts worldwide. This sector included banking, the capital market, and insurance. With over US\$260 billion assets, it has developed more than 300 global Islamic funds and institutions across the region with the majority Muslim people and Western countries. In contrary, prior studies found bank has been faced to low level of efficiency in some ASIAN and African regions before and during the COVID-19 pandemic (Govender & Maralack, 2022; Msomi, 2022; Sang, 2022) including, India (Gulati & Kumar, 2017), Jordan (Al-Rjoub, 2021); Malaysia (Ling et al., 2020), Egypt (Hafez, 2022). As well as in Indonesia, the growth of deposits, employees, operational expense, and offices are not positive effect on to increase of income and financing, primarily, three years latest (Sofilda et al., 2022). Despite Islamic banking has significantly grown up worldwide, few studies have been given to the financial and operational performance. The specific research to evaluate banking efficiency has become crucial since the 1990s (Kamarudin et al., 2019; Sahyouni & Wang, 2020). It is worthy to managers, stakeholders, policy-makers, and regulators, as well as researchers.

Past studies revealed the low level of products and services standards (Bukhtiarova et al., 2022; Sang, 2022), high operating expense, and unproductive employees (Wanke et al., 2019) are the essential factors of weakness the traditional and Islamic bank performance. However, the literature and prior studies on bank efficiency are widely discussed regarding the comparative study between Islamic and conventional banks and relatively little empirical research regarding the efficiency of Islamic banking operation context. The efficient frontier of banks will directly enhance profitability levels, and higher amounts of finance intermediated, theoretically constrained by technical and allocative efficiencies. A bank will attempt to minimize the operational and services

cost (cost-efficient), which is correlated to enhancing their income (revenue efficiency) and profit. However, preliminary studies avoid the concept of efficiency toward cost and revenue approach. Cost efficiency is used to analyze the bank performance toward comparative results between the expenditure is used to achieve higher output under similar technological circumstances. Meanwhile, revenue efficiency aims to compare operational bank practice or functional toward applying the entirely efficient (maximize the profits). Hence, DEA approach is worthy to validate banking performance which provide comprehensive result before and during the COVID-19 pandemic.

Furthermore, the performance of firms was dependent on truthful deal resolutions organism made. It shows that the study of decision-making units (DMU) performance is necessary to examine component processes, so the cause of any inefficiencies can be identified. It is, therefore, worth exploring the institution's financial effectiveness concerning the interaction between financial and non-financial aspects (e.g., employees and offices). Even with the rapidity of competition and development technology, bank employees and offices are also the central conduit and responsible for a large portion of efficiency, as well as provide customer services and bank operational expenses (Hafez, 2022; Sang, 2021) and specific banking model (Dolgun et al., 2019). Ling et al., (2020), Sahyouni and Wang (2019) and Sofilda et al. (2022), and in their study, recommended future research to investigate relationship technical efficiency, as well as the financial performance of Islamic bank. It can help achieve a holistic view of the Islamic bank's performance toward combining financial and non-financial fields and insights into the industry players.

This study seeks to address this gap and contribute to the financial and non-financial literature aspects which influence bank performance. Hence, this study examines Islamic banks' performance regarding economic (e.g., assets, deposits, equity, financing, and income) and non-financial fields (e.g., employees and offices) effect. The result from a recent study tends to help academicians, practitioners, and policy-makers obtain a better view of the effect of input to output bank performance. It also provides several theoretical and practical contributions. First, this study linked to financial and operational context with applying the data envelopment analysis (DEA) method. Second, except for literature and studies concerning the effect of deposits, employees, expenses, and offices on financing and income on the Islamic bank field is limited. The result from this analysis uncovers the crucial role of input variables and offers a detailed view of their impact on output variables that have been neglected in preliminary studies.

1. LITERATURE REVIEW

Data envelopment analysis (DEA) is a common and effective method to be measuring a firm financial and operation productivity toward apply inputs to produce outputs (Kao, 2014), specifically to examine efficiency in the banking sector (Emrouznejad & Yang, 2018). However, prior studies have had mixed results, such as the Islamic bank has become more prosperous than conventional banks. For instance, Rohmah et al. (2022) and Sofilda et al. (2022) empirical study of conventional and Islamic bank toward panel data analysis. Similarly, in Egypt (Hafez, 2022); Pakistan (Akram & Rahman, 2018). Contrarily, conventional bank performance is more efficient in GCC countries in 2005-2011 (Parsa, 2022); Southeast Asian countries during 2006-2014 (Kamarudin et al., 2019), Malaysia (Ling et al., 2020), South Africa (Govender, 2022), Ukraine (Bukhtiarova et al., 2022) and Vietnam (Sang, 2021; 2022). It indicates conventional bank has been utilized the efficiency of information technology and electronic system. In addition, the scale

efficiency (SE) is an essential source of technical efficiency (TE) for conventional and Islamic banks. However, the performance is denoting that the size (e.g., a total of asset, deposit, employees, and the number of branches) are essential in to improve their efficiency.

Moreover, Islamic banks' efficiency has improved with time. Although the Islamic banks operated at a reasonably optimal operation scale, the efficiency of Islamic banks, 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 clear confirmation which the main factor to encourage economic efficiency. One of the solutions to deep understand the crucial input to the output process to increase financial performance. Furthermore, the scholars must focus on Islamic bank study (Kamarudin et al., 2019; Yanıkkaya & Pabuçcu, 2017). With applied minimum assumption, DEA is an effective measurement tool when the number of data is low. Also, it does not entail a predetermined structure or specific well-designed form to avoid the data identifying and determining.

DEA is the method to examine the efficiency inputs and outputs of the decision-making units (DMU) (Charnes et al., 1978; Sakti & Mohamad, 2018). The crucial issue in the literature is the evaluation of banking sector return to scale (RTS) toward presenting the return to scale (IRS) and constant return to scale (CRS). Hence, it necessary to validate the differentiation of their efficiency. The PTE also called global efficiency, while the second model of PTE are administrative and managerial capability. SE is linked to the operating scale level, then calculates the ratio of OTE and PTE toward using both the CCR and the BCC models (Wanke et al., 2019).

Charnes, Cooper, and Rhodes (1978) were extended the financial and operation efficiency measurement concept, which assumed CRS to measure the efficiency of each DMUs. However, the difference of DMUs with operating at different scales was ignored in early studies. The CCR concept assumed no correlation between the scale of operations and efficiency by taking CRS and OTE. Meanwhile, the CRS concept is adopted when the DMU is operating on the expected scale. However, in practice, the DMU potency is affected by economies and non-economies factors, such as GDP, inflation, interest-rate, etc. With employed in line combination to convert the variables into single input and output, estimated efficiency of each DMU in CRS between 0 and 1. The score of the efficiency 1 pointed the level of efficient is good, otherwise is less efficient.

Banker, Charnes, and Cooper (1984) expanded the CCR concept and application scope into Farrell and CCR patterns. Therefore, this approach proposes two different strategies between OTE, PTE and SE, namely constant returns to scale (CRS) and variable returns to scale (VRS) (Belanès et al., 2015). The BCC procedures bridge across sections that enclose the data point is tighter than the CCR concept; therefore, the OTE score refers to CCR application, which is always larger than or equivalent to the value of the BCC model (Coelli et al., 2005; Mobarek & Kalonov, 2014). The VRS model can be applied to measure the pure technical efficiency, which designates the technical and scale efficiency effect. Scale efficiency (SE) is achieved by comparing technical efficiency (TE), which in line with constant returns-to-scale (CRS) and variable returns-to-scale (VRS) concepts. It calculates financial and operation performance toward input and output configuration (Belanès et al., 2015; Hafez, 2022; Sofilda et al., 2022). These models embraced the production system, the facility to consolidate, and an effective approach to employee surveillance in a firm to affect the decision-making process.

The scale efficiency (SE) provided the DMU technical and pure technical efficiency scores (Sakti & Mohamad, 2018). If the result between the technical efficiency and pure technical efficiency scores is different, it proves the firm's financial and operation is inefficient (Sofilda et al., 2022). The model confirms that each DMU is benchmarked in a similar size (Wanke et al., 2019). Mainly, the feature of DEA is attractive and useful for bank regulators, especially how to identify the best and worst practices within a financial institution group. The PTE and SE provided material to ensure OTE results. The measurement of technical efficiency provided by SE in scale returns for an exceptional level of activity concerning observed performance and situation of constant return to scale.

The CRS prediction operates in the optimal scale when all the DMU have good constant returns to scale and no correlation among scale efficiency. Hence, the OTE can be considered in this study, which realized whether the DMU operation in economies and diseconomies. Therefore, it is recommended to assume VRS hypothesis and score implications. SE enables us to prove the transformation between two approaches of efficiency.

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

The DEA concept allows us to control efficiency score under these two assumptions, namely, CRS and VRS, with the following program:

$$\text{Min } \lambda_0 \theta_0 \quad (1)$$

$$\text{Subject to } \sum_{j=1}^n \lambda_{0j} y_{rj} \geq y_{r0} \quad (r = 1, \dots, s) \quad (2)$$

$$\theta_0 x_{i0} \sum_{j=1}^n \lambda_{0j} x_{ij} \quad (i = 1, \dots, n) \quad (3)$$

$$\sum_{j=1}^n \lambda_{0j} = 1 \quad (4)$$

$$\lambda_{0j} \geq 0 \quad (j = 1, \dots, n) \quad (5)$$

With θ_0 : OTE; y_{r0} : output r of DMU₀; x_{i0} : input I of DMU₀; y_{rj} : output r concerning the unit of references j; x_{ij} : input I concerning the unit of references j; λ_{0j} : the weight of references unit j; s: number of outputs; n: number of DMU_s.

2. DATA AND METHODOLOGY

Data retrieved from the bank database. We have been considering 10 Indonesian Islamic banks (IIB) (see table I) for 2010 to 2020. This study, conducted the input and output approach refers to Belanès et al., (2015), Sakti and Mohamad (2018) and Sang (2022) to guarantee the number of inputs and outputs are equitable to preserve the DEA. In this study, the inputs are the number of employees, offices, total deposit, and total operational expense, and the outputs are total financing and revenue.

Table 1
The samples Indonesia Islamic bank

No.	Banks	Offices > 100	Category
1	Bank Muamalat Indonesia (BMI)	√	Big
2	Bank Syariah Mandiri (BSM)	√	Big
3	Bank Rakyat Indonesia Syariah (BRIS)	√	Big
4	Bank Syariah Bukopin (BSB)	√	Big
5	Panin Dubai Syariah Bank (BPS)		Middle
6	BNI Syariah (BNIS)	√	Big
7	BCA Syariah (BCAS)		Middle
8	Bank BJB Syariah (BJBS)		Middle
9	Bank Syariah Mega Indonesia (BMS)		Middle
10	Bank Victoria Syariah (BVS)		Middle

In the efficiency analysis, the most challenging task ahead of a researcher is selecting the relevant input and output observation. However, researchers have no agreement on establishing the input and output variables (Parsa, 2022). It is even more challenging in the banking industry with applied two approaches in preliminary studies to select the process. The production method, also known as the intermediation approach, is also called the asset approach (Wang et al., 2014). Both ways apply to examine the specification of banking activities and performance.

Benston (1965) delights banks as producers of loans, deposits, and other services using traditional inputs-labor, capital, and space as a pioneer of the production approach. It considers operating expenditure only, not interest expenses. In this concept, the DMU is applying employees and capital as inputs to enhance deposits and assets. Hence, the recent study adopts the intermediation approach to generate revenue and assets. It helped evaluate a bank's efficiency (Berger & Humphrey, 1997; Wang et al., 2014).

We refer to Xu and Zhou (2020) and Wang et al., (2014) are using deposits as intermediate input and output. Furthermore, we combine two prior studies and Bhatia et al., (2018), Chaffai and Hassan (2019), and Doumpos et al., (2017) deposits, fixed asset, labor, equity, and overheads expense as input and financing, non-interest incomes, interest incomes, nonperforming loans as output. The intermediation approach is more applicable for examining the bank efficiency, as the primary activities of banks are the channeling of funds across surplus and deficit units (Bhatia et al., 2018). More importantly, the intermediation approach includes interest expenses that are a considerable part of the total cost of any banking and financial institution. Therefore, in this paper, using the intermediation approach, we preferred financing and revenue as output variables, and assets, deposits, employees, and offices as input measurements.

DMUs can be regarded as having a network structure to obtain better performance. The complicated process of the entire production can be divided into several sub-processes or sub-stages in which some intermediate products are considered outputs of one sub-stage, then treated as inputs of the other sub-stage. These intermediate outputs/inputs are further defined as intermediate measures (Chaffai & Hassan, 2019; Xu & Zhou, 2020). Thus, the efficiency scores obtained using these variables would capture the ability of the banks to generate loans and other earning assets using deposits, equity, fixed asset, and other operating expenses. The sample size used in this study is consistent with the standard rules of thumb in DEA literature. Cooper, Li, Seiford, and Zhu (2011) provide two rules of thumb as $[n \geq \max \{m \times s, 2(m + s)\}]$. Where n , m ,

and s are the number of banks, the number of input variables, and the number of output variables. The rules indicate that the sample size should be at least greater or equal to the product of the number of input and output variables or greater or equal to three times the sum of input and output variables. In the present study, the sample size is $n = 10$ banks with $m = 3$, and $s = 2$, thus, consistent with both the rules stated above.

The inputs include the number of employees, branches, 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 intermediation approach views banks as financial intermediaries; therefore, the inputs and outputs are measured in monetary terms. In this sense, Islamic banks in Indonesia are essentially financial intermediaries whose primary business is to borrow funds from depositors to lend to others. Therefore, the intermediation approach is used in this study.

Selecting input and output variables for estimating bank efficiency is still debatable among scholars (Humphrey, 1985). Berger et al., (1993) suggest that the choice of variables in efficiency study significantly affects the result. In banking literature, three approaches are proposed to define inputs and outputs: the production approach, the intermediation approach, and the revenue approach. The production approach was first introduced by Benston (1965). He considered the bank as a producer of service for account holders. Therefore, the best measure of the output is the number of account transactions, and the input is measured through the number of employees and capital resources. Sealey and Lindley (1977) are the pioneers of the intermediation approach, which considers financial firm as an intermediary between savers and borrowers. The intermediation approach applied the relationship between investors and savers by transforming deposits into earning assets rather than producers of services and loans. The output measure is based on total deposits, loans, and securities, while deposits along with labor and physical capitals are defined as input. Xu and Zhou (2020) were proposed the intermediation approach concerning total assets, workers, operating expenses as input, and deposits as intermediation productivity. Under this approach, interest incomes, non-interest incomes, and on-performing loans are defined as output.

In a recent study, we adopt the intermediation approach for some reasons. Firstly, this approach is more suitable in the context of Islamic bank. Indeed, Islamic bank is often claimed as a joint venture firm in which shares the profit, loss, and risk. The principle of the Islamic financial system is the participation in enterprise and employing funds based on profit and loss sharing principles. Secondly, Henriques et al., (2020) and Xu and Zhou (2020) suggest that the intermediation approach is the most relevant bank context. Branches are the main outlet of bank services and serve as an interaction mechanism with the consumers of banking services. Ignoring the branch efficiency could result in several issues related to efficiency, product mix, and economies of scale (Aggelopoulos & Georgopoulos, 2017).

3. RESULT

In Table II we present the relationship between the input and output variables. The averages of the ratios for different ranges have a positive correlation, together with the Pearson's correlation coefficient between the input and the output.

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**

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

We investigate Indonesia's (IIB) efficiency under two assumptions: CRS and VRS. According to table III, all the banks' mean of OTE and SE scores have experience fluctuated. It is clear from Table III that during the study period, the mean of the IIB OTE is 82.13%. The overall results suggest that all banks could have saved about 17.87% to produce the same number of outputs by using the similar input resources. Therefore, the result decomposed the resource of IIB management is low. The frontier of technical efficiency is also measured under VRS technology, which enables assessing the PTE with an average of 90.83%, which implies that IIB can reduce their input by 8.17% by maintaining a constant output level if they had adapted the most efficient technology.

Table 3 Descriptive statistics of annual efficiency score of IIBs Model 1

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
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
Mean			95.15					97.27					97.41		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 2

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
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
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
Mean			95.10					97.85					95.58		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 3															
Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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
Mean			95.93					98.07					96.70		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 4															
Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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
Mean			93.58					97.53					95.42		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

It can be seen, from the table III, the resource management in IIB based on existing technology is very low. Indeed, a slight difference in this study reflects the variables are not under the control of the IIB, including macroeconomic and environmental variables. Besides, table VIII elucidate the average index of SE for all bank in whole is around 90.47%. This result clarified that, on average, IIB could earn 9.53% if they adopted the production structure to their optimal size.

The rest of the overall technical inefficiency appears due to the inappropriate scale of banking operation. Further, lower mean and high standard deviation of the PTE scores than SE scores indicate a more significant overall technical inefficiency due to pure technical inefficiency. The IIB's efficiency decreased from 2015 to 2020 (however, there is an increase in OTE, PTE and SE in 2013 until 2014). Overall, with the analysis of PTE and SE as a whole, the results revealed that the overall technical inefficiency of IIB is due to inadequate input utilization (i.e., pure technical inefficiency) and failure to operate the productive scale size (i.e., scale inefficiency).

Table IV highlight that IIB remain efficient at least once during the study period. Descriptive statistic elucidated that MBS, BPDN and BTPNS are the highest score of the big of IIB category with the perfect result 100%. In the big category, BMI is the highest of OTE, in the PTE BMI and BSM is the best. 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 95.40% which the highest. In sum, we deduced that BPS is the most efficient of IIB. The difference among the banks for all categories are quite significant.

Table 4: Descriptive statistics of efficiency scores across banks Model 1

Overall technical efficiency scores					Pure technical efficiency scores				Scale technical efficiency scores			
Banks	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
BSM	92.10	100.00	97.24	0.037	99.80	100.00	99.98	0.000	92.10	100.00	98.90	0.027
BNIS	87.70	100.00	96.63	0.040	89.20	100.00	98.50	0.035	92.70	100.00	98.11	0.025
BCAS	67.00	100.00	87.71	0.091	78.50	100.00	93.02	0.070	83.20	100.00	94.25	0.065
BJBS	87.70	100.00	96.70	0.049	89.40	100.00	97.70	0.042	92.70	100.00	98.96	0.023
BBS	88.60	100.00	96.13	0.042	89.80	100.00	97.37	0.039	92.70	100.00	98.75	0.023
BMS	87.90	100.00	98.04	0.043	89.70	100.00	98.95	0.033	92.00	100.00	98.27	0.032
BPS	82.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	73.10	100.00	90.32	0.102	99.80	100.00	99.98	0.000	73.10	100.00	90.34	0.102
BMI	90.40	100.00	97.74	0.042	95.10	100.00	99.21	0.016	90.40	100.00	96.75	0.450
BRIS	86.50	100.00	95.59	0.058	88.70	100.00	96.68	0.047	92.70	100.00	97.44	0.032

Input = Total asset, employees, offices, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 2

Overall technical efficiency scores					Pure technical efficiency scores				Scale technical efficiency scores			
Banks	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
BSM	92.10	100.00	97.24	0.037	98.50	100.00	99.85	0.370	92.10	100.00	98.90	0.027
BNIS	87.50	100.00	93.84	0.047	89.10	100.00	96.03	0.050	93.90	100.00	97.70	0.024
BCAS	70.40	100.00	87.57	0.085	78.50	100.00	92.85	0.064	71.70	100.00	91.35	0.102
BJBS	92.50	100.00	99.25	0.023	98.50	100.00	99.85	0.005	93.90	100.00	99.36	0.019
BBS	88.60	100.00	93.11	0.030	89.80	100.00	95.18	0.036	93.90	100.00	97.85	0.036
BMS	88.30	100.00	98.08	0.042	89.90	100.00	98.84	0.032	92.00	100.00	98.41	0.030
BPS	92.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	71.10	100.00	90.11	0.111	98.50	100.00	99.85	0.005	71.10	100.00	87.92	0.114
BMI	87.30	100.00	94.32	0.048	95.10	100.00	99.21	0.016	90.00	100.00	95.05	0.041
BRIS	86.50	100.00	95.92	0.056	93.00	100.00	98.83	0.022	89.30	100.00	97.02	0.041

Input = Total asset, deposits, offices, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 3

Overall technical efficiency scores					Pure technical efficiency scores				Scale technical efficiency scores			
Banks	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
BSM	92.10	100.00	96.49	0.038	100.00	100.00	100.00	0.000	92.10	100.00	96.49	0.038
BNIS	87.00	100.00	95.11	0.050	89.20	100.00	97.15	0.050	94.60	100.00	97.90	0.021
BCAS	61.10	100.00	83.13	0.118	78.50	100.00	91.36	0.068	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	96.11	0.042	89.80	100.00	96.74	0.041	97.20	100.00	99.35	0.010
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	98.77	0.028
BPS	98.90	100.00	99.86	0.004	100.00	100.00	100.00	0.000	98.90	100.00	99.86	0.004
BVS	73.50	100.00	88.73	0.104	100.00	100.00	100.00	0.000	73.50	100.00	88.74	0.104
BMI	90.50	100.00	97.76	0.041	100.00	100.00	100.00	0.000	90.50	100.00	97.76	0.041
BRIS	85.00	100.00	95.55	0.064	93.00	100.00	98.41	0.025	87.80	100.00	97.04	0.045

Input = Total asset, deposits, employees, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 4

Overall technical efficiency scores					Pure technical efficiency scores				Scale technical efficiency scores			
Banks	Min	Max	Mean	Sd	Min	Max	Mean	Sd	Min	Max	Mean	Sd
BSM	92.10	100.00	98.81	0.028	100.00	100.00	100.00	0.000	92.10	100.00	98.81	0.028

BNIS	68.90	100.00	90.98	0.111	69.10	100.00	91.93	0.114	95.20	100.00	99.01	0.017
BCAS	58.30	100.00	81.60	0.122	67.90	100.00	90.91	0.090	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	94.18	0.041	89.80	100.00	96.51	0.041	89.90	100.00	97.62	0.036
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	99.77	0.006
BPS	78.80	100.00	94.84	0.080	84.10	100.00	97.26	0.056	86.10	100.00	97.45	0.051
BVS	51.80	100.00	83.14	0.163	100.00	100.00	100.00	0.000	51.80	100.00	83.14	0.163
BMI	89.00	100.00	97.98	0.039	96.20	100.00	99.53	0.013	89.00	100.00	98.45	0.038
BRIS	90.10	100.00	97.46	0.038	90.90	100.00	98.52	0.032	93.70	100.00	98.91	0.022

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

Table V emphasizes a gradual decline during the study for the three types of efficiency, namely OTE, PTE and SE. However, the decline was relatively more intense from 2011 to 2016, and then an upward trend between 2017 and 2018. The OTE reached a minimum of 75.30% in 2016. This means that in 2016, Islamic banks could reduce inputs of 24.70% in constant returns to scale for the same level of output obtained. The PTE almost followed evolution: It peaked in 2017 and the minimum result in 2013, with the score at 95.10% and 87.10%. As for scale efficiency, it witnessed a gradual declined during the study. The best performance was achieved in 2010 with an average score of 94.90%, while the lowest was obtained in 2015 with 85.20%.

Table 5: Annual evolution of efficiency scores per category
Model 1

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OTE	96.50%	95.20%	92.80%	96.20%	98.00%	94.80%	96.30%	93.00%	95.40%	96.80%
PTE	98.70%	96.80%	97.50%	99.50%	99.20%	97.20%	97.80%	97.40%	99.50%	98.90%
SE	97.80%	98.00%	95.20%	96.70%	96.70%	97.50%	98.50%	95.50%	96.90%	97.90%

Input = Total asset, employees, offices, output = total revenue and financing

Model 2

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OTE	94.20%	94.00%	92.80%	95.30%	97.40%	94.90%	95.60%	93.20%	96.70%	96.50%
PTE	98.40%	95.90%	98.20%	99.00%	98.70%	97.40%	97.80%	97.40%	99.90%	99.00%
SE	95.80%	97.90%	94.50%	96.30%	98.60%	97.50%	97.70%	95.70%	96.80%	97.50%

Input = Total asset, deposits, offices, output = total revenue and financing

Model 3

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OTE	92.70%	96.50%	94.20%	96.10%	97.50%	94.90%	96.00%	93.10%	94.80%	96.10%
PTE	97.80%	97.90%	98.50%	99.50%	99.20%	97.20%	98.30%	97.20%	98.80%	99.00%
SE	94.40%	98.50%	95.60%	96.60%	98.20%	97.70%	97.60%	95.90%	84.00%	97.20%

Input = Total asset, deposits, employees. output = total revenue and financing

Model 4

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
OTE	86.40%	91.70%	93.20%	93.90%	98.10%	97.10%	97.40%	92.20%	84.00%	97.20%
PTE	93.70%	96.70%	98.60%	97.70%	98.60%	97.30%	97.60%	97.50%	99.10%	98.90%
SE	92.20%	94.80%	94.60%	96.00%	99.50%	99.70%	99.80%	94.70%	97.10%	98.20%

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

We further investigate the annual evolution of average efficiency across countries from 2010 to 2019 for the three kinds of efficiency, namely OTE, PTE, and SE. Table VI shows the annual highest scores of efficient belong to both BMI and BSM for big IIB category, while for the medium category achieved by BMS and BTPNS which have even succeeded to achieve 100% of PTE

during the study. As BPDA their PTE had slightly decreased in 2015. These findings are based on PTE that reveals a bank's own ability to manage the organization and the resource without considering external factors whose impact is taken into account on SE. Investigating SE of Indonesia Islamic bank reveal that no state was efficient except BTPNS and MBS for all periods. All scores of SE were on average, fluctuating. The lowest levels were observed in 2011, 2015, and 2016 for BNIS for big IIB, BMS and BPDA for the medium category.

DISCUSSION

This study confirmed that input (e.g., employees, offices, total deposit, and total operational expense) has significantly and positively influenced outputs (e.g., total financing and revenue). Therefore, instead of focusing on the Indonesian Islamic banking sector's profit efficiency alone, it is better to compare it with cost efficiency to identify the existence of revenue efficiency comprehensively concept on the Indonesian Islamic banking sector. It addresses to distinguish between three different types of efficiency, namely cost, revenue, and profit efficiencies.

The recent study identifies a decrease in average scores of OTE, PTE and SE since 2010. This result reveals the reduction of Islamic banks' performance in Indonesia. The main source of technical inefficiency was due to the IIB operating at the wrong scale. Hence, they needed to reduce their inputs to achieve optimum scales. It indicates that the banks' management was unable to efficiently control the costs and use the mix of inputs to produce outputs regardless of the scale effects. To fight this fact on strategy is the ability of IIB to meet the efficiency and performance will determine their viability and innovation of products and services, specifically, to pursue their roles as an intermediary between depositors and borrowers. It is critical motivations of Indonesia Muslim who have contributed to the increase of deposit banking due to looking for Sharia-compliant.

The present study contributes to the theoretical 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, expense, financing, and income) and non-financial variables (e.g., employees and offices). The findings of this research confirmed the effects of input variables on output variables, which elucidated the efficiency of the IIB. Second, this research portrayed that, besides financial variables, employees and offices involve the essential key point of IIB economic efficiency and performance. Past researchers did not investigate the relationships between these variables. Our findings provided a theoretical ground for future research. Finally, this study reinforces the data envelopment analysis (DEA) to examined Islamic bank efficiency. It also strengthens the relationships between variables, which observed and the Islamic banking system.

To sum up, the finding suggests several implications for bankers and policy-makers to improve efficiency. First, although IIB outperforms, the industry still lags in terms of their efficiency scores. Intensifying competition and innovation could lead to better efficiency. Furthermore, IIB needs to increase and invest their resources and capabilities and introduce know-how technology to better efficiency. Bankers need to focus their efforts on improving their PTE, rather than SE. It directly under the control of banks and managements is charged by examining the managerial side, reducing operating expenses, and improving employees' quality based on job procurement and

training activities. However, previous studies have reported the role of DMUs employees, offices, deposits, and operational expense as antecedents of financing and income (Alqahtani et al., 2017; Aggelopoulos & Georgopoulos, 2017; Kamarudin et al., 2019; Rohman et al., 2022; Sang, 2021, 2022; Sofilda et al., 2022). There were examined separately; the input variables are considered the most important to increase DMUs financial performance. The strength of the input role shows that output is possibly influenced DMUs performance. It is a consequence of efficient activities, experiences, skills, and knowledge of employees acquired by Islamic banks.

Second, the policymakers should take serious steps to allow for the entry of foreign banks by relaxing restrictions. It might improve competition and hence the overall efficiency of the banking industry. Most importantly, the role of the shariah supervisory board (SSB) and financial services authority (OJK) is one of the essential indicators of the operational system for strengthening the relationship between consumers, employees, and this banking system. In this regard, the regulators are expected to play a pivotal role with clearly established regulation and supervision mechanisms, which can be used as an operating system fundamentally different from conventional banking. Additionally, a comprehensive tool and intensive coordination are essential factors that support the sustainability of Islamic banking and its success to compete for both in the local and global market.

CONCLUSION

There are some limitations to this study. First, this study was carried out on Islamic banking field; therefore, the results need not be generalized. Future studies need to include conventional banks, more sample sizes, other regions, and geographical areas to encourage a better conclusion. Second, it only considered 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, although the input variables proposed in this research were proven positive, it was restricted and limited to Islamic banks with preliminary studies. Future studies also need to comprehensively focus on the relationship between financial and non-financial contexts. In addition, there is a need to ascertain whether Islamic bank managers understand the importance of this relationship because it aids in establishing when employees and the number of offices have a positive effect on bank performance.

We also observe that techniques to determine the values of the parameters based on the characteristics of the data set for any of the methods are not currently available in the literature; this is a valuable area for research. Future research needs to extend the sample by comparing the Shariah business bank, Shariah unit business bank, and Shariah rural bank or/and across the region and simultaneously. With concerning different method such as panel data techniques, namely the general method moment (GMM), instead of static panel data techniques, which help to account for endogeneity problems.

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11. 30 Agustus 2022 Revisi IV (empat)

MA6236: Notification on Submission

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Kepada: dirgahayu.lantara@umi.ac.id

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By Dirgahayu Lantara

Indonesian Islamic banks (IIB): An analysis of financial performance before and during 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 during the periods before and after the COVID-19 pandemic, 2010–2021. This study differentiated between different dimensions of IIB finance and non-finance aspects, as well as investigated the relationships between these dimensions of finance, including assets, deposits, equity, financing, ³⁹l income, and non-financial variables, namely employees and offices. Non-parametric analysis, data envelopment analysis (DEA) is used to compute the IIB of overall, pure, and scale efficiency with the framework input-oriented variable constant return to scale (CRS) and returns to scale (VRS) models. 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. It means that the number of offices has less 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.

1

Keywords: DEA, overall technical efficiency, pure technical efficiency, scale efficiency, IIB

JEL Classification C53, F65, G21

INTRODUCTION

53

In the past two decades, the Islamic finance industry has grown and exists in almost all parts of the world. This sector includes banking, the capital market, and insurance. With over US\$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 plays an important role in the real economy and the region's financial stability. 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.

19

The concept of efficiency has a strong correlation between variables' input and output. Efficiency in the banking sector refers to the optimal use of capital, third party funds, offices, and costs to facilitate financing and revenue. It plays an important role in boosting credit, economic growth and reducing inequality in income. Hence, the efficiency of the banking sector is applied to validate 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 adopted a dual banking system towards conventional and Islamic banks simultaneously. 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, the bank managers and 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

Banking intermediary role play important role to support economic growth. However, banks need stability and efficiency to support the financial operation and system. In the last two decades, the Islamic finance industry has overgrown and exists almost in all parts worldwide. This sector includes banking, the capital market, and insurance. With over US\$260 billion assets, it has developed more than 300 global Islamic funds and institutions across the region with the majority Muslim people and Western countries (IMF, 2019). However, some studies concluded mixed result of Islamic bank efficiency.

Rohman et al. (2022) examined the role of return on assets (ROA), return on equity (ROE) and net interest margin (NIM) on 43 Indonesian banking profitability. 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. Similarly, Sang (2021) applied the Generalized Method of Moments (GMM) and found that capital adequacy ratio has a positive and significant effect on banks' financial stability in Vietnam. Furthermore, Msomi (2022) concluded that the liquidity ratio, capital adequacy ratio, and inflation all play an important role in influencing non-performing loans in some African 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.

Prior studies found Islamic banks were able to survive during a crisis. However, the Islamic bank has also been faced with a low level of efficiency in the Middle Eastern and Asian regions (Rosman et al., 2014). It means that profitability and capitalization play an important role in efficiency. As well as in Indonesia, the growth of deposits, employees, operational expenses, and offices does not have a positive effect on the increase in income and financing, primarily, three years ago (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 size of the Islamic banks in Southeast Asia is more efficient in the small scope of generating outputs from the inputs (Basri et al., 2021). Moreover, Islamic banks' efficiency has improved with time. Although Islamic banks operate at a reasonably optimal operational scale, the efficiency of Islamic banks, especially the managerial resources inefficient, is needed. 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, Junaidi et al. (2022) concluded that Islamic bank financial

ratios suffered because of their ⁴⁵ level of efficiency. Furthermore, Shawtari et al. (2018) found that macro and micro indicators have a positive and significant effect on 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 ⁵⁴ outputs. Sealey and Lindley (1977) discovered a strong correlation between the technical aspects of input and output variables and the production and operational process.

⁴³ Henriques et al. (2020) confirmed that data envelopment analysis (DEA) plays an important role ¹⁹ validating efficiency. In Egypt, Hafez (2022) used DEA ³ compare conventional and Islamic bank efficiency. This study found that the efficiency of banks ³⁶ plays an important role in influencing financial stability and economic growth. It also proves that Islamic banks ⁶² are more efficient than traditional banks. This phenomenon also occurred in Indonesia, where Islamic banks outperformed conventional banks ⁴⁸ (Sofilda et al., 2022). Akram and Rahman (2018) found the same pattern in Pakistan, where ²⁸ Islamic bank performance and efficiency is better than conventional banks. In contrarily, ²⁸ conventional bank performance is more efficient in Southeast Asian countries during 2006-2014 (Kamarudin et al., 2019) and Malaysia (Ling et al., 2020). Besides, financial ratios, banking leaders also have a crucial role in banking efficiency and performance in South Africa (Govender, 2022). As a financial institution, banking plays an important role in ⁶¹ transferring capital to borrowers in Ukraine (Bukhtiarova et al., 2022) and Vietnam (Sang, 2022). Bank efficiency is influenced by the mean of efficiency and financial turnover (Parsa, 2022).

⁵¹ The decision-making units' (DMU's) efficiency inputs and outputs are examined using the DEA approach (Charnes et al., 1978). The evaluation of the banking sector's return to scale (RTS) with a view to presenting the return to scale (IRS) and continual return to scale is the key problem in the literature (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. It indicates 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.

²¹ Moreover, Islamic banks' efficiency has improved with time. Although Islamic banks operate at a reasonably optimal operational scale, the efficiency of Islamic banks, 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). When the number of data points is small, DEA is an effective measurement tool. It does not entail a predetermined structure or a specific well-designed form to avoid the data identifying

and determining. However, the crucial issue in the literature is the evaluation of the banking sector's return to scale (RTS) toward presenting the return to scale (IRS) and constant return to scale (CRS). Its concepts are also called global efficiency with regard to administrative and managerial capability (Wanke et al., 2019).

Therefore, this approach proposes two different strategies among OTE, PTE, and SE, namely constant returns to scale (CRS) and variable returns to scale (VRS). Furthermore, the VRS model can be applied to measure pure technical efficiency, which designates the technical and scale efficiency aspect. Scale efficiency (SE) is achieved by comparing technical efficiency (TE), which is in line with constant returns-to-scale (CRS) and variable returns-to-scale (VRS) concepts. 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 scale efficiency (SE), technical efficiency (TE), and pure technical efficiency (PTE) 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 considered in this study, which realized the DMU operation in economies and diseconomies. Therefore, it is recommended to assume the VRS hypothesis and score implication. SE enables us to prove the transformation between two approaches to efficiency. Hence, this study seeks to address this gap and contribute to the financial and non-financial literature aspects 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 having 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, the literature and prior studies on bank efficiency are widely discussed regarding the comparative study between Islamic and conventional banks, and there is relatively little empirical research regarding the efficiency of Islamic banking operations in this context. 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 address these questions and contribute to the financial and non-financial literature aspects which influence bank efficiency 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. It also provides several theoretical and practical contributions. First, this study is linked to financial and operational context by applying the data envelopment analysis (DEA) method. Second, except for literature and studies concerning the effect of deposits, employees, expenses, and offices on financing and income, the Islamic banking field is limited. The result from this analysis uncovers the crucial role of input variables and offers a detailed view of their impact on output variables that have been neglected in preliminary studies.

- H1: Islamic bank assets, employees, and offices positively influence total financing and revenue
H2: Islamic bank assets, deposits, and offices positively influence total financing and revenue
H3: Islamic bank assets, deposits, and employees positively influence total financing and revenue
H4: Islamic bank assets, deposits, and equity positively influence total financing and revenue

2. DATA AND METHODOLOGY

Data retrieved from the bank's database. We have been considering 14 Indonesian Islamic banks (IIB) (see table I) for 2010 to 2021. This study, conducted using the input and output approach referred to by Demircuc-Kunt et al., (2021) to guarantee the number of inputs and output is equitable to preserve 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.

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

Source: Indonesian financial services authority (OJK), SCB = Shariah commercial banks, SBU = Shariah business units, SRB = Shariah rural banks, * in trillion rupiah (IDR)

This study refers to Benston (1965), who developed banks as producers of loans, deposits, and other services using traditional inputs—labor, capital, and space—as a pioneer of the production approach. It considers operating expenditure only, not interest expenses. In this concept, the DMU applies employees and 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). We also refer to Sofilda et al. (2022) and Xu and Zhou (2020), which use deposits as intermediate input and output. Furthermore, we combine two prior studies and 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. The intermediation approach is more applicable for examining bank efficiency, as the primary activities of banks are the channeling of funds across surplus and deficit units (Bhatia et al., 2018). More importantly, the intermediation approach includes interest expenses that are a considerable part of the total cost of any banking or financial institution. Therefore, in this paper, using the intermediation approach, we preferred financing and revenue as output variables, and assets, deposits, employees, and offices as input measurements.

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

The DEA concept allows us to control efficiency score under these two assumptions, namely, CRS and VRS, with the following program:

$$\text{Min } \lambda_0 \theta_0 \quad (1)$$

$$\text{Subject to } \sum_{j=1}^n \lambda_{0j} y_{rj} \geq y_{r0} \quad (r = 1, \dots, s) \quad (2)$$

$$\theta_0 x_{i0} \sum_{j=1}^n \lambda_{0j} x_{ij} \quad (i = 1, \dots, n) \quad (3)$$

$$\sum_{j=1}^n \lambda_{0j} = 1 \quad (4)$$

$$\lambda_{0j} \geq 0 \quad (j = 1, \dots, n) \quad (5)$$

With θ_0 : OTE; y_{r0} : output r of DMU₀; x_{i0} : input i of DMU₀; y_{rj} : output r concerning the unit of references j ; x_{ij} : input i concerning the unit of references j ; λ_{0j} : the weight of references unit j ; s : number of outputs; n : number of DMU_s.

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 intermediation approach views banks as financial intermediaries; therefore, the inputs and outputs are measured in monetary terms. In this sense, Islamic banks in Indonesia are essentially financial intermediaries whose primary business is to borrow funds from depositors to lend to others. Therefore, the intermediation approach is used in this study.

The intermediation approach applies to the relationship between investors and savers by transforming deposits into earning assets rather than producers of services and loans. The output measure is based on total deposits, loans, and securities, while deposits, along with labor and physical capital, are defined as inputs. Xu and Zhou (2020) proposed the intermediation approach concerning total assets, workers, operating expenses as input, and deposits as intermediation productivity. Under this approach, interest income, non-interest income, and on-performing loans are defined as output. This approach is more suitable in the context of an Islamic bank. Indeed, an Islamic bank is often claimed as a joint venture firm in which members share the profit, loss, and risk. The principle of the Islamic financial system is the participation in enterprise and employing funds based on profit and loss sharing principles. Furthermore, Govender and Maralack (2022) and Xu and Zhou (2020) suggest that the intermediation approach is the most relevant bank context. Branches are the main outlets for bank services and serve as an interaction mechanism with the consumers of banking services. Ignoring branch efficiency could result in several issues related to efficiency, product mix, and economies of scale (Aggelopoulos & Georgopoulos, 2017).

3. RESULT

15

In Table 2, we present the relationship between the input and output variables. The averages of the ratios for different ranges have a positive correlation, together with the Pearson's correlation coefficient between the input and the output.

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**

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

11

We investigate Indonesia's Islamic banks' (IIB) efficiency under two assumptions: CRS and VRS. According to table 3, all the banks' mean OTE and SE scores have fluctuated. It is clear from Table 3 that during the study period, the mean of the IIB OTE was 82.13%. The overall results suggest that all banks could have saved about 17.87% to produce the same number of outputs by using similar input resources. Therefore, the result decomposed the resources of IIB management is low. The frontier of technical efficiency is also measured under VRS technology, which enables assessing the PTE with an average of 90.83%, which implies that IIB can reduce their input by 8.17% by maintaining a constant output level if they had adapted the most efficient technology.

65

Table 3 Descriptive statistics of annual efficiency score of IIBs Model 1

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
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
7 Mean			95.15					97.27					97.41		

Sd: standard deviation; Cv: coefficient of variation. Input = Total asset, employees, offices, output = total revenue and financing

Table 4 Descriptive statistics of annual efficiency score of IIBs Model 2

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
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

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
7 Mean			95.10					97.85					95.58		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descripti¹ statistics of annual efficiency score of IIBs Model 3

Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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
7 Mean			95.93					98.07					96.70		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descripti¹ statistics of annual efficiency score of IIBs Model 4

Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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
7 Mean			93.58					97.53					95.42		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

It can be seen, from table 3, the resource management in IIB based on existing technology is very low. Indeed, a slight difference in this study reflects the variables that are not under the control of the IIB, including macroeconomic and environmental variables. Besides, table 3 elucidates that the average index of SE for all banks as a whole is around 90.47%. This result clarified that, on average, IIB could earn 9.53% if they adopted the production structure to their optimal size.

The rest of the overall technical inefficiency appears due to the inappropriate scale of banking operations. Further, the lower mean and high standard deviation of the PTE scores than the SE scores indicate a more significant overall technical inefficiency due to 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). Overall, with the analysis of PTE and SE as a whole, the results revealed that the overall technical inefficiency of IIB is due to inadequate input utilization (i.e., pure technical inefficiency) and a failure to operate at the productive scale size (i.e., scale inefficiency).

Table 4 highlights that IIB remained efficient at least once during the study period. The descriptive statistics elucidated that 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, we deduce that BPS is the most efficient of IIB. The difference among the banks for all categories is quite significant.

Table 4: Descriptive statistics of efficiency scores across banks Model 1

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
BSM	92.10	100.00	97.24	0.037	99.80	100.00	99.98	0.000	92.10	100.00	98.90	0.027
BNIS	87.70	100.00	96.63	0.040	89.20	100.00	98.50	0.035	92.70	100.00	98.11	0.025
BCAS	67.00	100.00	87.71	0.091	78.50	100.00	93.02	0.070	83.20	100.00	94.25	0.065
BJBS	87.70	100.00	96.70	0.049	89.40	100.00	97.70	0.042	92.70	100.00	98.96	0.023
BBS	88.60	100.00	96.13	0.042	89.80	100.00	97.37	0.039	92.70	100.00	98.75	0.023
BMS	87.90	100.00	98.04	0.043	89.70	100.00	98.95	0.033	92.00	100.00	98.27	0.032
BPS	82.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	73.10	100.00	90.32	0.102	99.80	100.00	99.98	0.000	73.10	100.00	90.34	0.102
BMI	90.40	100.00	97.74	0.042	95.10	100.00	99.21	0.016	90.40	100.00	96.75	0.450
BRIS	86.50	100.00	95.59	0.058	88.70	100.00	96.68	0.047	92.70	100.00	97.44	0.032

Input = Total asset, employees, offices, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 2

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
BSM	92.10	100.00	97.24	0.037	98.50	100.00	99.85	0.370	92.10	100.00	98.90	0.027
BNIS	87.50	100.00	93.84	0.047	89.10	100.00	96.03	0.050	93.90	100.00	97.70	0.024
BCAS	70.40	100.00	87.57	0.085	78.50	100.00	92.85	0.064	71.70	100.00	91.35	0.102
BJBS	92.50	100.00	99.25	0.023	98.50	100.00	99.85	0.005	93.90	100.00	99.36	0.019
BBS	88.60	100.00	93.11	0.030	89.80	100.00	95.18	0.036	93.90	100.00	97.85	0.036
BMS	88.30	100.00	98.08	0.042	89.90	100.00	98.84	0.032	92.00	100.00	98.41	0.030
BPS	92.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	71.10	100.00	90.11	0.111	98.50	100.00	99.85	0.005	71.10	100.00	87.92	0.114
BMI	87.30	100.00	94.32	0.048	95.10	100.00	99.21	0.016	90.00	100.00	95.05	0.041
BRIS	86.50	100.00	95.92	0.056	93.00	100.00	98.83	0.022	89.30	100.00	97.02	0.041

Input = Total asset, deposits, employees, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 3

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
BSM	92.10	100.00	96.49	0.038	100.00	100.00	100.00	0.000	92.10	100.00	96.49	0.038
BNIS	87.00	100.00	95.11	0.050	89.20	100.00	97.15	0.050	94.60	100.00	97.90	0.021
BCAS	61.10	100.00	83.13	0.118	78.50	100.00	91.36	0.068	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	96.11	0.042	89.80	100.00	96.74	0.041	97.20	100.00	99.35	0.010
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	98.77	0.028
BPS	98.90	100.00	99.86	0.004	100.00	100.00	100.00	0.000	98.90	100.00	99.86	0.004
BVS	73.50	100.00	88.73	0.104	100.00	100.00	100.00	0.000	73.50	100.00	88.74	0.104
BMI	90.50	100.00	97.76	0.041	100.00	100.00	100.00	0.000	90.50	100.00	97.76	0.041
BRIS	85.00	100.00	95.55	0.064	93.00	100.00	98.41	0.025	87.80	100.00	97.04	0.045

Input = Total asset, deposits, employees, output = total revenue and financing

6

Table 4: Descriptive statistics of efficiency scores across banks Model 4

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
BSM	92.10	100.00	98.81	0.028	100.00	100.00	100.00	0.000	92.10	100.00	98.81	0.028
BNIS	68.90	100.00	90.98	0.111	69.10	100.00	91.93	0.114	95.20	100.00	99.01	0.017
BCAS	58.30	100.00	81.60	0.122	67.90	100.00	90.91	0.090	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	94.18	0.041	89.80	100.00	96.51	0.041	89.90	100.00	97.62	0.036
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	99.77	0.006
BPS	78.80	100.00	94.84	0.080	84.10	100.00	97.26	0.056	86.10	100.00	97.45	0.051
BVS	51.80	100.00	83.14	0.163	100.00	100.00	100.00	0.000	51.80	100.00	83.14	0.163
BMI	89.00	100.00	97.98	0.039	96.20	100.00	99.53	0.013	89.00	100.00	98.45	0.038
BRIS	90.10	100.00	97.46	0.038	90.90	100.00	98.52	0.032	93.70	100.00	98.91	0.022

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

Table 5 emphasizes a gradual decline during the study for the three types of efficiency, namely OTE, PTE and SE. However, the decline was relatively more intense from 2011 to 2021, and then there was an upward trend between 2017 and 2018. The OTE reached a minimum of 75.30% in 2016. This means that in 2016, Islamic banks could reduce inputs by 24.70% in constant returns to scale for the same level of output obtained. The PTE almost followed evolution: peaked in 2017 and the minimum result was in 2013, with the score at 91.10% and 87.10%. As for scale efficiency, it witnessed a gradual decline during the study. The best performance was achieved in 2010 with an average score of 94.90%, while the lowest was obtained in 2015 with 85.20%.

Table 5: Annual evolution of efficiency scores per category

Model 1												
	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%

Input = Total asset, employees, offices, output = total revenue and financing

Model 2												
	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%

Input = Total asset, deposits, offices, output = total revenue and financing

Model 3												
	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%

Input = Total asset, deposits, employees, output = total revenue and financing

Model 4												
	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%

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

¹ We further investigate the annual evolution of average efficiency across countries from 2010 to 2021 for the three kinds of efficiency, namely OTE, PTE, and SE. Table 4 shows the annual highest scores of efficiency belong to both BMI and BSM for the big IIB category, 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 findings are based on PTE that reveals a bank's own ability to manage the organization and the resources without considering external factors whose impact is taken into account on SE. Investigating the SE of Indonesian Islamic banks reveals that, for all time periods, only BTPNS and MBS were efficient. All scores of SE were, on average, fluctuating. The lowest levels were observed in 2011, 2015, and 2016 for BNIS for big IIB, BMS, and BPDA for the medium category.

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). Therefore, instead of focusing on the Indonesian Islamic banking sector's profit efficiency alone, it is better to compare it with cost efficiency to identify the existence of a comprehensive concept on revenue efficiency in the Indonesian Islamic banking sector. It addresses how to distinguish between three different types of efficiency, namely cost, revenue, and profit efficiencies.

¹ The recent study identifies a decrease in average scores of OTE, PTE, and SE since 2010. This result reveals the reduction of Islamic banking performance in Indonesia. The main source of technical inefficiency was due to the IIB's operating at the wrong scale. Hence, they needed to reduce their inputs to achieve optimum scales. It indicates that the banks' management was unable to efficiently control the costs and use the mix of inputs to produce outputs regardless of the scale effects. The ability of IIB to meet the efficiency and performance requirements will determine their viability and innovation of products and services, specifically, to pursue their roles as an intermediary between depositors and borrowers. It is the critical motivations of Indonesian Muslims who have contributed to the increase in deposit banking due to looking for Sharia-compliant.

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 findings of this research confirmed the effects of input variables on output variables, which elucidated the efficiency 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. Our 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.

⁴ To sum up, the finding suggests several implications for bankers and policy-makers to improve efficiency. First, although IIB outperforms, the industry still lags in terms of its efficiency scores. Intensifying competition and innovation could lead to better efficiency. Furthermore, IIB needs to

increase and invest in their resources and capabilities and introduce know-how technology to better efficiency. Bankers need to focus their efforts on improving their PTE, rather than SE. It is directly under the control of banks and management is charged with examining the managerial side, reducing operating expenses, and improving employees' quality based on job procurement and training activities. However, previous studies have reported the role of DMUs' employ³⁷, offices, deposits, and operational expenses as antecedents of financing and income (Alqahtani et al., 2017; Aggelopoulos & Georgopoulos, 2017; Kamarudin et al., 2019; Rohman et al., 2022; Sang, 2021, 2022; Sofilda et al., 2022). were examin⁵⁰ separately; the input variables are considered the most important to increase DMUs' financial performance. The strength of the input role shows that output is possibly influenced by DMUs' performance. It is a consequence of the efficient activities, experience, skills, and knowledge of employees acquired by Islamic banks.

⁴ Second, policymakers should take serious steps to allow for the entry of foreign banks by relaxing restriction⁸. It might improve competition and, hence, the overall efficiency of the banking industry. Most importantly, the role of the shariah supervisory board (SSB) and financial services authority (OJK) is one of the essential indicators of the operational system for strengthening the relationship between consumers, employees, and this banking system. In this regard, the regulators are expected to play a pivotal role with clearly established regulation and supervision mechanisms, which can be used as an operating system fundamentally different from conventional banking. Furthermore, a comprehensive tool and intensive coordination are critical factors that support Islamic banking's sustainability and success in competing in both the local and global markets.

CONCLUSION

⁴⁴ The purpose of this study was to examine the factors that input variables (e.g., Indonesia Islamic bank assets, deposits, offices, and equity) to output variables (e.g., financing and revenue). By analyzing the efficiency of Islamic banks during 2010–2021 with an intermediary approach, it has proven that Islamic banking operations have a strong correlation to economic development in some regions. The stability of the Islamic banking system is taken seriously by its efficiency and situational factors, from businesses, investors, and governments to borrowers or depositors. Therefore¹³ Islamic bank capital and financing have received attention from investors and scholars in the extensive and intensive fields. It is increasingly in⁵⁶ rative to increase the financial effectiveness of Indonesia's Islamic banks. It ⁶³ confirmed that the operational performance of Indonesian Islamic banks is better after the COVID-19 pandemic than before and during the pandemic. The operational of Islamic banks in Indonesia is also improved toward measures of deposits, employees, expenses, and offices to decrease operating expenses while developing technology applications and investing in productive sectors.

² There are some limitations to this study. First, this study was carried out in the Islamic banking field; therefore, the results need not be generalized. Future studies need to include conventional banks, more sample sizes, other regions, and geographical areas to encourage a better conclusion. 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, although the input variable² proposed in this research were proven positive, they were restricted and limited to Islamic banks with preliminary studies. Future studies

also need to comprehensively focus on the relationship between financial and non-financial contexts. In addition, there is a need to ascertain whether Islamic bank managers understand the importance of this relationship because it aids in establishing when employees and the number of offices have a positive effect on bank performance.

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Indonesian Islamic banks (IIB): A review of the financial situation both 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 during the periods before and after the COVID-19 pandemic, 2010–2021. This study differentiated between different dimensions of 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. It means that the number of offices has less 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, Indonesia' Islamic bank

JEL Classification C53, F65, 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 US\$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, the bank managers and 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 HYPHOTHESES DEVELOPMENT

Banking intermediary role play important role to support economic growth. However, 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. With over US\$260 billion assets, it has developed more than 300 global Islamic funds and institutions across the region with the majority Muslim people and Western countries (IMF, 2019). However, some studies concluded mixed result of Islamic bank efficiency.

6 The impact of return on assets (ROA), return on equity (ROE), and net interest margin (NIM) on 43 Indonesian banking profitability was studied by Rohman 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. Similar, Sang (2021) used the Generalized Method of Moments (GMM) and discovered that Vietnam's banks' financial stability is positively and significantly impacted by the capital adequacy ratio. Furthermore, Msomi (2022) concluded that the financial performance and inflation play an important role in influencing non-performing loans in some African 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). It means that profitability and capitalization play an important role in efficiency. As well as 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, Islamic banks' efficiency 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, Junaidi 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. Hafez (2022) used DEA to assess the effectiveness of conventional and Islamic banks in Egypt. 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 (Sofilda et al., 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 have a crucial role in banking efficiency and performance in South Africa (Govender, 2022). As a financial institution, banking plays an important role in transferring capital to borrowers in Ukraine (Bukhtiarova et al., 2022) and Vietnam (Sang, 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 to 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. It indicates 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 for 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 constant returns-to-scale (CRS) and variable returns-to-scale (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 fill 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 having 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 address these questions and contribute to the financial and non-financial literature aspects which influence bank efficiency 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 research 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, employees, and offices positively influence total financing and revenue
H2: Islamic bank assets, deposits, and offices positively influence total financing and revenue
H3: Islamic bank assets, deposits, and employees positively influence total financing and revenue
H4: Islamic bank assets, deposits, and equity positively influence total financing and revenue

2. DATA AND METHODOLOGY

Data retrieved from the bank's database. We have been considering 14 Indonesian Islamic banks (IIB) (see table I) for 2010 to 2021. This study, 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.

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

Source: Indonesian financial services authority (OJK), SCB = Shariah commercial banks, SBU = Shariah business units, SRB = Shariah rural banks, * in trillion rupiah (IDR)

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 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). We also refer to Sofilda et al. (2022) and Xu and Zhou (2020), which use deposits as intermediate input and output. Furthermore, we combine two prior studies and Bhatia et al., (2018); Chaffai and Hassan (2019); and Doumpou 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, we favored employing financing and income as output variables in this paper's intermediation technique, and assets, deposits, personnel, and offices as input measurements.

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

Under these two presumptions, the DEA idea enables us to regulate efficiency score, namely, CRS and VRS, with the following program:

$$\text{Min } \lambda_0 \theta_0 \quad (1)$$

$$\text{Subject to } \sum_{j=1}^n \lambda_{0j} y_{rj} \geq y_{r0} \quad (r = 1, \dots, s) \quad (2)$$

$$\theta_0 x_{i0} \sum_{j=1}^n \lambda_{0j} x_{ij} \quad (i = 1, \dots, n) \quad (3)$$

$$\sum_{j=1}^n \lambda_{0j} = 1 \quad (4)$$

$$\lambda_{0j} \geq 0 \quad (j = 1, \dots, n) \quad (5)$$

With θ_0 : OTE; y_{r0} : output r of DMU₀; x_{i0} : input I of DMU₀; y_{rj} : output r regarding the unit of references, input I regarding the unit of references j, and the weight of the references unit j are all included s: the quantity of outputs; n: the number of DMU_s.

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 of 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 include 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 Govender and Maralack (2022) 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).

3. RESULT

This study shown the correlation between the input and output variables in 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.

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**

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

We examine the effectiveness of Indonesia's 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 Descriptive statistics of annual efficiency score of IIBs Model 1

Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 2

Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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

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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 3

Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

Descriptive statistics of annual efficiency score of IIBs Model 4

Overall technical efficiency						Pure technical efficiency scores					Scale efficiency scores				
Year	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv	Min	Max	Mean	Sd	Cv
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		

Sd: standard deviation; Cv: coefficient of variation, Input = Total asset, employees, offices, output = total revenue and financing

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 approximately 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, we deduce that BPS is the most efficient of IIB. The difference among the banks for all categories is quite significant.

Table 4: Descriptive statistics of efficiency scores across banks Model 1

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
BSM	92.10	100.00	97.24	0.037	99.80	100.00	99.98	0.000	92.10	100.00	98.90	0.027
BNIS	87.70	100.00	96.63	0.040	89.20	100.00	98.50	0.035	92.70	100.00	98.11	0.025
BCAS	67.00	100.00	87.71	0.091	78.50	100.00	93.02	0.070	83.20	100.00	94.25	0.065
BJBS	87.70	100.00	96.70	0.049	89.40	100.00	97.70	0.042	92.70	100.00	98.96	0.023
BBS	88.60	100.00	96.13	0.042	89.80	100.00	97.37	0.039	92.70	100.00	98.75	0.023
BMS	87.90	100.00	98.04	0.043	89.70	100.00	98.95	0.033	92.00	100.00	98.27	0.032
BPS	82.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	73.10	100.00	90.32	0.102	99.80	100.00	99.98	0.000	73.10	100.00	90.34	0.102
BMI	90.40	100.00	97.74	0.042	95.10	100.00	99.21	0.016	90.40	100.00	96.75	0.450
BRIS	86.50	100.00	95.59	0.058	88.70	100.00	96.68	0.047	92.70	100.00	97.44	0.032

Input = Total asset, employees, offices, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 2

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
BSM	92.10	100.00	97.24	0.037	98.50	100.00	99.85	0.370	92.10	100.00	98.90	0.027
BNIS	87.50	100.00	93.84	0.047	89.10	100.00	96.03	0.050	93.90	100.00	97.70	0.024
BCAS	70.40	100.00	87.57	0.085	78.50	100.00	92.85	0.064	71.70	100.00	91.35	0.102
BJBS	92.50	100.00	99.25	0.023	98.50	100.00	99.85	0.005	93.90	100.00	99.36	0.019
BBS	88.60	100.00	93.11	0.030	89.80	100.00	95.18	0.036	93.90	100.00	97.85	0.036
BMS	88.30	100.00	98.08	0.042	89.90	100.00	98.84	0.032	92.00	100.00	98.41	0.030
BPS	92.50	100.00	99.25	0.024	98.50	100.00	99.85	0.005	93.90	100.00	99.39	0.019
BVS	71.10	100.00	90.11	0.111	98.50	100.00	99.85	0.005	71.10	100.00	87.92	0.114
BMI	87.30	100.00	94.32	0.048	95.10	100.00	99.21	0.016	90.00	100.00	95.05	0.041
BRIS	86.50	100.00	95.92	0.056	93.00	100.00	98.83	0.022	89.30	100.00	97.02	0.041

Input = Total asset, deposits, offices, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 3

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
BSM	92.10	100.00	96.49	0.038	100.00	100.00	100.00	0.000	92.10	100.00	96.49	0.038
BNIS	87.00	100.00	95.11	0.050	89.20	100.00	97.15	0.050	94.60	100.00	97.90	0.021
BCAS	61.10	100.00	83.13	0.118	78.50	100.00	91.36	0.068	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	96.11	0.042	89.80	100.00	96.74	0.041	97.20	100.00	99.35	0.010
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	98.77	0.028
BPS	98.90	100.00	99.86	0.004	100.00	100.00	100.00	0.000	98.90	100.00	99.86	0.004
BVS	73.50	100.00	88.73	0.104	100.00	100.00	100.00	0.000	73.50	100.00	88.74	0.104
BMI	90.50	100.00	97.76	0.041	100.00	100.00	100.00	0.000	90.50	100.00	97.76	0.041
BRIS	85.00	100.00	95.55	0.064	93.00	100.00	98.41	0.025	87.80	100.00	97.04	0.045

Input = Total asset, deposits, employees, output = total revenue and financing

Table 4: Descriptive statistics of efficiency scores across banks Model 4

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
BSM	92.10	100.00	98.81	0.028	100.00	100.00	100.00	0.000	92.10	100.00	98.81	0.028
BNIS	68.90	100.00	90.98	0.111	69.10	100.00	91.93	0.114	95.20	100.00	99.01	0.017
BCAS	58.30	100.00	81.60	0.122	67.90	100.00	90.91	0.090	70.60	100.00	90.89	0.102
BJBS	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000	100.00	100.00	100.00	0.000
BBS	88.60	100.00	94.18	0.041	89.80	100.00	96.51	0.041	89.90	100.00	97.62	0.036
BMS	88.30	100.00	98.54	0.041	89.90	100.00	98.74	0.036	92.00	100.00	99.77	0.006
BPS	78.80	100.00	94.84	0.080	84.10	100.00	97.26	0.056	86.10	100.00	97.45	0.051
BVS	51.80	100.00	83.14	0.163	100.00	100.00	100.00	0.000	51.80	100.00	83.14	0.163
BMI	89.00	100.00	97.98	0.039	96.20	100.00	99.53	0.013	89.00	100.00	98.45	0.038
BRIS	90.10	100.00	97.46	0.038	90.90	100.00	98.52	0.032	93.70	100.00	98.91	0.022

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

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 tendency. 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

	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%

Input = Total asset, employees, offices, output = total revenue and financing

Model 2

	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%

Input = Total asset, deposits, offices, output = total revenue and financing

Model 3

	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%

Input = Total asset, deposits, employees, output = total revenue and financing

Model 4

	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%

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

1
From 2010 through 2021, we further examine the annual evolution of average efficiency among nations for the three types of efficiency, 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.

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 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 pursue 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. Our 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; Kamarudin et al., 2019; Rohman et al., 2022; Sang, 2021, 2022; Sofilda 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 influences on Indonesia Islamic banks' assets, deposits, offices, and equity as well as other input and output variables (e.g., financing and revenue). By analyzing the efficiency of Islamic banks during 2010–2021 with an intermediary approach, it has proven that Islamic banking operations have a strong correlation to 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 operational of Islamic banks in Indonesia is also improved toward measures 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 off, because 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. In order 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.

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Dear Dirgahayu Lantara,

The submitted manuscript Indonesian Islamic banks (IIB): An analysis of financial performance before and during the COVID-19 pandemic to Banks and Bank Systems Journal has passed the review process and is waiting for your decision regarding the publishing.

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Dear Dirgahayu Lantara,

The manuscript Indonesian Islamic banks (IIB): An analysis of financial performance before and during the COVID-19 pandemic submitted to Banks and Bank Systems is agreed for publication on 09.09.2022

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Kepada: Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>

Dear Dirgahayu Lantara,

I would like to inform you that your manuscript titled "Indonesian Islamic banks (IIB): A review of the financial situation both before and after the COVID-19 pandemic" has been accepted for publication, and will be published in the issue 4, 2022 of the journal "Banks and Bank Systems".

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Ph.D, Faculty of Technique,
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Universitas Muslim Indonesia,
Indonesia

ACCEPTANCE LETTER

Dear Dirgahayu Lantara,

We are pleased to inform you that your paper “Indonesian Islamic banks (IIB): A review of the financial situation both before and after the COVID-19 pandemic” co-authored with Junaidi, Nurhayati Rauf, A. Pawennari and Ratu Noorita Achmad has been double blind peer-reviewed and accepted for publication in the international journal “Banks and Bank Systems”, which is scheduled to be published in Volume 17, Issue 4, 2022.

With cordial regards,
Yaroslava Mospanova

Managing Editor
International research journal
“Banks and Bank Systems”

E-mail: ya.mospanova@businessperspectives.org



PUBLICATION AGREEMENT

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The Publisher agrees to publish the manuscript “Indonesian Islamic banks (IIB): A review of the financial situation both before and after the COVID-19 pandemic” in Vol. 17, Issue 4, year 2022 by the Author(s) as an open-access article (the article will be available to all users immediately upon publication without registration on the site and embargo period) in the journal “Banks and Bank Systems” (ISSN 1816-7403 (print), 1991-7074 (online)), hereinafter – “Journal”.

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Dirgahayu Lantara
Ph.D, Faculty of Technique,
Department of Industrial Technique,
Universitas Muslim Indonesia,
Indonesia

Korespondensi Artikel

- 16. 12 September 2022 Balasan penulis tentang “Publication Agreement” dan informasi pembayaran**
-



Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>

MA6236: Notification on Submission

Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>
Kepada: ya.mospanova@manuscript-adminsystem.com

12 September 2022 08.42

Dear Yaroslava Mospanova

Thanks for your information. We send a Publication agreement. Furthermore, we will send the article processing charge (APC) by bank transfer. Hence, please send us bank account details.

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Dirgahayu Lantara
[Kutipan teks disembunyikan]



Publication Agreement.pdf
183K



PUBLICATION AGREEMENT

LLC “CPC “Business Perspectives”, hereinafter – “Publisher” and Dirgahayu Lantara (Ph.D, Faculty of Technique, Department of Industrial Technique, Universitas Muslim Indonesia, Indonesia), Junaidi (Doctoral, Faculty of Economic and Business, Department of Accounting, Universitas Muhammadiyah Palopo, Indonesia), Nurhayati Rauf (Doctoral, Faculty of Technique, Department of Industrial Engineering, Universitas Muslim Indonesia, Indonesia), A. Pawennari (Doctoral, Faculty of Technique, Department of Industrial Engineering, Universitas Muslim Indonesia, Indonesia), Ratu Noorita Achmad (Doctoral, Faculty of Economic and Business, Department of Management, STIE AMKOP Makassar, Indonesia) hereinafter – “Author” agree on the following:

The Publisher agrees to publish the manuscript “Indonesian Islamic banks (IIB): A review of the financial situation both before and after the COVID-19 pandemic” in Vol. 17, Issue 4, year 2022 by the Author(s) as an open-access article (the article will be available to all users immediately upon publication without registration on the site and embargo period) in the journal “Banks and Bank Systems” (ISSN 1816-7403 (print), 1991-7074 (online)), hereinafter – “Journal”.

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The Author
(sign here)

Date: September, 11th 2022

Dirgahayu Lantara
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Universitas Muslim Indonesia,
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Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>

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ya.mospanova@manuscript-adminsystem.com <ya.mospanova@manuscript-adminsystem.com>

12 September 2022
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26207313388455

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OSTAPENKO LIUDMYLA, 40000, Ukraine, reg. Sumaska, c. Sumy, ln. Grigoriia Skovorodi, build. 10

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Korespondensi Artikel

- 17. 12 September 2022 Pemberitahuan jurnal terkait detail informasi pembayaran**
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20.36

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Account No

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- 18. 15 September 2022 Balasan penulis terkait konfirmasi telah melakukan pembayaran**
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Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>

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Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>
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15 September 2022 12.54

Dear Yaroslava Mospanova

We send APC payment proof for the manuscript with entitled " Indonesian Islamic banks (IIB): An analysis of financial performance before and during the COVID-19 pandemic" to Banks and Bank Systems Journal

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APPLICATION FOR FUND TRANSFER

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IDR 9,404,063.00

85T87

Tanggal / Date : 11/5 2015 12/12
hari / day bulan / month tahun / year

Jenis Pengiriman : ☐ Kawat / Telegraphic Wire ☐ RTGS
Type of Transfer : ☐ Wesel / Draft ☐ SKN

A PENERIMA BENEFICIARY

NOMOR REKENING PENERIMA
BENEFICIARY'S ACCOUNT NUMBER 2620 7313 3009 55

NAMA PENERIMA
BENEFICIARY'S NAME BUSINESS PERSPECTIVE

ALAMAT PENERIMA
BENEFICIARY'S ADDRESS KOTA KINRAH, KINRAH, KINRAH

KOTA
CITY KINRAH

TIPE NASABAH
CUSTOMER TYPE ☐ PERORANGAN INDIVIDUAL ☒ PERUSAHAAN BUSINESS ☐ PEMERINTAH GOVERNMENT

STATUS
STATUS ☒ PENDUDUK RESIDENT ☐ NON PENDUDUK NON RESIDENT

NEGERA BAGIAN
STATE

NEGERA
COUNTRY UKRAINE

KODE NEGERA
COUNTRY CODE

C PENGIRIM REMITTER

NAMA PENGIRIM
REMITTER'S NAME RAYU NOORITA AHMAD

NOMOR KARTU IDENTITAS
IDENTITY CARD NUMBER

ALAMAT PENGIRIM
REMITTER'S ADDRESS

NAMA YANG DAPAT DIHUBUNGI
CONTACT PERSON

NO. HANDPHONE
CELLULAR PHONE NO. 0812412212

KOTA
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TIPE NASABAH
CUSTOMER TYPE ☒ PERORANGAN INDIVIDUAL ☐ PERUSAHAAN BUSINESS ☐ PEMERINTAH GOVERNMENT

STATUS
STATUS ☒ PENDUDUK RESIDENT ☐ NON PENDUDUK NON RESIDENT

NEGERA BAGIAN
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NEGERA
COUNTRY

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COUNTRY CODE

NO. REKENING DI BCA
ACCOUNT NUMBER WITH BCA 2420 22 400

B BANK PENERIMA BENEFICIARY BANK

NAMA BANK
BANK'S NAME JCB UNIVERSAL BANK

ALAMAT BANK
BANK'S ADDRESS

KOTA
CITY KIV

NEGERA BAGIAN
STATE

NEGERA
COUNTRY UKRAINE

KODE NEGERA
COUNTRY CODE

D DATA

HUBUNGAN KEUANGAN
FINANCIAL RELATIONSHIP ☐ Ya Yes ☐ Tidak No

TUJUAN TRANSAKSI
TRANSACTION PURPOSE

BERITA
MESSAGE

SUMBER DANA
SOURCE OF FUND

☐ TUNAI Cash ☐ Rp

☐ TABUNGAN Savings Account ☐ Rp

☐ CEK BCA Cheque ☐ Rp

DIISI OLEH BANK / BANK USE ONLY

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EUR	595	15.046	Rp 8.952.667,50
EUR	30	15.046	Rp 451.395
IDR			Rp 50.000
JUMLAH / TOTAL			Rp 9.454.063

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19.	3 Oktober 2022	Konfirmasi pada jurnal terkait status artikel
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Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>

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Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>
Kepada: ya.mospanova@manuscript-adminsystem.com

3 Oktober 2022 13.24

Dear Yaroslava Mospanova

We paid APC three weeks ago. Let us know our manuscript status.

Sincerely yours

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Korespondensi Artikel

20.	3 Oktober 2022	Balasan jurnal terkait proses persiapan publikasi
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ya.mospanova@manuscript-adminsystem.com <ya.mospanova@manuscript-adminsystem.com> 3 Oktober 2022 19.06
Kepada: Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>

Dear Dirgahayu Lantara,

Thank you for your letter.

We are preparing it for publication in Issue 4.

[Kutipan teks disembunyikan]

Korespondensi Artikel

21.	4 Oktober 2022	Penyampaian hasil proofreading dari jurnal
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MA6236_Proofreading

ya.mospanova@manuscript-adminsystem.com <ya.mospanova@manuscript-adminsystem.com> 4 Oktober 2022 16.10
Kepada: Dirgahayu Lantara <dirgahayu.lantara@umi.ac.id>

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Waiting for your ORCID id.

I look forward to hearing from you soon.

Kind regards,

Yaroslava Mospanova

Managing Editor | International Research Journal "Banks and Bank Systems" | LLC "CPC "Business Perspectives"

ya.mospanova@businessperspectives.org | https://businessperspectives.org/journals/banks-and-bank-systems?category_id=30 | <http://www.businessperspectives.org>

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Indonesian Islamic banks: A review of the financial ~~situation~~ **state** ~~both~~ before and after the COVID-19 pandemic

Dirgahayu Lantara (Indonesia), Junaidi, Nurhayati Rauf (Indonesia), A. Pawennari (Indonesia), Ratu Noorita Achmad (Indonesia)

Dirgahayu Lantara, Junaidi, Nurhayati Rauf, A. Pawennari, Ratu Noorita Achmad, 2022

Dirgahayu Lantara, Ph.D., Faculty of Technique, Department of Industrial Technique, Universitas Muslim Indonesia, Indonesia. (Corresponding author)

Junaidi, **Doctoral**, Faculty of Economics and Business, Department of Accounting, Universitas Muhammadiyah Palopo, Indonesia.

Nurhayati Rauf, **Doctoral**, Faculty of Technique, Department of Industrial Engineering, Universitas Muslim Indonesia, Indonesia.

A. Pawennari, **Doctoral**, Faculty of Technique, Department of Industrial Engineering, Universitas Muslim Indonesia, Indonesia.

Ratu Noorita Achmad, **Doctoral**, Faculty of Economic and Business, Department of Management, STIE AMKOP Makassar, Indonesia.

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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 ~~during the periods~~ before and after the COVID-19 pandemic, 2010–2021. This study differentiated between different dimensions of **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, F65, G21

Received on: 24th of June, 2022

Accepted on: 8th of September, 2022

Published on:

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 US\$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

Banking plays an important intermediary role in supporting economic growth. Repetition with Abstract However, 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. With over USB 260 billion assets, it has developed more than 300 global Islamic funds and institutions across the region with the majority Muslim people and Western countries repetition of the sentence with the Introduction (IMF, 2019). However, some studies concluded mixed result of Islamic bank efficiency.

The impact of return on financial performance on 43 Indonesian banking profitability was studied by Rohman 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. Similar, Sang (2021) used the Generalized Method of Moments (GMM) and discovered that financial stability of Vietnamese banks is positively and significantly impacted by the capital adequacy ratio. Furthermore, Msomi (2022) concluded that the financial performance and inflation play an important role in influencing non-performing loans in some African 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, Junaidi 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. Hafez (2022) used DEA to assess the effectiveness of conventional and Islamic banks in Egypt. 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 (Sofilda et al., 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 South Africa (Govender, 2022). As a financial institution, banking plays an important role in transferring capital to borrowers in Ukraine (Bukhtiarova et al., 2022) and Vietnam (Sang, 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 ~~having~~ **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 **address these questions???** and contribute to the financial and non-financial literature aspects that influence bank efficiency 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, employees, and offices positively influence total financing and revenue.

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

H3: Islamic bank assets, deposits, and employees positively influence total financing and revenue.

H4: Islamic bank assets, deposits, and equity positively influence total financing and revenue.

Almost all hypotheses repeat each other, you can do 2 instead of 4.

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.

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).

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 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 Sofilda et al. (2022) and 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.

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

Under these two presumptions, the DEA idea makes it possible to regulate efficiency score, namely, CRS and VRS, with the following program:

$$\text{Min } \lambda_0 \theta_0 \quad (2) \text{ This is not a formula}$$

$$\text{Subject to } \sum_{j=1}^n \lambda_{0j} y_{rj} \geq y_{r0} \quad (r = 1, \dots, s), \quad (3)$$

$$\theta_0 x_{i0} \sum_{j=1}^n \lambda_{0j} x_{ij} \quad (i = 1, \dots, n), \quad (4) \text{ This is not a formula}$$

$$\sum_{j=1}^n \lambda_{0j} = 1, \quad (5)$$

$$\lambda_{0j} \geq 0 \quad (j = 1, \dots, n). \quad (6)$$

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 Govender and Maralack (2022) 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).

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.

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).

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. 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
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	—	—

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 approximately 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 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.

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 tendency. 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.

Hypotheses testing results?

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 pursue 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; Kamarudin et al., 2019; Rohman et al., 2022; Sang, 2021, 2022; Sofilda 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.

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Korespondensi Artikel

**22. 5 Oktober Balasan proofreading dari penulis
 2022**

MA6236_Proofreading

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5 Oktober 2022 13.53

Dear Yaroslava Mospanova

Thanks for your best effort and comments.

We have revised our manuscript as suggested (see green words) and included removing BBS Journals for the references. We replace references from the BBS journal with new references.

We also added an Orcid number for all the authors.

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101K

Indonesian Islamic banks: A review of the financial **state** before and after the COVID-19 pandemic

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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

Received on: 24th of June, 2022

Accepted on: 8th of September, 2022

Published on:

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 US\$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, Junaidi 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.

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).

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 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.

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

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).

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.

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).

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. 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
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	–	–

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 approximately 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 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.

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 tendency. 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 pursue 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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Korespondensi Artikel

**23. 5 Oktober Final proofreading dari jurnal
 2022**

MA6236_Proofreading

ya.mospanova@manuscript-adminsystem.com <ya.mospanova@manuscript-adminsystem.com> 5 Oktober 2022 17.15
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Received on: 24th of June, 2022

Accepted on: 8th of September, 2022

Published on:

© Dirgahayu Lantara, Junaidi Junaidi,
Nurhayati Rauf, A. Pawennari, Ratu
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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).

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

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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Korespondensi Artikel

**24. 6 Oktober Balasan final proofreading dari penulis
 2022**



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MA6236_Proofreading

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6 Oktober 2022 08.03

Dear Yaroslava Mospanova
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The manuscript looks good. However, The author's details need slight revision.

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Sincerely

[Kutipan teks disembunyikan]

Korespondensi Artikel

25. 6 Oktober Artikel Terbit
2022

“Indonesian Islamic banks: A review of the financial state before and after the COVID-19 pandemic”

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ARTICLE INFO

Dirgahayu Lantara, Junaidi Junaidi, Nurhayati Rauf, A. Pawennari and Ratu Noorita Achmad (2022). Indonesian Islamic banks: A review of the financial state before and after the COVID-19 pandemic. *Banks and Bank Systems*, 17(4), 12-24. doi:[10.21511/bbs.17\(4\).2022.02](https://doi.org/10.21511/bbs.17(4).2022.02)

DOI

[http://dx.doi.org/10.21511/bbs.17\(4\).2022.02](http://dx.doi.org/10.21511/bbs.17(4).2022.02)

RELEASED ON

Thursday, 06 October 2022

RECEIVED ON

Friday, 24 June 2022

ACCEPTED ON

Thursday, 08 September 2022

LICENSE



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JOURNAL

"Banks and Bank Systems"

ISSN PRINT

1816-7403

ISSN ONLINE

1991-7074

PUBLISHER

LLC "Consulting Publishing Company "Business Perspectives"

FOUNDER

LLC "Consulting Publishing Company "Business Perspectives"



NUMBER OF REFERENCES

42



NUMBER OF FIGURES

0



NUMBER OF TABLES

5

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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

© Dirgahayu Lantara, Junaidi Junaidi,
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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).

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

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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Korespondensi Artikel

26. 10 Oktober 2022 Tampilan korespondensi pada website

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General

TITLE

Indonesian Islamic banks (IIB): An analysis of financial performance before and during the COVID-19 pandemic

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Banks and Bank Systems

ABSTRACT

This paper aims to perform a non-parametric production efficiency analysis of Indonesia of Islamic banks (IIB) estimated during periods 2010-2020. Non-parametric analysis, data envelopment analysis (DEA) is used to compute the IIB of efficiency (e.g., overall, pure, and scale) with the framework input-oriented variable constant return to scale (CRS) and returns to scale (VRS) model. Although, the resource of technology IIB management is lack, as well as macroeconomic and environmental effects. This study found that IIB need to enhance investment in technology beside office. It has crucial role to enhance IIB equity and income. Hence, the IIB managers and policy-makers need to improve their efficiency scores toward intensifying competition and innovation. Furthermore, IIB needs to increase and spend their assets and experiences to enhance technology, which significantly affects efficiency. This study differentiated between different dimensions of IIB finance and non-finance aspects, as well as investigated the relationships between these dimensions of financial (e.g., assets, deposits, equity, financing, and income) and non-financial variables (employees and offices).

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Dirgahayu Lantara 02.09.2022

Dear Editor

We did our best to give diligent and thoughtful consideration to each of the issues raised by the editor in revising the paper. We also send the plagiarism check result by email.

Sincerely

Dirgahayu Lantara 01.08.2022

Dear Yaroslava Mospanova

We would like for their detailed feedback. We have revised the manuscript according to your suggestion. If were specific ways, you would like us to address any remaining concern, please let us know.

Sincerely

Dirgahayu Lantara 26.07.2022

Dear Editor

We would like to thank the Editor for their detailed and helpful feedback regarding our manuscript, and for providing us with the opportunity to revise our manuscript.

Sincerely

Author(s)