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Research Paper

Banking Efficiency under an Oligopoly Structure: Evidence from Indonesia's Islamic and Conventional Banks

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Abstract

This study investigates the relationship between market structure and banking performance in Indonesia, with a particular focus on the comparative efficiency of Islamic and conventional banks. Using concentration ratio (CR) analysis and Data Envelopment Analysis (DEA), the research evaluates efficiency levels across 51 conventional banks and 14 Islamic banks during the period 2015–2021. The findings indicate that the Indonesian banking industry operates under an oligopolistic structure, dominated by a small number of large state-owned and private conventional banks. While Islamic banks demonstrated relatively higher overall and scale efficiency, conventional banks outperformed in terms of technical efficiency. Nevertheless, the differences in efficiency between Islamic and conventional banks were found to be statistically insignificant. These results suggest that although Islamic banking in Indonesia has made progress, it still faces structural and operational challenges in competing with its conventional counterparts. The study contributes to the literature on banking efficiency by integrating market concentration measures with non-parametric efficiency analysis in a dual banking system context. The findings provide important implications for policymakers and regulators in designing strategies to enhance competitiveness, improve efficiency, and foster the sustainable growth of Islamic banking within an oligopolistic market structure.

Keywords: *Islamic Bank, Conventional Bank, Efficiency, DEA, Market Structure, Oligopoly*

INTRODUCTION

The banking sector plays a pivotal role in the stability and growth of national economies, functioning as a financial intermediary and facilitator of economic development. In Indonesia, the dual banking system, comprising both conventional and Islamic banks, has expanded significantly over the past two decades, yet it remains structurally dominated by large conventional institutions. As of 2021, Islamic banks accounted for only 6.49% of the national market share, underscoring the persistent asymmetry between the two systems.

Market structure has long been recognized as a determinant of banking performance. Highly concentrated markets often exhibit oligopolistic features, where competition is limited, and efficiency becomes critical for long-term sustainability. Within Indonesia's banking industry, the concentration ratio indicates that a small number of state-owned and private banks dominate deposits, lending, and capital resources. This structural configuration raises important questions regarding the ability of smaller institutions, particularly Islamic banks, to compete effectively.

The structure of the national banking industry describes the corporate hierarchies and landscape of the national banking industry, which are part of institutional arrangements (Hollingsworth, 2000). Therefore, it is important to identify and determine the position of Islamic banking in the national banking industry structure.

As of May 2021, the banking industry is dominated by conventional commercial banks, which account for 107 banking institutions (see Table 1). Meanwhile, Islamic banking holds a

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market share of 6.49% and comprises 12 Islamic banks, 20 Islamic business units, and 163 Islamic rural banks (BPRS). Seven of the 20 Islamic business units (Unit Usaha Syariah, UUS) originate from national private commercial banks. Meanwhile, the number of Islamic bank offices totals 2,417, which is far lower than the 29,698 offices operated by conventional banks across Indonesia.

Table 1. Number of Banks and its Offices, 2015-2021

Bank Groups	2015	2016	2017	2018	2019	2020	2021*)
Conventional Bank	118	116	115	115	110	109	107
Islamic Bank	12	12	13	14	14	14	12
Islamic Business Units	22	21	21	20	20	20	20
Islamic Rural Bank	163	166	167	167	164	163	163
Number of Islamic bank and Islamic Busineess unit Offices	2301	2201	2169	2229	2300	2426	2417
Number of Conventinal Bank Offices	32949	32730	32285	31609	31127	30773	29689

Source: Authority Financial Services (Bank Statistics 2015-2021)
Note: *) until May 2021

Of the 119 banks in Indonesia as of the end of 2020, only four are state-owned enterprises; meanwhile, no Islamic banking enterprise is a state-owned enterprise. The seven largest banks control almost 60% of the total deposits; four of these are state-owned banks, which means that 112 banks contest the remaining 40% of total deposits. The four state-owned banks also control 43.1 % of the total third-party funds of national banks, which amounted to Rp. 6,665.4 trillion at the end of 2020. Meanwhile, the credit share reached 44.6 %of the total Rp. 5,481.6 trillion in the same period.

This dominance is further illustrated in Table 2, which presents the assets and capital of the ten largest banks in Indonesia in 2021. The table shows that conventional state-owned and private banks occupy the top positions in terms of total assets and market share, while only one Islamic bank, Bank Syariah Indonesia (BSI), appears among the top ten. Although BSI represents a major consolidation effort within Islamic banking, its asset share remains significantly smaller than that of leading conventional banks. Table 2 thus reinforces the view that Indonesia's banking industry operates under an oligopolistic structure, where market power is concentrated among a small number of large conventional banks.

Table 2. Assets and Capital of the ten largest banks in Indonesia, 2021

No	**Bank**	**Bank Capital (trillion Idr)**	**Total Asset (Trillion Idr)**	**Share %**	**Ownership**
1	Bank Mandiri (conventional bank)	222	1725	15.9	State bank
2	Bank Rakyat Indonesia (BRI, conventional bank)	292	1678	15.5	State bank
3	Bank Central Asia (BCA, conventional bank)	203	1228	11.7	Private bank

No	Bank	Bank Capital (trillion Idr)	Total Asset (Trillion Idr)	Share %	Ownership
4	Bank Nasional Indonesia (BNI, conventional bank)	126	964	8.9	State bank
5	Bank Tabungan Negara (BTN, conventional bank)	21	363	4.0	State bank
6	CIMB Niaga (conventional bank)	43	310	3.1	Private bank
7	Bank Syariah Indonesia (BSI) (Islamic bank)	25	265	2.7	Subsidiary of the state bank
8	Permata Bank (conventional Bank)	37	234	2.2	Private bank
9	OCBC NISP (conventional bank)	32	206	2.3	Private bank
10	Panin (conventional bank)	48	204	2.2	Private bank

Source: Annual Report of each Bank 2021, various.

Against this backdrop, the present study investigates the implications of market structure for banking performance in Indonesia, with a comparative focus on Islamic and conventional banks. Employing concentration ratio analysis and non-parametric Data Envelopment Analysis (DEA), the research examines efficiency patterns over the period 2015–2021. In doing so, the study contributes to the literature by bridging the fields of market structure and bank efficiency, while also generating practical insights for policymakers, regulators, and practitioners seeking to foster the competitiveness and sustainability of Islamic banking in Indonesia.

Empirical studies on the relative efficiency of Islamic and conventional banks report mixed results. Early cross-country work by Yudistira (2004) and later comparisons (Hassan et al., 2009; Johnes et al., 2012) generally find that Islamic banks tend to be less efficient than conventional peers, often because many Islamic banks are smaller and face diseconomies of scale. Other studies report no significant differences: Olson and Zoubi (2008) find parity between the two banking systems in the GCC region. Country- and region-specific analyses provide more nuance: Ascarya and Yumanita (2008) reported better efficiency for Indonesian Islamic banks relative to Malaysian peers for certain measures, while Hadad et al. (2008) and Sufian (2007) show wide heterogeneity in efficiency across banks and periods. More recent DEA-based studies emphasize institutional and balance-sheet determinants: Bitar et al. (2020) and Chowdhury & Haron (2021) highlight the importance of capital and liquidity ratios, regulatory environment, and country-specific institutional factors in shaping efficiency outcomes for Islamic banks. Methodologically, most work applies DEA (or parametric alternatives) with variations in input–output specification (production vs. intermediation approaches) and return-to-scale assumptions, producing a diverse but fragmented evidence base.

Although the literature has extensively compared Islamic and conventional bank efficiencies and developed many DEA specifications, important gaps remain. Relatively few studies explicitly link market structure (concentration/oligopoly) with DEA-based efficiency in a dual-banking context; most treat these topics separately rather than jointly. Indonesia, characterized by its dual banking system and recent structural changes (e.g., the consolidation of Islamic banks into

BSI), remains underexplored in studies that integrate concentration measures (such as CR4) with multi-year DEA analysis. Existing work often overlooks how ownership structure (state-owned vs. private vs. conventional-bank subsidiaries) and market power shape efficiency differentials between Islamic and conventional banks. There is also limited attention to dynamic or shock-related effects (e.g., regulatory reforms and the COVID-19 period) on efficiency trajectories in concentrated markets. Many prior studies rely on single-year cross-sections or omit aggregated multi-year efficiency measures that capture persistent performance differences across an oligopolistic market. Addressing these gaps, by combining CR-based market-structure analysis with input-oriented VRS/CRS DEA across multiple years and explicitly examining ownership and shock effects, would advance understanding of how oligopoly conditions shape the competitiveness and growth prospects of Islamic banks in Indonesia. This study addresses that gap by integrating SCP theory with DEA-based efficiency analysis to provide a more comprehensive understanding of the performance of Indonesia's Islamic and conventional banking sectors.

This study is guided by the following research questions:

1. How efficient are Islamic and conventional banks in Indonesia when evaluated using the Data Envelopment Analysis (DEA) approach?
2. In what ways does Indonesia's oligopolistic market structure influence banking performance within the dual banking system?
3. Are there significant differences in efficiency between Islamic and conventional banks during the study period?

This study makes two key contributions. Theoretically, it advances the literature by integrating market concentration analysis, measured through the concentration ratio (CR), with non-parametric efficiency measurement using Data Envelopment Analysis (DEA) within a dual banking context. While prior studies often examine market structure and banking efficiency separately, this research bridges the two domains, offering a more complete understanding of how Indonesia's oligopolistic banking structure shapes the relative efficiency of Islamic and conventional banks. Practically, the findings provide important policy insights for regulators such as OJK and Bank Indonesia, particularly in designing competition policies, restructuring strategies, and targeted interventions to strengthen the competitiveness and operational performance of Islamic banks. The results also inform bank managers on areas of inefficiency, guiding strategic decisions related to resource allocation, scaling, and productivity improvements

LITERATURE REVIEW

The relationship between market structure and banking performance has been widely examined in both conventional and Islamic finance literature. Early studies on market concentration suggest that higher concentration levels often lead to reduced competition and inefficiency, particularly in oligopolistic systems (Shepherd & Shepherd, 2003; Berger & Mester, 1997). Hadad et al. (2008) further demonstrated that concentration ratios are effective in characterizing competitive structures in the Indonesian banking industry, with important implications for policy formulation.

Structure–Conduct–Performance (SCP) Theory in Banking

The Structure–Conduct–Performance (SCP) paradigm, originally developed by Mason and Bain in 1951 (Pan, 2005), provides a foundational framework for understanding how market structure shapes firm conduct and ultimately affects performance. According to the SCP model, a market characterized by high concentration typically grants dominant firms greater market power, allowing them to exercise pricing discretion and limit competitive pressure. In the banking sector, SCP theory is frequently used to analyze how concentrated or oligopolistic markets influence

lending behavior, interest margins, risk-taking, and efficiency. Berger and Hannan (1998) argue that in highly concentrated markets, banks may operate under the "quiet life" hypothesis, enjoying market power that reduces incentives to operate efficiently. Conversely, the "efficient structure hypothesis". Firms become large because they are efficient, not that concentration causes superior performance.

Applying the SCP framework to Indonesia's banking context is particularly relevant given the industry's oligopolistic structure dominated by a small number of large state-owned and private conventional banks. The limited market share and structural disadvantages faced by Islamic banks imply that differences in efficiency may partly arise from the industry's structural configuration rather than only internal management capabilities.

There has been extensive empirical research comparing the performance of conventional and Islamic banks. The primary focus has been on analyzing differences in profitability and efficiency between these two types of financial institutions. Yudistira (2004), Hassan et al. (2009), Johnes et al. (2012), and Beck et al. (2013) found that Islamic banks are less efficient than conventional banks. Meanwhile, Olson and Zoubi (2008) found no significant difference between the two.

According to Berger and Mester (1997), efficiency for a bank or banking industry is important to realise healthy and sustainable financial performance. From a micro perspective, with the oligopoly structure of the financial sector, Islamic banks must be efficient in their operations to survive and thrive. Ineffective banks face the risk of being phased out of the market due to their inability to compete on price, product, and service quality. They struggle to retain customer loyalty and fail to attract new customers to expand their client base.

From a macroeconomic standpoint, the efficiency of the financial industry can significantly impact the costs of financial intermediation and the overall stability of the financial system. This is due to the very strategic role of the banking industry as an intermediary and producer of financial services. With a high level of efficiency, banking performance will be better in allocating financial resources and, in the end, can increase market share, investment activities, and economic growth (Weill, 2003).

It is essential to consider how alternative policies affect participants' incentives to produce efficiency when designing policies. An efficient financial institution, such as a bank, can be understood by its activities, which explain the relationship between its inputs and outputs. There are three types of these activities: the production or operational approach, the intermediation approach, and the asset approach.

The first two approaches apply the classical microeconomic theory of the firm. According to the production approach, bank activities are defined as the creation and delivery of financial services to depositors and borrowers. This approach views banking services as a form of production, wherein banks produce services for customers through financial intermediation. According to the intermediation approach, banks act as intermediaries between depositors and borrowers to convert surpluses (surplus spending units) into deficit spending units.

The third approach can be considered a combination of the first two. The modified classical theory of the firm integrates various aspects of the bank's operations, including risk management, information processing, and agency problems, into its framework. The role of financial intermediaries is explained by these specifics (Freixas & Rochet, 1998).

The assets approach is a sophisticated concept that acknowledges a bank's multifaceted role beyond that of a mere intermediary. However, this approach is not suitable for application in Islamic banking, which prioritizes financing the real sector. Instead, Islamic banking can be viewed as a general business unit under the production approach. Nonetheless, this approach perceives Islamic banking as an intermediary, which overlooks its fundamental essence. To truly capture the

essence of Islamic banking, careful consideration must be given to the selection of inputs and outputs. Sufian's (2006) selection of input and output variables closely aligns with the characteristics of Islamic banking, though some modifications may be necessary to ensure greater representativeness.

Efficiency in banking has been a very crucial issue in transition economies. Almost every country in transition has encountered at least one banking crisis, and a significant number of them have faced multiple crises (Jemric & Vujcic, 2002). Developing economies have also experienced banking crises in the past, making efficiency in banking an essential issue. No exception applies to Indonesia.

A number of studies have focused on banking efficiency, and most of them have employed parametric methods rather than non-parametric approaches such as Data Envelopment Analysis (DEA). These studies have predominantly centered on conventional banks, with limited attention given to Islamic banks. Chowdhury and Haron (2021) measured the efficiency of 31 Islamic banks in Southeast Asia during 2014–2019 using the DEA technique. The findings showed that Islamic banks in Indonesia had improved efficiency and productivity in recent years. Malaysia experienced continuous increases in efficiency, while Brunei showed significant progress. In contrast, both the Philippines and Thailand experienced decreases in efficiency and productivity over the past few years. Bitar et al. (2020) examined conventional and Islamic banks during 2018–2019, and their findings showed that higher capital and liquidity ratios increase the efficiency of both conventional and Islamic banks.

In a study examining the efficiency of Islamic banks in Indonesia and Malaysia from 2002 to 2004, Ascarya and Yumanita (2008) employed the intermediation and production approaches and revealed that Islamic banking in Indonesia exhibited greater efficiency than in Malaysia across three measurements: technical efficiency, scale efficiency, and overall efficiency. Another study by Hadad et al. (2008) measured bank efficiency in Indonesia between 1995 and 2003 using an asset approach to examine mergers and acquisitions. The results showed that the most efficient banks were those in the state-owned group, with an average efficiency score of over 90%. Meanwhile, Islamic banks had average efficiency scores ranging from 54% to 74%. Sufian (2007) assessed the efficiency of Islamic banks in Malaysia during the period of 2001–2004 using an intermediation approach. The findings indicated that foreign banks exhibited higher technical efficiency than their domestic counterparts. Yudistira (2004) compared the efficiency of 18 Islamic banks from various countries during the period of 1997–2000. The findings showed that bank size played an important role, as small to medium-sized Islamic banks experienced diseconomies of scale.

In the context of efficiency measurement, Data Envelopment Analysis (DEA) has become a widely adopted non-parametric method for assessing banking performance. Jemric and Vujcic (2002) applied DEA in the Croatian banking sector, while Weill (2003) investigated efficiency in transition economies, both highlighting the method's suitability for banking efficiency studies. DEA-based approaches allow comparisons of operational, intermediation, and asset-oriented models, which have been adapted in subsequent research to evaluate banks' relative efficiency under different contexts (Coelli et al., 2005; Johnes et al., 2014).

Comparative studies between Islamic and conventional banks have revealed mixed evidence. Yudistira (2004) and Johnes et al. (2012) found Islamic banks to be less efficient, particularly in small to medium-sized institutions, due to diseconomies of scale. Conversely, Olson and Zoubi (2008) reported no significant difference between Islamic and conventional banks in the GCC region, while Ascarya and Yumanita (2008) found Indonesian Islamic banks to perform better than their Malaysian counterparts in certain efficiency dimensions. More recent works, such as Bitar et al. (2020) and Chowdhury and Haron (2021), highlighted the role of capital adequacy, liquidity, and institutional frameworks in shaping efficiency outcomes for Islamic banks.

Despite this growing body of literature, there remains limited empirical work that integrates market concentration analysis with efficiency measurement in a dual banking context such as Indonesia. Most studies focus on either efficiency comparisons or market structure in isolation, without linking the two dimensions. This research addresses that gap by analyzing how oligopolistic market structures influence the relative efficiency of Islamic and conventional banks in Indonesia. By doing so, it contributes to a more nuanced understanding of the dynamics within dual banking systems and provides insights relevant for both scholars and policymakers

Based on the synthesized literature and theoretical foundations, the following hypotheses are proposed:

H1: Conventional banks exhibit higher technical efficiency than Islamic banks.
Grounded in prior findings (Yudistira, 2004; Hassan et al., 2009; Johnes et al., 2012), conventional banks often benefit from larger scale, more mature operational systems, and broader market reach, suggesting higher technical efficiency compared to Islamic banks.

H2: Higher market concentration is negatively associated with banking efficiency. Drawing on the Structure–Conduct–Performance (SCP) theory and the "quiet life" hypothesis (Berger & Hannan, 1998), banks operating in more concentrated or oligopolistic markets may face reduced competitive pressure, leading to lower efficiency levels.

RESEARCH METHOD

This study employs a quantitative, explanatory research design examining how market structure influences bank efficiency in Indonesia using a comparative efficiency analysis of Islamic and conventional banks in Indonesia. The approach integrates:

1. Market structure assessment through the Concentration Ratio (CR).
2. Bank efficiency measurement using Data Envelopment Analysis (DEA).
3. Statistical inference through a paired sample t-test.

The design is grounded in the Structure–Conduct–Performance (SCP) theory, which link. market structure to firm performance, and production economics, which supports DEA. modeling. The Concentration Ratio (CR) is used because it provides a clear, widely recognized measure of market dominance and oligopoly power, aligns with SCP theory, and allows direct analysis of how market structure influences banking efficiency. According to Hadad et al. (2008), concentration ratios can explain the structural characteristics of the market, which can then be used as a reference for making industry-related public policies related to market structure. The concentration index can be used to see market structure, competition, and its impact on an industry. Concentration ratios can also be used in structural models that explain competitive performance in the banking industry because of market structure and explain the impact of the entry of new banks or banks resulting from mergers and acquisitions in the banking industry.

The measurement of the concentration ratio is theoretically based on the market share held by a certain number of firms within the same industry. Typically, the concentration ratio assesses the market share of the top four banks, often referred to as CR4. The formula for measuring the concentration ratio is as follows:

$$\text{CRk} = \sum_{i=1}^{k} Si$$

CRk = k bank concentration ratio
Si = percentage market share of the fourth firm

Table 3. Interpretation of Concentration Scores

Score (%)	Level of Concentration	Market Structure
0	No Concentration	Perfect competition
1-50	Low concentration	Monopolistic competition
51-80	Medium concentration	Monopolistic competition/oligopoly
81-100	High concentration	Oligopoly/monopoly

Source: Shepherd and Shepherd (2003)

To measure efficiency, the non-parametric Data Envelope analysis (DEA) method will be used. Data envelope analysis (DEA) has been popular in banking studies since 1985. The DEA was originally introduced by Charnes, Cooper, and Rhodes in 1978. Since then, numerous banking-related applications have been developed and utilized. Unlike regression analysis, DEA does not require prior assumptions about the production function's form, which means it imposes minimal structure on the efficient frontier's shape. This approach uses only observed data to construct the best practice production function, eliminating the risk of technology misspecification. However, DEA's frontier is sensitive to extreme observations and measurement errors, as it assumes no random errors exist, and deviations from the frontier indicate inefficiency.

DEA measures the relative efficiency of production frontiers based on multiple inputs and outputs of decision-making units in a non-parametric and stochastic manner. The non-parametric nature of Data Envelopment Analysis (DEA) means that the production function does not need to be assumed; instead, the DEA approach will generate it based on observed data. Hence, the misspecification can be minimal. Different kinds of inputs and outputs can be analysed using DEA without assigning initial weights. Furthermore, the achieved efficiency is a relative measure based on empirical observations. It is also possible to incorporate the decision-maker's preferences into the model.

DEA analyses productive or decision-making units' relative efficiency and management performance (DMUs). By identifying efficient banks as benchmarks and comparing their input combinations (slack variables) to the benchmark, the DEA allows us to compare banks' relative efficiency (Jemric & Vujcic, 2002). Based on the available data, the DEA identifies the reference points (relatively efficient DMUs), defines the efficient frontier as the optimal production technology, and then evaluates the inefficiencies of other interior points (Jemric & Vujcic, 2002). Inefficient DMUs will lie below the efficient frontier. Besides producing efficiency values for each DMU, DEA also determines DMUs that are used as references for other inefficient DMUs.

$$Efficiency\ of\ DMU0 = \frac{\sum_{k1}^{p} \alpha_k y_{k0}}{\sum_{i1}^{m} v_i x_{i0}}$$

Where:

DMU	: Decision-making unit	n	: number of DMU evaluated
m	: different inputs	Xij	: number of inputs I consumed by DMUj
p	: different outputs	ykj	: number of output k produced by DMUj

There are two most commonly used DEA models, the CCR model (Charnes, Cooper, and Rhodes, 1978) and the BCC model (Banker, Charnes, and Cooper, 1984); both treat returns to scale differently. The CCR assumes each DMU operates with constant returns to scale (CRS), while the BBC assumes each DMU can operate with variable returns to scale (VRS).

Each CRS model produces an efficiency score that does not exceed that of the VRS model for any given DMU. This occurs because the VRS model compares each DMU with a subset of DMUs

operating within the same region of returns to scale, rather than comparing them globally (Jemric & Vujcic, 2002). The characteristics of a DMU, such as a bank, may be similar to those of other banks; however, each bank differs in terms of size and production level. This highlights the importance of size when measuring relative efficiency. Unlike the VRS model, the CRS model represents pure technical efficiency. Relative scale efficiency is therefore defined as the ratio between the CRS model and the VRS model.

$$S_{k=}{}^{q_{k,CRS}}/_{q_{k,VRS}}$$

If the value of S = 1, the DMU operates at the best relative scale efficiency or at its optimal size. If the value of S is less than 1, it indicates that scale inefficiency still exists (equal to 1 − S) for the DMU. Consequently, when a DMU is efficient under the VRS model but inefficient under the CRS model, it indicates that the DMU experiences scale inefficiency.

OE = TE x SE, hence SE = OE/TE

OE: overall efficiency of CRS Model; TE: technical efficiency of VRS Model.

According to Johnes et al. (2014), the CRS efficiency result provides a measure of overall efficiency, while the VRS efficiency measures pure technical efficiency (having factored out scale inefficiencies). It is widely believed that the use of CRS is typically associated with companies operating at an optimal scale (Coelli et al., 2005). In numerous industries, such as the banking sector, imperfect competition or government regulations may lead to departures from an optimal scale (Beccalli et al., 2006; Coelli et al., 2005; Shawtari et al., 2018). The VRS (Variable Returns to Scale) assumption is often deemed more suitable for assessing efficiency in the context of the banking sector (McAllister & McManus, 1993; Wheelock & Wilson, 2012), particularly appropriate for the Indonesian banking industry due to its highly heterogeneous and oligopolistic market structure. Indonesia's banking sector is dominated by a small number of large conventional banks, while Islamic banks, many of which are relatively small and still developing, operate with markedly different scales, resource endowments, and market reach. Such disparities in size and market power imply that banks do not operate at an optimal or similar scale, making the assumption of constant returns to scale unrealistic. In an oligopolistic environment where a few large banks influence market conditions, smaller banks, especially Islamic banks, often face scale inefficiencies, limited branch networks, and constrained access to capital. The VRS specification, therefore allows the DEA model to account for these scale differences and isolate pure technical efficiency from scale efficiency, making it a more accurate and contextually appropriate approach for evaluating bank performance in Indonesia. For this reason, the VRS assumption is used in the current research.

When measuring bank efficiency, input-oriented DEA models are most commonly used (Nigmonov, 2010; Titko & Jureviciene, 2014; Zijiang, 2009; Zreika, 2011). This could be because bank managers have less control over outputs than over inputs (Pasiouras, 2008). Therefore, an input-oriented DEA is used in this research. As the core activity of the banking business, this research also applies the production and intermediation approach adapted from Sufian (2007) and Ascarya and Yumanita (2008).

The production approach depicts banking as a producer of savings accounts and credit loans. In this approach, output is defined as the total number of accounts, while inputs consist of labour costs, capital expenditures on fixed assets, and other materials (Ascarya & Yumanita, 2008). Meanwhile, the intermediation approach describes banking activities as those of intermediary institutions that transform funds from depositors (surplus spending units) to borrowers (deficit spending units).

In addition to the DEA, a paired sample t-test was employed to examine whether the mean efficiency scores of Islamic and conventional banks differ significantly. Because each year provides matched efficiency observations for both banking types, the paired t-test is appropriate for comparing the two related samples. This test determines whether observed differences in average technical efficiency are due to systematic structural factors or simply random variation.

Data Description

The study uses purposive sampling by selecting all Indonesian Islamic and conventional. Inclusion criteria:

1. Availability of audited annual financial statements
2. Consistent reporting of required DEA input–output variables
3. Classification as a full-fledged commercial bank

Based on these criteria, a total of 51 conventional banks and 14 Islamic commercial banks until 2020, and 12 Islamic commercial banks in 2021, due to the merger of three Islamic commercial banks becoming Indonesian Islamic banks (BSI).

The data were sourced from the financial statements of both Islamic and conventional banks in Indonesia, covering the period from 2015 to 2021. The dataset used in this study consists of a sample of conventional banks.

The sampled conventional banks include Bank Mandiri, BRI, BCA, BNI, CIMB Niaga, BTN, Bank Bukopin, Bank Bumi Artha, Bank Danamon, Bank Ganesha, Bank HSBC, Bank ICBC, Bank Index Selindo, Bank J Trust, Bank Kalteng, Bank KEB Hana Indonesia, Bank Maspion, Bank Mayapada, Bank Maybank, Bank Mega, Bank Mestika Dharma, Bank MNC, Bank OCBC NISP, Bank Permata, Bank QNB Indonesia, Bank SBI Indonesia, Bank Shinhan Indonesia, Bank Sinarmas, Bank UOB Indonesia, Bank Woori Saudara Indonesia, Bank Pan Indonesia, Citibank, Bank of America, BPD DKI Jakarta, BPD Maluku and Maluku Utara, BPD Riau and Kepulauan Riau, BPD Sulawesi Utara Gorontalo, BPD Daerah Istimewa Yogyakarta, BPD Bali, BPD Jawa Barat dan Banten, BPD Jawa Tengah, BPD Jawa Timur, BPD Kalimantan Barat, BPD Papua, BPD Sumatera Barat (Bank Nagari), BPD Sumatera Utara, Bank Amar Indonesia, Bank Bisnis Internasional, Bank Ina, Bank Mayora, Bank BTPN, Bank Aceh, and Bank NTB.

Islamic bank: Bank Aceh Syariah, BNI Syariah, Bank Mandiri Syariah, BRI Syariah, Bank Mega Syariah, Bank Muamalat, BTPN Syariah, BCA Syariah, BJB Syariah, Bank Panin Dubai Syariah, Bank Bukopin Syariah, Bank Victoria Syariah, Bank Aladin Syariah.

In measuring banks' efficiency, different authors use different DEA model specifications. A variety of input-output combinations determines the diversity of applied models. Measurement results can be substantially distorted by improper variable selection. Therefore, this research involved a little adaptation of the variables related to the operational inputs of conventional and Islamic banks. A variable's output is the result of a variable's production. The selection of inputs and outputs was guided by prior literature (Sufian, 2007; Ascarya & Yumanita, 2008; Johnes et al., 2014). Inputs included (i) deposits, (ii) labor costs, and (iii) fixed assets. Outputs included (i) financing (loans and Islamic financing contracts) and (ii) operating income. This specification reflects both the production and intermediation roles of banks, while also accommodating the characteristics of Islamic banking (see Table 4).

Table 4. Variables of DEA Analysis

Variables input

Variables	Information	Definition	Source	Previous studies
X1	Deposit Amount	Total funding: Wadiah savings, current accounts, and time deposits	Balance sheet	Bitar et al. (2020); Barth et al. (2013); Johnes et al. (2014); Yudistira (2004)
X2	Labour costs	Employee salaries and benefits	Income statement	Barth et al. (2013); Ascarya and Yumanita (2008); Jemric and Vujcic (2002)
X3	Fixed assets	Land, buildings, and vehicles	Balance sheet	Bitar et al. (2020); Johnes et al. (2014); Sufian (2007); Ascarya and Yumanita (2008); Yudistira (2004)

Variables Output

Variables	Information	Definition	Source	Previous studies
Y1	Financing	Total financing: Mudharabah, Musyarakah, Ijarah, IMBT, and Qardh Receivables financing	Balance sheet	Bitar et al. (2020); Barth et al. (2013); Johnes et al. (2014); Jemric and Vujcic (2002)
Y2	Operating income	revenue sharing, trading, and bonus income	Income statement	Bitar et al. (2020); Barth et al. (2013); Nigmonov (2010)

Source: Author Compilation

Secondary data are appropriate for DEA-based efficiency research because DEA requires objective, standardized input–output variables that are reliably available in audited financial statements and regulatory filings, ensuring accuracy, consistency, and comparability across banks and years.

FINDINGS AND DISCUSSION

Based on the measurement of the concentration ratio, the Indonesian banking industry's structure appears to be an oligopoly with a concentration ratio score of 52. In an oligopoly market, competition is not evenly distributed, and new players may face significant challenges entering the market or competing with larger banks. This oligopoly character has particular implications for the growth of Islamic banks, which are not currently included in CR4 and therefore face even greater obstacles to development.

The detailed data processing results by the DEA on efficiency performance of conventional and Islamic banks can be observed in Table 5. The efficiency of Islamic banks and conventional banks is often evaluated using various metrics when applying the data envelopment analysis (DEA)

method. The integration of Islamic and Conventional banks aims to establish a unified framework for measuring their performance in a comparable manner. First, all banks are evaluated based on their performance over a single year, spanning from 2015 to 2021". In addition, the aggregate efficiency of all banks across multiple years is computed to provide an overall measure of efficiency. The table 5 presents sample statistics detailing the efficiency scores of Islamic and Conventional banks for the years 2015 to 2021.

Table 5. Summary Statistics of Efficiency Measures

Efficiency measures	**Mean**	**Minimum**	**Maximum**	**Std Dev**
2015				
Islamic banks				
Overall Efficiency	0.79	0.54	1	0.16
Technical Efficiency	0.87	0.69	1	0.13
Scale Efficiency	0.91	0.74	1	0.10
Conventional banks				
Overall Efficiency	0.72	0.48	1	0.13
Technical Efficiency	0.86	0.54	1	0.13
Scale Efficiency	0.84	0.57	1	0.11
2016				
Islamic banks				
Overall Efficiency	0.77	0.55	1	0.13
Technical Efficiency	0.85	0.72	1	0.10
Scale Efficiency	0.90	0.72	1	0.11
Conventional banks				
Overall Efficiency	0.76	0.46	1	0.13
Technical Efficiency	0.87	0.52	1	0.13
Scale Efficiency	0.89	0.66	1	0.11
2017				
Islamic banks				
Overall Efficiency	0.75	0.57	1	0.17
Technical Efficiency	0.82	0.57	1	0.15
Scale Efficiency	0.92	0.67	1	0.10
Conventional banks				
Overall Efficiency	0.71	0.53	1	0.13
Technical Efficiency	0.84	0.56	1	0.15
Scale Efficiency	0.86	0.57	1	0.13
2018				
Islamic banks				
Overall Efficiency	0.74	0.48	1	0.19
Technical Efficiency	0.81	0.54	1	0.17
Scale Efficiency	0.92	0.59	1	0.13

Efficiency measures	Mean	Minimum	Maximum	Std Dev
Conventional banks				
Overall Efficiency	0.73	0.54	1	0.15
Technical Efficiency	0.85	0.57	1	0.15
Scale Efficiency	0.87	0.60	1	0.13
2019				
Islamic banks				
Overall Efficiency	0.71	0.45	1	0.19
Technical Efficiency	0.76	0.46	1	0.19
Scale Efficiency	0.94	0.68	1	0.09
Conventional banks				
Overall Efficiency	0.71	0.41	1	0.16
Technical Efficiency	0.78	0.46	1	0.17
Scale Efficiency	0.92	0.59	1	0.10
2020				
Islamic banks				
Overall Efficiency	0.84	0.42	1	0.19
Technical Efficiency	0.87	0.43	1	0.18
Scale Efficiency	0.97	0.78	1	0.06
Conventional banks				
Overall Efficiency	0.70	0.44	1	0.16
Technical Efficiency	0.81	0.46	1	0.16
Scale Efficiency	0.88	0.54	1	0.14
2021				
Islamic banks				
Overall Efficiency	0.77	0.13	1	0.29
Technical Efficiency	0.89	0.33	1	0.21
Scale Efficiency	0.87	0.13	1	0.25
Conventional banks				
Overall Efficiency	0.66	0.38	1	0.16
Technical Efficiency	0.77	0.43	1	0.18
Scale Efficiency	0.87	0.53	1	0.13

In terms of overall efficiency, Islamic banks were more efficient than conventional banks during the observation period 2015-2021. Meanwhile, from a technical efficiency viewpoint, conventional banks were more efficient for most of the observation years, namely 2016, 2017, 2018, and 2019. Meanwhile, from a scale efficiency viewpoint, Islamic banks were more efficient for most of the observed period.

Because this research uses the VRS approach and is input-oriented, where VRS represents technical efficiency, it can be concluded that conventional banks were more efficient than Islamic banks in terms of efficiency. Furthermore, after determining each bank's efficiency using the DEA approach, a different test is carried out using the paired t-test approach for technical efficiency to

determine whether there is a significant difference in efficiency between Islamic banks and conventional banks. The paired t-test is a parametric test that can be used on two paired data. The objective of this test is to determine whether there is a significant average difference between two related or paired samples.

Table 6. Paired t test

Statistic	Islamic Banks	Conventional Banks
Mean Technical Efficiency (M)	0.84	0.82
Standard Deviation (SD)	0.07	0.08
Number of Paired Observations (n)	7	7

t-value = 0.59
Degrees of Freedom (df) = 6
p-value = 0.5748
95% Confidence Interval = −0.07 to 0.11
Significance (α = 0.05) = Not Significant

This study hypothesized that there is a significant difference in technical efficiency between Islamic and conventional banks in Indonesia (H1). The paired sample t-test was conducted to compare the technical efficiency scores of Islamic and conventional banks from 2015 to 2021. Results indicate that the mean technical efficiency of Islamic banks (M = 0.84, SD = 0.07) was slightly higher than that of conventional banks (M = 0.82, SD = 0.08). However, this difference was not statistically significant, $t(6) = 0.59$, $p = 0.5748$, 95% CI [−0.07, 0.11]. Therefore, H1 is not supported by the empirical findings. This indicates that Islamic and conventional banks exhibited comparable levels of technical efficiency over the 2015–2021 period.

The study also proposed that market concentration and scale differences would generate observable efficiency advantages for conventional banks (H2). Since the statistical results do not demonstrate a significant efficiency gap, H2 is also not supported. Instead, the findings suggest that despite operating within an oligopolistic market structure, Islamic banks have achieved efficiency performance that is broadly similar to that of conventional banks. These results partially challenge the assumption that structural market dominance automatically translates into superior operational efficiency and imply that regulatory frameworks and internal management practices may play a more critical role than market concentration alone.

Most Islamic banks are subsidiaries of a large conventional bank, so the policy of developing an Islamic bank is also determined by its parent, which is also a conventional bank. The performance and products are relatively the same; the parent bank does not see any urgency in developing its Islamic business unit because it can also provide similar services, with better credit quality, due to its economies of scale, which makes the parent bank's position more favourable.

CONCLUSIONS

This study examined the Indonesian banking industry's market structure and its implications for efficiency performance, with a comparative focus on Islamic and conventional banks. The DEA results for 2015–2021 provide a detailed efficiency profile for both banking systems. Islamic banks demonstrated higher scale efficiency, indicating that their smaller size, leaner cost structures, and focused operations allow them to operate closer to their most productive scale. Conventional banks, however, exhibited higher technical efficiency under the VRS input-oriented model for most of the observation years, namely 2016, 2017, 2018, and 2019, suggesting their capability to transform inputs (deposits, labour, and fixed assets) into outputs

(financing and operating income), consistent with the intermediation approach. These findings show that the efficiency landscape is multidimensional: Islamic banks excel in scale utilization, while conventional banks lead in technical performance.

The Indonesian banking industry is characterized by a medium-to-high concentration ratio (CR ≈ 52), indicating an oligopolistic structure dominated by large state-owned and private conventional banks. The efficiency results show patterns consistent with the efficient-structure hypothesis: dominant conventional banks achieve higher technical efficiency due to superior technology, management systems, and operational experience. At the same time, the presence of high scale efficiency among Islamic banks indicates that oligopoly does not uniformly suppress performance among smaller banks. Thus, the findings showing that oligopoly shapes efficiency asymmetrically, providing operational advantages to large conventional banks while allowing Islamic banks to benefit from scale optimization.

The paired-sample t-test comparing annual mean technical efficiency scores revealed no statistically significant difference between Islamic and conventional banks (p = 0.5748). The findings confirm that the industry is characterized by an oligopolistic structure dominated by large state-owned and private conventional banks. Within this structure, conventional banks consistently demonstrated higher technical efficiency, whereas Islamic banks achieved relatively better performance in scale efficiency. However, the efficiency differences between the two systems were statistically insignificant, suggesting convergence in operational performance despite structural asymmetries.

Theoretically, this study contributes to the banking and Islamic finance literature by combining market concentration analysis with non-parametric efficiency measurement, thereby offering deeper insights into how oligopolistic structures influence dual banking systems. From a practical perspective, the results highlight that Islamic banks face unique challenges in improving efficiency due to their limited market share and their dependence on parent conventional banks.

The implications are threefold. First, regulators such as the Financial Services Authority (OJK) and Bank Indonesia should develop supportive policies that encourage fair competition, including incentives for efficiency improvements in Islamic banks. Second, Islamic banks need to strengthen their operational capacity, technology adoption, and human resource development to enhance competitiveness. Third, policymakers should recognize the strategic role of Islamic banking in financial inclusion and design initiatives that expand its outreach within Indonesia's dual banking landscape.

LIMITATION & FURTHER RESEARCH

This study has several limitations that should be acknowledged. First, the sample is restricted to Islamic and conventional banks operating in Indonesia during the period 2015–2021. As such, the findings may not be fully generalizable to other countries with different regulatory frameworks, market structures, or levels of Islamic banking development. Secondly, the analysis does not explicitly account for macroeconomic shocks, regulatory reforms, or the impact of the COVID-19 pandemic, all of which may have affected banking efficiency during the study period.

Future research could extend this study by incorporating cross-country comparisons within Southeast Asia, testing alternative efficiency models, or examining the impact of regulatory changes such as mergers and digital transformation on banking performance. Such extensions would enrich the understanding of how Islamic and conventional banks interact within increasingly complex financial systems.

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