

**EFFICIENCY ANALYSIS OF ISLAMIC BANKING IN
YEAR 2018 - 2023 USING STOCHASTIC FRONTIER ANALYSIS**

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ABSTRACT

This study aims to analyze the efficiency of 12 Islamic commercial banks and the market competition of Islamic commercial banks in Indonesia during 2018 to 2023. The data used is secondary data per quarter taken from each bank's website and from OJK. The method used in this study is Stochastic Frontier Analysis (SFA) with input variables, namely operating costs, labor costs, fixed assets, total assets, and third party funds, while the output variable is the total financing of Islamic commercial banks and the Panzar-Rosse method to measure the level of competition in the banking industry. The test results show the highest efficiency value for Category 2 Commercial Bank category by Muamalat Indonesia Bank with a score of 93,67%. The highest efficiency value for Islamic commercial banks in the Bank Group 3 category is Sharia Indonesia Bank with a score of 95,04%. In addition, the lowest efficient value for Category 1 Commercial Bank Islamic commercial banks is Aladin Sharia Bank with a score of 53,66%, and the lowest efficiency value for Bank Group 1 Islamic commercial banks is Aladin Sharia Bank with a score of 82,03%. Islamic commercial banks simultaneously in Category 1 Commercial Bank to Category 3 Commercial Bank and Bank Group 1 to Bank Group 3 show market competition classified as monopolistic competition and the market is not concentrated.

ABSTRAK

Penelitian ini bertujuan untuk menganalisis efisiensi 12 bank umum syariah dan daya saing pasar bank komersial syariah di Indonesia selama tahun 2018 hingga 2023. Data yang digunakan adalah data sekunder per kuartal yang diambil dari website masing-masing bank dan dari OJK. Metode yang digunakan dalam penelitian ini adalah *Stochastic Frontier Analysis* (SFA) dengan variabel input, yaitu biaya operasional, biaya tenaga kerja, aset tetap, total aset, dan dana pihak ketiga, sedangkan variabel output adalah total pembiayaan bank komersial syariah dan metode Panzar-Rosse untuk mengukur tingkat daya saing di industri perbankan. Hasil pengujian menunjukkan nilai efisiensi tertinggi untuk kategori BUKU 2 oleh Bank Muamalat Indonesia dengan skor 93,67%. Nilai efisiensi tertinggi untuk bank umum syariah dalam kategori KBMI 3 adalah Bank Syariah Indonesia dengan skor 95,04%. Selain itu, nilai efisiensi terendah untuk bank umum syariah BUKU 1 adalah Bank Aladin Syariah dengan skor 53,66%, dan nilai efisiensi terendah untuk bank komersial syariah KBMI 1 adalah Bank Aladin Syariah dengan skor 82,03%. Bank komersial syariah secara bersamaan di BUKU 1 hingga BUKU 3 dan KBMI 1 hingga KBMI 3 menunjukkan persaingan pasar yang diklasifikasikan sebagai persaingan monopolistik dan pasar tidak terkonsentrasi.

INTRODUCTION

Banks are financial institutions that play a very important role in a country's economy, where the banking industry is one of the needs for citizens who have many needs for financial services, both in the form of deposits, channeling funds and providing other services. Islamic banks as financial institutions whose main business is to provide financing and other services in payment and circulation of money that are adjusted using Islamic sharia principles. The increasing growth of Islamic banking has resulted in competition between Islamic banks which can lead to feuds in the community.

The development of the Islamic banking industry from the past until now continues to share good growth in terms of total assets as well as total Islamic bank financing. The development of Islamic banking itself can be observed from the increase in total assets and total financing. The bank's ability to produce maximum *output* with available *inputs* is a measure of expected performance. By identifying the allocation of *outputs* and *inputs*, banking performance can be further analyzed to see banking inefficiency.

Efficiency is one of the performance parameters that theoretically underlies the entire performance of a company. Efficient banks are expected to get optimal profits, more funds, and better quality services to the community. Efficiency is very important for Islamic banking, given the increasing competition, both among Islamic banks themselves, and with conventional banking. According to Berger (1993), to measure efficiency in the banking industry, there are two approaches that are generally used, namely the *traditional approach* and the *frontier approach*. The traditional approach is an approach that compares the existing financial ratios of banks and is a partial approach, while the *frontier approach* is an approach that uses a combination of assets (*input-output*) in a certain standard.

Banks play a crucial role in modern society, which is constantly evolving and changing (Sari et al. 2022). Considering the development and performance of banks in Indonesia, as well as their impact on the financial industry, the Financial Services Authority (OJK) has finally changed the bank classification, originally called Commercial Bank Business Activities to Bank Grouping based on Core Capital. This classification is essentially the same: it applies to all regular commercial banks, commercial banks operating under Sharia principles, and overseas bank branches. The difference is that the core capital requirements for Commercial Bank Business Activities banks are lower. Commercial Bank Business Activities was a classification established before the pandemic, but current conditions require an update. The rapid development of digital technology, coupled with the development of the financial industry, requires the OJK, as the regulator, to create new policies that are more compatible with the current situation.

Essentially, Commercial Bank Business Activities and Bank Grouping based on Core Capital contain regulations concerning both conventional and Sharia banking business activities. These include regulations on bank establishment, business process regulations, office networks, digital services, and the establishment of digital banks (OJK Regulation 12/2021). It even regulates how to terminate a banking business. However, the Bank Grouping based on Core Capital (Indonesian Financial Accounting Standard) is more modern to meet the demands of the times and current global conditions. Digital developments require various digital financial activities to actively improve themselves. Consumers want faster and easier service through digital services. Improved digital services are urgently needed and even prioritized. This is seen as an effort to increase healthy competitiveness among banks. Consumers will choose banks with fast, secure, and adequate service, so each bank will strive to provide the best digital services for consumers.

Efficiency measurement can be done with the *Stochastic Frontier Analysis* (SFA) method. According to Coelli et al. (2005), the SFA method has advantages over other methods, namely: *First*, it involves *disturbance terms* that represent disturbances, measurement errors, and exogenous surprises that are out of control. *Second*, environmental variables are easier to treat, allowing hypothesis testing using

statistics, and easier to identify *outliers*. The author presents the effect or impact of bank grouping based on core capital, both based on Commercial Bank Business Activities and Bank Grouping based on Core Capital provisions on the efficiency of Islamic commercial banks, as well as whether the Bank Grouping based on Core Capital policy is better in supporting bank efficiency performance when compared to the Commercial Bank Business Activities bank policy. In addition, to see whether there is a difference in the value of efficiency between Islamic banks in the Commercial Bank Business Activities and Bank Grouping based on Core Capital categories and to analyze the influence of the variables of total fixed assets, total third party funds, and operating costs on total financing in Islamic banks for the period 2018-2023. This study aims to analyze the efficiency of 12 Islamic commercial banks in Indonesia during 2018 to 2023 using the *Stochastic Frontier Analysis* (SFA) method and analyze the market competition of Islamic commercial banks in Indonesia.

LITERATURE REVIEW & HYPOTHESIS DEVELOPMENT

Efficiency can be defined as the utilization of resources to maximize output; therefore, efficiency is a key measure of banking performance. If a bank cannot increase its output without increasing its inputs or cannot produce the same output with fewer inputs, then the bank is considered inefficient (Usman *et al.*, 2010). Banking efficiency is defined as a bank's ability to optimize resources (inputs) to produce maximum output to achieve organizational goals (such as profitability or asset growth). In the tightly regulated banking industry, efficiency is not only about cost savings but also about risk management and resilience to economic fluctuations (Astiyah, 2009).

In banking studies, the main theory underlying efficiency is not simply a comparison of inputs and outputs, but is rooted in several microeconomic and strategic management theories. (1) Production Theory (Theory of the Firm) is the most basic foundation. Banks are viewed as production units that transform inputs (capital, labor, customer deposits) into outputs (credit, investment, financial services). Efficiency is measured by the bank's position on the optimal point on the production frontier. If the bank is below the curve, then technical inefficiency occurs. (2) X-Efficiency Theory, introduced by Leibenstein (1966). This theory states that inefficiency is not only caused by the wrong allocation of resources, but more due to internal managerial factors. In banking, X-efficiency describes the failure of management to minimize costs or maximize profits due to a lack of motivation, weak supervision, or an uncompetitive organizational culture. (3) Financial Intermediation Theory, where the bank acts as an intermediary between parties with excess funds (surplus units) and those in need of funds (deficit units). An efficient bank is a bank that is able to reduce transaction costs and overcome information asymmetry as much as possible in the process of distributing funds.

Banking efficiency has attracted many researchers with various approaches. Among them are Astiyah and Husman (2006) who examined the efficiency level of 20 banks with the largest assets in Indonesia using the *stochastic frontier* analysis method. Their results showed that banks from the foreign bank group tended to be more efficient. The same thing also happened to the Regional Development Bank (BPD) group. Another finding from their study is that some banks that calculate efficiency based on the intermediation emphasis model show high profits but are inefficient. This suggests that these banks have not performed their intermediation function well. As a result, they do not optimally contribute to broader economic growth.

Another finding regarding banking efficiency in Indonesia was reported by Faruk *et al.* (2017) who used the DEA method. They revealed that banks performed poorly in the period 2009-2015, and managers were incompetent to use their input resources effectively even though they had achieved fairly optimal operations previously. In other words, banks in Indonesia operated inefficiently in that period. From the various findings of the study of bank efficiency in Indonesia in various observation periods, it can be concluded that banks in Indonesia are still not operating efficiently. Therefore, further research is needed

on the factors that can cause bank efficiency. Studies on the factors that cause bank efficiency have been conducted before, but the results show the inconsistency of variables (Salem & Rahman, 2016).

Muharam (2007) explains that efficiency measurement can be done through three approaches, namely: (1) The Ratio Approach is done by calculating the ratio of output and input used. High efficiency is considered to be able to produce maximum output with minimum input. This approach has a weakness, namely if many inputs and outputs are calculated, it will produce uncertain assumptions. (2) The Regression Approach, efficiency is measured using a model of a certain output level as a function of various inputs. This will produce an estimated relationship that can be used to produce a certain output level at a certain input level. A bank can be said to be efficient if it produces output greater than the estimated output. The weakness of this approach is its inability to accommodate multiple outputs, because the regression equation can only accommodate one output indicator, so that if many outputs are combined in one indicator, the resulting information becomes no longer detailed. (3) The parametric limit approach can be measured using the Stochastic Frontier Analysis (SFA) and Distribution Free Analysis (DFA) methods. The non-parametric limit approach is measured using the Data Envelopment Analysis (DEA) method.

Research on the efficiency of financial institutions, both Islamic and conventional, has been conducted by several groups. Apriyana et al. (2015) examined the factors affecting the cost efficiency of banks in the ASEAN-5 region, which includes Indonesia, Singapore, Malaysia, the Philippines, and Thailand. Efficiency measurement using the SFA method on 23 commercial banks during the period 2005-2012 showed a significant relationship between cost efficiency and the characteristics of each bank, namely *Return on Equity* (ROE). In addition, external shocks in the form of the global crisis in 2008 were found to affect the increase in bank costs. Based on the time-varying *decay* method, it was concluded that there was an increase in cost efficiency during the observation period. The study also shows that commercial banks in Indonesia as a whole have not been operating efficiently.

The Rose-Panzar method is one approach to measuring the level of competition in the banking industry. Here, researchers use this technique to obtain a quantitative measure (H-stat) that can be used to determine the banking market structure in the research area. Banking requires three inputs in the production process: labor, physical capital, and financial capital. The log-normal function of the diminishing returns model is used to calculate the Panzar-Rose H statistic as a measure of the level of competition in the banking industry. The initial measurement uses general market equilibrium. There are three main hypotheses of the Panzar-Rose model based on the H-statistic value, namely: (1) Monopoly or Cartel Hypothesis ($H \leq 0$). If the H-statistic value is zero or negative, then the market structure is classified as a perfect monopoly or cartel. In a monopoly condition, an increase in input costs (marginal costs) will cause the company to raise prices and reduce the amount of output. This results in a decrease in total revenue for the company. (2) Monopolistic Competition Hypothesis ($0 < H < 1$). If the H-statistic value is between 0 and 1, then the market structure is monopolistic competition. This is the most common condition found in the banking industry (including the findings in the draft you cited earlier). Here, an increase in input prices causes an increase in total revenue, but this increase in revenue is not as large as the increase in costs. The company has little market power to determine prices but still competes with many other companies. (3) Perfect Competition Hypothesis ($H = 1$). If the H-statistic is equal to 1, the market is classified as Perfect Competition. In a perfectly competitive market, an increase in input prices will be followed by an increase in total revenue in the same proportion. This occurs because firms are price takers, and to survive, they must fully adjust selling prices to reflect increases in marginal costs to maintain long-run equilibrium.

This quantitative research uses parametric efficiency analysis (SFA) and panel data regression analysis. The hypotheses and supporting previous research are as follows:

- H1: Operational costs have a positive effect on total costs
- H2: Labor costs have a positive effect on total costs
- H3: Fixed assets have a positive effect on total costs
- H4: Bank Operating Cost Proxy (w1) has a positive effect on total costs
- H5: Labor Cost Proxy (w2) has a positive effect on total costs
- H6: Fixed Asset Cost Proxy (w3) has a positive effect on total costs

RESEARCH METHODS

The sampling technique is carried out by *purposive sampling*, which is a method of selecting samples selected based on *judgment (judgment sampling)*, which means non-random sample selection whose information is obtained with certain considerations (Sugiono, 2005). The sample used amounted to 12 Islamic commercial banks operating in Indonesia during the observation period 2018 to 2023 and presenting financial reports in the observation period 2018-2023 and have been published at OJK.

The data used is secondary data obtained from the bank's financial statements for the period 2018-2023 that have been published in OJK, including total fixed assets, total third party funds, operating costs, and total financing. Islamic banking efficiency uses a parametric method with *Stochastic Frontier Analysis* (SFA) based on the production function for efficiency measurement, as well as the intermediation approach in determining *output-input* variables. Bastian (2009) explained that the parametric method has several advantages, namely that it can draw statistical conclusions, include *random errors* in the calculation, and take into account macro variable factors such as differences in the size of banking assets and regulations that affect the efficiency level of a bank.

Operational Definition

The definition of the variables used in this study are input components, namely: (1) Cost of funds (P1), which is the total interest costs paid by the bank on third party deposits divided by total assets, (2) Labor costs (P2), which is labor costs divided by total assets, (3) Third Party Funds (DPK) is the sum of Wadiah Current Accounts, Mudharabah Savings, and Mudharabah Deposits, and (4) Paid-in Capital (MDS) is the capital that has been effectively received by the bank with the nominal value of shares (Muhammad, 2004). While the output components consist of (1) Loans (Q1), which is the total loans given to parties related to the bank and parties not related to the bank divided by total assets. (2) Securities (Q2), which are securities held divided by total assets. (3) Placements in Bank Indonesia (PBI) are the balance of Islamic bank current accounts in rupiah and foreign currency at Bank Indonesia (Muhammad, 2004). (4) Placement in Other Banks (PBL) is an investment of funds in other Islamic banks, both domestically and internationally, in the form of, among others, Interbank Mudharabah Investment Certificates, mudharabah deposits, mudharabah savings, wadiah demand deposits, and wadiah savings aimed at optimizing fund management. (5) Provided Financing (PD) is the provision of funds and/or bills of exchange based on mudharabah and/or musyarakah contracts and/or other financing based on the profit-sharing principle.

Wadiah demand deposits are deposits that can be withdrawn at any time by issuing a check for cash withdrawals or a transfer form for bookkeeping, while the owner can use this check or transfer form as a means of payment based on the profit-sharing principle, while Mudharabah savings are deposits based on the profit-sharing principle that can be withdrawn under certain agreed conditions. Mudharabah deposits are deposits based on the profit-sharing principle that can only be withdrawn at certain times according to the agreement.

The bound components in this study consist of (1) Total expenses (TC), namely (Total interest expense + Expenses for estimated losses on commitments and contingencies + Total other operational costs + Reserves for possible losses on assets + Amortization expenses + Non-operational expenses): Total

assets. (2) Efficiency is the ability of Islamic banking to generate profits with inputs and outputs that have been determined and measured relatively over time.

Stochastic Frontier Analysis (SFA)

Stochastic Frontier Analysis (SFA) is used to determine the efficiency value over time. The value of efficiency produced is in the form of a score from 0 to 1. The closer to 1, the more efficient the bank is, and vice versa, the closer to 0, the less efficient the bank is. The SFA method uses U (controllable error) to obtain the efficiency score (Aigner and Chu, 1968, Meeusun and van der Broeck, 1977). Production function analysis using SFA is done using equation (4) by following the parameterization of *time varying model*. For data processing with SFA, Frontier 4.1 software can be used. The SFA standard function with the production function has a general (log) form as follows:

$$\ln(Q_1) = \beta_0 + \beta_1 \ln(P_1) + \beta_2 \ln(P_2) + \beta_3 \ln(P_3) + \dots + \beta_n \ln(P_n) + E_n \dots \dots \dots (1)$$

where P_1 , P_2 , and P_3 are *inputs*, namely operating costs, labor costs, fixed assets, total assets, and third party funds at bank n . While, Q_1 is the output quantity, namely the total financing at bank n . The error term, E_n , of both functions consists of two components, as shown in the following equation (Battese and Coelli, 1993 and 1995):

$$E_n = V_i - U_i \dots \dots \dots (2)$$

where: U_i is a controllable random factor (inefficiency) and V_i is an uncontrollable random factor (random noise). The assumptions used are $U_i \sim iid | N(0, \sigma^2) |$ and $V_i \sim iid N(0, \sigma^2)$. U_i and V_i are distributed independently of each other, as well as the input variables.

Panzar-Rosse Method

The Panzar-Rosse method is one approach to measuring the level of competition in the banking industry. The method proposed by Panzar and Rosse (1987) focuses on a general market equilibrium model. In this model, firms employ different pricing strategies to respond to changes in input prices. Price changes depend heavily on how participants participate in the market. In short, the model developed by Panzar and Rosse states that input prices, or marginal costs, must be balanced with gross revenue, or gross income.

Banks require three inputs in the production process: labor, physical capital, and financial capital. The log-normal function of the diminishing returns model is used to calculate the Panzar-Rosse H-statistic as a measure of the level of competition in the banking industry. This measure first uses general market equilibrium. The Panzar-Rosse hypothesis (1987), often measured using the H-statistic, is a method for determining market structure or the level of competition in an industry (particularly banking) by observing how changes in input prices affect firm revenue.

An empirical test is then conducted for competitive capital market equilibrium, which equates the level of risk with the bank's rate of return. If the market is not in equilibrium, a decrease or increase in factor prices will cause a temporary decrease in the rate of return or an increase in the rate of return (Molyneux *et al.* 1994). To test for statistical equilibrium or disequilibrium, a decrease or increase in factor prices will cause a temporary decrease in the rate of return or an increase in the rate of return (Molyneux *et al.* 1994). The level of competition can be measured using the Panzar and Rosse Model, which uses banking inputs and outputs as variables. This model uses data from each bank which can then show how much change will occur from changes in input (production factors) to the output (income) obtained, which

can then also be used to measure the level of competition in the industry being studied.

The regression equation used in measuring H statistics in Banks in Indonesia, both Commercial Bank Business Activities and Bank Grouping based on Core Capital categories, is as follows: Revenue Ratio, namely income and interest expenses to total assets as the dependent variable (Y) which is influenced in the transmission of bank income acquisition. The independent variables are divided into the main input independent variable groups, namely: the ratio of interest expenses to total third party funds (X1), the ratio of labor expenses to total assets (X2), the ratio of bank operational expenses to fixed assets (X3). The banking-specific factor independent variable group, namely: the ratio of total financing to total assets (X4), the ratio of total third party funds to total assets (X5), and the ratio of operational expenses to bank operational income (X6). The hypotheses developed are:

H1: The ratio of interest expense to total third-party funds (X1) has a positive effect on the revenue ratio.

H2: The ratio of labor expense to total assets (X2) has a positive effect on the revenue ratio.

H3: The ratio of bank operating expenses to fixed assets (X3) has a positive effect on the revenue ratio.

H4: The ratio of total financing to total assets (X4) has a positive effect on the revenue ratio.

H5: The ratio of total third-party funds to total assets (X5) has a positive effect on the revenue ratio.

H6: The ratio of operating expenses to bank operating income (X6) has a negative effect on the revenue ratio.

RESULTS AND DISCUSSION

The analysis of the efficiency value of Islamic banking in Islamic commercial banks for the period 2018-2023 using the SFA method refers to the equation:

$$\ln(Q_1) = \beta_0 + \beta_1 \ln(P_1) + \beta_2 \ln(P_{(2)}) + \beta_3 \ln(P_{(3)}) + V_i - U_i \dots\dots\dots (3)$$

From this equation, a frontier model will be produced in the form of a translog model which is not a linear model, so that all variables are converted into natural logarithms (Hakim, 2009).

The Islamic commercial banks in the The Category 1 Commercial Bank consist of 4 banks including Victoria Sharia Bank, Bukopin Sharia Bank, BTPBN Sharia Bank, and Aladin Sharia Bank. The Category 2 Commercial Bank consists of 8 banks, namely Aceh Sharia Bank, NTB Sharia Bank, Muamalat Indonesia Bank, Jabar Banten Sharia Bank, Sharia Indonesia Bank, Mega Sharia Bank, Panin Dubai Sharia Bank, and BCA Sharia Bank. The Bank Group 1 (based on core capital) category consists of 11 banks, namely Aceh Sharia Bank, NTB Sharia Bank, Muamalat Indonesia Bank, Victoria Sharia Bank, Jabar Banten Sharia Bank, Mega Sharia Bank, Panin Dubai Sharia Bank, KB Bukopin Sharia Bank, BCA Sharia Bank, BTPN Sharia Bank, and Aladin Sharia Bank. Bank Group 3 (based on core capital) consists of 1 bank, namely Sharia Indonesia Bank.

The SFA efficiency proxy is Total Cost which consists of interest cost, operating cost, and non-operating cost. There are several independent variables, namely, operating costs (X₁), labor costs (X₂), fixed assets (X₃), total assets, w₍₁₎ (x₁/Total Assets, proxy for the price of bank operations), w₍₂₎ (x₂/Total Assets, proxy for the price of labor), and w₍₃₎ (x₃/Total Assets, proxy for the price of fixed assets).

SFA is used to determine the efficiency value over time. The efficiency value produced is in the form of a score from 0 to 1. The closer the score to 1, the more efficient the bank is, and vice versa, the closer to 0, the less efficient the bank is. The SFA method uses *U* (controllable error) to obtain the efficiency score. Production function analysis using SFA is carried out using equations by following the parameterization of the *time varying model*. For data processing with SFA, Frontier 4.1 software can be used.

The Islamic commercial bank regression equation model can be written as follows:

$$\ln TC = 1,083449 + 0,6471299 \ln_operating\ cost + 0,0752136 \ln\ cost_tk + 0,2176447 \ln_fixed\ assets + 5,368867 w_1 - 3,36025 w_2 - 6,786341 w_3 \dots\dots\dots(4)$$

From the regression equation above, the constant is 1,083449. This shows that the constant value has a positive value of 1,083449. This shows that if all independent variables which include operating costs, labor costs, fixed assets, proxy for the price of bank operations, proxy for the price of labor, and proxy for the price of fixed assets or worth 0 percent or no change, then the amount of efficiency is increased by 108,3%.

The operational cost input variable is known to have a significant positive effect on total costs, as the probability value of operational costs is $0,000 < \alpha 0,05$ (Hypothesis 1 is accepted). This means that if the operational cost variable increases by 1%, the efficiency level will increase by 64,7%. Labor costs are known to have a significant positive effect on total costs, as the probability value of labor costs is $0,016 < \alpha 0,05$ (Hypothesis 2 is accepted). This means that if the operational cost variable increases by 1%, the efficiency level will increase by 7,5%.

Furthermore, the fixed assets variable is known to have a significant positive effect on total costs, as the probability value of fixed assets is $0,000 < \alpha 0,05$ (Hypothesis 3 is accepted). This means that if the fixed assets variable increases by 1%, the efficiency level will increase by 21,7%. For variable w_1 , known as $x_1/\text{total assets}$, the proxy for bank operating costs was found to have a significant positive effect on total costs because the probability value of w_1 was $0,000 < \alpha 0,05$ (Hypothesis 4 is accepted). This means that if variable w_1 increases by 1%, total cost efficiency will increase by 5,36%. For variable w_2 , known as $x_2/\text{total assets}$, the proxy for labor costs was found to have no significant effect on total costs because its probability value was greater than $\alpha 0,05$ (Hypothesis 5 is rejected). Ideally, if the average salary per employee increases, total operating costs will also increase.

On the other hand, for variable w_3 , known as $x_3/\text{total assets}$, the proxy for fixed asset prices was found to have a significant negative effect on total costs because the probability value of w_3 was $0,000 < \alpha 0,05$ (Hypothesis 6 is rejected). This means that if variable w_3 increases by 1%, total efficiency will decrease by 6,78%. This is in contrast to the existing conditions, if the cost of renting a building or the price of procuring technology per unit increases, then the total cost will also increase. The Bank Grouping based on Core Capital Islamic commercial bank regression equation model can be written as follows:

$$\ln TC = 0,436771 + 1,00812 \ln_operating\ cost + 0,0650845 \ln\ cost_tk - 0,0904915 \ln_fixed\ assets - 1,529031 w_1 - 6,174902 w_2 + 3,102855 w_3 \dots\dots\dots(5)$$

From the regression equation above, the constant is 0,436771. This shows that if all independent variables which include operating costs, labor costs, fixed assets, proxy for the price of bank operations, proxy for the price of labor, and proxy for the price of fixed assets are 0 percent or do not change, then the amount of efficiency is increased by 43,6%.

The operational cost input variable is known to have a significant positive effect on total costs, because the probability value of operational costs is $0,000 < \alpha 0,05$ (Hypothesis 1 is accepted). This means that if the operating cost variable increases by 1%, the efficiency level will increase by 100%. Labor costs are known to have a significant positive effect on total costs, as the labor cost probability value is $0,000 < \alpha 0,05$ (Hypothesis 2 is accepted). This means that if the labor cost variable increases by 1%, the efficiency level will increase by 6,5%.

Furthermore, the fixed asset variable is known to have a significant negative effect on total costs, as the fixed asset probability value is $0,047 < \alpha 0,05$ (Hypothesis 3 is rejected). This means that if the fixed asset variable increases by 1%, the efficiency level will decrease by 9%. In the context of costs, fixed assets are related to depreciation costs, maintenance costs, and property taxes. The greater the value of

fixed assets, the greater the depreciation expense charged to total costs. W_1 , known as $x_1/\text{total assets}$, as a proxy for bank operating costs, is known to have a significant negative effect on total costs, as the probability value of w_1 is $0,018 < \alpha 0,05$ (Hypothesis 4 is rejected). This means that if the variable w_1 increases by 1%, the total efficiency will decrease by 1,52%. This contrasts with the situation where an increase in interest costs (the Deposit Interest Rate/BI Rate) increases the bank's cost of funds, resulting in an increase in the bank's total operating costs.

The variable w_2 , known as $x_2/\text{total assets}$, as a proxy for fixed asset prices, is known to have a significant negative effect on total costs, as the probability value of w_2 is $0,004 < \alpha 0,05$ (Hypothesis 5 is rejected). This means that if the variable w_2 increases by 1%, the total efficiency will decrease by 6,17%. Ideally, if building rental costs or the price of technology procurement per unit increase, total costs will also increase.

Meanwhile, the variable w_3 , known as $x_3/\text{total assets}$, as a proxy for fixed asset prices, is known to have a significant positive effect on total costs, because the probability value of w_3 is $0,000 < \alpha 0,05$ (Hypothesis 6 is accepted). This means that if the variable w_3 increases by 1%, the amount of efficiency will increase by 3,10%.

Stochastic Frontier Analysis (SFA)

The results of the efficiency test for Islamic commercial banks that have been conducted are as follows: In The Category 1 Commercial Bank, it is known that the highest banking efficiency is in BTPN Sharia Bank at 82,65% then Victoria Sharia Bank has an efficiency of 79,80%, KB Bukopin Sharia Bank has an efficiency of 72,71%, and the lowest position is in Aladin Sharia Bank at 53,66%.

Table 1. Efficiency Test Results of Islamic Commercial Banks The Category 1 Commercial Bank

Bank Name	Efficiency
Victoria Sharia Bank	0,798091
KB Bukopin Sharia Bank	0,727183
BTPN Sharia Bank	0,826529
Aladin Sharia Bank	0,536612
Average	0,722104

Source: Processed Data (2025)

Table 2. Efficiency Test Results of Islamic Commercial Banks The Category 2 Commercial Bank

Bank Name	Efficiency
Aceh Sharia Bank	0,91745
NTB Sharia Bank	0,91031
Muamalat Indonesia Bank	0,93677
Jabar Banten Sharia Bank	0,90010
Sharia Indonesia Bank	0,93173
Mega Sharia Bank	0,91200
Panin Dubai Sharia Bank	0,92319
BCA Sharia Bank	0,90316
Average	0,91684

Source: Processed Data (2025)

Table 3. Efficiency Test Results of Islamic Commercial Banks Bank Group 1 (based on core capital)

Bank Name	Efficiency
Aceh Sharia Bank	0,919350
NTB Sharia Bank	0,920962

Bank Name	Efficiency
Muamalat Indonesia Bank	0,843744
Victoria Sharia Bank	0,883687
Jabar Banten Sharia Bank	0,889743
Mega Sharia Bank	0,834185
Panin Dubai Sharia Bank	0,913781
KB Bukopin Sharia Bank	0,893345
BCA Sharia Bank	0,915448
BTPN Sharia Bank	0,894971
Aladin Sharia Bank	0,820345
Average	0,884505

Source: Processed Data (2025)

In The Category 2 Commercial Bank, it is known that the highest banking efficiency is at Muamalat Indonesia Bank at 93,67% then Sharia Indonesia Bank has an efficiency of 93,17%, Panin Dubai Sharia Bank has an efficiency of 92,31%, and the lowest position is at Jabar Banten Sharia Bank 90,01%.

In Bank Group 1 (based on core capital), it is known that the highest banking efficiency is in NTB Sharia Bank at 92,09% then Aceh Sharia Bank has an efficiency of 91,937%, Panin Dubai Sharia Bank has an efficiency of 91,37%, and the lowest position is in Aladin Sharia Bank 82,03%. These findings are also not much different from the findings of several previous studies (Puteh et al., 2018), which show that Islamic banking in Indonesia has not operated efficiently. The average efficiency level of Islamic banks in Indonesia ranges from 89% to 94%, which means there is still room for improvement, especially in reducing operating costs compared to operating income. The only difference with this research is that it uses the Data Envelopment Analysis (DEA) method approach. The DEA results also show that both Islamic Commercial Banks (BUS) and Islamic Business Units (UUS) have not been efficient in the intermediation function (Puteh et al., 2018). In line with the findings of Hidayati et al. (2016) that Islamic banks in Indonesia do not operate efficiently, with total financing and capital and net profit having a positive impact on efficiency, while deposits have a negative impact on it.

On the other hand, banking efficiency is also shown by *Intellectual Capital Efficiency (ICE)*, especially structural and relational capital efficiency, which is proven to be the main driver of Islamic bank performance. In contrast, human capital efficiency has a negative impact on performance. Bank size and foreign ownership also play a significant role in improving efficiency (Rehman et al., 2021). The relevance of this research to this study is both using the size of the bank, only in this study more on the amount of core capital and main financial ratios, not using intellectual capital and human capital. In fact, Islamic banks in Indonesia are not yet fully efficient, with external factors beyond management control being the main cause of their non-performing financing and inefficiency (Purwanto, 2021).

Table 4. Efficiency Test Results of Islamic Commercial Banks Bank Group 3 (based on core capital)

Bank Name	Efficiency
Sharia Indonesia Bank	0,95041
Average	0,95041

Source: Processed Data (2025)

In Bank Group 3 (based on core capital), it is known that banking efficiency is found in Sharia Indonesia Bank by 95,04%. The regression equation used in the measurement of H statistics on Banks in Indonesia in the Commercial Bank Business Activities category is as follows: Revenue ratio, namely interest income and expense to total assets as the dependent variable (Y) which is influenced in the

transmission of bank income. Independent variables are divided into groups of main *input* independent variables, namely: the ratio of interest expense to total third party funds (X_1), the ratio of labor expense to total assets (X_2), the ratio of bank operating expenses to fixed assets (X_3). The independent variable group of banking-specific factors, viz: ratio of total financing to total assets (X_4), ratio of total third party funds to total assets (X_5), ratio of operating expenses to bank operating income (X_6). The main challenges of Islamic banking efficiency in Indonesia are high operational costs, human resource management, and not optimal utilization of information technology (Nahar et al. 2022 and Puteh et al. 2018). To improve efficiency, Islamic banks are advised to manage resources optimally, strengthen product innovation, and expand the scale of operations both organically and inorganically (Nahar et al. 2022 and Puteh et al. 2018).

Comparative studies between Indonesia and Malaysia show that Islamic banks in Indonesia are more efficient than Malaysia in terms of technical, scale and overall efficiency. However, the source of inefficiency in Indonesia mainly comes from the aspect of human resources (Ascarya & Yumanita, 2009). At the global level, Indonesian Islamic banks still face challenges to achieve optimal economies of scale in order to compete internationally (Mala et al., 2023). Efficiency is believed to be a major factor in improving the competitiveness of Islamic banks, although changes in efficiency do not always have a direct impact on competitiveness among Islamic banks (Syariah, 2020). Therefore, this research continues to analyze the competition of the banking industry.

Based on statistical tests on Commercial Bank Business Activities category banking data in Indonesia, the results show that the H-statistic value is less than 1, indicating the level of industry competition is *monopolistic competition*. If *input* prices increase, revenue will also increase. This comes from the assumption that the increase in *input* costs arises as a result of the increasing number of banking services and *outputs* provided so that it can ultimately increase banking revenues.

The research results that put the banking sector into a monopolistic market are in line with research conducted by Athoillah (2012). All the main and specific factors together have a significant effect of 0.000000 with a contribution value at adjusted *R-squared* of 87.73% on the transmission of accelerated profit or income (Y) in Islamic commercial banking Commercial Bank Business Activities category in Indonesia. Then the equation model of the H-statistic = Y value of the regression coefficient is :

$$H = 0,573579 + 0,000575 X_1 - 11,79647 X_2 + 8,57E-06 X_3 + 19,30251 X_4 + 0,006686 X_5 + 0,708344 X_6 + \varepsilon \dots\dots\dots (6)$$

Table 5. H-Statistic Panzar-Rosse Commercial Bank Business Activities Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Ratio of interest expense to total third party funds	0,000575	0,001128	0,509894	0,6109
Ratio of labor expense to total assets	-11,79647	3,243126	-3,637378	0,0004
Ratio of bank operating expenses to fixed assets	8,57E-06	0,000111	0,076941	0,9388
Ratio of total financing to total assets	19,30251	1,045932	18,45484	0,0000
Ratio of total third party funds to total assets	0,006686	0,012388	0,539722	0,5903
Ratio of operating expenses to bank operating income	0,708344	0,048627	-14,56600	0,0000
R-squared	0,877370	Mean dependent var		-2,238010
Adjusted R-squared	0,871999	S.D dependent var		0,708700
S.E. of regression	0,253553	Akaike info criterion		0,140904
Sum squared resid	8,807630	Schwarz criterion		0,285270
Log likelihood	-3,145113	Hannan-Quinn criterion		0,199567
F-statistic	163,3630	Durbin-Watson stat		1,823664
Prob (F-statistic)	0,000000			

Source: Processed Data (2025)

The empirical model in the H-Statistic regression test for the Commercial Banking Business Activity category in Indonesia shows that the main variable, the ratio of interest expense to total third-party funds

(X1), has an insignificant effect on profit or income transmission (Y) in the Commercial Banking Business Activity category in Indonesia, with a value of $0,6109 > \alpha 0,05$ (H1 is accepted). The ratio of labor costs to total assets (X2) has a significant effect of $0,0004 < \alpha 0,05$ on profit or income transmission (Y) in the Commercial Banking Business Activity category in Indonesia (H2 is rejected). Large banks in Commercial Bank Business Activities category 4 are undergoing a major digital transformation. Therefore, bank revenue is currently driven more by technological infrastructure (mobile banking, AI, cloud) than by branch staff. The impact is that increased labor costs (especially for traditional operational staff) are perceived as inefficiencies. Banks with high labor costs but still using manual methods will lose out to banks that are lean in terms of human resources but sophisticated in terms of systems. Investment in human resources (salaries, bonuses, training) is expected to increase employee productivity in finding customers and managing assets, ultimately increasing revenue per unit of asset.

Meanwhile, the ratio of bank operating expenses to fixed assets (X3) does not provide sufficient evidence to indicate an effect because its probability value is greater than $\alpha 0,05$ (H3 is accepted). Meanwhile, specific variables such as the ratio of total financing to total assets (X4) have a significant effect of $0,0000 < \alpha 0,05$ on the transmission of bank profits or income (Y) in the category of Commercial Banking Business Activities in Indonesia (H4 is accepted). Meanwhile, the ratio of total third party funds to total assets (X5) has an insignificant effect of $0,5903 > \alpha 0,05$ on the transmission of bank profits or income (Y) in the category of Commercial Banking Business Activities in Indonesia (H5 is accepted). The ratio of operating costs to bank operating income (X6) has a significant effect of $0,0000 < \alpha 0,05$ on the transmission of bank profits or income (Y) in the category of Commercial Banking Business Activities in Indonesia (H6 is rejected). BOPO is an efficiency ratio, if BOPO is high it means that operational costs consume a large portion of income. Managerially, inefficient banks usually have a small net income margin or difficulty optimizing income from their operations).

The main and specific factors of Indonesian banks in the Commercial Bank Business Activities category show a significant influence on bank profit transmission in Indonesia. The measurement results of the Panzar-Roose H-statistic method assume that if all X variables are 0 (zero), the results of the equation $Y = H = 0,5737 < 1$. The H-statistic value is less than 1 indicating the level of industry competition is *monopolistic competition* (**Hypothesis 2**). The smaller the BOPO ratio, the better, because the bank in question can cover operating expenses with its operating income so that the ROE value will increase. Operating income from both loans and high interest income will be able to increase bank profitability but trigger high non-performing loans or NPLs so that it can cause cost overruns. An increase in NPLs will cause swelling in expenses due to an increase in the cost of provisioning for productive assets or other expenses and have an impact on the bank's performance. So that indirectly BOPO through NPL affects ROE.

Table 6. H-Statistic of Panzar-Rosse Bank Grouping based on Core Capital model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Ratio of interest expense to total third party funds	3,508045	2,602992	1,347697	0,1800
Ratio of labor expense to total assets	-7,649130	6,353571	-1,20390	0,2307
Ratio of bank operating expenses to fixed assets	0,000671	0,002393	0,280569	0,7795
Ratio of total financing to total assets	22,65424	3,371278	6,719778	0,0000
Ratio of total third party funds to total assets	0,134926	0,040902	3,298753	0,0012
Ratio of operating expenses to bank operating income	-0,681804	0,038160	-17,86713	0,0000
R-squared	0,920642	Mean dependent var		-2,573429
Adjusted R-squared	0,917141	S.D dependent var		0,730562
S.E. of regression	0,210294	Akaike info criterion		-0,232908
Sum squared resid	6,014403	Schwarz criterion		-0,087874
Log likelihood	23,65294	Hannan-Quinn criterion		-0,173973
F-statistic	262,9592	Durbin-Watson stat		1,878596

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Prob (F-statistic)	0,000000			

Source: Processed Data (2025)

Based on the table above, it can also be seen that the DW value of 1,823664 will be compared with the 5% significance table value, with a sample size of 144 (n) and the number of independent variables 6 (k = 6). The DU value of 1,8151 is obtained, and the DW value of 1,823664 is greater than the upper limit (DU) and less than (4-DU) or $4 - 1,8151 = 2,1849$. It can be written that $1,8151 < 1,8236 < 2,1849$, so it can be concluded that there is no autocorrelation between these variables.

Based on the analysis of banking data within the Bank Grouping based on Core Capital categories, the H-statistic value of less than 1 indicates that the level of industry competition is characterized by monopolistic competition. The regression equation used in measuring the H-statistic on Banks in Indonesia in the Bank Grouping based on Core Capital category is as follows.

All the main and specific factors together have a significant effect of 0,000000 with a contribution value at adjusted *R-squared* of 92,06% on the transmission of accelerated profit or income (Y) of Bank Grouping based on Core Capital category banks in Indonesia. Then the equation model of the H-statistic = Y value of the regression coefficient is :

$$H = -0,871244 + 3,508045 X_1 - 7,649130 X_2 + 0,000671 X_3 + 22,65424 X_4 + 0,134926 X_5 - 0,681804 X_6 + \varepsilon \dots\dots\dots (7)$$

The empirical model in the H-Statistic regression test of Bank Grouping based on Core Capital categories in Indonesia shows that key variables such as the ratio of interest expense to total third-party funds (X1) and the ratio of bank operating expenses to fixed assets (X3) have an insignificant effect on the transmission of profit or income (Y) from Bank Grouping based on Core Capital in Indonesia because the probability value is $> \alpha 0.05$ (H1 and H3 are accepted). Interest expense is an input price, meaning the greater the cost a bank incurs to obtain funds (TPF), the greater the volume of funds it can manage to generate revenue. Therefore, the focus is not on reducing net profit, but rather on the bank's capacity to generate gross income.

Meanwhile, the ratio of labor costs to total assets (X2) has an insignificant effect on the transmission of profit or income (Y) from Bank Grouping based on Core Capital in Indonesia because the probability value is $> \alpha 0.05$ (H2 is rejected). Although in theory, human capital investment in Human Resource increases productivity, a negative relationship was found in banks in the Bank Grouping based on Core Capital category. This indicates that large banks have reached a point where increasing labor costs are no longer responsive to increased revenue. This phenomenon is driven by the digitalization of banking, where the role of labor is starting to be replaced by more efficient automated systems in generating revenue.

Meanwhile, specific variables such as the ratio of total financing to total assets (X4) and the ratio of total third party funds to total assets (X5) have a significant influence of $0,0000 < \alpha 0,05$ on the transmission of profit or income (Y) from Bank Grouping based on Core Capital category in Indonesia (H4 and H5 are accepted). The ratio of operating costs to bank operating income (X6) has a significant influence on the acceleration of transmission of profit or income (Y) of banks in Indonesia because the probability value is smaller than $\alpha 0,05$ (H6 is accepted).

The main and specific factors of Indonesian banking in the Bank Grouping based on Core Capital category show a significant influence on bank profit transmission in Indonesia. The measurement results of the Panzar-Roose H-statistic method assume that if all X variables are 0 (zero), the results of the equation $Y = H = -0,871244 < 1$. The value of the H-statistic is less than 1 indicating the level of industry competition is *monopolistic competition* (**Hypothesis 2**). The smaller the BOPO ratio, the better, because the bank in question can cover operating expenses with its operating income so that the ROE value will increase and vice versa the higher the BOPO value, the lower the ROE value of the bank. High ROE

indicates good company performance, as long as it is supported by healthy revenue growth. Meanwhile, low BOPO indicates good company performance, because the operating costs incurred are more efficient. According to Athoilah (2012) the monopolistic competition market structure has the advantage of being able to combine the advantages and disadvantages of two very opposite types of markets (perfect competition and monopoly).

Based on the table above, it can also be seen that the DW value of 1,878596 will be compared with the 5% significance table value, with a sample size of 143 (n) and a total of 6 independent variables (k = 6). The DU value of 1.8149 is obtained, and the DW value of 1.878596 is greater than the upper limit (DU) and less than (4-DU) or $4 - 1,8149 = 2,1851$. It can be written that $1,8149 < 1,878596 < 2,1851$, so it can be concluded that there is no autocorrelation between these variables.

CONCLUSION

The average efficiency value is at 93%-95% indicating that Islamic banks (Bank Group 2 (based on core capital) are quite optimal. Islamic commercial banks simultaneously in the Commercial Bank 1 to Commercial Bank 3 categories and Bank Group 1 (based on core capital) to Bank Group 3 (based on core capital) show market competition classified as monopolistic competition and a non-concentrated market. This is characterized by a high ROE value and a low BOPO ratio, the lower the BOPO ratio, the better, because the bank can cover operational costs with its operating income, which means the ROE value will increase. The lower the BOPO, the greater the bank's ability to cover operational costs with operating income, which will directly boost profitability (ROE). Given the market structure is monopolistic competition, Islamic banks cannot rely solely on price (profit sharing). Management needs to differentiate products and improve service quality to win in a non-concentrated market, where customers have many choices of banks with similar services. The analysis of Islamic banking efficiency using the production function using the SFA method can serve as a foundation for Islamic banking in future decision-making. This study only analyzed the efficiency level between banks using the production function. It is hoped that future researchers can develop better research and methods, preferably using the Cost Function or Profit Function, to obtain a broader picture of efficiency from an economic perspective.

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