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Financial Efficiency of Islamic Rural Banks in Indonesia: A Two-Stage DEA Approach

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ABSTRACT

This study examines the financial efficiency of Islamic Rural Banks (BPRS) in West Java, Indonesia, by using a two-stage Data Envelopment Analysis (DEA) framework grounded in Financial Intermediation Theory. The first stage measures efficiency through multiple inputs operating expenses, fixed assets and inventory, total deposits, and total assets and outputs, profit-sharing financing, receivables, fund distribution income, and other operating income. The second stage applies Tobit regression to evaluate the effects of key financial ratios: Non-Performing Financing (NPF), Return on Assets (ROA), Operating Expenses to Operating Income Ratio (BOPO), and Financing to Deposit Ratio (FDR) on efficiency scores. Findings indicate that 7 of 10 BPRS consistently achieved optimal efficiency (DEA score = 1.00), while 3 institutions experienced persistent inefficiencies across various inputs and outputs. Tobit analysis shows that ROA, BOPO, and FDR have significant positive effects on efficiency, whereas NPF is not statistically significant. The results underscore the critical role of cost control and effective fund intermediation in improving performance. The study advances the application of Financial Intermediation Theory in Sharia-compliant rural banking by integrating ethical considerations into technical efficiency measurement. Limitations include geographic focus, data quality variability, and exclusion of qualitative performance measures.

Contribution/Originality: This study's theoretical significance comes from applying Financial Intermediation Theory to Sharia-compliant financial institutions, filling a vacuum in the literature that is still dominated by research on traditional banking and financing. For policymakers, regulators, and bank management looking to enhance performance, governance, and resource optimization in the Islamic microfinance industry.

1. INTRODUCTION

Financial services play a strategic role as an intermediary between parties with surplus funds (savers) and those in need of funds (borrowers), thereby serving as a key driver of economic growth (Cameron et al., 2021; Chowdhury & Uddin, 2021; Okello Candiya Bongomin et al., 2024). Over the past three decades, Indonesia's Islamic banking industry has experienced rapid growth and has become one of the main pillars of the national financial system. According to the Sharia Banking Statistics of the Financial Services Authority (OJK, 2023), as of January 2023, the total assets of Islamic commercial banks amounted to IDR 765.36 trillion. An important component of this system is the Islamic Rural Bank known as Bank Pembiayaan Rakyat Syariah (abbr. BPRS), which operates at the grassroots level under

specific regulations and guidelines. Based on Indonesian Financial Service Authority - *Otoritas Jasa Keuangan* (OJK)- data, the total assets of 187 BPRS institutions in January 2023 reached IDR 20.18 trillion. Unlike Islamic Commercial Banks (BUS), BPRS primarily serve the microeconomic sector, particularly Micro, Small, and Medium Enterprises (MSMEs) (Okello Candiya Bongomin et al., 2024; I. Setiawan, 2021; Wajdi Dusuki, 2008). The majority of BPRS financing is directed toward business groups that are underserved by conventional banks, which tend to impose stricter requirements. This aligns with the mandate of Bank Indonesia Regulation No.14/22/PBI/2012, which requires commercial banks to allocate at least 20% of their credit portfolio to MSMEs, positioning BPRS as a key in promoting financial inclusion and local economic empowerment (Ahmad et al., 2020; Blanco-Oliver et al., 2023; Kamla & Rammal, 2013).

However, the increasing penetration of commercial banks into the microfinance market has intensified competition, eroding MSME customer loyalty and slowing the growth of BPRS. Limited business scale, technological capacity, and financial infrastructure make it difficult for BPRS to compete with institutions that possess greater capital and broader networks. (Lebdaoui & Wild, 2016; Mohamed & Elgammal, 2023; Zaini & Kusuma, 2024). In addition, the high levels of non-performing financing (NPF) in BPRS are often attributed to inadequate managerial capabilities, business behavior shaped by local cultural norms, and low financial literacy among MSME players. These vulnerabilities have become increasingly evident over the past three years (Adriana et al., 2023; Budiandru, 2021; Maknuun et al., 2022).

Several previous studies have examined the performance and effectiveness of Islamic banks and BPRS using various approaches, including Data Envelopment Analysis (DEA), which is also employed in this study (Fall et al., 2018; Wasiaturrahma et al., 2020; Widiastuti et al., 2022). Some have applied Two-Stage DEA to analyze the impact of environmental factors, such as financial ratios, on efficiency (Al-Awlaqi & Aamer, 2019; Alam, 2013; Ben Abdelkader & Mansouri, 2019; Sanyinna & Omar, 2017). Nonetheless, most prior studies have been limited to assessing technical efficiency alone, without providing a comprehensive understanding of the input–output performance of BPRS (Ben Abdelkader & Mansouri, 2019; Wasiaturrahma et al., 2020; Widiarto & Emrouznejad, 2015). The earlier research outcomes was not enough to understand, document, and encompass input-output performance comprehensively (Alandejani, 2022; Fan et al., 2019; Liu et al., 2022; Mahyudin & Rosman, 2022; Rohman et al., 2021; Sari et al., 2024). In the context of Indonesia's evolving financial ecosystem, the sustainability and competitiveness of BPRS are influenced not only by internal efficiency but also by the complex interaction between financing risk, market competition, policy changes, and the broader institutional regulatory framework, that have thus far been insufficiently addressed in the academic literature (Muslichah & Sanusi, 2019; Puteri, 2023; Sadali et al., 2024; I. Setiawan, 2021).

This context underscores the urgency of research that goes beyond measuring the financial performance of BPRS to also examine their operational practices, ethical standards, and contributions to MSMEs in Islamic microfinance (Amelia & Hardini, 2017; Azmansyah et al., 2022). The issue is strategically aligned with the national agenda for equitable growth and financial inclusion and is critical to supporting Indonesia's Vision 2045 and long-term growth strategy (AbdulGaniyy & AbdulKareem, 2020; Widiastuti et al., 2022). This study aims to provide critical and analytical insights into how BPRS can respond to regulatory changes, manage financing risks, and enhance competitiveness in the microfinance sector (Ahsan & Qureshi, 2021; Santosa et al., 2020).

The focus of this research is West Java Province, a highly populated and economically dynamic region that serves as one of the major hubs for BPRS operations and the MSME sector (Addury & Pangestu, 2023; Fathimah, 2023; Syahid & Noviarita, 2022).

West Java is also a competitive arena between BPRS and BUS. BUS hold a competitive advantage due to their larger asset base and broader market reach, requiring BPRS to improve their performance to maintain market share (Bakhri, 2021; Maharani, 2018; Maharani & Setiyono, 2018; Mohd Thas Thaker & Mohd Thas Thaker, 2016). In addition to being shaped by local characteristics, BPRS in West Java face additional pressures from their proximity to Jakarta and involvement in national economic corridors such as the Greater Jakarta (Jabodetabek) and Southern West Java regions, which expose them to both national regulatory reforms and market dynamics (R. A. Setiawan, 2023; Zaini & Kusuma, 2024).

One important indicator of BPRS resilience is operational efficiency. This study will evaluate the efficiency level of BPRS in West Java while identifying internal factors that may influence it. Given the strategic role of BPRS in both urban and rural areas of the province, this research is expected to provide a comprehensive understanding of their risk management, financial performance, operational efficiency, and financing outcomes. To date, no study has specifically examined the efficiency of BPRS in West Java along with its determinants, making this research well-positioned to address this empirical gap.

2. LITERATURE REVIEW

Financial Intermediation Theory, in the context of Islamic rural banking (BPRS), as described by Lewis et al. (2014), emphasizes the role of banks as intermediaries that mobilize funds and channel them to customers through profit-and-loss sharing schemes, as opposed to the interest-based conventional system. By effectively distributing funds and mobilizing savings, banks demonstrate their capacity as intermediaries whose main functions include managing risks between savers and borrowers, reducing transaction costs, and mitigating information asymmetry (Alhammadi et al., 2024; Halik et al., 2022; Nosheen & Rashid, 2020). Effective intermediation directs financial resources toward the most productive uses in the economy (Beck et al., 2013; Halik et al., 2022; Miah & Uddin, 2017).

Efficiency is an essential benchmark of bank performance. A firm is considered efficient if it: (1) uses the same inputs but produces larger outputs; (2) uses fewer inputs but maintains the same level of outputs; or (3) uses more inputs but produces proportionally greater outputs (Bello et al., 2017; Hakim, 2023; Santosa et al., 2020). Efficiency is closely related to profitability, where the more efficient a bank is, the greater the profits it generates. Among the factors that affect bank profitability is financial performance which is reflected in financial ratios (Iqbal et al., 2019; Masruroh, 2022). The profitability of the bank is reflected in the *Return on Assets* or ROA. Based on research by Santosa et al (2020), FDR, NPF, and BOPO have a significant effect on bank profitability (ROA). NPF and FDR variables have a partial positive and insignificant effect on profitability (ROA) (Santosa et al., 2020). The BOPO variable partially has a negative and significant influence on profitability (ROA). If NPF, FDR, BOPO affect ROA, then these four variables are thought to also affect efficiency because the essence of efficiency is to generate optimal profits (Arif & Rahmawati, 2018; SHAIKH, 2022). A review of banking efficiency (especially BPRS) is very necessary because it concerns the sustainability of banks that manage customer funds.

Inefficiencies in BPRS can be identified from suboptimal resource allocation, high operating expenses, complex banking procedures, weak debtor assessment systems, and limited capital (Abdullah & Ismail, 2017; Blanco-Oliver et al., 2023). Similarly, the failure to incorporate debtor screening procedures and credit scoring systems leads to problems with asymmetric information, credit supervision, and stakeholder trust (Lodhi, 2020; Sartono et al., 2023). These issues are further exacerbated by localized economic risks arising from narrow loan portfolios and regional specialization. Furthermore, rural banks are more susceptible to localized economic shocks due to their limited loan portfolio and regional specialization, which frequently leads to a poor challenge-taking attitude (Fianto et al., 2019; Shirazi, 2019;

Ülev et al., 2023). Capital constraints that limit rural banks' ability to mobilize and use financial resources optimally exacerbate these inefficiencies (Abdullah & Ismail, 2017; Khir & Mohamed, 2023).

To measure efficiency, Data Envelopment Analysis (DEA) is used as a non-parametric quantitative approach that compares decision-making units (DMUs) against an efficient frontier formed by top-performing entities (Alam, 2013; Ben Abdelkader & Mansouri, 2019; Liu et al., 2022; Mohsin et al., 2021; Widiarto & Emrouznejad, 2015). DEA models can be output-oriented or input-oriented, with the latter assessing how well human, capital, and deposit resources are managed to generate financing and income. Advanced applications use two-stage DEA to link efficiency scores with determinants such as market competition, capital adequacy, and liquidity ratios (Lebdaoui & Wild, 2016; Pertiwi, 2023; Wasiaturrahma et al., 2020).

Advanced applications employ two-stage DEA, in which factors influencing efficiency (such as market competitiveness, capital sufficiency, and liquidity ratios) are analyzed in the second stage after efficiency scores have been estimated in the first. According to Financial Intermediation Theory, this method aids in connecting efficiency assessment to the underlying operational and financial characteristics and capabilities (Alzwi et al., 2024; Hammadi et al., 2024; Issa & Abbaszadeh, 2023). The intricacies of financial intermediation choices under risk and information asymmetry are reflected in recent DEA models that incorporate stochastic features and fuzzy variables to address unpredictability and challenges in banking inputs and outputs (Abalkhail & Presley, 2002; Blanco-Oliver et al., 2023). By identifying peers who implement excellent practices, DEA data provide inefficient banks benchmarks. In line with the objectives of Financial Intermediation Theory, this supports management and regulatory actions meant to increase financial stability, lower costs, and improve intermediation efficiency (Hakim, 2023; Widiarto & Emrouznejad, 2015; Yusfiarto, 2021).

BPRS are vital financial institutions in Indonesia that promote financial inclusion through Sharia-compliant principles. Although their operational scale is smaller than that of Islamic commercial banks, their fundamental principles align with the intermediation theory, which views banks as entities that transform inputs into financing, revenue, and profit (Aubel et al., 2022; Elkreem, 2017; Sari et al., 2024; Fadlyanti & Sutrisno, 2023; Mennawi, 2020; Suhartini et al., 2024). The research gap lies in the limited studies that measure BPRS efficiency using DEA within the framework of Financial Intermediation Theory. Particularly by incorporating financial performance variables such as ROA, FDR, NPF, and BOPO as determinants of efficiency.

3. METHODOLOGY

The research employed a quantitative method with an inferential statistical approach. This approach involves the systematic collection of data containing factual information and characteristics of the research object, followed by statistical testing and interpretation grounded in relevant theoretical or empirical literature. The sampling technique applied was probability sampling, specifically proportionate stratified random sampling. This method is appropriate when the population comprises heterogeneous elements that are organized into strata (Cresswell, 2013; Takona, 2024). The study focused on Islamic Rural Banks (BPRS) operating in West Java. According to 2022 data from the Financial Services Authority (OJK), there were 27 BPRS distributed across 10 regencies/cities in the province. From each regency/city, the BPRS with the largest total assets and complete financial statement data was selected, resulting in a final sample of 10 institutions, as seen in table 1.

Table 1. Research Sample

No	BPRS	Location
1	BPRS Harta Insan Karimah Parahyangan	Bandung Regency
2	BPRS Amanah Insani	Bekasi Regency
3	BPRS Amanah Ummah	Bogor Regency
4	BPRS Gaido Indonesia	Cianjur Regency
5	BPRS PNM Mental	Garut Regency
6	BPRS Baiturridha Pusaka	Bandung City
7	BPRS Harta Insan Karimah Cibitung	Bekasi City
8	BPRS Daarut Tauhid	Cimahi City
9	BPRS Al Salaam Amal Salman	Depok City
10	BPRS Almadinah	Tasikmalaya City

The study was conducted in two stages (Kloke & McKean, 2024). The first stage involved a nonparametric efficiency analysis, which compared historical input and output data to generate efficiency scores for BPRS. The input variables consisted of Operating Expenses, Fixed Assets and Inventory, Total Deposits, and Total Assets, while the output variables comprised Financing, Receivables, Income from Fund Disbursement, and Other Operating Income. Efficiency measurement was performed using the nonparametric Data Envelopment Analysis (DEA) approach. In the DEA framework, the evaluation process begins by identifying decision-making units (DMUs) and specifying the relevant input and output indicators (DeMeo, 2016; Smeeton et al., 2025). The model then calculates productivity scores and identifies units that either fail to utilize inputs efficiently or fail to produce optimal output (Arif & Rahmawati, 2018; Fianto et al., 2019).

The second stage examined the influence of financial ratio variables on efficiency. In this stage, efficiency served as the dependent variable, while the independent variables comprised four financial ratios: Non-Performing Financing (NPF), Return on Assets (ROA), Operating Efficiency Ratio (BOPO), and Financing-to-Deposit Ratio (FDR).

$$\theta_{it} = \beta_0 + \beta_1 NPF_{it} + \beta_2 ROA_{it} + \beta_3 BOPO_{it} + \beta_4 FDR_{it} + \varepsilon it$$

Because the dependent variable (y) in this study is a ratio ranging from 0 to 1, the appropriate regression technique is Tobit regression. The Tobit model is a modified form of regression that differs from ordinary least squares (OLS) in its treatment of censored dependent variables. This method assumes that the independent variables have an unrestricted range, while the dependent variable is bounded; that all variables are measured accurately; that there is no autocorrelation or heteroscedasticity; that no perfect multicollinearity exists; and that the specified mathematical model is correct (Chali et al., 2022; Cresswell, 2013). In OLS, model fit is typically assessed using the R-squared value or the F-statistic. However, in Tobit regression, these metrics are not valid for inference; model justification relies solely on the t-statistic (Smeeton et al., 2025). Accordingly, the hypothesis testing procedure in this study employs only the t-test, which evaluates the statistical significance of each independent variable's effect on the dependent variable at a 5% significance level.

4. DISCUSSION OF THE RESULT

4.1. Result

4.1.1 Measurement the Efficiency BPRS in West Java

Efficiency serves as a key parameter for evaluating organizational performance. It is defined as the ratio of the expected output to a given set of inputs (Mahyudin & Rosman, 2022; Özdemir, 2022). Measuring efficiency is essential, as it forms an integral part of performance assessment across various organizational contexts, including Islamic Rural

Banks (BPRS). Table 2 presents the efficiency scores of 10 BPRS operating in West Java over the period 2019–2022, representing institutions distributed across 10 regencies/cities.

Table 2. West Java BPRS Efficiency Level

BPRS	Efficiency Scale			
	2019	2020	2021	2022
BPRS HIK Parahyangan	1	1	1	1
BPRS Amanah Insani	1	1	1	1
BPRS Amanah Ummah	0,924	0,907	1	1
BPRS Gaido Indonesia	1	1	1	1
BPRS PNM Mental	1	1	1	1
BPRS Baiturridha Pusaka	1	1	1	1
BPRS HIK Cibitung	1	1	1	1
BPRS Daarul Hayat	1	0,84	1	1
BPRS Al Salaam Amal Salman	0,933	0,826	0,75	0,907
BPRS Almadinah	1	1	1	1

Source: Output DEAP 2.1

Between 2019 and 2022, seven BPRS consistently achieved optimal efficiency scores (DEA score = 1.00) each year. These institutions are BPRS HIK Parahyangan, BPRS Amanah Insani, BPRS Gaido Indonesia, BPRS PNM Mentari, BPRS Baiturridha Pusaka, BPRS HIK Cibitung, and BPRS Almadinah. In contrast, the remaining three BPRS did not consistently attain optimal efficiency during the observation period. Specifically, BPRS Amanah Ummah recorded inefficiencies in 2019 (0.924) and 2022 (0.907); BPRS Daarul Hayat experienced inefficiency in 2020 (0.840); and BPRS Al Salaam Amal Salman exhibited inefficiencies in 2019 (0.933), 2020 (0.826), 2021 (0.750), and 2022 (0.907). Institutions that failed to achieve an efficiency score of 1.00 are classified as inefficient, and subsequent analysis focuses on identifying the factors contributing to these inefficiencies.

4.1.2 *Inefficiency in BPRS Outputs and Inputs in West Java*

The DEA computations using DEAP 2.1 not only generate efficiency scores but also provide diagnostic information regarding the sources of inefficiency. This diagnostic output includes four key components: (1) *Original Value*, representing the actual input and output values based on the financial and operational data of each BPRS; (2) *Projected Value*, referring to the input or output levels required for the institution to operate at relative efficiency; (3) *Radial Movement*, indicating the proportional adjustment needed—either by increasing outputs for the same level of inputs or by reducing inputs while maintaining the same output level; and (4) *Slack Movement*, denoting additional non-proportional input reductions beyond radial adjustments, which reflect surplus inputs that can be eliminated without negatively affecting output.

This study presents only a summary of these DEA components, focusing on both input and output inefficiencies. The results reveal that output inefficiencies occur across all output variables, namely profit-sharing financing, income from fund distribution, and other operating income. All inefficiency values are positive, indicating that each BPRS would need to increase the respective output variables by the specified amounts to reach optimal efficiency. A positive (+) sign signifies that the corresponding variable requires an upward adjustment to align with the efficient frontier showed in Table 3.

Table 3. Output Inefficiency of West Java BPRS, 2019–2022 (*in thousand rupiah*)

	Profit Sharing Financing	Receivables	Income from Disbursement	Other Operating Income
BPRS Amanah	(+) Rp953.148	(+)	(+) Rp18.328.409	(+) Rp619.862

Ummah (2019)		Rp16.685.616		
BPRS Amanah Ummah (2020)	(+) Rp640.301	(+) Rp21.399.447	(+) Rp12.733.014	(+) Rp2.565.568
BPRS Daarut Tauhid (2020)	(+) Rp245.988	(+) Rp1.602.978	(+) Rp1.237.675	(+) Rp32.276
BPRS Al Salaam Amal Salman (2019)	(+) Rp1.035.154	(+) Rp16.395	(+) Rp4.508.478	(+) Rp3.053.374
BPRS Al Salaam Amal Salman (2020)	(+) Rp2.792.538	(+) Rp38.598.938	(+) Rp11.934.171	(+) Rp2.540.667
BPRS Al Salaam Amal Salman (2021)	(+) Rp10.968.648	(+) Rp56.650.442	(+) Rp16.791.067	(+) Rp3.333.890
BPRS Al Salaam Amal Salman (2022)	(+) Rp1.229.846	(+) Rp20.731.483	(+) Rp5.291.598	(+) Rp5.381.250

Source: DEAP 2.1 output (data processed by researchers)

Based on the output, it can be explaining; First, inefficiency in profit-sharing financing indicates that the total financing disbursed is below the predetermined target. This shortfall stems from the cautious approach adopted by BPRS in extending financing. While the application of the precautionary principle is important for mitigating risk, it should not excessively constrain financing activities to the extent that disbursement falls short of the target. To address this issue, BPRS can implement rigorous monitoring mechanisms during the financing process and periodically reassess its financing targets to ensure they remain realistic yet growth-oriented.

Second, inefficiency is observed in receivables, where the total receivables distributed do not meet the established target. Receivable performance is closely linked to the quality of the business relationship between BPRS and its customers. To address this, BPRS should align receivable disbursement with the set targets while continuing to uphold prudent lending standards (Amin et al., 2021; Mindra et al., 2022).

In addition to these two variables, inefficiencies are also evident in income from fund distribution and other operating income. In the case of income from fund distribution, the realized profit remains suboptimal and below the target. Fund distribution activities in BPRS follow both the sale-and-purchase principles—using contracts such as *murabaha*, *istishna*, and *salam* (Riduwan & Danupranata, 2020; Ropiah, 2025), and the profit-sharing principles of *mudharaba* and *musharaka* (Asadov, 2020; Suhartini et al., 2024). To improve performance in this area, BPRS should review its financing schemes to minimize risk exposure, for example, by requiring deposit guarantees from financing customers, securing ownership certificates for financed goods in sale-and-purchase contracts, and continuously monitoring macroeconomic trends that influence purchasing power and repayment capacity.

For inefficiencies in other operating income, which primarily originate from service fees, BPRS could consider increasing administrative charges, provided such adjustments are accompanied by measurable improvements in service quality (Blanco-Oliver et al., 2023; Khir & Mohamed, 2023; Sutrisno et al., 2023).

On the input side, inefficiencies are detected across almost all input variables, namely operating expenses, fixed assets and inventory, total deposits, and total assets. A negative (–) value indicates the extent to which a variable should be reduced, whereas a positive (+) value indicates the degree to which it should be increased to achieve optimal efficiency.

Table 4. Input Inefficiency of West Java BPRS, 2019–2022 (in thousand rupiah)

	Operating Expenses	Fixed Assets and Inventory	Total Deposit	Total Aset
BPRS Amanah Ummah (2019)	-	(–) Rp1.556.594	(–) Rp84.072.432	-
BPRS Amanah	-	(–) Rp9.534.958	(–)	(–) Rp34.782.129

Ummah (2020)			Rp122.392.786	
BPRS Daarut Tauhid (2020)	-	(–) Rp395.203	(–) Rp4.173.208	(–) Rp861.054
BPRS Al Salaam Amal Salman (2019)	(–) Rp1.245.311	(–) Rp22.139.320	(-) Rp104.684.880	-
BPRS Al Salaam Amal Salman (2020)	(–) Rp1.061.241	(–) Rp17.421.637	(-) Rp97.456.499	-
BPRS Al Salaam Amal Salman (2021)	-	(–) Rp17.061.384	(-) Rp17.061.384	-
BPRS Al Salaam Amal Salman (2022)	(+) Rp3.420.283	(+) Rp22.382.327	-	-

Source: DEAP 2.1 output (data processed by researchers)

First, operational expense inefficiencies occur when operational costs incurred exceed the required level. Operational costs in Islamic banks typically include labor expenses, general administrative expenses, marketing costs, profit-sharing expenses, depreciation and provisions for productive assets, building rental fees, and others (Fadlyanti & Sutrisno, 2023; Shahzadi1 et al., 2021). To improve labor cost efficiency, banks can collaborate with educational institutions or universities to recruit high-quality and competent human resources. Marketing costs can be streamlined by designing strategies aligned with targeted market segments, while profit-sharing costs can be mitigated through credit guarantees provided by credit guarantee institutions (Chenguel, 2019; Ozdemir et al., 2023).

Second, inefficiencies in fixed assets and inventory occur when their utilization is suboptimal or exceeds the required capacity. Fixed assets include land, buildings, banking equipment, and other physical resources. Addressing inefficiencies in this variable does not necessarily require asset reduction; rather, assets should be used optimally to prevent inefficiency. Any addition to fixed assets should be aligned with their efficient utilization to avoid negative impacts on overall efficiency (Ben Abdelkader & Mansouri, 2019; Hachami et al., 2019).

Third, total deposit inefficiency—covering *wadiah* savings as well as time and demand deposits—indicates that the total deposit input is greater than the target, thereby underutilizing its potential to generate output. To address this, excess funds can be allocated for the acquisition of productive assets or by increasing the volume of financing disbursed (Alzwi et al., 2024; Özdemir, 2022).

Fourth, inefficiencies in total assets occur when the value of total assets, including both productive and non-productive assets, exceeds optimal levels. Total assets are a critical determinant of a bank's ability to expand its operations; larger total assets enhance competitive capacity in business expansion and market strengthening. Based on the input inefficiency table above, several BPRS exhibit positive inefficiency values, indicating excess total assets (Khir & Mohamed, 2023; Sang, 2024). In such cases, asset reduction is unnecessary; instead, optimization of existing assets is recommended to improve efficiency.

4.2 The Effect of Financial Ratios (NPF, ROA, BOPO, FDR) on the Efficiency of West Java BPRS in 2019-2022

Table 5. Output of Tobit Regression Analysis

Variable	Coefficient	Std. Error	z-Statistic	Prob.
NPF	0.046145	0.025579	1.804059	0.0712
ROA	0.064885	0.025600	2.534580	0.0113

BOPO	0.004863	0.002458	1.978185	0.00479
FDR	0.006466	0.003224	2.005312	0.00449
C	−0.136526	0.321804	−0.424253	0.6714

Source: Output E-views 13 (data processed by researchers)

Based on Table 5, the results of the Tobit regression analysis using EViews 13, some variables significantly influence efficiency (either positively or negatively), while others have no statistically significant effect. Significance is determined by the p-value in the "Prob" column for each variable. If the p-value is less than 0.05, the variable is considered to have a statistically significant effect on efficiency; the sign of the coefficient indicates whether the effect is positive or negative. Conversely, if the p-value exceeds 0.05, the variable is considered to have no significant effect.

The results indicate that the NPF variable does not significantly affect efficiency, as shown by its p-value of 0.0712, which is greater than $\alpha = 0.05$. This finding is consistent with the studies of Naufal et al. (2017), who found that NPF had no effect on the efficiency of BPRS in Jakarta and surrounding areas, and with the studies of Candra et al. (2015) and Lestari et al. (2015), which reported that NPF had no significant impact on the efficiency of BUS.

In contrast, the ROA variable shows a p-value of 0.0113, which is less than $\alpha = 0.05$, indicating a significant effect on efficiency. The coefficient sign suggests that this effect is positive. The BOPO and FDR variables are found to have a significant influence on efficiency. Based on the regression results, the BOPO variable has a p-value of 0.0479 (< 0.05) and the FDR variable has a p-value of 0.0449 (< 0.05), indicating statistical significance at the 5% level. Both variables have positive coefficients, suggesting that increases in BOPO and FDR are associated with higher efficiency scores. These findings are consistent with the research of Azwar et al (2021), which showed that BOPO positively influences the efficiency of BPRS in Indonesia using a Two-Stage DEA approach. They are also in line with the studies of Candra et al (2015) and Lestari et al (2015), which found that FDR has a positive effect on efficiency.

4.2. Discussion

4.2.1 Efficiency Performance of West Java BPRS in 2019–2022

Based on the findings, among the 10 BPRS institutions in West Java analyzed as research samples, 7 consistently achieved an efficiency score of 1.00 during the 2019–2020 period. These institutions include BPRS Harta Insan Karimah (HIK) Parahyangan, BPRS Amanah Insani, BPRS Gaido Indonesia, BPRS PNM Mentari, BPRS Baiturridha Pusaka, BPRS Harta Insan Karimah (HIK) Cibitung, and BPRS Almadinah. The remaining three—BPRS Amanah Ummah, BPRS Daarul Hayat, and BPRS Al Salaam Amal Salman—either failed to attain or did not consistently maintain full efficiency. These results suggest that the efficient BPRS demonstrated strong managerial capabilities and sound operational strategies that effectively supported their intermediation function within the Islamic banking system.

Conversely, DEA scores falling below 1.00 for multiple years indicate persistent inefficiency in the three underperforming institutions. Among them, BPRS Al Salaam Amal Salman exhibited the most sustained inefficiency between 2019 and 2022, with efficiency scores ranging from 0.75 to 0.933. The inefficiencies were systemic, affecting both input variables (operating expenses, fixed assets and inventory, total deposits, and total assets) and output variables (profit-sharing financing, receivables, fund distribution income, and other operating income). This pattern points to structural and managerial shortcomings requiring targeted strategic interventions. Specifically, inefficiencies in receivables and fund distribution income were universal among these institutions, reflecting excessive and sub-

optimally allocated inputs. In contrast, inefficiencies in profit-sharing financing and other operating income appeared sporadically, indicating occasional failures to maintain optimal input levels.

These results align with prior literature on rural banking efficiency. Studies have shown that limited human capital capacity and suboptimal asset utilization frequently drive inefficiency in Indonesian rural banks (Ben Abdelkader & Mansouri, 2019; Blanco-Oliver et al., 2023; Wasiaturrahma et al., 2020). Comparable trends have been reported in Malaysian Islamic microfinance institutions, attributed to inadequate client outreach and insufficient technological innovation (Amin et al., 2021; Ramlan & Adnan, 2016; Zakariyah et al., 2022). Similarly, rural non-commercial Islamic banks often experience reduced efficiency due to scale-related limitations and a lack of operational diversification (Hamad, 2014; Haq et al., 2023). In Pakistan, Lodhi (2020) found that outdated financial technologies and poor credit recovery practices hinder efficiency in Islamic microfinance banks. Likewise, in Nigeria, Islamic microfinance institutions face similar challenges, performing below their conventional counterparts due to governance issues, insufficient capital support, and inadequate human resource management (Abdullahi & Othman, 2021; Aliyu et al., 2017).

4.1.2 Determinants of Efficiency

The results of the Tobit regression analysis indicate that some variables significantly influence efficiency, while others do not. Specifically, the NPF variable (X1) shows no statistically significant effect on efficiency (Y), with a p-value of 0.0712, exceeding the significance threshold α (0.0712 > 0.05). In contrast, ROA (X2) has a positive and significant impact on efficiency, with a p-value of 0.0113 (0.0113 < 0.05). BOPO (X3) also exerts a positive and significant effect, with a p-value of 0.0479 (0.0479 < 0.05). Similarly, FDR (X4) demonstrates a statistically significant influence, with a p-value of 0.0449 (0.0449 < 0.05).

Overall, these results suggest that efficiency levels are significantly affected by three financial ratios (ROA, BOPO, and FDR), while NPF does not exhibit a significant relationship. The positive effect between ROA and efficiency implies that a higher capacity of BPRS to generate net income from its asset base reflects optimal resource utilization, enabling revenue growth without proportional increases in input. The significance of BOPO underscores the role of operating cost control in enhancing productivity. FDR's significance is consistent with the core function of BPRS as a financial intermediary, channeling deposits into productive financing. The non-significance of NPF indicates that, in this context, credit risk and loan performance do not directly translate into DEA-measured efficiency levels.

The study aligns with earlier research on rural banks in Bangladesh (Hasan, 2019; Islam & Sultana, 2019), Malaysia (Bashir & Azeez, 2022; Kamaruddin & Auzair, 2019) and India (Khan & Bhatti, 2008; Noor & Bagrecha, 2024), which found that internal cost control and efficient fund mobilization, rather than profitability indicators, serve as the primary drivers of operational efficiency in rural banks. This reinforces the importance of intermediation effectiveness within rural Islamic banking systems (Ahmed et al., 2021; Alzwi et al., 2024; Hachami et al., 2019). The findings are further consistent with evidence from Pakistan and Malaysia, where efficient fund intermediation and rigorous operational cost management were identified as critical to sustaining the performance of Islamic financial institutions (Qureshi & Hussain, 2020; Sardar & Iqbal, 2023).

Although the BPRS sector in Indonesia has seen stable institutional development, persistent global challenges remain, including inefficient resource allocation, suboptimal cost management, and technology gaps. Comparative insights from other countries underscore the need for strategic reforms in financial innovation, regulatory integration, governance digitalization, and capacity building (Fall et al., 2018; Liu et al., 2022; Wasiaturrahma et al., 2020). Furthermore, the results highlight substantial institutional variability arising from

differences in internal managerial practices and regional operational dynamics. Overall, the study underscores the centrality of operational efficiency and financing performance in maintaining BPRS competitiveness, while also providing strong empirical support for policy reforms and targeted capacity-building programs aimed at underperforming institutions.

Despite employing profit-sharing and trade-based financing mechanisms, Islamic Rural Banks (BPRS) fulfill comparable intermediation functions, thus reinforcing the theoretical legitimacy of Islamic finance within value-based financial systems. By combining DEA with the intermediation approach, the research incorporates ethical objectives such as risk-sharing and equitable wealth distribution into efficiency measurement, refining the concept of efficiency in socioeconomically constrained contexts. The application of DEA to BPRS—a culturally and geographically distinct microfinance sector—demonstrates its methodological versatility, especially for decentralized financial systems with heterogeneous outputs and data quality issues. Empirical efficiency ratings generated within this framework also support performance-based regulation, providing a dynamic benchmarking tool aligned with supervisory paradigms of regulators like OJK.

The DEA-based assessment offers a rigorous tool to evaluate operational efficiency, guiding strategies for process reengineering, human capital adjustment, and technology enhancement. Efficiency scores allow BPRS to benchmark performance against peers, while enabling regulators such as OJK and Bank Indonesia to identify underperformance, resource misallocation, and management gaps. The approach supports targeted interventions, such as customized capacity-building, IT upgrades, and product diversification—over generic policy measures. For rural banks with chronic inefficiency, DEA results can inform performance-based licensing, incentive schemes, and the integration of efficiency monitoring into compliance frameworks. Development agencies, donors, and Islamic financial associations can also use these insights to strategically allocate funds, address capability gaps, and foster digital transformation in rural financial services.

5. CONCLUSIONS, LIMITATION AND FUTURE RESEARCH

5.1 Conclusion

This study employed a two-stage Data Envelopment Analysis (DEA), grounded in Financial Intermediation Theory, to comprehensively evaluate the financial efficiency of Islamic Rural Banks (BPRS) in West Java, Indonesia, over the 2019–2022 period. The findings indicate that seven out of the ten sampled BPRS consistently achieved optimal efficiency scores (DEA score = 1.00), reflecting strong control over resource-related decision-making, particularly in managing operational expenditures, fixed assets, and deposits. These institutions demonstrated the ability to generate both productivity and favorable financial outcomes. In contrast, the remaining three BPRS exhibited financial underperformance, primarily due to inefficient resource utilization and overall weak managerial and operational capabilities.

The Tobit regression analysis revealed that only a limited number of financial indicators significantly influenced efficiency. Specifically, Return on Assets (ROA), the Financing to Deposit Ratio (FDR) and the Operating Expenses to Operating Income Ratio (BOPO) emerged as significant predictors of efficiency, while Non-Performing Financing (NPF) did not show statistically significant effects. These findings underscore the strategic importance of cost control and effective fund intermediation in achieving efficiency within Sharia-compliant banking, aligning with similar international studies on Islamic financial institutions in Asia and Africa.

5.2 Limitations

While demonstrating DEA's applicability to Islamic rural banking, the study faces several limitations. The chosen input-output variables that focused on assets, deposits, financing, and profit, may not fully capture non-financial dimensions such as Shariah compliance, customer satisfaction, or broader ethical objectives. The static two-stage DEA model assesses efficiency at a single point in time, limiting its ability to reflect dynamic changes due to economic shocks, regulatory shifts, or internal reforms. The dataset's geographic scope—restricted to West Java—may not represent national variations in operational conditions, and partial disclosures required data estimation, potentially affecting accuracy. Moreover, the model does not account for external macroeconomic factors, regulatory alignment issues, or internal managerial strategies, limiting its explanatory depth. Future research should incorporate longitudinal or mixed-method approaches to capture both contextual influences and internal decision-making processes.

5.3. Future Research

This research contributes both theoretically and practically to the literature in areas including regulatory frameworks, banking leadership and management, Islamic banking efficiency, and rural banking governance. Theoretically, it reinforces the role of Financial Intermediation Theory in explaining the resource–output relationships of Islamic rural banks. Practically, it offers actionable insights for policymakers, regulators, and BPRS managers on enhancing operational performance and financial sustainability through targeted decision-making, effective resource management, adherence to national banking and Islamic finance agendas, and the strategic use of technology. The novelty of this study lies in integrating a two-stage DEA with Tobit regression to simultaneously measure efficiency and identify its determinants in Islamic rural banks—an approach that has not been extensively applied in the Indonesian context. Future research could extend this work by incorporating qualitative assessments and expanding the geographic scope to examine institutional practices that shape efficiency outcomes.

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