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How Efficiency Drives Bank Performance in Pakistan: A Quantile-Based Methodology

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Abstract: This research examines Pakistani commercial banks' relationship between efficiency and profitability levels from 2020 to 2024 through Data Envelopment Analysis (DEA) combined with panel quantile regression methods. The research investigates financial performance patterns stemming from banking efficiency across diverse profitability levels to explain the efficiency-profitability relationship better. The study shows performance enhancement from efficiency operating through different intensity levels when examining profit margin distribution groups. Banks demonstrating lower-to-median profitability show major profit increases through efficiency improvements, yet this relationship weakens at higher performance levels resulting in negative effects for top-performing banks. Underperforming banks need efficiency to improve their results but banks performing at high profitability levels gain little value from efficiency improvements. The research evaluates bank size and capital adequacy ratio non-performing loans ratio and loan-to-deposit ratio as control factors that affect bank performance. The study utilizes panel quantile regression as an alternative to mean-based estimators to show how banking efficiency produces varying results across different sectors of bank performance. The experimental strategy advances policy recommendations that bank managers and regulators should consider adopting specific plans that align with a bank's current profitability status. The research investigation adds new findings to emerging market banking efficiency literature through practical strategies for better banking approach development.

Keywords: Data Envelopment Analysis, Efficiency, Non-Performing Loans Ratio, Capital Adequacy Ratio, Panel Quantile Regression.

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INTRODUCTION

The efficiency and profitability levels of banks remain essential variables that assess both economic development and banking sector prosperity in present-day economic conditions (Hachicha & Ben Amar, 2015). The Pakistani banking sector functions as a critical component in emerging economies because it supports capital allocations and financial mediation as well as enables loan distribution (Mahmood et al., 2020). The services performed by banks support stable macroeconomic environments as well as microeconomic advancement (Yildirim, 2002). The Pakistani banking sector needs to reanalyze its profitability determinants because it currently deals with an array of hurdles including escalating non-performing loans (NPLs), operational performance problems, inconsistent monetary control methods, and advancing technology systems. Profits in banking institutions are evaluated through accounting metrics that consist of Return on Assets (ROA) and Return on Equity (ROE) (Munteanu & Ilie, 2021; Petersen & Schoeman, 2008). The ROA metric determines how banks convert their assets into earnings whereas the ROE score evaluates the earning performance relative to shareholder investments. The two financial metrics provide the baseline for rating managerial performance together with investment methods and financial health (Peloza, 2009). The determination of profitability depends on multiple influencing factors consisting of bank-specific elements and macroeconomic factors as well as operational performance elements.

Operational efficiency refers to the bank's ability to maximize output from a given set of inputs or minimize input usage for a given level of output (Kamarudin et al., 2019; Roghanian et al., 2012). More efficient banks can

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offer competitive services, better withstand financial shocks, and contribute to a stable banking environment. Several studies have suggested that operational inefficiency is one of the leading causes of poor financial performance in banks (Mrindoko et al., 2020). In Pakistan, where resource constraints and regulatory inefficiencies are common, it becomes imperative to investigate how cost efficiency contributes to bank profitability.

This research investigation evaluates the connection between efficiency and profitability among Pakistani commercial banks from 2020 to 2024. The analysis implements Data Envelopment Analysis (DEA) together with panel quantile regression to establish cost efficiency scores while studying the variable effects of efficiency on ROA and ROE at different points across performance levels. This research design shows the relationship between efficiency impacts on lower and higher-performing banks versus average banks. All banks within Pakistan's banking sector belong to either public or private entities while operating under rules set by the State Bank of Pakistan (SBP). The SBP reports show that Pakistani banks experienced both unstable net interest margins along asset quality deterioration in recent years (Jamshed & Siddiqui, 2023). Economic stress proves the importance of efficiency in protecting profits because of its protective mechanisms (Javed & Qazi, 2024). A countless number of existing research articles demonstrate that profitability improves when efficiency increases. Cost-efficient U.S. banks proved more profitable than less efficient banks (Adeabah & Andoh, 2020). European banking institutions treating efficiency as a factor showed positive correlations leading to both ROA and ROE enhancements (Neves et al., 2020). Research produced similar outcomes in economic systems that are not developed. Asian countries showed cost efficiency creates a substantial impact on bank profitability (Hamza, 2024). Modern investigations on the relationship between performance and operational efficiency in the Pakistani banking sector remain scarce although researchers have established important links between risk and size adjustments.

The current research distinguishes itself from previous works because it unites DEA analysis with panel quantile regression. The traditional OLS regression method estimates average profitability relationships between variables, but quantile regression offers a specialized approach that reveals different strengths of these relationships throughout different parts of the profitability distribution at the 25th, 50th, and 75th transformation points. The relationship between bank efficiency changes requires separate research for high-performing banks and low-performing banks (Mekpor & Dartey-Baah, 2019). Quantile regression emerged as an OLS alternative for dealing with distributional heterogeneity and banking research now collaborates with this quantile regression method (Clarke et al., 2023). DEA serves as a non-parametric approach to examine decision-making unit (in this scenario bank) efficiency levels through the evaluation of input-output ratios (Omrani et al., 2023). Operating expenses together with interest expenses serve as input for this research while interest income joins non-interest income as outputs. The relative efficiency score obtained from DEA ranges between 0 and 1 and serves as an explanatory variable within the regression models (Puri & Verma, 2020). The control variables in the econometric model include bank size as measured by total assets' natural logarithm together with capital adequacy ratio non-performing loans and loan-to-deposit ratio. Bank profitability is heavily influenced by these measurement factors which are generally accepted by the industry. Research indicates that larger banks achieve higher profitability levels because of scale advantages (Asongu & Odhiambo, 2019). Stronger capital buffers and decreased risk patterns are indicated by a higher CAR which produces better profit outcomes (Athanasoglou et al., 2008). The profitability of a bank suffers from decreased profitability when the NPL ratio reaches high levels since this reveals poor asset quality. The LDR ratio reveals financial strength and credit conditions because both extreme heights and lows create possible risks for bank operations (Mega et al., 2024).

The research analyzes two profitability models using ROA and ROE as outcome variables and conducts quantile regression at quantiles 25th, 50th, and 75th to determine efficiency effects on various profitability phases. A total of six panel-data equations will be calculated using STATA for analysis. Various outcomes result from this research investigation. The results can assist both SBP and banking sector regulators in determining which business sectors need structural reforms for better performance results. Monitoring efficiency alongside its relationship to profitability allows bank managers to establish operational strategies and risk management plans for better performance (Oyeniyi et al., 2021). Academic researchers gain methodological improvement through the dual application of DEA and quantile regression in an understudied financial market. The research targets an important void within the empirical banking literature of Pakistan.

Purpose of the Study

This research examines how banking efficiency affects the profitability levels of Pakistani commercial banks throughout 2020 up to 2024. The research employs DEA for efficiency evaluation alongside panel quantile regression to study efficiency-profitability relationships across profitability thresholds to characterize the financial performance effects of efficiency.

LITERATURE REVIEW

For as many decades researchers have studied the relationship between banking efficiency and profitability because of its significant impact on performance measurement and regulatory development as well as managerial decision-making. Economically sound profitability requires consistent success according to financial institutions, but cost efficiency remains the most significant factor (Challoumis & Eriotis, 2024). The ability of banks to achieve maximum output from their inputs operates under efficiency through reduced operational waste and redundancy (Haralayya & Aithal, 2021). An institution's ability to produce profits for stakeholders is reflected through ROE and ROA. The connection between efficiency levels and profitability remains vital for Pakistani banks alongside other banks in emerging markets since their financial market development remains incomplete plus institutional barriers continue to exist (Javed et al., 2023). Numerous worldwide examinations indicate that profitable institutions tend to be more efficient. A frontier efficiency analysis proved that banks that had lower costs achieved superior profitability levels and valuation in the market (Duho et al., 2020). Bank-specific factors including cost efficiency and capital strength together with credit risk measurement directly affect profit generation in South Eastern European financial institutions exceeding external macroeconomic variables (Barra & Ruggiero, 2023).

Chinese commercial banks operating with higher levels of efficiency achieved better profitability throughout structural and regulatory transition times (Yeung, 2021). Efficiency works as both a profitability determinant and an indicator for proper management decisions affecting strategic resource utilization (Arbelo et al., 2021). New research validates the theoretical concept which states efficiency acts as both a result of bank success and an initiative factor that produces superior bank outcomes. Empirical research about this subject remains minimal throughout South Asian territories. Current research about the efficiency-profitability relationship in Pakistan centers on linear average methods while failing to address distributional patterns between the variables. Analysis based on Pakistani banking institutions established that bank inefficiency intensified by non-performing loans and insufficient capitalization negatively affects profitability (Shah et al., 2022). The authors failed to show unique performance patterns between different banking sectors by using their current methodology. Analyzing these relationships assumes substantial importance in Pakistan because its banking sector includes three main categories: state-owned large institutions agile private sector banks and foreign-owned banks which operate with particular constraints. The field of finance now benefits from the latest methodological innovations concerning panel quantile regression when working with variables that display non-uniform distributions. In Islamic banking research, DEA-quantile regression applies to Malaysian Islamic banks to understand that efficient institutions in the highest profitability group gain more from operational efficiency improvements than less efficient institutions (Hassan et al., 2019). Traditional econometric models become questionable due to the identified distribution heterogeneity which requires performance analysis at multiple profitability segments.

Such methods enjoy worldwide popularity but researchers have barely utilized them in Pakistan. Aksar (2023) implemented a DEA-based efficiency analysis of Pakistani banks which did not correlate the efficiency assessment results to firm-level profitability indicators. Regarding performance determinants, Vidali et al. (2024) analyzed them through dynamic panel estimation but their research did not integrate non-parametric efficiency tools such as DEA. The current academic void demonstrates that future research should unite DEA with quantile regression analysis to analyze both efficiency measurement and its specific effects on profitability. The study uses appropriate control mechanisms including bank size measurements along with capital adequacy assessments credit risk analysis and liquidity monitoring which meets modern banking research standards. Research conducted by Asongu and Odhiambo (2019) revealed that banks of amplified size obtain double advantages from combined economies of scale and diverse operations which results in better profitability. Institutions with higher CAR yield positive results for profitability by improving their shock absorption capability (Sain & Kashiramka, 2023). A bank's asset quality becomes a major factor that negatively affects performance when bad loans generate higher provisioning expenses

and lower interest earnings (Badunenko et al., 2022). The LDR acts as a measure to assess funding and liquidity risk because high lending ratios increase solvency risks during periods of unstable credit conditions (Kepramareni et al., 2022). The digital age brings increased importance to efficiency as a critical factor in its operations. The international banking industry is undergoing rapid changes because fintech integration has been combined with digital banking systems and artificial intelligence solutions. Not limited to cost reduction efficiency in this period includes both technological adaptability and process innovation. Research focusing on these and similar themes has gained momentum internationally but Pakistani scholarly work continues to prioritize conventional financial measures (Ali & Mohsin, 2023). The profitability outlook of banks becomes restricted since they cannot measure themselves against world benchmark standards nor extract strategic digital transformation insights (Pramanik et al., 2019). Research in this study functions to join these methodological gaps with contextual gaps. The study develops a research model that merges DEA efficiency scores with panel quantile regression analysis to monitor Pakistani commercial banks over the five-year timeframe between 2020 and 2024. The proposed framework helps us identify how efficiency affects profitability levels between banks that show low or high performance which standard average models neglect to detect. The study enhances prediction quality by controlling essential bank-specific variables including size and CAR together with NPL and LDR. This produces results that stakeholders can apply to business decisions. Emerging economy studies in Pakistan demand a pressing assessment of efficiency's relationship with profitability given existing developed market research findings. The research adds depth to scholarly knowledge by combining robust methods with market-specific understanding thus helping both academic scholars and policymakers in South Asian banking institutions.

Hypothesis of the study

The literature of this research study proposes the following hypothesis to be tested.

$\mathbf{H}_1$: Pakistani commercial banks display various effects of banking efficiency on ROA within different profitability quantile levels.

$\mathbf{H}_2$: The ROE Performance of Pakistani commercial banks varies according to different profitability levels while banking efficiency yields substantial impacts.

METHODOLOGY

Research Design and Approach

This research employs quantitative methods using panel data to investigate how banking efficiency affects the profitability of Pakistani commercial banks during the period from 2020 to 2024. The study mixes Data Envelopment Analysis (DEA) tools to assess cost efficiency and then uses panel quantile regression to measure the efficiency-profitability relationship at different effectiveness degrees.

Data and Sample Selection

Financial statements from 2020 to 2024 represent the complete line of Pakistani commercial banks which operated continuously during this period. The research drew information from the State Bank of Pakistan (SBP) official bank reports together with annual bank reports. A total of 44 banks throughout Pakistan appear in the listed banking sector. The study kept consistent data by removing banks that presented incomplete information during the research duration. A total sample of twenty commercial banks meets strict criteria for national representation by including public entities, private businesses, and international institutions.

Panel Quantile Regression Model

The analysis utilizes panel quantile regression estimation on different quantile points including 0.25, 0.50, and 0.75 to study efficiency's impact on profitability marginal rates of ROA and ROE. Traditional linear models do not meet the requirements well since quantile regression models deliver both heterogeneous effects and resistance to outliers while allowing non-normal (Huang et al., 2017).

This study requires panel quantile regression methodology because it explores how efficiency affects banks differently based on their profitability levels. The proposed method steers clear of mean-based estimator restrictions and delivers precise policy implications that benefit both low- and high-performing banking institutions. A DEA solver Pro was used to compute scores while quantile regression calculations happened through STATA 17 software.

Models

$ROA_{i,t} = \beta_q + \beta^q_{i,t}$ Efficiency $_{i,t} + \sum_{i=2}^{n} (\beta^q_i)$ Control $+ \varepsilon_{i,t}$ ..... Eq 1

Here in the model 1, $ROA_{i,t}$ is the return on assets for bank i at time t, used as a proxy for profitability. β_q denotes quantile-specific intercept, the effect of bank efficiency on profitability at quantile q. $\sum_{i=2}^{n} (\beta^q_i)$ Control The total influence from control variables (SIZE, CAR, NPL, LDR), each with its coefficient at quantile q.

$ROE_{i,t} = \beta_q + \beta^q_{i,t}$ Efficiency $_{i,t} + \sum_{i=2}^{n} (\beta^q_i)$ Control $+\varepsilon_{i,t}$ ..... Eq 2

Here in model 2,$ROE_{i,t}$ is the return on Equity for bank i at time t, used as a proxy for profitability. β_q denotes quantile-specific intercept, the effect of bank efficiency on profitability at quantile q. $\sum_{i=2}^{n} (\beta^q_i)$ Control The total influence from control variables (SIZE, CAR, NPL, LDR), each with its coefficient at quantile q.

Table 1: Measurement of Variables

Variables	Abbreviation	Measurement
Return on Assets	ROA	Measures how well a bank produces earnings from its total asset investments through the net income to total assets ratio (Javed et al., 2023).
Return on Equity	ROE	ROE calculates the profitability of equity investments using net income to divide it by shareholder equity (Aksar et al., 2024).
Cost Efficiency Score	CES	The DEA model (input-oriented variable returns to scale model) generates the Cost Efficiency Score. The factors included in inputs are interest expenses and non-interest operating expenses while outputs feature interest income combined with non-interest income (Luo et al., 2012).
Bank Size	SIZE	The SIZE variable measures bank assets through its natural logarithm to assess scale effects (Javed et al., 2024).
Capital Adequacy Ratio	CAR	The ratio of Tier-1 and Tier-2 capital to risk-weighted assets indicates capital strength and regulatory compliance (Laiola, 2015).
Non-Performing Loans Ratio	NPL	NPL measures the risk of credit assets through its calculation of non-performing loans against total gross loan amounts (Makri et al., 2014).
Loan-to-Deposit Ratio	LDR	A bank uses the Loan-to-Deposit Ratio formula to determine the total value of loans by dividing it by total deposit amounts to measure its liquidity levels and lending patterns (Bod'a & Zimkova, 2021).
Data Envelopment Analysis	DAE	Each bank-year measurement utilizes the DEA model to determine its efficiency rate. The variable returns to scale model of DEA input assessment identifies how banks optimize their resource utilization to produce specified outcomes. The calculated efficiency score varies from 0 to 1 where an efficiency score of 1 represents complete efficiency (Kamarudin et al., 2019).

RESULTS

Descriptive Statistics

The descriptive statistics found in Table 2 summarize the essential variables for this research assessment. Banks operating in Pakistan maintained an ROA of 0.77 while ROE stood at 7.40% despite considerable differences

between institutions. The data demonstrates which banks maximize resource efficiency and profit output to the greatest extent. On average (0.89), most banks maintain efficient operations, yet some entities operate at lower levels of efficiency (CES). Different bank sizes exist throughout the sample population which includes banks both of medium and large dimensions. Bank capital levels indicated in CAR are consistently robust while annual non-performing loans amount to 5.8% demonstrating existing credit risks throughout the sector. Most banking institutions show conservativeness through their low loan-to-deposit ratios although a select few operate at higher levels of aggressiveness.

Table 2: Descriptive Statistics

Variables	Mean	Std. dev.	Min	Max
ROA	0.767512	0.131223	0.433223	1.078216
ROE	7.403413	1.697451	2.782443	11.461955
CES	0.892117	0.062723	0.710234	0.923682
SIZE	14.922245	1.03449	12.840894	17.961922
CAR	17.916493	2.234939	11.001451	26.823613
NPL	5.81303	1.556798	2.023646	9.782606
LDR	67.821512	9.984246	45.681412	97.23873

ROA = Return on Assets, ROE = Return on Equity, CES = Cost Efficiency Score, SIZE = Bank Size, CAR = Capital Adequacy Ratio, NPL = Non-Performing Loans Ratio, LDR = Loan-to-Deposit Ratio

Table 3: Correlation Analysis

Variables	ROA	ROE	CES	SIZE	CAR	NPL	LDR
ROA	1						
ROE	0.55	1					
CES	-0.212	0.0345	1				
SIZE	0.1141	0.2235	-0.121	1			
CAR	-0.073	-0.087	0.1823	-0.042	1		
NPL	-0.275	-0.212	-0.162	-0.022	0	1	
LDR	0.5512	0.6235	-0.132	0.1812	-0.1101	0.2111	1

ROA = Return on Assets, ROE = Return on Equity, CES = Cost Efficiency Score, SIZE = Bank Size, CAR = Capital Adequacy Ratio, NPL = Non-Performing Loans Ratio, LDR = Loan-to-Deposit Ratio

The data from Table 3 demonstrates significant relationships between different variables of the study. A moderate relationship between ROA and ROE (r = 0.55) is reasonable because profitability serves as the common denominator between these measures. Bank total loan deployment correlates positively with a strong magnitude to ROA (0.55). The study results demonstrate that ROA exhibits a slight negative relationship (-0.21) with cost efficiency (CES) while the two variables show no meaningful relationship (0.03) toward ROE. Efficiency improvements may not lead to increased profits because other market factors could influence the relationship between them. A positive connection exists between bank size and both ROA (0.11) and ROE (0.22) which implies larger banks might achieve slightly better profitability levels. The measurements of CAR demonstrate a very weak association before becoming negative with profitability on the one hand and NPL generating opposite correlations of -0.28 with ROA and -0.21 with ROE on the other hand. Efficient lending emerges as a vital key to profitability in banks since LDR demonstrates positive relationships with both ROA (0.55) and ROE (0.62).

Table 4: Panel Quantile Regression Results for ROA

Variable	25th Quantile	50th Quantile	75th Quantile
Cons	0.612566	0.872211	1.332934
CES	0.382131	0.234369	0.037699
SIZE	-0.0319	-0.01242	-0.02263
CAR	-0.00168	-0.00228	-0.00342
NPL	0.008225	-0.02491	-0.01299
LDR	0.002323	-0.00011	0.000112

Cons = Constant, CES = Cost Efficiency Score, SIZE = Bank Size, CAR = Capital Adequacy Ratio, NPL = Non-Performing Loans Ratio, LDR = Loan-to-Deposit Ratio

Table 4 CES effect on ROA throughout different profitability levels which validates Hypothesis H_1. The lowest profitability groups (0.25) experience the greatest impact from cost efficiency which is measured by the positive and statistically significant coefficient of 0.3821. Therefore, efficiency helps lower-profit banks perform better. Efficiency influences profitability to the highest degree at the low-profiting end of the bank sector but this effect diminishes and becomes nearly nonexistent at the high-profit end. SIZE has a slight inverse correlation to ROA across every quantile since bigger institutions do not always convert their growth into improved efficiency-based profits. The relationship between CAR and short-term profitability remains negative at minimal intensity throughout the analysis thus showing that increased capital holds may cause a slight decrease in immediate profitability. Banks holding high NPL experience positive effects until they reach profitability levels where NPL becomes a negative factor in the 50th and 75th quantiles. The relationship between LDR and ROA remains insignificant across every quantile indicating that this ratio is unimportant in this setting. H_1 obtains support from this analysis since efficiency impacts mostly less productive banks rather than banks at higher performance levels.

Panel Quantile Regression Results for ROE

The analysis of ROE with panel quantile regressions sheds light on Hypothesis H_2 because it exposes how bank efficiency impacts return on equity at different points in the profitability range. The effect of CES on return on equity is positive and powerful (0.4563) at the 25th quantile thus demonstrating that less profitable banks experience marked improvement in ROE from increased efficiency. Higher levels of efficiency lead to diminishing or negative ROE effects in profitable banks based on the results obtained at the median (-1.7230) and the 75th quantile (-1.6158). The quantile-based structure of your model proves effective since it demonstrates differences in efficiency impacts exist between various bank types. At the 25th quantile, SIZE produces a positive outcome of 0.1313 but develops a negative impact at higher levels of bank profitability.

Table 5: Panel Quantile Regression Results for ROE

Variable	25th Quantile	50th Quantile	75th Quantile
Cons	4.383707	8.800001	10.97213
CES	0.456264	-1.72301	-1.61582
SIZE	0.131285	-0.11019	-0.1715
CAR	0.000344	0.132174	0.087212
NPL	-0.2208	-0.13023	-0.11345
LDR	0.007851	0.005812	0.011321

Cons = Constant, CES= Cost Efficiency Score, SIZE = Bank Size, CAR = Capital Adequacy Ratio, NPL = Non-Performing Loans Ratio, LDR = Loan-to-Deposit Ratio

Smaller banks tend to receive enhanced benefits from increased size at low profitability levels whereas high-performing banks experience reduced equity returns as their dimensions grow beyond what efficiencies or management complexities can handle. CAR delivers weak positive effects only at the two higher quantiles (0.1322 and 0.0872). The data demonstrates how well capitalization supports or improves return on equity

performance in banking institutions which demonstrate solid operational results. The relationship between ROE and NPL ratio remains negative for every quantile because defaulting loans reduces earnings potential. The positive yet modest influence of LDR (loan-to-deposit ratio) on equity returns persists throughout all operational performance levels. The research findings validate Hypothesis H_2 because efficiency has a quantile-dependent relationship with ROE which modifies its magnitude and nature across different profitability levels.

DISCUSSION

The research reveals dissimilar levels of advantage from efficiency growth between different banks (Berger, 2007; Rahman, 2023). Banks with current low profitability levels gain substantial performance enhancement through improved operational efficiency. Highly profitable banks do not obtain significant benefits from increased operational efficiency but might sometimes show reduced performance levels, especially regarding their return on equity. These banks have possibly reached peak efficiency levels thus directing their focus towards innovation and market expansion instead of cost management (Attah et al., 2024). Research by Al-Homaidi et al. (2020) alongside their work demonstrated that profit levels from emerging market banks determine which operational adjustments yield better benefits. Firm profitability relations response to findings confirms that preserving asset quality stands equal to operational efficiency (Ali et al., 2021). The research results support the important requirement for banks to adopt distinct strategic approaches. Banks experiencing low or average profitability levels should put their efforts toward efficiency enhancement and banks demonstrating superior performance should opt for strategic expansion instead of additional cost reduction initiatives (Ali et al., 2021).

CONCLUSION

The research design includes analyzing banking efficiency effects on commercial bank profitability in Pakistan by using panel quantile regression for 2020 to 2024. The study findings demonstrate that the relationship between banking efficiency varies through different performance quantiles for ROA and ROE. Changes in efficiency lead to higher profitability rates for financially underperforming banks along with those at median performance levels yet the effect becomes non-significant or negative in banks with high profitability levels. Our findings confirm the hypotheses which show that bank efficiency operates differently based on the position of financial performance. Banks in need of profitability stabilization and improvement receive maximum benefits from operational improvements at the lower and middle quantile levels (Alqahtani et al., 2022). Profitable banks that already demonstrate high-efficiency levels realize extra efficiency gains do not result in increased profitability because the relationship can lead to marginal returns decline or over-optimization (Chaudhari et al., 2022). Policymakers must develop performance-specific strategies because banks require differentiated approaches based on their current state of operations. The study produces enhanced knowledge about how efficiency levels affect bank profitability under diverse conditions within a banking system that shows consistent changes. The research offers vital guidance to policymakers together with bank managers and financial regulators so they can develop adaptable but performance-oriented operational strategies that cover the entire banking industry.

IMPLICATIONS

The study offers usable recommendations to bank administrators and government officers in Pakistan. Fewer and moderately profitable banks benefit most from efficiency enhancements. Management should use performance-based approaches to develop strategies that match specific performance levels of individual banks. These results enable regulators to establish performance standards and protection systems that assist weak banking institutions. The research develops an individualized methodology to handle efficiency instead of adopting generic regulatory frameworks.

LIMITATIONS AND FUTURE ASPECTS

The research employs an effective methodological framework, but its analysis involves Pakistani commercial banks exclusively for a brief five-year period. External economic shocks which include the post-COVID recovery could potentially impact the results obtained. The focus should shift toward two areas: extending the research to more banks in South Asian regions and implementing inflation rate and interest rate analysis. The analysis

can benefit from additional depth through qualitative factors that measure customer satisfaction and management quality.

NOVELTY OF STUDY

The research combination of DEA-based efficiency scoring technique with panel quantile regression analysis distinguishes itself by being unusual in Pakistani banking studies. The analysis demonstrates how efficiency affects banks through various profitability levels using this approach which delivers better practical insights than traditional average-based models. The detailed method gives banks practical information which leads to better execution of performance goals.

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