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Competition, Risk-Taking, and Input–Output Contributions to Efficiency: A WRDDM Perspective on Pakistani Banks

Faluk Shair*
Department of Finance and Management Sciences, Lasbela University of Agriculture, Water and Marine Sciences, Uthal Email: falak.malghani@gmail.com

Dr. Muhammad Ghazanfar Abbas
Mir Chakar Khan Rind University of Technology, DG Khan Email: m.ghazni2live.com

Iqra Sami
Department of Finance and Management Sciences, Lasbela University of Agriculture, Water and Marine Sciences, Uthal Email: iqrasami@gmail.com

ABSTRACT
This study examines the nexus between competition, risk-taking behaviors, and bank performance, where performance is measured using technical efficiency. For measuring technical efficiency this study employed Weighted Russell Directional Distance Model (WRDDM) that quantifies the contribution of each input and output to inefficiency. This approach is particularly useful in identifying operational inefficiencies at a granular level. The results reveal that non-performing loans (NPLs) and excessive labor costs are the major contributors to inefficiency in private, state-owned, and foreign banks, while Islamic banks exhibit inefficiencies due to lower asset utilization. By identifying these inefficiency sources, WRDDM provides actionable insights for banks to optimize resource allocation and improve operational efficiency. Furthermore, it investigates the impact of competition and various risk-taking behaviors (credit risk, liquidity risk, and insolvency risk) on banking efficiency. Bootstrap truncated regression is employed to investigate the impact of competition and risk along with other bank-specific, industry-specific and macroeconomic variables on the technical efficiency of the Pakistani banks. Results revealed that competition asserted positive while credit and insolvency risks have negative impact on technical efficiency.
Keywords: Technical efficiency, competition, risk-taking behaviors, Bootstrap truncated regression

Introduction
Banking sector play crucial role in the development of the countries, particularly, in developing economies where financial intermediaries serve as conduits for the efficient allocation of resources and management of risks. The success of the banking sector foster economic growth of the countries; conversely their insolvencies can cause systemic crises with negative ramifications on the whole economy. The global financial system has undergone several reforms to enhance banking efficiency since last three decades. It is worth interesting to assess the determinants of banks performance in developing economies where banks are facing unique challenges related to the resource constraints, market dynamics and regulatory fluctuations(Shair & Shaorong, 2022). Technical efficiency is considered most appropriate tool to assess banks performance because it uses labor resources and capital as inputs in such a way to get their best of their output,

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typically measured by services provided or profit generation. Achieving technical efficiency for the Pakistani banks is especially significant because of economic constraint and competition pressure(Shair & Sami, 2025). It does not only help to minimize their costs but also reflects managerial competence and strategic resource allocations, providing insights into their internal practices and decision making processes. During the period of economic stress, efficient banks can survive better because of their lower operational cost and ability to sustain profit margins. Moreover, financial institutions in developing countries like Pakistan are facing more challenges to modernize their business operations and adopt modern technologies; one of the important benchmark is the technical efficiency which helps for assessing the success of such transformation. Several studies conducted in developing economies related with banks performance have shown that technical efficiency leads to the resilience and stability, making it most crucial indicator of banks performance for regulators and shareholders alike(Shah et al., 2022).

The Pakistani government had initiated and implemented several reforms during last three decades to create more competitive environment and to enhance the performance of Pakistani banks. The banking industry of Pakistani has undergone significant transformations since the early 1990s, transitioning from a heavily regulated environment dominated by state-owned banks to a more liberalized structure following financial reforms. These financial reforms were initiated to improve competition level and banks performance in Pakistan.

However, before 2013, most of the Pakistani banks were involved in anti-competitive practices. Therefore, an inquiry initiated by competitive commission of Pakistan (CCP) promoted to maintain healthy competition in the Pakistani industry, as it directly impacts the performance of banks. The inquiry revealed that Pakistani banks were engaged in anti-competitive practices. As a result, the State Bank of Pakistan imposed a penalty of 25 million on the seven largest banks and 30 million on the Pakistan Banking Association. This investigation raised important questions about the competitive dynamics within the Pakistani banking sector. While competition and prudential regulations in the banking industry are interconnected in many ways, the stability and strength of the financial sector are closely tied to the level of competition and market concentration (Delis, Staikouras, & Varlagas, 2008). Based on this scenario, it is crucial to investigate the competition dynamics in the Pakistani banking industry, its relationships with various risk-taking behaviors and performance indicators.

In addition to the competition, risk is another important factor that can influence technical efficiency of banks(Shair et al., 2021) . This study used three types of risks including credit risk, liquidity risk, and insolvency risk to investigate their impact on technical efficiency of the Pakistani banks.

Literature review

There is bulk of literature with examples of how the role of competition for banks' performance is unclear. Existing literature that examined the relationship between technical efficiency and competition has come up with two hypotheses. First hypothesis is known as competition-efficiency hypotheses that suggest that competition leads to improve efficiency. Scholars in the favor of this hypothesis argue that higher competition encourages banks to refine their lending technologies and borrower screening practices, thereby improving their overall performance. Higher competition encourages banks to specialize, concentrating on specific types of loans and targeting particular group of borrowers which lead to enhance their lending technologies, improving borrowers'

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Vol. 3 No. 11 (November) (2025)

screening and reducing lending costs(Wei, Han, Abedin, Ma, & Chai, 2023). There are several other studies that confirmed that competition leads to enhance banking efficiency (Ferreira, 2023; Handoyo, Suharman, Ghani, & Soedarsono, 2023; Tuyet & Ninh, 2023).

Contrary to the competition-inefficiency hypothesis, some other scholars claims that competition leads to deteriorate efficiency(Mateev, Usman Tariq, & Sahyouni, 2023; Olszak & Kowalska, 2023). This hypothesis claims that higher competition leads to a less stable relationship between customers and banks, increasing the likelihood that customers will switch to competitors. It results in information asymmetry, requiring banks to allocate additional resources for borrowers' screening and monitoring, which negatively impacts their efficiency. This prevailing confusion regarding the competition-efficiency relationship is one of the primary motivation of this study.

In addition to competition, risk is another important factor that can influence efficiency of banks. The modern banking theory claims that borrowers and lenders engagements and financial markets where they operate create uncertainty in the banking operations. This uncertainty is risk and it shows the extent to which a bank is willing to take on. The level of risk-taking is triggered by the competition and it can further influence technical efficiency of banks(Abel, Mukarati, Jeke, & Le Roux, 2023; Pham & Nguyen, 2023; Sharma, Gupta, & Jangir, 2024). Beltratti and Stulz (2012) claimed that during the financial crises of 2008-2009, excessive risk-taking contributed to bank runs, fire sales, limited lending, and financial instability. In order to avoid such risk-taking behaviors, banking regulators introduced stricter capital and liquidity requirements, leverage ratios, countercyclical loan loss provisions, and other regulatory measures (Basel III, 2013; BCBS III, 2010; BIS, 2011). The primary goal of these regulations is to deter excessive risk-taking by imposing higher costs for banks that involves more risk-taking activities. Thus, it has become crucial in literature to comprehend how risk-taking affects bank performance. Some studies focused on the relationship between risk and performance while focusing on credit risk or capital (Hussain, Ihsan, & Hussain, 2016; Saghir & Ch, 2020). However, these studies primarily address credit risk or capital risk; they do not take insolvency risk or liquidity risk into account. Studying the impact of liquidity risk and insolvency risk on the performance of banks is crucial due to their profound implications for financial stability and the overall economy. Insolvency risk pertains to the potential for a bank's liabilities to exceed its assets, resulting in bankruptcy while liquidity risk refers to a bank's capacity to fullfill its short-term financial obligations. Understanding and managing these risks are essential for maintaining the smooth functioning of the banking sector, as they directly affect a bank's ability to fund its operations, honor customer withdrawals, and lend to the economy. In Pakistan, economic volatility and regulatory requirements pose unique challenges for banking sector to maintain a certain balance between returns and risks. Investigating the impact of risk-taking behaviors on the technical efficiency is crucial to shape regulatory policies and managerial strategies.

In addition to the competition and risks, this study also focuses the role of other explanatory variables including macroeconomic variables, industry-specific, and bank-specific to shape banking efficiency. While competition and risk-taking behaviors are included as primary drivers of banks' performance but these effects do not occur in isolation. Bank-specific variables such as banks' size, capitalization, diversification and operational cost management act as explanatory factors that can mitigate or increase the impact of competition and risks on the performance of banks. For instance, well capitalized and larger banks may have better resources to face competitive pressure and implement more risk-taking strategies to enhance their profits. Similarly, among bank-

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specific variables, like banking sector development and e-banking influence how banks innovate and enhance their productivity. Information infrastructure development and GDP growth rate are the macroeconomic factors that shape the market opportunities and systemic risks. So, the use of all aforementioned variables with competition and risk-taking behaviors provides a comprehensive understanding for the determinants of banks' efficiency.

Methodology

Population and Sampling

Evaluation of this study is based over the period from 2007-2024 and population of this thesis encompasses all commercial banks operating in Pakistan during this period. The banking sector consists of 36 institutions, comprising state-owned banks, private banks, Islamic banks and foreign banks by 2024. To maintain consistency and ensure data reliability, the sample this study will include only those banks that have operated continuously from 2007 to 2024, resulting in a total of 26 banks being selected. This approach ensured a robust longitudinal analysis of the banking sector in Pakistan, accounting for structural changes and temporal trends.

The sample selection is guided by the availability of complete and reliable data. Banks that entered the market after 2007 or had important missing data related to the variables of interest are excluded from the analysis. This decision is obligatory to ensure the accuracy and consistency of the empirical results of this study, as incomplete data could lead to biased or unreliable findings.

To ensure uniformity, all monetary values are converted to Pakistani rupees (in millions). The variables selection and time span are constrained by data availability, particularly for some banks and variables. Despite these limitations, the comprehensive dataset compiled for this study provides a robust foundation for investigating the nexus among competition, risk-taking behaviors and banks' performance in Pakistan.

Purposive sampling method is employed, as it aims to include all banks that meet the criteria of continuous operation and availability of required data over the entire study period. This method made ensure that the sample is representative of the core banking sector in Pakistan, encompassing diverse ownership structures and operational models, such as foreign, Islamic, state-owned, and private banks. By focusing on a consistent sample over an extended period, this research captures the dynamic interplay between competition, risk-taking behaviors, and bank performance in a rapidly evolving economic and regulatory environment.

Measurement of technical efficiency

This study used Weighted Russell directional distance model (WRDDM) to measure productive inefficiency using production technology following (Chen, Yu, Chang, & Managi, 2014) and (Barros, Managi, & Matousek, 2012). Chen et al. (2014) proposed a new measure in linear form based on the directional distance function. This model proposes different advantages like easy computation and allows the inclusion of undesirable output into the programming problems. The main advantage of WRDDM is that it not only helps to measure technical inefficiency associated with desirable outputs and undesirable outputs and inputs to be different but also allows the technical inefficiency among each of the desirable outputs, undesirable outputs and inputs to be different (Chen et al., 2014). It helps the banks to identify where they need to focus more to improve their efficiency. This model provides more accurate results as compared to the conventional models as it directly incorporates weights to consider the appropriate

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

relationship between inputs and outputs, while traditional models weight them equally. WRDDM also considers for all the slacks for inputs, desirable outputs and undesirable outputs. WRDDM allows us to include non-performing loans as undesirable output and helps us to identify which resources used need to be improved. The study used this model because of its ability to incorporates NPLs into account which will help us to get more comprehensive results for the measurement of technical efficiency. Major advantage of WRDDM is that it can determine contribution effect of each variable for inefficiency and helps the firms to discuss how can they minimize their productive inefficiency.

The WRDDM used in this study includes three inputs, two desirable outs and one undesirable output. For the selection of inputs and outputs we used intermediate approach. We used three inputs including deposits, number of full-time employees and fixed assets. The desirable outputs are total advances (excluding non-performing loans) and non-interest income. An undesirable output is non-performing loans.

Let's inputs be denoted by x ϵ RN+ , good outputs by Y ϵ RM+ and undesirable outputs by b ϵ RL+ . the directional distance function seeking to decrease inputs and undesirable outputs and increase desirable outputs cab be defined by the following:

$$\vec{D}(x, y, b|g) = \sup(\beta : (x + \beta g, y + \beta g, b + \beta g) \epsilon T) \quad (1)$$

Where vector g = (gx, gy, gb) determines the directions in which inputs, desirable outputs and undesirable outputs are scaled. The technology reference set T = {(x, y, b): x can produce (y,b)} satisfies strong disposability of inputs and desirable outputs , and weaken disposability of undesirable outputs.

Suppose there are j = 1,2, 3…, k…, J firms in the data set. Each firm uses inputs x = (x1, x2…, xN) ϵ RN+ to mutually produce desirable outputs y = (y1, y2….,yM) ϵ RM+ and undesirable outputs b = (b1, b2,…bL) ϵ RL+. The Weighted Russell distance directional model of inefficiency calculation of firm can be described as:

$$\vec{D}(x, y, b|g) = \text{maximize}\left(\frac{1}{N} \sum_{n=1}^{N} \beta_n^k + \frac{1}{M} \sum_{m=1}^{M} \beta_m^k + \frac{1}{L} \sum_{l=1}^{L} \beta_l^k\right) \quad (2)$$

Subject to

$$\sum_{j=1}^{J} Z_k y_{mj} \geq y_{mk} + \beta_m^k \, g_{ymk} \quad (3)$$

$$\sum_{j=1}^{J} Z_k b_{lj} = b_{lk} + \beta_l^k \, g_{blk} \quad (4)$$

$$\sum_{j=1}^{J} Z_k x_{nj} \leq x_{nk} + \beta_n^k \, g_{xnk} \quad (5)$$

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

$$Zj \geq 0, \quad j = 1, 2, \ldots, k, \ldots, J \tag{6}$$

Where βkm, βkl and βkn are the individual inefficiency measures for desirable outputs, undesirable outputs and inputs respectively. Zk is the intensity variable to shrink or expand the individual observed activities of the firm k for the purpose of constructing convex combinations of the observed inputs and outputs. To estimate productivity change indicator, we set directional vector g = (gxnk, gymk , gblk) = (- xnk , ymk , -blk) ; WRDDM is shown as follow:

Subject to

$$\sum_{j=1}^{J} Z_k y_{mj} \geq y_{mk}(1 + \beta_m^k) \tag{7}$$

$$\sum_{j=1}^{J} Z_k b_{lj} = b_{lk}(1 - \beta_l^k) \tag{8}$$

$$\sum_{j=1}^{J} Z_k x_{nj} \leq x_{nk}(1 - \beta_n^k) \tag{9}$$

$$Zj \geq 0, \ j = 1, 2, \ldots, k, \ldots, J \tag{10}$$

This type of directional vector assumes that an inefficient firm can reduce productive inefficiency while decreasing inputs/ or undesirable outputs and increasing desirable outputs in proportion to the initial combination of actual inputs and outputs. The major advantage of WRDDM model that distinguishes it from other methods is that it yields a straightforward interpretation of inefficiency score. It helps us to identify the source which needs to be improve most. By using WRDDM, we incorporated non-performing loans into account for estimating technical efficiency. WRDDM allows us to recognize inefficiencies with respect to all variables that will help us to identify where we need to focus. This contribution effect cannot be determined with conventional methods to estimate technical inefficiency.

Measurement of explanatory variables and their expected impact on technical efficiency

In addition to the risk-taking behaviors and competition, this study also focuses various bank-specific, industry-specific and macroeconomic variables to examine their impact on the technical efficiency and total factor productivity of the Pakistani banks. Bank-specific variables include size, capitalization, operational cost management and diversification. Macroeconomic variables include GDP growth rate and information infrastructure development, while banking sector development and is used as an industry-specific variable. We also used financial crises as a dummy variable to capture the impact on the technical efficiency and TFP of the Pakistani banks.

Among bank-specific variables, banks size is measured by the natural logarithm of total assets that is frequently used in the empirical literature (Shair, Sun, Shaorong, Atta, & Hussain, 2019; Tan, 2016b). Usually, size asserts a positive influence on the performance of the banks because larger banks are more capable of reducing their cost through the economies of scale and scope. However, the banks with large sizes can enjoy such luxury

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to a certain extent, because when the bank's size becomes extremely large their efficiency could reduce because of bureaucratic and other reasons. So, we do not have any prior expectations about the impact of size on the technical efficiency and total factor productivity of the Pakistani banks.

Bank capital is calculated by the ratio of shareholders' equity to total assets, it has been extensively used as a proxy of capitalization in many recent studies like (Dietrich & Wanzenried, 2011; Shair et al., 2019; Tan, 2016b). Well capitalized banks are usually in a better position to utilize their capital more productively, so the higher ratio of this variable can lead to more efficiency in the Pakistani banks. On the other side, a higher capital can spoil the efficiency and productivity because the accumulated capital is also an expense source of financing. These contradictory opinions leave the door open for us to expect its impact on the technical efficiency and total factor productivity of the Pakistani banks.

Operational cost is another important factor that can influence the efficiency of banks. Many recent studies observed its impact on the performance of banks (Dietrich & Wanzenried, 2011; Kosmidou, 2008; Liu & Wilson, 2010; Shair et al., 2019; Tan, 2016b). Usually, the efficient banks have more operational costs because they paid higher salaries to their skilled and competent workers. So, we expect that banks with higher operational costs will perform better.

Diversification is calculated by the ratio of non-interest income to gross revenues (Tan & Anchor, 2017). More diversified banks engaged in various types of businesses that can decrease operational costs from the economies of scope. This reduction of operational cost can assert a positive influence on the efficiency of banks. So, we expect the positive influence of diversification on the efficiency of the Pakistani banks.

Risk is another important factor that can affect efficiency and total factor productivity. We used four types of risks to investigate their impact on efficiency and total factor productivity. We measured credit risk with loan loss provisions to total loans ratio, liquidity risk with liquid assets to total assets ratio. By following Tan and Anchor (2017) we expect negative impact of credit and liquidity risks on the efficiency and total factor productivity. We used Z-score as an inverse proxy for insolvency risk and capital risk is measured with capital adequacy ratio. We expect a positive impact of both these risks on efficiency and total factor productivity.

Banking sector development is estimated by the ratio of overall banking assets to the GDP of the economy. It may assert a negative impact on the efficiency of banks because it identifies further demand for banking services in the economy which may lead to an increase in the prices of banking services. The resulting increases in the banks' profits may encourage managers to behave carelessly to control various banking costs, which may lead to reduced efficiency.

GDP growth rate is used as a macroeconomic indicator to observe how monetary stable conditions of the economy can affect banking efficiency. In economics, the favorable macroeconomic and stable monetary conditions might enhance the efficiency of financial institutions. So, a positive association between GDP growth rate and banks efficiency is expected.

Information infrastructure development is another macroeconomic variable that is used in this study to observe its possible impact on the efficiency of banks. It is calculated by the number of mobile subscribers per 100 persons in Pakistan each year. We expect a positive association of this variable with banking efficiency because the higher ratio of this indicator means the country has better telecommunication infrastructure.

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

Measurement of risks

The study used the Z-index as an inverse proxy for a bank's insolvency risk, integrating profitability, leverage, and return volatility into a single comprehensive measure. The Z-index is frequently used as a risk and stability indicator in empirical literature (A. Berger, Klapper, & Turk-Ariss, 2009; Noman, Gee, & Isa, 2017; Tan, 2016b).

The Z-index is calculated using the formula:

$$Z - Index_{it} = \frac{ROA_{it} + \frac{E_{it}}{TA_{it}}}{\delta ROA_{it}} \quad (11)$$

Where

ROA_{it} represents the average return on assets for bank i during period t.

E_{it}/ TA_{it} denotes the average ratio of equity to total assets for bank i in period t.

δROA_{it} is the standard deviation of the return on assets for bank iii over the specified period.

A high Z-index value reflects financial stability and a low probability of insolvency, while a lower value indicates higher credit risk. As an inverse proxy for credit risk, the Z-index remains a critical measure in understanding a bank's financial soundness.

In addition to insolvency risk, the study measures credit risk using the ratio of loan loss provisions to total loans, where a higher ratio implies lower credit risk. This ratio serves as a direct and interpretable indicator of a bank's exposure to credit risk by reflecting the portion of total loans set aside as provisions for potential loan losses. It is a key measure of a bank's risk management and provisioning strategies, demonstrating its ability to absorb credit losses. A higher ratio indicates a more conservative risk management approach, while a lower ratio could signal potential vulnerabilities. By tracking this ratio over time and across banks, researchers can evaluate the adequacy of credit risk management measures and identify emerging credit concerns. Numerous studies have utilized this ratio to assess credit risk (Guevara, J., & Perez, 2005; Tan, 2016b).

In addition to measuring insolvency risk, this study also analyzes credit risk, where the closer to zero a loan loss provision to total loans ratio is, the lower is the credit risk. For a long time researchers in the field of banking use this ratio as a reliable estimate of credit risk because it is a simple and easy to interpret indicator of a bank's vulnerability to possible default of loans. For example, what's unique about the ratio is that it shows what percentage of a bank's total loans that bank sets aside for provisions in case these loans go into default. Consequently, it is a valuable signal of how well banks manage their risks of credit losses as well as their ability to absorb credit losses. A higher ratio means a more conservative and proactive risk management and a low ratio may indicate possible weaknesses and vulnerability increase. By looking at this ratio over time and comparing it across different banks, researchers can measure how well banks are managing their credit risk, gauge the emergence of new credit risks and make a contribution to policy development. ... and numerous studies have relied on this ratio as a pivotal measure of credit risk, including (Guevara et al., 2005; Tan, 2016b).

Measurement of competition

This study used Lerner index to measure competition for the Pakistani banks. This method was introduced by Lerner (1934) and continues to be employed in recent papers including (Bátiz-Zuk & Lara-Sánchez, 2023; Benzecry, Smith, & Reinarts, 2024; Kanoujiya, Rastogi, Abraham, & Bhimavarapu, 2023; Li & Peng, 2024; Srivastava, Singh, & Jain, 2023). It expresses the disparity between a bank's cost and the price for a

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

product with the mark-up pointing to the level of the market competition. Banking market competition is expected to be higher if the Lerner index has a low value. The Lerner index is computed as:

$$\text{Lerner index}_{it} = \frac{\text{PTA}_{it} - \text{MCTA}_{it}}{\text{PTA}_{it}} \quad (12)$$

Where PTAit represents the price of total assets for bank i in a specific period t. This total price is calculated by dividing, total revenue (which includes both interest and non-interest income) to total assets , following the methodologies applied by (Guevara et al., 2005; Tan, 2016b). Whereas the marginal cost of total assets, MCTAit, is calculated by translog cost function, as outlined in the works of (Anginer, Demirguc-Kunt, & Zhu, 2014; Demirguc-Kunt & Huizinga, 2010; Noman et al., 2017) . The value of the Lerner index lies between 0-1, where lower value shows higher competition. In addition to the Lerner index, this study also used the Boone indicator and Panzar-Rose H Statistic to measure competition.

Modeling the impact of competition on the Technical efficiency

A widely adopted approach in the literature involves a two-stage methodology. Initially, efficiency scores or productivity indices are calculated then those scores are regressed on various explanatory variables, particularly those representing the banking environment (Kumar Sharma & Dalip, 2014; Shair et al., 2021; Tan, 2016a). This approach facilitates the analysis of how bank-specific, industry-specific, and macroeconomic factors influence dependent variables, such as technical efficiency and total factor productivity (TFP). In this research, along with competition, risk-taking behavior, additional bank-specific, industry-specific, and macroeconomic variables are included in the regression analysis.

Firstly, this study employed bootstrap truncated regression to investigate the impact of competition and risk on the performance of banks when it is assessed with technical efficiency. In banking studies, efficiency is often analyzed using non-parametric and parametric frontier approaches, with the second-stage regression employed to identify key influencing factors (Simar & Wilson, 2007). However, efficiency scores are bounded between zero and one, violating the assumptions of ordinary least squares (OLS) regression, which assumes normally distributed residuals. In such cases, truncated regression is a more appropriate econometric approach (McDonald, 2009). This study employs bootstrap truncated regression in the second stage to examine the impact of competition and risk-taking behaviors on the technical efficiency of commercial banks in Pakistan. The efficiency scores are estimated using the Weighted Russell Directional Distance (WRDDM) model, which provides a comprehensive measure of inefficiency by capturing input-output contributions. Since efficiency scores are left-truncated at zero, a truncated regression model with bootstrapping is applied to ensure statistical validity and to correct for potential bias in the estimation process.

The importance of this methodology stems from the need to obtain unbiased and consistent estimates when dealing with efficiency scores. Traditional two-stage DEA-based regressions have been criticized for producing biased estimates due to serial correlation among efficiency scores (Simar & Wilson, 2007). To overcome this issue, the double-bootstrap truncated regression approach is applied, allowing for more accurate inference in the presence of truncated data. The bootstrapping technique repeatedly resamples the data, correcting for bias and improving the reliability of estimated

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

coefficients. This approach is particularly relevant in banking studies, where market competition, financial stability, and risk-taking behaviors influence efficiency outcomes in complex ways (A. N. Berger, Klapper, & Turk-Ariss, 2017).

Foe empirical estimation, this study formulates the following truncated regression model:

$$TE_{it} = \alpha + \beta_1 + \beta_2 Risk_{it} + \beta_3 X_{it} + \beta_4 Inds_{it} + \beta_5 Macro_t + Dummy_t + e_{it} \quad (13)$$

Here, subscript i and t denotes banks and years respectively. $Competition_{it}$ represent market competition that is measured with Lerner index. $Risk_{it}$ comprises a vector of risk variables including the liquidity, insolvency and credit risks. X_{it} includes bank-specific variables such as banks size, capitalization, operational cost management and diversification. $Inds_{it}$ are industry-specific variables such as E-banking and banking sector development. $Macro_{it}$ represent macroeconomic variables including GDP and information infrastructure development. Lastly, financial crises are accounted for using dummy variable to observe their effects on the technical efficiency of Pakistani banks.

Results and Discussions

Results of the Table 1 and Figure 1 reports the longitudinal analysis of bank inefficiency from 2007 to 2024, assessed using the Weighted Russell Directional Distance Model (WRDDM), reveals a nuanced trajectory of technical inefficiency alongside dynamic fluctuations in key input and output variables. The line graph illustrates how inefficiency scores, although initially high in the pre-2010 period, exhibit a general declining trend over time—indicating incremental improvements in operational performance. In the earlier years (2007–2010), inefficiency remains elevated (e.g., 0.389 in 2007), influenced by relatively high values in non-performing loans (NPLs) and suboptimal use of advances and deposits. The contribution of inputs such as number of employees and fixed assets was also disproportionate to outputs, reflecting inefficiencies in resource utilization.

From 2011 to 2015, the inefficiency scores begin to taper, albeit with some volatility, hinting at reforms and tightening of financial regulations that may have started to yield results. This period witnesses a more balanced alignment between inputs and outputs, although NPLs and low levels of non-interest income continue to exert upward pressure on inefficiency. The most significant improvements occur post-2016, where the line graph shows a downward movement in inefficiency, aligning with improved asset management, better credit allocation, and consistent performance in non-interest income—suggesting diversification of revenue streams. Notably, the inefficiency score reaches its lowest point in 2015 (0.167), reflecting operational tightening, leaner asset structures, and more targeted financial intermediation.

In the later years (2020–2024), inefficiency levels begin to stabilize at lower levels, accompanied by relatively optimized input usage—particularly with regards to employee count and fixed assets. This stabilization, as evidenced by the plateauing trend in the line graph, indicates that banks have likely reached a structural equilibrium in efficiency practices, supported by digital transformations and enhanced risk assessment frameworks. Throughout the period, the role of outputs such as advances and non-interest income becomes increasingly central to explaining efficiency gains. Overall, the analysis underscores a gradual but persistent improvement in banking efficiency over nearly two decades, reflecting adaptive capability, policy interventions, and the strategic reallocation of financial and human capital. The decomposition of inefficiency through WRDDM offers granular insight into input-output mismatches and provides an empirical

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

foundation for targeted performance enhancement in the banking sector.

Table 1: Disaggregated scores of technical inefficiency (overall banks)

Year		No of employees	Fixed Assets	Total deposits	Advances	Non-interest income	NPLs	Inefficiency
2007	Average	0.573	0.051	0.357	0.186	0.273	0.573	0.389
	Std.	(0.361)	(0.162)	(0.321)	(0.321)	(0.198)	(0.447)	(0.210)
2008	Average	0.416	0.146	0.168	0.749	0.354	0.482	0.465
	Std.	(0.276)	(0.234)	(0.192)	(0.613)	(0.291)	(0.342)	(0.348)
2009	Average	0.375	0.178	0.123	0.567	0.477	0.613	0.439
	Std.	(0.238)	(0.198)	(0.172)	(0.514)	(0.187)	(0.312)	(0.229)
2010	Average	0.438	0.009	0.156	0.369	0.522	0.589	0.384
	Std.	(0.228)	(0.039)	(0.214)	(0.287)	(0.132)	(0.272)	(0.180)
2011	Average	0.339	0.029	0.103	0.634	0.528	0.423	0.368
	Std.	(0.277)	(0.101)	(0.132)	(0.332)	(0.098)	(0.278)	(0.257)
2012	Average	0.294	0.018	0.094	0.287	0.378	0.391	0.295
	Std.	(0.265)	(0.029)	(0.143)	(0.265)	(0.298)	(0.265)	(0.160)
2013	Average	0.272	0.021	0.011	0.104	0.296	0.248	0.213
	Std.	(0.234)	(0.019)	(0.132)	(0.180)	(0.222)	(0.178)	(0.120)
2014	Average	0.179	0.037	0.142	0.008	0.269	0.587	0.246
	Std.	(0.314)	(0.048)	(0.265)	(0.006)	(0.176)	(0.319)	(0.110)
2015	Average	0.097	0.044	0.176	0.021	0.231	0.129	0.167
	Std.	(0.413)	(0.055)	(0.103)	(0.102)	(0.123)	(0.212)	(0.090)
2016	Average	0.143	0.033	0.193	0.124	0.189	0.324	0.215
	Std.	(0.251)	(0.022)	(0.091)	(0.156)	(0.241)	(0.275)	(0.100)
2017	Average	0.226	0.041	0.224	0.135	0.142	0.518	0.268
	Std.	(0.298)	(0.022)	(0.129)	(0.132)	(0.154)	(0.331)	(0.120)
2018	Average	0.267	0.134	0.155	0.238	0.323	0.138	0.254
	Std.	(0.210)	(0.104)	(0.186)	(0.197)	(0.284)	(0.297)	(0.198)
2019	Average	0.193	0.053	0.109	0.152	0.266	0.082	0.184
	Std.	(0.178)	(0.152)	(0.118)	(0.213)	(0.183)	(0.007)	(0.090)
2020	Average	0.144	0.046	0.076	0.008	0.292	0.006	0.129
	Std.	(0.338)	(0.113)	(0.132)	(0.075)	(0.310)	(0.013)	(0.197)
2021	Average	0.233	0.051	0.131	0.216	0.274	0.327	0.237
	Std.	(0.050)	(0.015)	(0.018)	(0.040)	(0.050)	(0.039)	(0.050)
2022	Average	0.216	0.044	0.117	0.182	0.246	0.117	0.187
	Std.	(0.067)	(0.025))	(0.152)	(0.068)	(0.076)	(0.248)	(0.09)
2023	Average	0.255	0.056	0.165	0.239	0.289	0.327	0.245
	Std.	(0.054)	(0.035)	(0.018)	(0.034)	(0.038)	(0.065)	(0.073)
2024	Average	0.296	0.060	0.127	0.259	0.347	0.367	0.303
	Std.	(0.047)	(0.025))	(0.152)	(0.045)	(0.036)	(0.135)	(0.044)
Mean		0.275	0.058	0.146	0.249	0.316	0.347	0.278

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

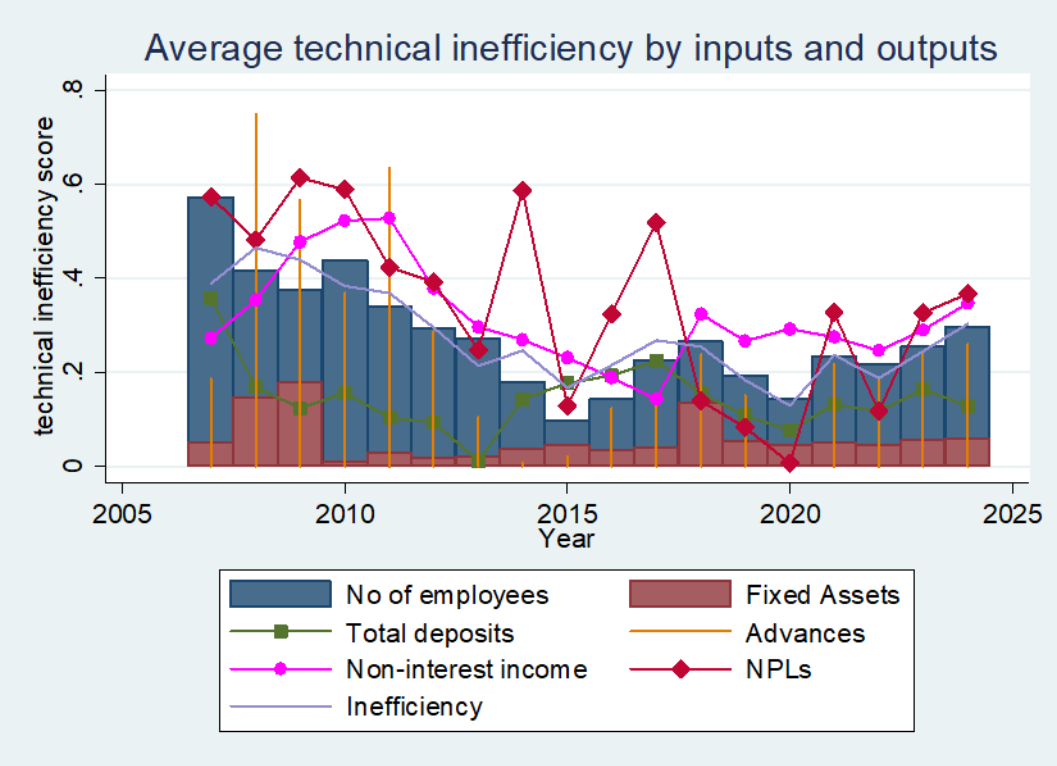

Figure 1: Disaggregated technical inefficiency of overall banks

There exist difference in operational and institutional performance among banks. To examine the difference in term of their performance we have divided the pakistani banks into four groups including private, state-owned, Islamic and foreign banks. Table 2 and Figure 2 represent the results of variable wise inefficiency levels across all these four groups. The analysis of group-wise technical inefficiency of Pakistani banks from 2007 to 2024 reveals significant insights into the input-output inefficiency dynamics across different banking groups. Private banks demonstrated a notable decline in inefficiency over time, with a mean inefficiency of 0.251. In the early years, inefficiency was substantially high, particularly in 2007 and 2009, driven largely by employee-related inefficiencies and advances. However, the trend shows marked improvement in later years, particularly from 2013 onwards, where the inefficiency levels remained relatively low and stable. Among inputs, the number of employees consistently contributed the most to inefficiency, followed by advances and non-performing loans (NPLs). The minimal inefficiency contributions of fixed assets and total deposits suggest these resources were managed more efficiently in the private sector. Non-interest income also played a moderate role in inefficiency, reflecting the challenges private banks faced in diversifying income streams.

In contrast, state-owned banks exhibited persistently higher inefficiency, with a mean value of 0.300. Their inefficiency trajectory indicates volatility, particularly in the period between 2007 and 2012. Advances and NPLs were the most significant contributors to inefficiency across the entire time span. In several years, the inefficiency linked to advances was exceptionally high, especially in 2008 and 2011, reflecting weak credit risk assessment and loan management practices. Moreover, state-owned banks consistently showed poor performance in converting non-interest income into efficient output. The number of employees remained another key inefficiency driver, underscoring longstanding issues of overstaffing and underutilization of human capital in public banking institutions. Compared to private banks, the inefficiency reduction in state-

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

owned banks was slower, indicating institutional rigidity and less effective reforms.

Islamic banks demonstrated a comparatively better inefficiency profile, with a mean value of 0.198. The inefficiency levels declined steadily over time, showing the sector's improving operational performance. Inefficiency from employee input showed a consistent downward trend, indicating growing labor productivity. However, inefficiency in advances was relatively high in the early years, particularly in 2008 and 2009, likely due to the sector's initial challenges in credit structuring and risk assessment under Shariah-compliant models. Fixed assets and total deposits contributed the least to inefficiency, reflecting disciplined investment and deposit mobilization strategies. Notably, Islamic banks maintained low inefficiencies in NPLs in the later years, suggesting improved asset quality and risk management. Their non-interest income inefficiencies remained moderate but better managed than in state-owned banks.

Foreign banks displayed the lowest average inefficiency among all groups, at 0.230. These banks benefited from lean operational structures and robust management systems. Over time, inefficiencies related to employees and advances declined significantly. Fixed assets consistently had minimal inefficiency contributions, and foreign banks showed better deposit mobilization efficiency as well. Despite some inefficiency spikes in the early years in terms of NPLs and non-interest income, they improved considerably in subsequent periods. The overall trend indicates that foreign banks adapted swiftly to market changes and managed their resources efficiently. Their superior performance also reflects global best practices and stringent internal controls.

Table 2: Disaggregated inefficiency score estimated by Weighted Russell distance model (group wise)

Private	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**Mean**
No of Employees	0.562	0.381	0.361	0.391	0.312	0.272	0.243	0.135	0.083	0.172	0.192	0.223	0.189	0.125	0.139	0.115	0.157	0.196	0.236
Fixed Assets	0.048	0.119	0.192	0.006	0.036	0.023	0.017	0.026	0.021	0.029	0.045	0.102	0.041	0.055	0.062	0.042	0.058	0.06	0.055
Total Deposits	0.328	0.129	0.108	0.098	0.082	0.061	0.008	0.132	0.123	0.103	0.186	0.132	0.087	0.059	0.071	0.063	0.089	0.127	0.11
Advances	0.196	0.592	0.671	0.402	0.539	0.312	0.136	0.092	0.051	0.094	0.139	0.287	0.172	0.01	0.078	0.095	0.212	0.259	0.241
Non-Interest Income	0.259	0.276	0.413	0.432	0.452	0.345	0.245	0.218	0.201	0.168	0.119	0.279	0.234	0.249	0.271	0.219	0.289	0.347	0.279
NPLs	0.478	0.397	0.557	0.521	0.382	0.367	0.216	0.662	0.159	0.362	0.439	0.172	0.112	0.016	0.083	0.127	0.327	0.367	0.319
Inefficiency	0.364	0.372	0.431	0.351	0.345	0.276	0.178	0.251	0.15	0.192	0.221	0.241	0.172	0.102	0.127	0.193	0.245	0.303	0.251
State-owned																			
No of employees	0.653	0.513	0.432	0.482	0.391	0.374	0.295	0.246	0.123	0.21	0.284	0.325	0.237	0.183	0.257	0.217	0.225	0.231	0.315
Fixed Assets	0.056	0.201	0.167	0.143	0.025	0.028	0.031	0.052	0.074	0.041	0.036	0.156	0.07	0.061	0.052	0.092	0.063	0.066	0.079

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

Total deposits	0.556	0.191	0.148	0.228	0.134	0.015	0.015	0.176	0.265	0.312	0.292	0.211	0.145	0.038	0.089	0.058	0.061	0.059	0.166
Advances	0.265	0.827	0.482	0.472	0.832	0.434	0.173	0.004	0.087	0.157	0.118	0.363	0.214	0.017	0.089	0.049	0.061	0.065	0.262
Non-interest income	0.342	0.557	0.623	0.613	0.635	0.482	0.362	0.318	0.278	0.216	0.187	0.4	0.315	0.367	0.278	0.247	0.263	0.274	0.375
NPLs	0.663	0.562	0.715	0.649	0.492	0.436	0.285	0.539	0.276	0.394	0.718	0.228	0.143	0.026	0.079	0.052	0.058	0.055	0.354
Inefficiency	0.473	0.521	0.482	0.494	0.468	0.332	0.227	0.258	0.221	0.253	0.312	0.324	0.225	0.138	0.185	0.158	0.162	0.168	0.3
Islamic																			
No of employees	0.467	0.263	0.342	0.381	0.327	0.243	0.251	0.162	0.052	0.082	0.164	0.213	0.163	0.111	0.184	0.208	0.085	0.069	0.209
Fixed Assets	0.044	0.135	0.258	0.008	0.027	0.007	0.012	0.035	0.031	0.025	0.031	0.092	0.043	0.03	0.074	0.067	0.032	0.029	0.054
Total deposits	0.217	0.221	0.176	0.107	0.062	0.008	0.004	0.001	0.089	0.208	0.156	0.213	0.086	0.113	0.162	0.127	0.116	0.0114	0.115
Advances	0.112	0.772	0.492	0.219	0.489	0.103	0.082	0.005	0.002	0.165	0.092	0.152	0.129	0.003	0.135	0.083	0.093	0.057	0.177
Non-interest income	0.137	0.212	0.344	0.472	0.421	0.286	0.219	0.258	0.189	0.153	0.09	0.263	0.254	0.248	0.178	0.219	0.189	0.174	0.239
NPLs	0.428	0.461	0.572	0.524	0.416	0.359	0.239	0.438	0.067	0.162	0.376	0.102	0.007	0.004	0.092	0.115	0.078	0.09	0.252
Inefficiency	0.28	0.386	0.404	0.326	0.318	0.187	0.157	0.174	0.101	0.165	0.176	0.204	0.142	0.115	0.108	0.163	0.093	0.057	0.198
Foreign																			
No of employees	0.511	0.452	0.391	0.498	0.412	0.334	0.287	0.152	0.154	0.114	0.295	0.337	0.248	0.201	0.235	0.267	0.155	0.137	0.288
Fixed Assets	0.046	0.176	0.103	0.009	0.03	0.012	0.024	0.044	0.051	0.038	0.053	0.173	0.058	0.04	0.062	0.082	0.063	0.063	0.063
Total deposits	0.031	0.145	0.067	0.183	0.129	0.017	0.018	0.27	0.215	0.221	0.301	0.043	0.123	0.108	0.082	0.118	0.151	0.154	0.132
Advances	0.176	0.642	0.443	0.284	0.685	0.239	0.037	0.007	0	0.086	0.068	0.173	0.076	0.001	0.056	0.092	0.123	0.094	0.182
Non-interest income	0.195	0.382	0.423	0.494	0.437	0.432	0.351	0.249	0.276	0.238	0.167	0.361	0.302	0.365	0.317	0.333	0.291	0.286	0.328
NPLs	0.218	0.368	0.593	0.558	0.362	0.338	0.222	0.538	0.092	0.294	0.479	0.006	0.005	0.003	0.076	0.009	0.124	0.073	0.242
Inefficiency	0.235	0.402	0.375	0.381	0.392	0.268	0.183	0.249	0.162	0.193	0.257	0.217	0.164	0.142	0.172	0.127	0.114	0.098	0.23

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

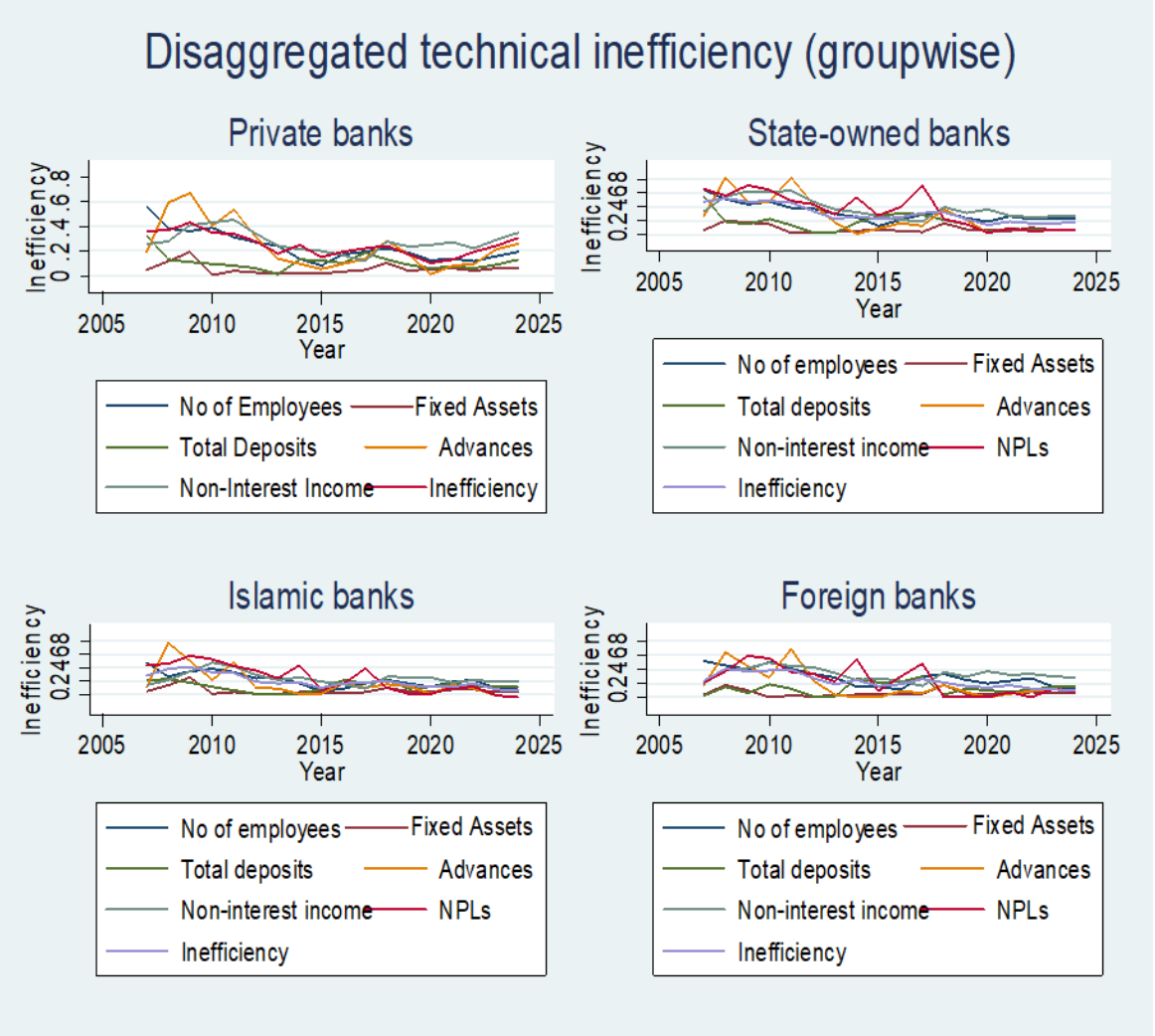

Figure 2 Groupwise technical inefficiency with contribution effect

In Table 3 ,we apply Kruskal- Wallis test to examine whether inefficiency scores among all four banks' groups are statistically different or not. Kruskal- Wallis test is an alternative to the non-parametric method of two-sample t-test. The results of the test suggest that we have to reject null hypothesis that all four groups have similar inefficiency scores. The results suggest that inefficiency scores are statistically different among four bank groups. It is evident that all variables are strongly significant at 0.1% level.

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

Table 3: Difference of technical inefficiency among banks

	Private	State-owned	Islamic	Foreign	Chi^2	Sig
Technical inefficiency						
No of employees	0.240	0.316	0.217	0.306	14.31	***
Fixed Assets	0.057	0.091	0.066	0.063	15.76	***
Total deposits	0.115	0.190	0.120	0.129	21.81	***
Advances	0.241	0.297	0.193	0.192	10.57	***
Non-interest income	0.256	0.375	0.238	0.333	33.56	***
NPLs	0.312	0.402	0.277	0.260	13.53	***
Inefficiency	0.240	0.315	0.212	0.245	19.88	***

*** represent 0.1% significant level

Figure 3 shows the technical efficiency of the Pakistani banks from 2007-2024. The result reveals critical insights into the sector's operational performance across different banking groups—private, state-owned, Islamic, foreign, and the overall industry. Over the 18-year period, a clear trajectory of improvement is evident, particularly after 2011, suggesting the impact of post-financial crisis regulatory reforms and technological adoption. Private banks have consistently demonstrated strong efficiency scores, outperforming other groups for most of the observed period. Their steady ascent from 0.636 in 2007 to a peak of 0.898 in 2020 reflects dynamic resource management, customer-centric innovation, and agility in market adaptation. Islamic banks, despite starting at a relatively lower efficiency level, exhibited remarkable progress, especially after 2012. This indicates the growing maturity of Islamic banking infrastructure, increased financial inclusion, and product diversification aligned with Shariah principles. Interestingly, Islamic banks surpassed all other groups in technical efficiency in the final years (2022–2024), achieving a high of 0.943 in 2024—a testament to their resilience and optimized use of inputs.

State-owned banks, in contrast, displayed a more volatile efficiency pattern, with modest improvements and occasional stagnation, reflecting challenges related to bureaucratic inertia, governance inefficiencies, and legacy operational constraints. Nonetheless, their gradual climb from a score of 0.527 in 2007 to 0.832 by 2024 suggests that ongoing reform efforts and digitalization initiatives are slowly bearing fruit. Foreign banks showed moderate but consistent performance, maintaining relatively high efficiency throughout the period. Their operational consistency may stem from superior management practices, global best standards, and strategic market focus, although they did not significantly outpace local private competitors.

The overall banking sector mirrored the trends of its most efficient constituents, with average efficiency improving from 0.662 in 2007 to 0.844 in 2024. This trend reflects systemic enhancements in risk management, technological integration, and regulatory compliance. Notably, the period from 2013 to 2020 stands out as a phase of significant convergence across banking groups, possibly due to the unified push toward branchless banking, core banking system upgrades, and macroeconomic stabilization. The slight decline in 2023 and 2024 for private and foreign banks, contrasted with the continued rise in Islamic and state-owned banks, hints at a shifting competitive landscape and possibly emerging constraints faced by traditionally dominant actors.

Overall, the evolution of technical efficiency in the Pakistani banking sector underscores

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DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

a gradual but meaningful transformation, with Islamic banks emerging as a new frontier of efficiency leadership. These findings highlight the importance of sustained investment in digital innovation, human capital, and institutional reforms for maintaining and enhancing technical efficiency in a dynamic financial environment.

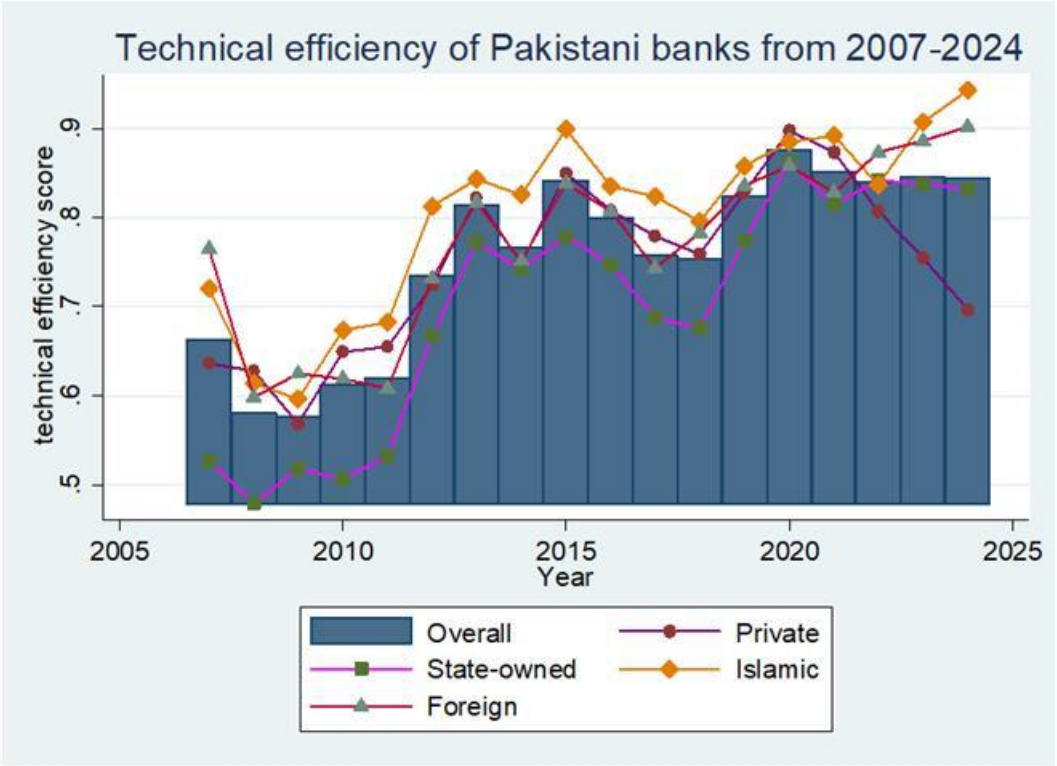

Figure 3: Groupwise technical efficiency (WRDDM)

Impact of competition and Risk on the technical efficiency by using truncated regression

Table 4 show the impact of risk and competition on the technical efficiency of the commercial banks when technical efficiency is measured with WRDDM respectively. The results show that competition has a significant positive relationship with technical efficiency in all three models. It shows that technical efficiency of the Pakistani banks improves with the increase of competition because lower value of the Lerner index and Boone indicator means higher competition. These findings are consistent with the competition-efficiency hypothesis. The Quite life hypothesis that is considered as heart of the competition hypothesis argue that a “Quite life” in concentrated banking markets induces incompetent managerial practices because their market power allow those managers to pass higher costs in the form of higher prices. These findings can also be justified as more competition prompts banks to specialize and focus on specific types of loans and targeting a particular group of borrowers. It encourages management to adjust their lending technologies which results in better borrowers screening and reduce lending cost that ultimately improves their efficiency.

By viewing that higher competition motivates banks to adopt modern technologies to get competitive advantage, we also include an E-Banking variable to observe its impact on technical efficiency. With respect to this variable, our results support the absorptive capability theory. According to the theory of absorptive capability, banks with greater levels of capacity are better able to recognize and assimilate new knowledge connected

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to technology and innovation, allowing them to embrace and integrate new technologies more successfully. The use of new technologies, such as mobile banking, online banking, and automated teller machines (ATMs), has transformed the banking industry and enabled banks to operate more efficiently. In Pakistan, the use of the digital transactions improved substantially during last decade where ATM, internet and banking mobile banking transactions increased 611%, 1994% and 88050% respectively. Modern technologies helped the Pakistani banks to improve their efficiency and reduce their cost. For instance, online banking allows the Pakistani banks to provide services to their clients without having to maintain physical branches, which saved money on things like rent, staffing, and utilities. By enabling customers to complete routine transactions without a teller's assistance, automated teller machines (ATMs) also helped to reduce the costs associated with physical branches. The absorptive capability theory suggests that banks with higher absorptive capacity are better able to recognize and assimilate new information related to technology and innovation, which enables them to adopt and integrate new technologies more effectively.

Moreover, technology can also enable banks to develop new financial products and services, which can help them to expand their customer base and increase their revenue. For example, the development of mobile payments and digital wallets has enabled banks to offer new services to their customers and capture new markets. The absorptive capability theory suggests that banks with higher absorptive capacity are better able to recognize and assimilate new information related to technology and innovation, which enables them to develop and implement effective strategies for developing new products and services.

Moving towards risk-taking behaviors, all of three risk indicators show a significant negative relationship with the technical efficiency. As a consequence, the negative relationship between risk-taking behaviors and technical efficiency highlights the importance of effective risk management practices within Pakistani banks to enhance their efficiency and overall financial performance. The study's findings reveal a significant negative effect of credit risk on the technical efficiency of Pakistani banks. This implies that higher levels of credit risk within these banks can hinder their ability to operate efficiently. Credit risk refers to the likelihood of borrowers defaulting on their loans, and its negative impact on technical efficiency suggests that banks with a higher credit risk face challenges in effectively allocating resources and managing their loan portfolios. This may be attributed to various factors, such as increased provisioning for non-performing loans, higher administrative costs associated with credit risk management, and potential disruptions in the lending process due to defaults.

Liquidity risk shows a significant negative relationship with technical efficiency in all three models. The technical efficiency of the Pakistani banks suffered from liquidity risk in a number of ways. First off, when the Pakistani banks faced with a lack of liquidity, they compelled to sell their assets rapidly and at low prices, which resulted in losses and reduced their capital base and made it harder for them to make money. Second, in ordered to minimize liquidity risk, the Pakistani banks retained a bigger proportion of liquid assets, such as cash or low-yielding, highly liquid securities. It constrained the bank's ability of the Pakistani banks to invest in more productive and higher-yielding assets, which lowers the bank's total profitability and efficiency. Thirdly, liquidity risk also forced banks to turn to more expensive sources of liquidity, including borrowing from institutions that charge higher interest rates that ultimately asserted negative effect on their performance. These findings are in line with the results of Tan and Floros (2018) and Fiordelisi, Marques-Ibanez, and Molyneux (2011) who investigated the relationship

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between risk and efficiency in China and Europe respectively. Z-score that is used as an inverse proxy of insolvency risk, shows significant positive relationship with technical efficiency. This result can be interpreted as stable banks that have a lower probability of being insolvent are more efficient.

Among banks-specific variables, bank size shows a highly significant positive relationship with efficiency at 0.1% level. These results are consistent with the findings of Safiullah and Shamsuddin (2022). Due to a number of circumstances, larger banks in Pakistan are technically more efficient. First of all, larger banks typically have access to more resources, including cash and technology, which may be used to improve operating procedures and efficiency. Furthermore, economies of scale are essential since they allow larger banks to spread fixed expenses across a wider customer base, which results in cost advantages. This enables them to make investments in cutting-edge equipment, infrastructure, and employees, resulting in streamlined operations and increased efficiency. Additionally, larger banks frequently have a wider geographic presence and a more varied offering of goods and services, which can draw in more clients and increase income. By serving a larger customer base, these banks can achieve higher utilization rates of their resources, further enhancing their efficiency.

Among industry-specific variables, banking development shows significant positive relationship with technical efficiency which shows that efficiency of the Pakistani banks improves in a more developed banking sector. These findings show that a highly developed banking sector reflects the fact that the demand for banking services is large. The increase volume of traditional deposits, loans and non-interest income activities enables the Pakistani banks to minimize their costs via economies of scale and economies of scope; hence, this cost reduction leads to improve banks efficiency.

Among macroeconomic variables, results revealed that infrastructure development had significant positive impact on the technical efficiency in all three models highlighting the changing landscape of banking services and consumer behavior. This result suggests that increased mobile subscribership, indicative of the growing adoption of mobile banking and digital financial services, contributes positively to banks' technical efficiency. The expansion of mobile banking channels allows banks to reach a wider customer base, offering convenient and accessible banking solutions. Moreover, it implies that banks leveraging mobile platforms efficiently enhance their service delivery, optimizing their operational processes and resource utilization. This finding underscores the pivotal role of technology and digitalization in reshaping banking practices, emphasizing the importance for banks to continually invest in and capitalize on mobile-based services to bolster their technical efficiency and adapt to evolving customer preferences in the digital era.

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ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 3 No. 11 (November) (2025)

Table 4: Bootstrap truncated regression when TE is measured with WRDDM

	(1) TE (When competition is measured with the Lerner index)	(2) TE (When competition is measured with the Boone indicator)	(3) TE (When competition is measured with the H-statistic)
Competition	-0.312**	-0.275**	0.172***
	(-3.11)	(-3.71)	(7.31)
Credit risk	-0.291*	-0.183*	-0.361**
	(-2.23)	(-2.56)	(-2.71)
Liquidity risk	1.512*	1.245*	1.234**
	(2.67)	(2.65)	(3.23)
Insolvency risk	0.00321**	0.00451**	0.00362
	(2.67)	(2.33)	(0.23)
Size	0.0822***	0.0735***	0.0744***
	(4.67)	(5.88)	(5.98)
Capitalization	-0.396	-0.345	-0.435
	(-1.31)	(-1.36)	(-1.44)
Diversification	0.344	0.377	0.163
	(1.75)	(1.43)	(0.73)
Operational cost management	-0.356	-0.366	-0.391
	(-1.19)	(-1.43)	(-0.98)
Banking sector development	0.632***	0.623*	0.667
	(3.88)	(2.68)	(1.63)
E-Banking	0.0341**	0.0377**	0.0266**
	(2.66)	(2.65)	(2.45)
GDP growth	1.152	1.062**	1.666*
	(1.55)	(3.71)	(2.22)
Information infrastructure development	-0.0372***	-0.0448**	-0.0227**
	(-5.57)	(-2.89)	(-3.62)
Financial crises	0.0649	0.0653	0.0669
	(1.77)	(1.80)	(1.89)
Constant	-0.183	-0.549	-0.607*
	(-0.62)	(-1.66)	(-2.00)
Sigma	0.0512***	0.0129***	0.0515***
	(8.63)	(12.22)	(10.43)
No of Observations	312	254	223
Wald chi2	232.610	120.614	346.302
P-Value	0.0000	0.0000	0.0000

t statistics in parentheses
* p < 0.05, ** p < 0.01, *** p < 0.001

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Conclusion and Suggestions

Conclusion

This study presents the methodology and empirical strategy employed in analyzing the technical efficiency of commercial banks in Pakistan. The study measures technical efficiency using the Weighted Russell Directional Distance Model (WRDDM). The WRDDM is utilized to determine the input-output contributions in efficiency measurement, capturing inefficiencies in multiple dimensions.

WRDDM not only helped us to measure technical efficiency comparisons across different banking groups (private, state-owned, Islamic, and foreign banks), but also helped us to determine how much input and outputs can be improved. So, to know about the contribution of inputs and outputs study used advanced WRDDL model that not only helped us to find technical inefficiency and efficiency scores but also helped us to investigate contribution effect of inputs and outputs. It helped us to determine that how much there is a scope for the Pakistani banks to improve their inputs and outputs efficiency. Later, we compared the inefficiency among four groups of banks. We apply to examine whether inefficiency scores among all four banks' groups are statistically different or not. The Kruskal- Wallis test confirms that differences of inefficiency scores among all groups are statistically significant. Contribution effect of input and output variables confirm that there is higher inefficiency to handle non-performing loans in Pakistani banks. Furthermore, to investigate the impact of competition and risk-taking behaviors on the technical efficiency of banks, the study employs Bootstrap Truncated Regression. The choice of Bootstrap Truncated Regression preferred as efficiency scores lie between 0 and 1, making standard regression techniques inappropriate due to their unbounded assumptions. Truncated regression accounts for this limitation by properly modeling efficiency as a censored variable. Moreover, bootstrapping provides bias-corrected confidence intervals, improving the reliability of parameter estimates while addressing heteroskedasticity and small-sample issues. This method ensures more accurate inference in efficiency-related studies where dependent variables are constrained. The empirical models incorporate three different competition measures: the Lerner Index (Model 1), the Boone Indicator (Model 2), and the Panzar-Rosse H-statistic (Model 3). Additionally, bank-specific, industry-specific, and macroeconomic control variables are incorporated to capture their influence on efficiency. Findings revealed that the higher competition led to improved technical efficiency which is consistent with the competition-efficiency hypothesis. While among risk-taking behaviors, results revealed that credit and insolvency risks have a significant negative relationship with technical efficiency.

Recommendations

The results of our study are helpful for the Pakistani government and regulatory authorities to improve the performance of the Pakistani banks. The study suggested following policy recommendations to regulatory authorities in Pakistan to improve banks performance.

First, Policymakers should concentrate on establishing a competitive environment through facilitating market entrance and regulatory control in order to take advantage of the good benefits of competition on technical efficiency in the Pakistani banking business. Additionally, it is important to support technology progress, improve financial inclusion, and make investments in the growth of human capital. Policymakers can establish an environment that leverages the advantages of competition while fostering

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sustainable growth and efficiency in Pakistani banks by supporting healthy competition, facilitating digital transformation, enhancing access to financial services, and developing talented staff.

Second, strict regulatory policies should be implemented for proper borrowers screening and monitoring to minimize credit risk which adversely affected efficiency of the Pakistani banks. Furthermore, WRDDM also helped us to identify that major area for Pakistani banks to focus is non-performing loans because they were major contributors in technical inefficiency and negative total factor productivity. Therefore, SBP should play its role in discouraging the accumulation of non-performing loans.

Third, Pakistani banks should be encouraged to engage in more loan business with proper risk management. Holding more liquid assets negatively affected the efficiency, so regulatory authorities should encourage banks to be involved in lending activities with effective borrowers screening, it will also help to enhance investment opportunities in the economy by providing timely loans to entrepreneurs.

Fifth, relevant policies can be made by the State bank of Pakistan to increase capital for Pakistani banks. Higher capital works as cushion to absorb risks and high capitalized banks also engaged more in traditional loan activities, which proceeds an increase in output and enhance performance of banks. Furthermore, high capitalized banks have a good reputation and are capable of attracting more customers and also increase number of transactions which can assert positive impact on the performance of banks.

Finally, the Islamic banking should be encouraged more as it is contributing positively to improving the performance of Pakistani banks with respect to profitability and efficiency. They performed better as compared to the private and state-owned banks since the last decade.

References

Abel, S., Mukarati, J., Jeke, L., & Le Roux, P. (2023). Credit risk and bank profitability in Zimbabwe: an ARDL approach. International Journal of Economics and Finance Studies, 15(1), 370-385.

Anginer, D., Demirguc-Kunt, A., & Zhu, M. (2014). How does competition affect bank systemic risk? Journal of Financial Intermediation, 23(1), 1-26.

Barros, C. P., Managi, S., & Matousek, R. (2012). The technical efficiency of the Japanese banks: non-radial directional performance measurement with undesirable output. Omega, 40(1), 1-8.

Basel III, B. (2013). The Liquidity Coverage Ratio and liquidity risk monitoring tools. Bank for International Settlements.

Bátiz-Zuk, E., & Lara-Sánchez, J. L. (2023). The impact of bank competition on contagion risk: The case of Mexico. Journal of Economics and Business, 127, 106135.

BCBS III, B. (2010). International Framework for Liquidity Risk Measurement. Standards and Monitoring.

Beltratti, A., & Stulz, R. M. (2012). The credit crisis around the globe: Why did some banks perform better? Journal of financial economics, 105(1), 1-17.

Benzecry, G. F., Smith, D. J., & Reinarts, N. A. (2024). Analyzing the Lange–Lerner Hypothesis: is a monopolized banking sector a threat to democracy? Journal of Public Finance and Public Choice, 1-31.

Berger, A., Klapper, L. F., & Turk-Ariss, R. (2009). Bank competition and financial stability. Journal of Financial Services Research, 35(2), 99-118.

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 11 (November) (2025)

Berger, A. N., Klapper, L. F., & Turk-Ariss, R. (2017). Bank competition and financial stability Handbook of competition in banking and finance (pp. 185-204): Edward Elgar Publishing.

BIS. (2011). Basel III: A Global Regulatory Framework for more Resilient Banks and Banking Systems (Revised Version June 2011): Basel Committee on Banking Supervision, Bank for International Settlements.

Chen, P.-C., Yu, M.-M., Chang, C.-C., & Managi, S. (2014). Non-radial directional performance measurement with undesirable outputs.

Delis, M. D., Staikouras, K. C., & Varlagas, P. T. (2008). On the measurement of market power in the banking industry. Journal of Business Finance & Accounting, 35(7-8), 1023-1047.

Demirguc-Kunt, A., & Huizinga, H. (2010). Are banks too big to fail or too big to save? International evidence from equity prices and CDS spreads: The World Bank.

Dietrich, A., & Wanzenried, G. (2011). Determinants of bank profitability before and during the crisis: Evidence from Switzerland. Journal of International Financial Markets, Institutions and Money, 21(3), 307-327.

Ferreira, C. (2023). Competition and Stability in the European Union Banking Sector. International Advances in Economic Research, 29(4), 207-224.

Fiordelisi, F., Marques-Ibanez, D., & Molyneux, P. (2011). Efficiency and risk in European banking. Journal of Banking & Finance, 35(5), 1315-1326.

Guevara, F. d., J., M., J, & Perez, F. (2005). Market power in European banking sectors J. Financ. Serv. Res, 27(2), 109-137.

Handoyo, S., Suharman, H., Ghani, E. K., & Soedarsono, S. (2023). A business strategy, operational efficiency, ownership structure, and manufacturing performance: The moderating role of market uncertainty and competition intensity and its implication on open innovation. Journal of Open Innovation: Technology, Market, and Complexity, 9(2), 100039.

Hussain, A., Ihsan, A., & Hussain, J. (2016). Risk management and bank Performance in Pakistan. NUML International Journal of Business & Management, 11(2), 68-80.

Kanoujiya, J., Rastogi, S., Abraham, R., & Bhimavarapu, V. M. (2023). Does Competition Affect Financial Distress of Non-Financial Firms in India: A Comparison Using the Lerner Index and Boone Indicator. Journal of Risk and Financial Management, 16(7), 340.

Kosmidou, K. (2008). The determinants of banks' profits in Greece during the period of EU financial integration. Managerial Finance, 34(3), 146-159.

Kumar Sharma, S., & Dalip, R. (2014). Efficiency and productivity analysis of Indian banking industry using Hicks-Moorsteen approach. International Journal of Productivity and Performance Management, 63(1), 57-84.

Lerner, A. (1934). The Concept of Monopoly and the Measurement ofMonopoly Power. Review of Economic Studies, 1, 157-175.

Li, Y., & Peng, W. (2024). Bank price competition and enterprise innovation——Based on empirical evidence of Chinese A-share listed companies. International Review of Financial Analysis, 91, 103004.

Liu, H., & Wilson, J. O. (2010). The profitability of banks in Japan. Applied Financial Economics, 20(24), 1851-1866.

Mateev, M., Usman Tariq, M., & Sahyouni, A. (2023). Efficiency, market concentration and bank performance during the COVID-19 outbreak: Evidence from the MENA region. PloS one, 18(5), e0285403.

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 11 (November) (2025)

McDonald, J. (2009). Using least squares and tobit in second stage DEA efficiency analyses. European journal of operational research, 197(2), 792-798.

Noman, A. H. M., Gee, C. S., & Isa, C. R. (2017). Does competition improve financial stability of the banking sector in ASEAN countries? An empirical analysis. PloS one, 12(5), e0176546.

Olszak, M., & Kowalska, I. (2023). Do competition and market structure affect sensitivity of bank profitability to the business cycle? Pacific-Basin Finance Journal, 80, 102098.

Pham, M. H., & Nguyen, N. M. (2023). Bank funding diversity, risk and profitability: Evidence from Vietnam in the context of the Covid-19 pandemic. Cogent Business & Management, 10(1), 2191305.

Safiullah, M., & Shamsuddin, A. (2022). Technical efficiency of Islamic and conventional banks with undesirable output: Evidence from a stochastic meta-frontier directional distance function. Global Finance Journal, 51, 100547.

Saghir, G., & Ch, E. T. (2020). Risk Management & Financial Performance of Commercial Banks in Pakistan Ghulam Saghir and Emad Tabassam Ch. Risk Management, 9(1), 87-103.

Shah, W. U. H., Hao, G., Zhu, N., Yasmeen, R., Padda, I. U. H., & Abdul Kamal, M. (2022). A cross-country efficiency and productivity evaluation of commercial banks in South Asia: A meta-frontier and Malmquist productivity index approach. Plos one, 17(4), e0265349.

Shair, F., & Sami, I. (2025). Impact of competition and risks on the financial performance of Pakistani banks: An application of Panzar-Rosse H Statistic: https://doi. org/10.5281/zenodo. 17624672. Journal of Management Science Research Review, 4(4), 983-1003.

Shair, F., & Shaorong, S. (2022). Nexus between Technical Efficiency and Market Competition in the Banking Sector: Revisiting Economic Performance and Risk Evaluation. Transylvanian Review, 30(2).

Shair, F., Shaorong, S., Kamran, H. W., Hussain, M. S., Nawaz, M. A., & Nguyen, V. C. (2021). Assessing the efficiency and total factor productivity growth of the banking industry: do environmental concerns matters? Environmental Science and Pollution Research, 28, 20822-20838.

Shair, F., Sun, N., Shaorong, S., Atta, F., & Hussain, M. (2019). Impacts of risk and competition on the profitability of banks: Empirical evidence from Pakistan. PloS one, 14(11).

Sharma, V., Gupta, M., & Jangir, K. (2024). Exploring the Impact of Risk Factors on Profitability in Commercial Banking in India: A PLS-SEM Analysis Approach The Framework for Resilient Industry: A Holistic Approach for Developing Economies (pp. 89-107): Emerald Publishing Limited.

Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. Journal of econometrics, 136(1), 31-64.

Srivastava, B., Singh, S., & Jain, S. (2023). Bank competition, risk-taking and financial stability: insights from an emerging economy. Competitiveness Review: An International Business Journal, 33(5), 959-992.

Tan, Y. (2016a). Efficiency and competition in Chinese banking: Chandos Publishing.

Tan, Y. (2016b). The impacts of risk and competition on bank profitability in China. Journal of International Financial Markets, Institutions and Money, 40, 85-110.

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 11 (November) (2025)

Tan, Y., & Anchor, J. (2017). The impacts of risk-taking behaviour and competition on technical efficiency: evidence from the Chinese banking industry. Research in International Business and Finance, 41, 90-104.

Tan, Y., & Floros, C. (2018). Risk, competition and efficiency in banking: Evidence from China. Global Finance Journal, 35, 223-236.

Tuyet, N. L. H., & Ninh, L. K. (2023). Competition and firm performance: evidence from Vietnam. RAUSP Management Journal, 58(2), 111-124.

Wei, W., Han, Y., Abedin, M. Z., Ma, J., & Chai, S. (2023). Empirical study on the technical efficiency and total factor productivity of power industry: Evidence from Chinese provinces. Energy Economics, 128, 107161.