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RESEARCH ARTICLE

Determinants of Bangladeshi Banking Inefficiency: Do Non-Performing Loans and BASEL III Affect Banking Inefficiency?

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The efficiency of commercial banking is a crucial determinant of the longevity of the financial system. High credit risk is a significant feebleness that leads to high non-performing loans (NPLs), which reduce banking efficiency in any economy. In this context, this study aims to identify the determinants of banking inefficiency in Bangladesh. The Data Envelopment Analysis (DEA) technique was employed to measure banking efficiency, whereas TOBIT regression was performed to identify the determinants of inefficiency of 38 commercial banks from 2016–2022. Findings demonstrated size, ownership structure and orientation, capital structure regulations (BASEL III), GDP growth, and inflation as significant determinants of Bangladeshi banking inefficiency. However, although the non-performing loan ratio posited a deteriorating factor to banking efficiency, it was statistically insignificant. Similarly, the COVID-19 pandemic was not a significant determinant of banking inefficiency. The findings suggest that bank managers should strengthen their risk management assessments, particularly to reduce NPLs and adjust Basel III capital requirements to achieve higher efficiency scores. Besides, policymakers are required to improve BASEL III requirements to strike a balance between bank efficiency and financial stability by deregulating capital requirements while encouraging banks to improve their credit risk management.

Keywords: banking efficiency, BASELL III, COVID-19, non-performing loans, commercial banks, Bangladesh

JEL Classifications: G21, G32, E31, E32

The core of the financial system is comprised of commercial banks. Commercial banks originally functioned as financial intermediaries. Currently, they perform a variety of functions and generate sizable amounts of non-interest revenue in addition to offering services such as factoring, custodial services, investment advice, commodity exchange facilitation, financial securities trading, and so forth (Casu et al., 2022; Sharma & Rawat, 2023). Irrespective of the various forms of economic systems globally, the banking system remains a dynamic domain that influences domestic financial policies (Al-Gasaymeh & Samarah, 2023; Fakhrunnas et al., 2023). Nonetheless, continuously enhancing banking productivity while reducing

expenses places a greater emphasis on the key objective through banking operations and enticing services (Al-Gasaymeh & Samarah, 2023; Alam, Chowdhury et al., 2021; Chowdhury et al., 2022).

The Basel Committee on Banking Supervision (2004) has suggested the market discipline concept as one of the three fundamental elements that should support the overall regulatory framework of banks. The third pillar of the Basel III Capital Accord, known as market discipline, mandates that banks must exhibit transparency and furnish information that enables market players to evaluate the financial stability and soundness of banks. The pillar mandates that banks must openly publish all information regarding their capital, including its sufficiency, as a safeguard against different types of risk exposure (Godspower-Akpomiemie & Ojah, 2021). According to the market principle, investors, creditors, and depositors are more inclined to favor institutions that are judged to be financially stable over those that are considered to be unstable (Tarbert, 2000). When a bank exhibits an excessively high level of risk, market participants have the option to either withdraw their current investments or abstain from investing in that particular bank (Kwan, 2002; Park, 1995).

According to the World Bank (data.worldbank.org), Bangladesh's GDP growth rate has consistently increased between 2011 and 2019 (Figure 1). The global pandemic crisis greatly affected the economy, resulting in a decline in 2020. Non-performing loans have also shown significant growth up to 2019 and have started to decline slowly from 2020 onwards. However, both economic growth and non performing loans (NPLs) started to rise afterward. Hence, the GDP growth rate increased from 5.57% to 7.88% (2011 to 2019). Nevertheless, this tremendous rise in economic growth signifies that the banking segment will play a more crucial role in providing credit to diverse economic sectors. Figure 2 indicates that domestic credit to the private sector by banks increased until 2015, and thus, it gradually declined. Besides, the number of depositors is significantly increasing with commercial banks in Bangladesh. However, the growth of NPLs raised the question of their efficiency.

As reported by HSBC Global Research, Bangladesh's equity market is unimpressive due to a lack of investor confidence (Habib, 2023). Therefore, the figure is expected, given that Bangladesh lacks a developed stock market, whereas the banking sector plays a foremost role in loan distribution, much like other developing countries. Thus, several critics and news reports regarding banking crises and mismanagement raised the question of how the banking sector allocates resources efficiently throughout the banking production process because non-performing loans or bad loans have been mounting in recent times.

Nevertheless, the banking sector becomes crucial in achieving the highly specialized bank function of serving the economy, which is the purpose of the banking industry (Antunes et al., 2022). Due to

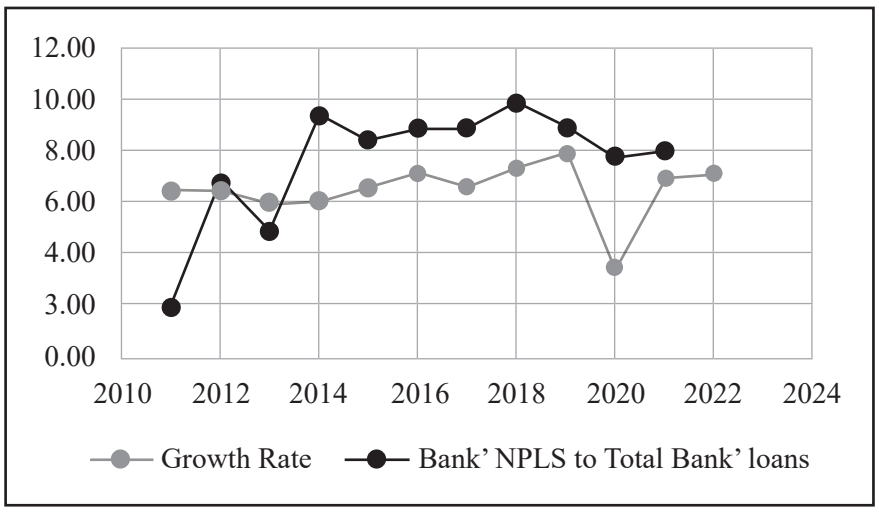

Figure 1
GDP Growth vs NPLs

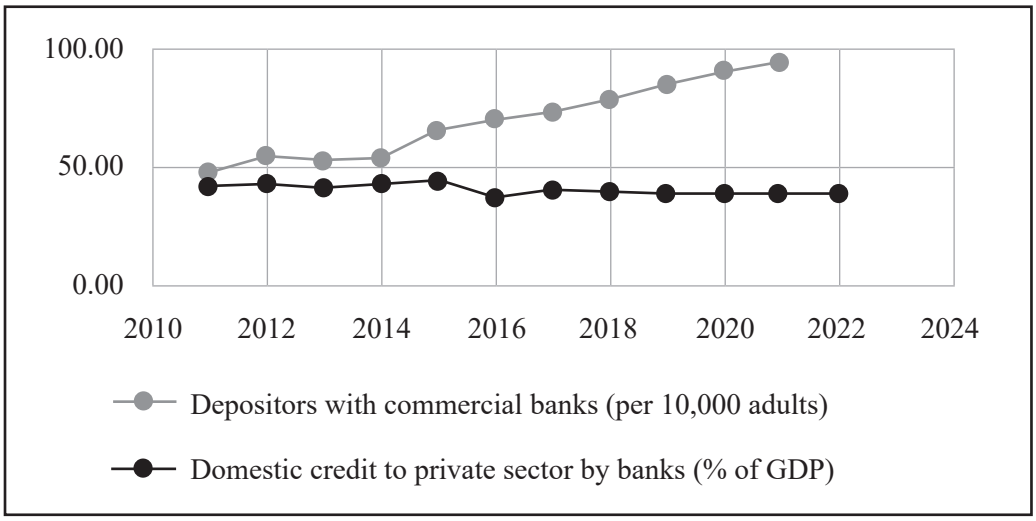

Figure 2
The Growth of Domestic Credits and Deposits

technological advancements and intense competition, banking efficiency has drawn the attention of economists, scholars, and bankers in recent decades. The majority of risk and cost variables have the potential to significantly affect how efficiently banks can motivate decision-makers to focus on enhancing bank performance (Al-Gasaymeh & Samarah, 2023). According to Van Greuning and Brajovic Bratanovic (2020), banks' profitability indices and financial ratios proved to be inadequate tools for analyzing and assessing their performance without considering additional significant factors. Therefore, in parallel with firm-specific and economic performance, the majority of current research studies have emphasized the primary factors influencing banking efficiency (Al-Gasaymeh, 2020). Excessive country risk combined with an unfavorable economic environment is a major factor in the banking industry. For example, banks' performance could be lowered by country risk and pandemic crisis, as the loss of investment leads to a detrimental effect on deposits (Iannotta et al., 2007). Empirical research has been diligently striving to accomplish this goal by examining the degree of efficiency in different economic sectors (Al-Gasaymeh & Samarah, 2023). Nonetheless, prior studies related to efficiency determinants have focused on bank risks and a relatively small number of them (Antunes et al., 2022; Isayas, 2022; Li et al., 2022). The other factors that are crucial to the efficiency of banks, like bank size, ownership structure and orientation, NPL, tangibility, new capital regulation (Basel III), COVID-19 effect, and macroeconomic variables, have been scarcely considered in Bangladeshi banking studies. Therefore, it has become crucial to measure banking efficiency and analyze the factors influencing banking inefficiency in Bangladesh.

The findings contribute to the theoretical lens by measuring banking efficiency and link to regulatory requirements in a developing country. By incorporating NPLs and Basel III into the determinants of banking inefficiency, this study ties the gap between governance and banking inefficiency. Empirically, this study provides evidence on the effect of Basel III capital requirements and NPLs on banking inefficiency. Moreover, this study also provides evidence of whether Basel III capital requirements expand or deteriorate banking efficiency in developing countries. Banks can use the findings to enhance their internal governance and reinforce risk management to attain higher efficiency levels.

The remainder of this paper is structured first with a literature review where it discusses previous studies relevant to banking efficiency or performance. In the subsequent section, it discusses the methodology, which covers data and data analysis technique, followed by empirical results and discussion. Finally, this paper ends with a conclusion which incorporates implications and limitations.

Literature Review

Banking Performance Assessment

Efficiency measurement is a crucial task in operation management for any organization in order to comprehend the bygone undertakings of a unit better and plan for its future development (Kao, 2014). The extensively applied techniques to measure efficiency are categorized into two parts: parametric stochastic frontier analysis and nonparametric data envelopment analysis. Stochastic frontier analysis is rigorously used in the non-banking sector (Chowdhury et al., 2022; Sakouvogui, 2020; Wanke et al., 2020) and the banking sector (Fang et al., 2019; Tan & Floros, 2019). However, there are a number of limitations to the stochastic frontier approach. According to Charnes et al. (1994), it performs inadequately with small samples and it requires the classification of a specific function form, with differing specifications resulting in varying efficiency scores. Data Envelopment Analysis (DEA) can be criticized in different ways than the stochastic frontier analysis: the efficiency scores are impacted by the input and output selection; DEA fails to take into account statistical noise, and its results are subject to extreme observations and measurement errors. Nevertheless, empirical studies exhibited that employing DEA to calculate efficiency can give vigorous outcomes (Seiford & Thrall, 1990). In DEA, multiple efficiency metrics have been formed, and there must be particular features for an efficiency measure to be appropriate for ranking DMUs and evaluating performance (Li et al., 2022). For instance, monotonicity, unit invariance, and translation invariance are a few key features of an efficiency measure (Charnes et al., 1994; Fare et al., 1994). Unit invariance is a feature that makes efficiency estimation independent of the units considered to measure inputs and outputs. When the inputs or outputs of an inefficient DMU deteriorate, the efficiency measure is deemed to be consistently decreasing, an effect known as monotonicity (Antunes et al., 2024). Translation invariance is another essential feature of an efficiency metric. If decoding the primary input or output data values creates a new issue with an identical ideal solution for the envelopment form as the previous one, the DEA model is said to be translation invariant.

In addition to illustrating the distribution of input and output resources throughout the production process, performance evaluations with efficiency analyses facilitate the design of specific policies that improve the distribution of production factors by increasing or decreasing the production of particular product types. Nevertheless, the scope of this policy's implications is mostly limited to the production process itself; all other variables are disregarded. As a result, an increasing number of empirical researchers seek insight into the performance determinants using a second-stage regression analysis (Antunes et al., 2022; Defung, 2018; Konara et al., 2019). Efforts have been made, particularly in the banking sector, to use a variety of econometric techniques to evaluate the factors that influence bank performance. Specifically, efforts have been made to examine the determinants of efficiency using Tobit regression (Defung et al., 2016; Takahashi & Vasconcelos, 2024) and bootstrapped truncated regression (Wanke et al., 2016)this technique is applied first in a two-stage approach to assess the relative efficiency of Malaysian Islamic banks using the most frequent indicators found in the banking literature. Besides, in the second stage, neural networks are combined with TOPSIS results as part of an attempt to produce a model for banking performance with effective predictive ability. The results reveal that variables related to cost structure have a prominent negative impact on efficiency levels, although some parsimony in equity leveraging derived from Islamic finance principles maybe helpful in achieving higher efficiency levels. Findings also indicate that the Malaysian Islamic banking market also imposes cultural and regulatory barriers to foreign banks, so that their efficiency levels are lower when compared to their national counterparts. Learning curves (trend impact. For instance, Konara et al. (2019) delved into the link between FDI and bank efficiency between 2009 and 2013, utilizing banks from eight emerging economies. Different efficiency estimates, such as scale, cost, revenue, pure technical, and technical efficiencies, are derived using a typical DEA model, and the three-stage least square estimator facilitates the relationship test. An additional step in this process has been taken in the empirical literature, in which efforts have been made to examine the links between other variables and efficiency using a three-stage least square estimator (Konara et al., 2019), simultaneous equation modeling (Altunbas et al., 2007), and Grainger-causality test (Fiordelisi et al., 2011).

Determinants of Banking Inefficiency

The *bad management hypothesis* posits that inadequate managerial practices contribute to a bank's credit risk, which emerges from poor management in banking operations (Bhuyan et al., 2022). The global financial crisis highlighted vulnerabilities in the global banking system, which started in the United States in 2007 and was affected globally from 2008 to 2009. High credit risk was a significant feebleness that led to an increase in NPLs, which decreased bank earnings. These losses frequently surpass available capital during crises, necessitating an immediate recapitalization and restricting lending to the economy (Chalampalakis et al., 2024). Elevated levels of non-performing loans impede confidence in the banking system, instilling systemic risk that triggers deposit withdrawals and significantly inhibits banks' operational efficiency (Anastasiou et al., 2019)first, to examine the causes of NPLs. This may have negative repercussions on the economy as a whole, such as lowered confidence and slower GDP growth in the future (Chalampalakis et al., 2024). However, if institutions engage in practices that jeopardize their integrity, efficiency will not be attained (Ujah et al., 2017). Fukuyama and Tan (2022) unveiled an adverse effect of NPLs on banking efficiency in China. In addition, Miguélez et al. (2019) suggested that banks should critically monitor loan distributions to avoid NPLs. Christopoulos et al. (2020) also unveiled the significant negative effect of NPLs on banks' efficiency. A study found diverse levels of bank efficiency that were influenced by credit risks among multinational banks in eight developing Asian economies (Sun & Chang, 2011). Partovi and Matousek (2019) investigated determinants of efficiency, unveiling that non-performing loans negatively impact technical efficiency in Turkish banks. However, Bhuyan et al. (2022) discovered that NPLs insignificantly impact Indian banking productivity.

The COVID-19 pandemic represents the most unforeseen, extensive, and pervasive external economic shock in history, surpassing even the Global Financial Crisis in its global impact (Mateev et al., 2024; Nusannas et al., 2020). The COVID-19 pandemic immediately stagnated the global economy by amalgamating substantial supply and demand shocks (Carletti et al., 2020). The substantial effect stemmed from the disruptions in the global supply chain and diminished demand owing to lockdowns (Carletti et al., 2020). Moreover, as cash sources began to diminish, debtors encountered critical circumstances with reduced capacity to fulfill loan obligations (Carletti et al., 2020; Nusannas et al., 2020). As a result, credit losses manifested as NPLs are anticipated to rise, and exposure to credit risk is predicted to intensify (Carletti et al., 2020). The detrimental impacts of the crisis on the banks' balance sheets are further intensified by substantial rises in operational costs (Carletti et al., 2020).

The financial crisis (2007–2009) demonstrated the significance of financially sound banks to the efficient operation of the business sector because they encourage resource allocation in the economy (Chalampalakis et al., 2024; Pathan & Faff, 2013). The Basel Committee implemented the Basel III framework to strengthen supervision, regulation, and credit risk management after the financial crisis of 2008–2009. Berger and Bouwman (2013) stated that capital requirements strengthen financial stability while also having an adverse effect on operational efficiency. Le et al. (2023) also found that capital regulations under Basel III lessen the profitability and efficiency of British and Australian banks. Therefore, this study argues that Basel III affects banking inefficiency.

Nevertheless, bank size has also been posited as a significant determinant of efficiency in the previous literature (Bhuyan et al., 2022; Lee, 2020). For instance, Gulati and Kumar (2017) unveiled that intermediation efficiency differs on bank size, intermediation cost, liquidity, and lending. A substantial bank size decreases expenses due to its economies of scale and operational scope. Consequently, bank size is considered a crucial factor in enhancing banking efficiency (Bhuyan et al., 2022). Phan et al. (2018) found a notable influence of banks' size on bank efficiency in Hong Kong, whereas Bhuyan et al. (2022) unveiled a negative effect on productivity, and Arora (2014) this study employs a blend of tests including profitability analysis (suggested by Spong et al., 1995 found no substantial link between bank size and efficiency in Indian banks.

The ownership structure is recognized in finance and economics literature as a crucial factor influencing financial performance (Cornett et al., 2010; Fonseka & Farooque, 2024; Suttipun & Pratoomsri, 2019). A notable aspect of ownership structure that has garnered significant attention is the impact of domestic and foreign ownership (Kamarudin et al., 2017). Besides domestic and foreign ownership, a significant aspect

of ownership structure is the distinction between state or public ownership and private ownership (Cornett et al., 2010; Megginson & Netter, 2001; Moudud-Ul-Huq et al., 2022). Empirical studies posited contradictory findings, whereby state-owned banks positively affect performance (Fonseka & Farooque, 2024) and negatively affect banking performance (Kumar & Kar, 2023; Nabi et al., 2019). In addition, studies have also crucially focused on ownership orientation, mainly in terms of conventional and Islamic banking performance (Ben Slimen et al., 2022; Kamarudin et al., 2017)Indonesia and Brunei over the period of 2006–2014. This study employ the DEA. Past studies indicated several general characteristics of Islamic banks: possess superior capitalization and asset quality (Beck et al., 2013), they are more profitable (Hasan & Dridi, 2011), share a comparable risk profile with conventional banks (Pappas et al., 2017), and demonstrate greater technical efficiency (Johnes et al., 2014).

In addition, past studies have also demonstrated a mixed influence of inflation on banking efficiency. For instance, Tan and Anchor (2017) found a significant negative effect on Chinese banking inefficiency, whereas Phan et al. (2018) found a positive effect of inflation on banking inefficiency in Hong Kong. On the other hand, rapid economic growth fosters a conducive atmosphere that enhances production (Meher & Zewudu, 2020; Phan et al., 2018; Stewart et al., 2016) through increasing loans and enhancing their interest income (Bhuyan et al., 2022). Moreover, it enhances asset quality, thus likely to positively influence banking efficiency (Bhuyan et al., 2022).

Methodology

This study employed data envelopment analysis (DEA) to compute the bank efficiency and Tobit regression analysis to analyze the environmental factors driving banking inefficiency.

Data Envelopment Analysis

The method known as data envelopment analysis (Charnes et al., 1978) is widely considered to assess the relative efficiency of a group of entities known as decision-making units (DMUs), which have uniform structures. The measure of a DMU's efficiency in DEA is its distance from the worst or best practices if an optimistic approach is taken. DEA makes use of a production possibility set that is fundamentally defined and provides an efficiency metric, and the under-evaluation DMU's distance from the efficient frontier is estimated by the efficiency measure. The DEA technique is capable of handling multiple outputs and inputs. Financial institutions such as banks apply multiple inputs to generate various outputs and allow comparison among different institutions; therefore, the DEA technique is appropriate for this study to measure banking efficiency (Salleh et al., 2022; Sherman & Gold, 1985). Moreover, the DEA is flexible and data-driven, which does not require specific presumptions about the variables' relationship. Numerous studies have applied the DEA technique to measure banking efficiency in different countries (Chowdhury et al., 2022; Chowdhury & Haron, 2021, 2022; Christopoulos et al., 2020; Sherman & Gold, 1985)

CCR-DEA Model

Following the DEA, it is required to decay the overall efficiency indexes; this study has applied the CCR (Charnes, Cooper, and Rhodes) model, which measures technical efficiency (TE). In the CCR (constant returns to scale) model, in view of undertaking a set of *J* DMUs with *a* input and *b* output in *P* (*p*=1,…,*P*) periods. Assume in time *p*, decision-makers are producing $Y^p \in R^b$ deriving from inputs $X^p \in R^a$. Outline the input requisite set in period *t,* is;

$$L^p(Y^p) = [X^p \; ; \; Y^p \; derive \; from \; X^p \tag{1}$$

Suppose $L^p(Y^p)$ is not a zero, closed, bounded, convex, and satisfies the resilient disability property of inputs and outputs $L^p(Y^p)$ governed from the below by the input isoquant (equal product curve-a CCR production boundary);

$$IsqL^p(Y^p) = [X^p \; ; \; X^p \in L^p(Y^p), \lambda X^p \notin L^p(Y^p) \; for \; \lambda < 1] \tag{2}$$

Outline the input distance function of period *p* is;

$$D^p(Y^p, X^p) = sup[\theta \; ; (\frac{X^p}{\theta} \in L^p(Y^p), \theta > 0] \tag{3}$$

Thus, the CCR-DEA model for calculating TE in period *p* is as follows;

$$TE^p(Y^p, X^p) = 1/D^p(Y^p, X^p) \tag{4}$$

Generally, TE<1 designates that a particular DMU is under study compared with other DMUs. It presents

that this DMU is prolifically inefficient due to using excessive inputs, whereas TE = 1 represents that DMU is fully efficient.

Tobit Regression Analysis

The DEA technique computes the relative efficiency level by comparing inputs and outputs, which does not explain what external factors drive inefficiency. Thus, the results derived from DEA analysis primarily concentrate on the internal aspects of a firm, which may result in certain managers overlooking improvement suggestions (Marjanović et al., 2023). This criticism stems from the hypothesis that the outcomes are affected by extrinsic environmental variables that are not considered in the model (Paradi et al., 2011). Therefore, the Tobit regression model is employed to identify the determinants of banks' technical inefficiency. This regression model is usually applied where the dependent variable is measured within intervals that have a predetermined threshold value (Takahashi & Vasconcelos, 2024). The Tobit regression is appropriate for censored explained variables, whereas the OLS (ordinary least squares) regression may present biased outcomes as it undertakes normally distributed errors. Explicitly, the TE score of the DEA model ranges from 0 to 1, therefore limiting the range of the dependent variable (Defung et al., 2016). Hence, in order to assess the determinants of technical inefficiency (TE*) of the banking industry, this study used the following equation of the Tobit model for unbalanced panel data;

$$\begin{aligned} ITE_{it} = {} & \alpha + \beta_1 NPLR_{it} + \beta_2 LTA_{it} + \beta_3 OS_{it} + \\ & \beta_4 OO_{it} + \beta_5 TY_{it} + \beta_6 MS_{it} + \beta_7 BIII_{it} + \\ & \beta_8 GDP_{it} + \beta_9 INF_{it} + \beta_{10} INT_{it} + \epsilon_{it} \end{aligned} \quad (5)$$

where *i* denotes banks (DMU), *t* presents the year, α is the intercept, β is the coefficient of each independent variable, and ϵ denotes the error term. The set of variables in the model: ITE (Technical Inefficiency = 1 - TE) is the outcome variable, which is the TE index from DEA analysis, NPLR presents the non-performing loan percentage, LTA refers to the log of total assets, OS refers to ownership structure, OO indicates the ownership orientation, TY stands for tangibility, MS posits market share, BIII demonstrates the impact of BASEL III, GDP denotes the gross domestic growth, and INF and INT stand for inflation and interest rate, respectively.

Data and Variables

This study collected sample data from 38 Bangladeshi commercial banks composed of state-owned, private, Islamic, and conventional commercial banks. Infant banks may not be able to potentially utilize their inputs to generate outputs because they need a longer period to observe loan outputs as well as collect deposits. Therefore, a purposive sampling method was employed by limiting the banks' age and data availability. The data was drawn from the audited annual reports for the period from 2016 to 2022. Selecting the input and output variables for the study of banking efficiency is always a challenging task due to the type and quality of the variables impacting the measurement results (Chowdhury et al., 2022; Chowdhury & Haron, 2021). In this regard, there has been a long discussion of selection of inputs and outputs among researchers (Abdulahi et al., 2023; Banya & Biekpe, 2018). Despite this, several factors, such as the concept and nature of banking firms, are important criteria in determining the inputs and outputs (Alam, Chowdhury et al., 2021; Banya & Biekpe, 2018; Chowdhury & Haron, 2022). Usually, the selection process of variables relies on the data availability, past literature, and the banking model, whether following a production or intermediation approach (Achi, 2021; Banya & Biekpe, 2018; Marjanović et al., 2023; Sherman & Gold, 1985; Takahashi & Vasconcelos, 2024) a methodology of two-stage network DEA. In the production approach, physical and human capital and their related costs are referred to as inputs. In addition, equities and different forms of cash reserves are applied to enlarge customers' deposits and loans, thereby creating assets and generating profit for the banks (Achi, 2021; Chen et al., 2018; Chowdhury & Haron, 2022). In the intermediation model, banks are regarded as agents between surplus and deficit units (Achi, 2021; Casu et al., 2022; Chowdhury et al., 2022).

However, this study did not only choose inputs and outputs based on the literature review but also based on the availability of data and the business nature of the understudy banks (Barros et al., 2018) following the intermediation approach. The values used in the data are written in local currency (BDT) and in millions. This study chose total deposits (X1), salaries and allowances (X2), fixed assets (X3) as inputs to generate loans (Y1), and investments (Y2) as outputs (Achi, 2021; Chowdhury et al., 2022; Luo

et al., 2023; Nasim et al., 2024). Besides, institutional variables such as bank size, non-performing loan ratio, ownership structure and orientation, assets' tangibility, BASEL III, COVID-19, GDP, and inflation were selected to determine the factors that affect bank inefficiency (Achi, 2021; Bakour, 2023; Deli & Hasan, 2017; Ghenimi et al., 2024; Gržeta et al., 2023; Isayas, 2022; Marjanović et al., 2023; Mateev et al., 2023a, 2024; Sharma & Rawat, 2023; Yudaruddin, 2023)

Table 1. *Variable Descriptions*

Variable	Description	Reference
Deposits	The total deposits collected by banks	Chowdhury & Haron, 2022; Mateev et al., 2023b; Takahashi & Vasconcelos, 2024
Salaries and Allowances	Salaries and wages paid to employees	Chowdhury et al., 2022; Mateev et al., 2023a; Takahashi & Vasconcelos, 2024
Fixed Assets	Total fixed assets	Mateev et al., 2023a
Loans and Advances	Total loans and advances disbursed to customers	Achi, 2021; Chowdhury et al., 2022; Luo et al., 2023; Mateev et al., 2023a; Takahashi & Vasconcelos, 2024
Investments	Total investments made by banks	Achi, 2021; Chowdhury et al., 2022; Luo et al., 2023; Nasim et al., 2024
Size	Log of total assets	Abdulahi et al., 2023; Isayas, 2022; Mateev et al., 2023a; Takahashi & Vasconcelos, 2024
Inefficiency	1-TE (computed by CRS) Score	Chowdhury & Haron, 2022; Galán et al., 2015
Non-Performing Loan Ratio (NPLR)	Ratio of non-performing loans and total loans	Takahashi & Vasconcelos, 2024
Ownership Structure	Dummy variable: Private (0) and state-owned (1)	Mateev et al., 2024; Sharma & Rawat, 2023; Takahashi & Vasconcelos, 2024
Ownership Orientation	Dummy variable: Conventional (0) and Islamic (1)	Bakour, 2023; Ghenimi et al., 2024; Yudaruddin, 2023
Assets' Tangibility	Fixed asset/total asset	Isayas, 2022
BASEL-III	Dummy variable; Up to 2010 = 0, otherwise 1	Deli & Hasan, 2017; Gržeta et al., 2023; Le et al., 2023
COVID-19	Dummy variable; Year up to 2020 = 0, otherwise 1	Bakour, 2023; Ghenimi et al., 2024; Marjanović et al., 2023; Mateev et al., 2023a, 2024; Sharma & Rawat, 2023; Yudaruddin, 2023
GDP	The growth rate of GDP for the study timeframe	Abdulahi et al., 2023; Isayas, 2022; Marjanović et al., 2023; Mateev et al., 2023a; Nasim et al., 2024; Takahashi & Vasconcelos, 2024
Inflation	Inflation rate for study timeframe	Abdulahi et al., 2023; Isayas, 2022; Marjanović et al., 2023; Nasim et al., 2024; Takahashi & Vasconcelos, 2024

A large bank may receive an advantage from economies of scale; however, the high ratio of NPLs reduces banking efficiency and profitability because it refers to poor loan quality, which is also a significant issue in the Bangladeshi banking sector. Ownership structure and orientation—state-owned banks can be less efficient and posit poor loan quality due to weak governance and political interference, and Islamic banks may posit better loan quality as they focus on ethical financing. Asset tangibility indicates the physical assets to total assets, whereby higher tangible assets may posit a low level of credit risk. Basel III regulates banks to uphold a certain level of capital and transparency, which can improve or weaken efficiency due to additional expenditure. Finally, COVID-19 interrupted operations globally, which has increased credit defaults and lessened economic activity.

Results and Discussion

DEA Results

In the initial stage, the technical efficiency scores were computed for each year. Table 2 presents the technical efficiency scores for each bank for each year from 2016–2022. The results depicted that only 10 banks (26.32%) were efficient (100% efficiency level), and four banks (10.53%) had less than 50% efficiency score in the year 2016. On the other hand, only eight banks (21.05%) were efficient in 2022, and none of the banks had less than 50% efficiency scores. Nevertheless, 10 banks had a score of less than 50% efficiency, but only seven banks were efficient in 2020. Expectedly, the COVID-19 pandemic (the year 2020) caused lower efficiency scores for all banks on lending and financing activities (Mateev et al., 2024; Moudud-Ul-Huq et al., 2022; Sharma & Rawat, 2023).

Figure 1 displays the average score of all banks' technical efficiency for each period as well as for the analyzed timeframe. The average technical efficiency score of Bangladeshi commercial banks for the analyzed timeframe was 77.30%. This score postulates the room for banking efficiency improvement to achieve another 22.70% efficiency level to become efficient. The results indicate that inefficient banks should utilize their resources optimally to improve their efficiency level. Accumulating a substantial amount of deposits does not always result in a proportional increase in loans or financing and investments (Henriques et al., 2018). Inefficient banks, thereby, should utilize their human capital to enlarge deposits and translate them into productive loans/financing and investments. In addition, inefficient banks have room to optimally utilize their fixed assets to generate more outputs.

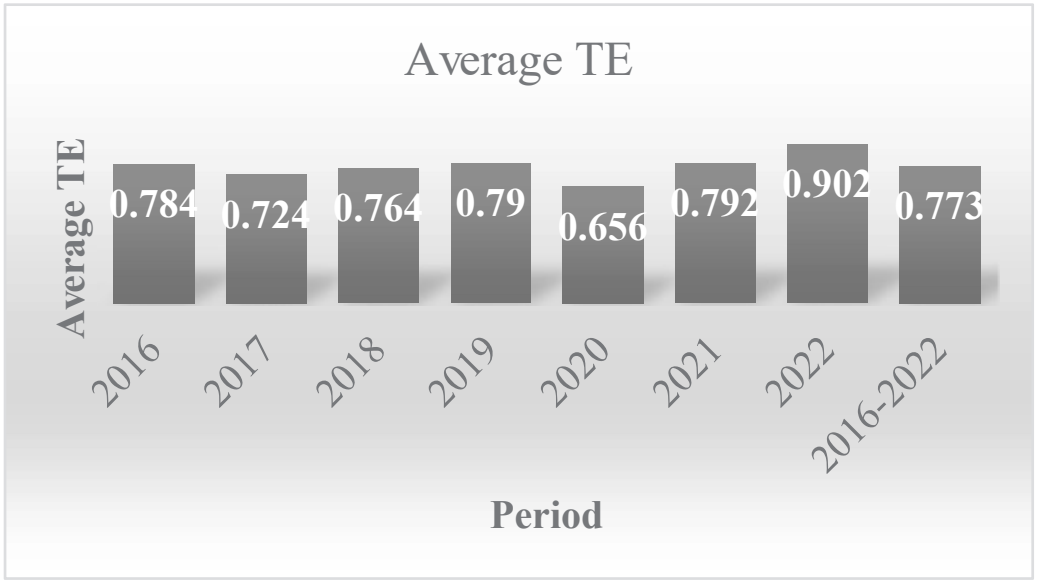

Figure 3
Average Technical Efficiency of All Banks During the Analyzed Timeframe

Table 2. *Results of Technical Efficiency (TE) for Each Bank for Each Year*

Bank	TE'22	TE'21	TE'20	TE'19	TE'18	TE'17	TE'16
Agrani Bank (S, C)	0.745	1	1	0.727	0.617	0.65	0.418
AIBL (P, I)	0.926	0.722	0.484	0.701	0.671	0.641	0.744
BCB (P, C)	0.516	0.362	0.274	0.457	0.457	0.483	1
Bank Al Falah (P, I)	0.764	0.987	1	1	1	1	1
Bank Asia (P, C)	0.762	0.669	0.64	0.772	0.744	0.714	0.771
Basic Bank LTD (S, C)	0.84	0.943	0.829	0.731	0.775	0.874	0.953
BRAC Bank (P, C)	0.963	0.665	0.405	0.58	0.58	0.474	0.635
City Bank (P, C)	0.96	0.654	0.428	0.564	0.6	0.477	0.586
Dhaka Bank (P, C)	0.899	0.762	0.561	0.791	0.767	0.646	0.699
Dutch-Bangla Bank (P, C)	0.755	0.663	0.583	0.627	0.612	0.538	0.597
Eastern Bank (P, C)	0.886	0.72	0.507	0.656	0.665	0.572	0.577
Exim Bank (P, I)	1	0.933	0.713	0.902	0.921	0.781	0.7
First Security Islami (P, C)	1	0.827	0.615	0.927	0.936	0.895	0.6
Global Islamic (P, I)	0.9	0.715	0.542	0.901	0.894	1	0.817
HSBC Bank (P, C)	1	1	1	1	1	1	1
IBBL (P, I)	0.936	1	1	0.634	0.623	0.506	0.604
IFIC Bank (P, C)	0.897	0.784	0.637	0.795	0.865	0.679	0.637
Jamuna Bank (P, C)	0.786	0.705	0.455	0.647	0.631	0.582	1
Janata Bank (S, C)	1	1	0.749	0.855	0.76	0.774	0.725
Mercantile Bank (P, C)	0.905	0.711	0.591	0.982	0.889	0.846	0.488
Midland Bank (P, C)	1	0.818	0.664	1	0.766	0.821	1
Mutual Trust Bank (P, C)	0.98	0.705	0.476	0.665	0.692	0.625	0.743
National Bank (P, C)	0.92	0.959	0.83	0.97	0.876	0.854	0.945
NCC Bank (P, C)	0.884	0.698	0.55	0.755	0.737	0.666	0.99
NRB Bank (P, C)	0.823	0.655	0.63	0.676	0.573	0.594	0.883
One Bank (P, C)	0.903	0.768	0.578	0.752	0.748	0.683	0.897
Premier Bank (P, C)	0.862	0.789	0.624	0.856	0.789	0.774	0.709
Prime Bank (P, C)	1	0.744	0.485	0.683	0.571	0.503	0.825
Pubali Bank (P, C)	0.823	0.721	0.681	0.803	0.646	0.649	0.677
Rupali Bank (S, C)	0.922	0.864	1	1	0.796	0.873	1
Shahjalal Islami (P, C)	0.936	0.746	0.47	0.696	0.738	0.534	0.971
SIBL (P, I)	0.909	0.754	0.549	0.746	0.767	0.675	1
Sonali Bank (S, C)	1	1	1	1	1	1	1
Southeast Bank (P, C)	1	0.955	0.85	1	1	1	1
Standard Bank (P, I)	0.92	0.675	0.431	0.66	0.726	0.662	1
Trust Bank (P, C)	0.987	0.881	1	1	1	1	0.856
UCB Bank (P, C)	0.986	0.683	0.454	0.58	0.587	0.464	0.401
Union Bank (P, I)	0.977	0.856	0.659	0.942	1	1	0.361
Mean	0.902	0.792	0.656	0.79	0.764	0.724	0.784

Note: S = State-owned, C= Conventional, P= Private, I=Islamic, TE= Technical efficiency

Descriptive Results

Table 3 displays the descriptive statistics of variables used in regression analysis. On average, a 22.7% inefficiency level with a standard deviation of 0.176 is observed among commercial banks in Bangladesh, whereas the maximum and minimum inefficiency levels are 72.6% and 0%, respectively. This result indicates that the level of inefficiency level significantly varies among commercial banks. The non-performing loan ratio posited 27.1% among commercial banks with a standard deviation of 0.919, which shows a large deviation among commercial banks. In other words, the difference between NPLRs is significantly large, whereas some banks have very low and others have large NPL ratios. Meanwhile, tangibility shows an average of 0.027 ratios with a small deviation of 0.097 among commercial banks in Bangladesh.

Table 4 exhibits the correlation between variables, whereas NPLR predicts a positive insignificant relationship with banking inefficiency, but the size of the banks exhibits a significant negative relationship. Both GDP and inflation are negatively correlated with banking inefficiency. However, tangibility is positively correlated, but it is not statistically significant. The results further demonstrated that all relationships among variables are less than 0.50, indicating no multicollinearity issue in the data.

Regression Results and Discussion

Prior to Tobit regression analysis, this study performed the White test to check heteroskedasticity in the data sample. This test entails regressing the explanatory variables on the squared residuals of the initial Tobit model. The result confirmed the existence of heteroskedasticity as the p-value is significant ($p < 0.05$), indicating that the residuals' variance varies across data. Therefore, this study performed robust standard error Tobit regression to adjust the heteroskedasticity. The results are presented in Table 5, which shows the estimated coefficients of determinants of banking inefficiency.

Table 3. *Descriptive Statistics*

Variable	Obs	Mean	Std. Dev.	Min	Max
ITE	266	.227	.176	0	.726
NPLR	237	.271	.919	.005	6.16
LTA	266	5.455	.38	3.695	6.264
TY	266	.027	.097	0	.781
GDP	266	6.627	1.35	3.448	7.882
INF	266	5.898	.739	5.514	7.697

Table 4. *Pairwise Correlation*

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) ITE	1.000					
(2) NPLR	0.053	1.000				
(3) LTA	-0.248*	0.068	1.000			
(4) TY	0.109	-0.024	-0.022	1.000		
(5) GDP	-0.277*	0.042	-0.050	-0.017	1.000	
(6) INF	-0.278*	0.133*	0.134*	0.019	0.085	1.000

*Note: * refers to significance level at 5%.*

The regression results indicate that NPLR is an insignificant (= 0.15, t=1.71, p>0.05) determinant of banking inefficiency; however, it is significant at a 90% confidence level. NPLR reflects the assessment of loan portfolio quality in financial institutions and exhibits a positive correlation with technical inefficiency. Thus, the results unveil a marginal significance level that suggests a positive link, although a statistically weak effect on banking inefficiency. This finding contradicts prevailing studies that substantiated the notion that banks with lower NPLR, on average, are the most technically efficient (Fukuyama & Matousek, 2017; Phung et al., 2022). Thus, this finding suggests that beyond NPLR, other factors such as management quality, internal policies, and financing mechanisms are more influential determinants of inefficiency. In a similar vein, the size of the banks posited a significant negative effect (β=-0.113, t=-1.86, p<0.10) on banking inefficiency at a 90% confidence level. Although the relationship is not statistically robust, it supports the notion that there is a positive correlation between the higher efficiency of major banks and their larger proportion of total deposits, which in turn leads to a larger share of the credit market (Isayas, 2022; Takahashi & Vasconcelos, 2024). Likewise, the finding suggested that an increase in the size of the banks' asset reduce banking inefficiency.

Subsequently, tangibility posited a substantial effect (β=0.182, t=3.27, p<0.05) on banking inefficiency. However, tangibility has failed to show a significant positive effect on banking inefficiency, which contradicts the past literature (Isayas, 2022). This finding implies that Bangladeshi banks with greater tangible assets possess superior collateral, which can mitigate credit default risk and inefficiencies. Tangible assets are usually easier to convert into liquidity, thus improving operational efficiency. Both macro variables, GDP growth rate (β=-0.04, t=-3.58, p<0.05) and inflation (β=-0.046, t=-2.90, p<0.05), unveiled a substantial negative effect on banking inefficiency, which suggests that the increase in both GDP and inflation reduces banking inefficiency. These findings relevant to the nexus between GDP and efficiency are supported by Stewart et al. (2016), Bhuyan et al.

Table 5. *Tobit Regression With Robust Standard Error Adjustments*

Inefficiency	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]
Non-Performing Loan Ration	.015*	.009	1.71	.088	-.002	.033
Total Assets (log)	-.113*	.06	-1.86	.063	-.232	.006
Tangibility	.182***	.056	3.27	.001	.072	.292
State-owned	-.129***	.045	-2.87	.004	-.218	-.04
Islamic Bank	-.054*	.031	-1.73	.086	-.116	.008
BASELLIII	-.099**	.047	-2.11	.036	-.192	-.006
COVID-19	-.023	.031	-0.75	.455	-.084	.038
GDP	-.04***	.011	-3.58	0	-.061	-.018
Inflation	-.046***	.016	-2.90	.004	-.078	-.015
Constant	1.4***	.335	4.17	0	.739	2.061
Pseudo r-squared			2.109			
F-test			9.313			
Akaike Crit. (AIC)			-8.070			
Number of Obs			237			

*Note: *** p<.01, ** p<.05, * p<.1*

(2022), and Phan et al. (2018). Therefore, enhancing the interest revenue generated from loans during times of economic expansion enhances the profitability of banks (Tan, 2016). The substantial association between inflation and technical efficiency is also in line with Tan (2016). The repercussions of inflation are evident throughout the economy. For instance, as inflation increases, banks typically raise interest rates to maintain profitability. This might deter financial activity and consequently decrease loan disbursement and profitability.

Unexpectedly, ownership structure posited a substantial negative influence on banking inefficiency whereby state-owned banks (β=-0.129, t=-2.87, p<0.10) appear to utilize their resources more than private-owned banks. This finding contradicts earlier studies in different economies whereby they posited lower efficiency levels for state-owned banks (e.g., Le et al., 2022; Takahashi & Vasconcelos, 2024). However, the current finding is supported by studies relevant to the neighboring country, India (e.g., Agarwala et al., 2023; Sharma & Rawat, 2023). Despite several criticisms relevant to state-owned banks, they posited a significantly higher efficiency score in Bangladesh. This finding adds a new dimension to the literature relevant to the Bangladeshi banking sector. State-owned banks often receive direct capital infusions and support from the government, enhancing their financial stability and operational efficiency. Meanwhile, Islamic banks (Shariah-based banking models) are prone to reduce inefficiency levels at a 90% confidence level. Though statistical significance (β=-0.054, t=-1.73, p<0.10) is not robust, thus Islamic banks make ethical and viable financing, which allows them to reduce non-performing loans.

Henceforth, Basel III has a substantial negative effect (β=-0.099, t=-2.11, p<0.05) on banking inefficiency, which supports the notion that banks formed after 2010 posit less inefficiency level compared to those formed before or in 2010. This result suggests that newly formed banks adopted Basel III capital requirements, whereas earlier established banks underwent poor capital growth due to strict capital regulation (Deli & Hasan, 2017; Gržeta et al., 2023). The rationale behind this result is that older banks had to carry out additional costs to fit and adopt new regulations in their

Table 6. *Robustness Test*

Inefficiency (DV)	Coef.	t.Err.	t-value	p-value	[95% Conf	Interval]
Non-Performing Loan Ration	.015	.013	1.18	.24	-.01	.041
Total Assets (log)	-.113***	.04	-2.82	.005	-.191	-.034
Tangibility	.182	.122	1.49	.137	-.058	.422
State-owned	-.129***	.041	-3.14	.002	-.21	-.048
Islamic Bank	-.054*	.029	-1.89	.059	-.111	.002
BASELLII	-.099**	.045	-2.23	.027	-.187	-.012
COVID-19	-.023	.034	-0.67	.503	-.091	.045
GDP	-.04***	.011	-3.62	0	-.061	-.018
Inflation	-.046**	.021	-2.26	.024	-.087	-.006
Constant	1.4***	.236	5.92	0	.934	1.866
Pseudo r-squared				2.109		
Akaike Crit. (AIC)				-8.070		
Number of Obs				237		

*Note: *** p<.01, ** p<.05, * p<.1*

existing capital structure. Although the COVID-19 pandemic led to an unanticipated global disruption that resulted in substantial economic transformations and banking operations (Demirgüç-Kunt et al., 2021), the COVID-19 pandemic posited an insignificant (β=-0.023, t=-0.75, p>0.10) negative effect on Bangladeshi banking inefficiency. Several measures (e.g., loan moratoriums, deferred payments) taken by the central bank amid the COVID-19 crisis could alleviate its effect on operational efficiency. Despite experiencing structural issues with NPLs, Bangladesh's banking sector might demonstrate significant resilience to the disruptions induced by COVID-19.

Robustness Test

This study further performed regular Tobit regression analysis without adjusting heteroskedasticity for the robustness of the findings. The results (Table 6) suggest that the nexus between NPLs and banking inefficiency remains insignificant, although it was significant at a 90% confidence level earlier. However, banking size attained a significant negative effect at a 1% confidence level, which was significant at a 10% significance level. It indicates that the regular Tobit model overstated the significance of the nexus. However, the results for other relationships remain constant in the robustness test.

Conclusion

The efficiency of banking is a crucial determinant of the longevity of the financial system and, consequently, the overall economy. In this setting, this study aimed to identify the determinants of banking inefficiency in Bangladesh. Although the NPL ratio was not a significant determinant of inefficiency, it had a negative effect. Thus, a high level of NPL can weaken the loan quality and reduce overall performance. Ownership structure and orientation both play a significant role in banking inefficiency, and both state-owned banks and Islamic banks have demonstrated lower inefficiency levels in Bangladesh. Given the importance of capital regulations, it requires additional cost and time for existing banks to adopt and fit into their operational and capital structure, which significantly reduces their efficiency level.

The findings of this study unfold several implications. Theoretically, this study aids the literature relevant to banking efficiency and determinants of inefficiency. Banks' size, ownership structure and orientation, and new capital regulation implementation (Basel) added to the breadth of literature by confirming the negative effect on banking inefficiency. Surprisingly, state-owned banks, which were criticized for bad loans and liquidity issues, showed a significant negative effect on banking inefficiency, which added a new dimension to Bangladeshi commercial banking literature. However, the effect of NPL added to the dearth of literature, wherein major studies found a significant positive effect on banking inefficiency. Similarly, the COVID-19 effect is also considered to be one of the few literatures that showed an insignificant effect on banking inefficiency. Finally, economic growth is positively related to baking performance.

At the management level for banks, firstly, the efficiency score for each bank demonstrates a concern for managers. For those who are comparatively efficient, managers may find the determinants of inefficiency level and take prescriptive measures to allow them to stay resilient. On the other hand, management from inefficient banks can use the findings to identify their loopholes. As a result, they can take necessary measures such as productive loans and investments while emphasizing the cost of collecting deposits and acquiring assets. In addition, banks must examine the effects of moving macroeconomic variables, such as GDP growth and inflation, on their efficiency and associated risks (Nasim et al., 2024)this paper investigates the implications of the regulatory environment, macroeconomic factors, monetary conditions, and uncertainty for the banking sectors' operating as well as investment efficiencies. Using data from G7 and E7 countries from 2001 to 2020, we employ a set of empirical techniques, including Fixed Effects, Random Effects, Panel Fully Modified Least Squares, Panel Dynamic Least Squares and Generalized Method of Moments. Our key findings show that leverage, capital adequacy, monetary conditions, economic growth, price stability as well as exchange rate stability and uncertainty have substantial effects on bank efficiency, with notable differences between impact on operational and investment efficiencies and developed (G7. This suggests that policies aimed at stabilizing both inflation and GDP growth should be prioritized to enhance the role of banks. In the interim, bank regulators may use the findings to reinforce their macroprudential policy and monitor each bank, particularly those that are inefficient.

Similar to any study, the scope of this paper is also limited. Subsequent studies may incorporate additional variables, such as corporate governance, political connections with the board of directors, and financial leverage as determinants of banking inefficiency. This study concentrated exclusively on Bangladeshi commercial banks; future research may encompass additional countries or regions. Digital finance, including digital currencies, mobile money, financial technology, and blockchain, are presenting novel glitches in the banking sector. These variables exceed the parameters of the current study; nonetheless, their inclusion in further analyses could yield additional insights into the efficiency of the banking sector. Moreover, it would be beneficial to expand the examination of banking efficiency to include technical and allocative efficiencies in subsequent studies. Furthermore, further study may use machine learning or artificial neural networking to determine the inputs and outputs for the DEA techniques as well as to determine the most crucial factors affecting banking inefficiency and banks with large NPL ratios.

List of abbreviations

CRS = Constant Returns to Scale
DEA = Data Envelopment Analysis
DMU = Decision-making units
FDI = Foreign direct investment
GDP = Gross Domestic Product
NPL = Non-performing loan
NPLR= Non-performing loan ratio
PTE = Pure Technical Efficiency
SE = Scale Efficiency
TE = Technical Efficiency
VRS = Variable Returns to Scale

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