



EFFECT OF CREDIT RISK MANAGEMENT ON PROFITABILITY OF COMMERCIAL BANKS IN BANGLADESH

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ABSTRACT

In the banking industry, efficient credit risk management is crucial since it has a bigger influence on the survival, expansion, and financial success of banks. This study was conducted to identify the credit risk management practices, measure the effect of credit risk management on profitability, and assess the efficiency of the purposively selected 5 private commercial banks of Bangladesh: IBBL, DBBL, PBL, BRAC, and BAL. The primary data were collected from the Mymensingh branches of the respective banks through a semi-structured interview schedule. Secondary data were collected from the annual reports of the respective banks for the period 2008-2018. A five-point Likert scale was used to identify the credit risk management practices. Pooled regression analysis and panel data analysis were applied to measure the effect of credit risk management on profitability. A non-parametric Data Envelopment Analysis (DEA) method was utilised to assess the efficiency of the banks. The findings indicate that banks place great emphasis on borrowers' capacity, collateral, and regular review of borrowers' reports and onsite visits in loan appraisal and subsequent approval, controlling loss, and monitoring. The results of panel data analysis indicate that credit risk management has a significant effect on bank profitability. The corresponding mean efficiency scores show that the banks' overall efficiencies are extremely high. As far as TE, PTE, and SE are concerned, only DBBL is on the efficient frontier; PBL is far from it. Lastly, the results show that in order to boost profitability, it must monitor and reduce NPL, maintain optimal CAR, and improve managerial effectiveness. Besides having some limitations, this study provides practical guidelines to the bank regulators and policymakers to strengthen the credit risk management, financial stability and long-term sustainability of the financial sector of Bangladesh.

Keywords: Credit Risk, Risk management strategy, Profitability, Efficiency, Bangladesh.

INTRODUCTION

The financial industry is a major factor in a nation's economic development, and banks are a crucial part of that sector (Zhuang *et al.*, 2009). With branches and subsidiaries throughout, touching everyone's life, banks are currently the biggest financial institutions in the world (Berger *et al.*, 2000). In particular, commercial banks are essential to the distribution of resources in the majority of nations. The banking industry is focused on keeping financial assets of customers, using those assets as leverage to invest in other financial assets, and allowing government authorities to regulate these operations. Over the past few decades, this industry has grown increasingly complex as a result of compound transactions that necessitate knowing the whole extent of risk (Lisa and Hermanto, 2020). According to Al-Husainy and Jadah (2021), there are several hazards associated with banking operations, such as interest rate risk, liquidity risk, and credit risk. Credit risk, liquidity risk, interest rate risk, mismatch risk, market liquidity risk, market risk, and foreign exchange risk are some of the common hazards that banks encounter, according to Bessis (2011). The financial sector in Bangladesh has recently been in appalling condition. A few private banks and the majority of state-owned institutions have been operating in what is regarded as a "risky" region and beyond the law (Afroze *et al.*, 2019). The banking industry in Bangladesh is exposed to a number of hazards, chief among them being credit risk brought on by the high number of non-performing loans, lack of capital and liquidity, poor governance, money laundering, and ineffective regulations. According to Poudel (2012), banks' financial performance is negatively impacted by efficiency metrics like default rate, cost per

loan assets, and capital adequacy ratio since these indirectly influence profitability. Particularly in the biggest economies in the world, credit risk continues to have a great impact on the stability and profitability of the banking industry (Mwanjilinjji *et al.*, 2025).

There are numerous regulations governing commercial banking in almost every nation. (Hull and John, 2012). Over time, the banking industry has been disrupted by the deregulatory actions that resulted in an overly quick extension of credit, which has led to severe banking crises, non-performing loans, and credit losses in addition to widespread bankruptcies (Hosna *et al.*, 2009). The last ten years have seen a significant improvement in knowledge regarding the role of commercial banks in the financial industry (Mutua, 2014). A traditional bank might also benefit from a thorough risk management strategy (Iqbal and Mirakhor, 2007). The risks connected to lending and credit activities are identified and managed by credit risk management (Murtaza *et al.*, 2023). All banks worldwide still focus on providing credit, even though one of the key contributors to severe banking issues is inadequate credit risk management (Claessens *et al.*, 2018). Tuladhar (2017) found that Nepalese commercial banks' profitability is significantly impacted by credit risk management. Ndoka and Islami (2016) explored a correlation between the credit risk management of commercial banks in Albania and their profitability. Since credit risk accounts for a significant portion of assets and the majority of bank revenue in Bangladesh, it is clear that careful risk management is essential to a bank's long-term viability (Banu *et al.*, 2021). Ensuring a substantial performance in commercial banks and the economy at large which are contingent upon robust credit risk management in the process of developing excellent loan portfolios (Charles and Kenneth, 2013).

Credit risk influences the bank's cash flow, liquidity position, and profitability in addition to other variables that are known to be the biggest threats to banks' performance and the main reasons for bank failure. The high volume of non-performing loans, which have grown to constitute a crucial component of industry credit, is upsetting Bangladesh's banking sector (Uddin *et al.*, 2023). Fig. 1 illustrates the ISO 31000:2009 risk management process. It demonstrates that monitoring and evaluating the internal and external surroundings as well as interacting and consulting with internal and external stakeholders are the two primary elements of the risk management process. The heart of the risk management process consists of three steps: setting the context, risk assessment, and risk treatment. Every bank must have a clearly defined credit risk management strategy to mitigate losses. Because credit risk can affect profitability and cause a systemic catastrophe for both the bank and the economy, institutions must carefully define and manage it (Noman *et al.*, 2015). A bank must know how various factors affect profitability to continue its function sustainably. Proper knowledge of credit risk may help in managerial decision-making to a large extent.

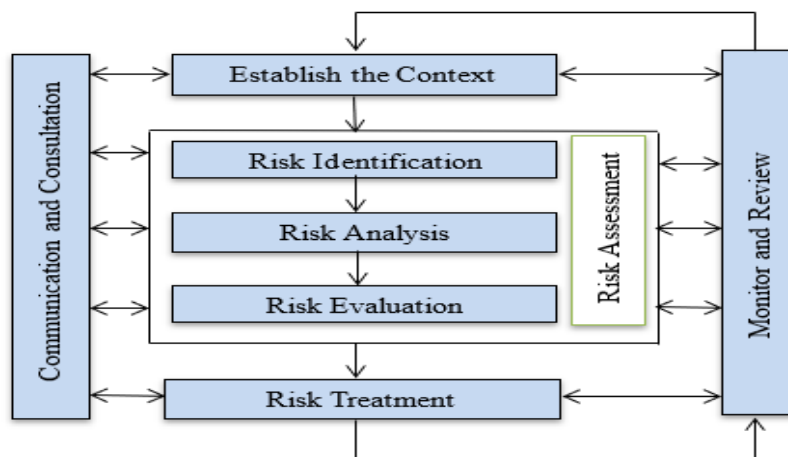


Fig. 1. Risk Management Process

Review of the previous studies shows that numerous research on credit risk management has been conducted worldwide including Bangladesh. Gazi *et al.* (2014) evaluated the efficiency of Bangladeshi banks' credit risk

management procedures, using United Commercial Bank PLC as a specific example covering the period 2006-2010. In that study, both ROE and ROA are used to measure profitability, which is a measure of bank's performance, and the NPL ratio is used to measure loan recovery performance, which is a measure of credit risk management. The impact of credit risk management on profitability was determined by Banu et al. (2021) through an analysis of the 2012–2016 annual reports of four state-owned commercial banks in Bangladesh. ANOVA approach, multiple regression model, and correlation matrix were used in that study. In their study, Uddin et al. (2023) used average lending rate, inflation, NPL size, capital adequacy ratio, liquidity ratio as measurement factors of credit risk and return on asset as financial performance and a dynamic regression model was used to analyse seven years of data of nine selected banks. Lalon and Morshada (2020) studied ten years' data of seven commercial banks of Bangladesh and identified that higher non-performing loans do not always lower banks' net income; instead, they increase their future profitability by guaranteeing sound governance and the credit management department's adherence to it. Nguyen (2023) discovered that Vietnam's profitability and financial stability were directly impacted by non-performing loans and loan loss reserves. Additionally, there was an indirect connection between financial stability, profitability, and credit risk management. Return on assets (ROA), capital adequacy ratio (CAR), non-performing loan ratio (NPL), cost to loan assets ratio (CLA), cash reserve ratio (CRR), and bank size (BS) were used by Biswas et al. (2021) as indicators of bank profitability and credit risk. The results of the investigation showed a significant positive association between ROA and both CAR and CLA. Nonetheless, there was a significant inverse relationship between ROA and both BS and NPL. The credit risk variables used by Kwashie et al. (2022) included return on asset and economic value-added as financial performance and other efficiency metrics like non-performing loans, capital adequacy ratio, loans and advances ratio, bank size, bank age (years of existence), GDP, inflation, and monetary policy rate. They employed the panel estimation technique on 15 commercial banks in Ghana between 2013 and 2018. The findings demonstrate that both financial performance metrics are negatively impacted by non-performing loans. Sabore (2025) investigated how different risk management and financial factors affected Tanzanian commercial banks' financial performance from 2017 to 2024 focussing on how return on equity (ROE) is impacted by NPLs, capital adequacy ratio (CAR), firm size (F_SIZE), and debt-to-equity ratio (DER). A non-significant positive correlation between NPLs and ROE has been found. Previous studies show that different studies used different variables and methods for the analysis. So, there is a significant gap for further research. However, this study has analysed eleven years data to assess the effect of credit risk management on bank profitability. This made an approach to include independent variables of which some are different than the previous studies such as return on equity, liquidity ratio, leverage ratio etc.

A conceptual framework that outlines the connections between different financial measurements and business performance is shown in Fig. 2. This framework considers NPLR, CAR, LER, BS and LR as independent variables and ROA and ROE as dependent variables. According to this concept, changes in credit risk, as shown by the selected indicators, can have a direct impact on a company's financial performance.

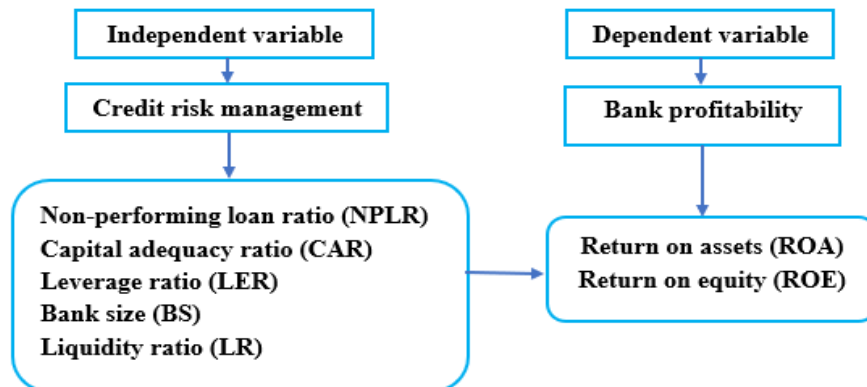


Fig. 2. Conceptual framework constructed by the author



This study adds to the body of knowledge regarding bank profitability and credit risk in developing nations. Following questions are answered here: What are the credit risk management practices adopted by commercial banks? How does credit risk management affect the profitability of commercial banks? And how efficient are the banks in their operation? The specific objectives of this study are to identify the credit risk management practices adopted by commercial banks, to measure the effect of credit risk management on the profitability of banks, and to assess the efficiency of the banks.

This study provides valuable insights to the bank regulators and policymakers to strengthen the credit risk management of the banking industry. Moreover, it offers practical guidelines to ensure the financial stability and long-term sustainability of the financial sector of Bangladesh. Furthermore, efficiency assessment helps benchmark the banks against their opponents in the fierce competitive environment.

METHODOLOGY

Study Area and Sample Size

Five private commercial banks of Bangladesh have been selected using purposive sampling technique for conducting this research. They are Islami Bank Bangladesh PLC (IBBL), Dutch-Bangla Bank PLC (DBBL), BRAC Bank PLC (BRAC), Prime Bank PLC (PBL), and Bank Asia PLC (BAL). The availability of data, diversity in size and performance, degree of credit risk, and the viability of carrying out in-depth quantitative and qualitative analysis were taken into consideration when selecting these banks. Therefore, the chosen sample supports the empirical investigation of the connection between credit risk management and profitability and accurately reflects the credit-risk characteristics of the industry.

Both primary and secondary data have been used for the achievement of the objectives. For primary data collection, the Mymensingh district of Bangladesh was purposively selected because it was the nearest place to the researcher. The survey schedule was semi-structured, which contained both open-ended and closed-ended questions. The survey schedule was pre-tested before final data collection. The data were collected during the month of July 2019. Primary data on risk management practices used by the banks were collected which were qualitative in nature. Secondary data used for this study were obtained from the audited annual reports of all the sample banks for the period 2008-2018. Data were also collected from the annual reports of the Bangladesh Bank and financial reports of the respective banks. This study includes data over 11 years, from 2008 to 2018, and the total observations are 55. After the completion of data collection, the data were compiled into tabular form. Descriptive statistics were used for a substantial part of the data analysis. A five-point Likert scale was used to analyse primary data to identify the credit risk management practices. Secondary data were used to show the effect of credit risk and the efficiency of banks. Pooled regression analysis and panel data analysis were applied to measure the effect of credit risk management on profitability. A non-parametric DEA method was utilised to assess the efficiency of the banks.

Likert Scale

Following Afande (2014), a Likert scale has been developed that specifically uses five responses: not at all, somewhat, neutral, much, and very much. Questions related to identification of credit risk and policy formulation, credit risk management strategies, tools in loan appraisal, approval and monitoring and dealing with problem loans were asked to get the responses. According to Mugenda and Mugenda (2008), it helps translate the qualitative replies into numerical values. Since a general assessment of credit risk management methods was acquired and a Likert scale was helpful in gathering particular data, its use in this study was justified.

Model Specification

The study used the following models to examine the relationship between credit risk management and bank profitability. The specific models are:

$$ROA_{it} = \alpha_0 + \alpha_1 NPLR_{it} + \alpha_2 CAR_{it} + \alpha_3 LER_{it} + \alpha_4 BS_{it} + \alpha_5 LR_{it} + \epsilon_{it} \dots\dots\dots (1)$$

And,

$$ROE_{it} = \beta_0 + \beta_1 NPLR_{it} + \beta_2 CAR_{it} + \beta_3 LER_{it} + \beta_4 BS_{it} + \beta_5 LR_{it} + v_{it} \dots\dots\dots (2)$$



Where,

- ROA_{it} = Return on assets of bank i in the year t
- ROE_{it} = Return on equity of bank i in the year t
- $NPLR_{it}$ = Non-performing loan ratio of bank i in the year t
- CAR_{it} = Capital adequacy ratio of bank i in the year t
- LER_{it} = Leverage ratio of bank i in the year t
- BS_{it} = Bank size of bank i in the year t
- LR_{it} = Liquidity ratio of bank i in the year t
- α_n, β_n = Intercept terms
- ϵ_{it}, v_{it} = Error terms

The variables ROA and ROE represent the profitability of the commercial banks, and the variables NPLR, CAR, LER, BS, and LR represent credit risk management of the banks.

Pooled Regression Analysis

To determine which of the components listed are crucial in explaining financial performance, the functional relationship between the independent variables and the dependent variable is established using the pooled regression analysis that follows.

$$ROA_{it} = \alpha_0 + \alpha_1 NPLR_{it} + \alpha_2 CAR_{it} + \alpha_3 LER_{it} + \alpha_4 BS_{it} + \alpha_5 LR_{it} + \epsilon_{it} \dots\dots\dots(1)$$

and,

$$ROE_{it} = \beta_0 + \beta_1 NPLR_{it} + \beta_2 CAR_{it} + \beta_3 LER_{it} + \beta_4 BS_{it} + \beta_5 LR_{it} + v_{it} \dots\dots\dots (2)$$

Before going for panel analysis, multicollinearity (VIF and Tolerance), heteroskedasticity (Breusch-Pagan test and White test), autocorrelation (Durbin-Watson test, Breusch-Godfray test), AIC, and BIC tests have been done.

Panel Data Analysis

The data also uses a panel data estimate technique because it includes information on cross-sectional units observed across time. The models for panel data analysis can be expressed as follows —

$$ROA_{it} = \pi_0 + \pi_1 NPLR_{it} + \pi_2 CAR_{it} + \pi_3 LER_{it} + \pi_4 BS_{it} + \pi_5 LR_{it} + k_{it} \dots\dots\dots(3)$$

and,

$$ROE_{it} = \mu_0 + \mu_1 NPLR_{it} + \mu_2 CAR_{it} + \mu_3 LER_{it} + \mu_4 BS_{it} + \mu_5 LR_{it} + w_{it} \dots\dots\dots (4)$$

All the dependent and independent variables are explained in the previous section. Here, π_n and μ_n are intercept terms and k_{it} and w_{it} are error terms. A Hausman test was conducted at the 5 percent significance level using STATA (statistical data analysis software) to identify the optimal model between the fixed effect model and the random effect model. The random effect estimator and fixed effect estimator estimate the same coefficient, which is tested using the Hausman test to determine whether the null hypothesis is true (Afriyie and Akotey, 2012). Because each bank has its intercept value, the fixed effect model permits individuality or heterogeneity among banks. The random effect model is commonly used in panel data analysis where changes across entities are assumed to be random and unrelated to the independent variables (Torres-Reyna, 2007).

Sharma *et al*, (2023) used both panel data analysis and pooled regression analysis in their study. Both the pooled regression and the panel data analyses are used for the same study because firstly, pooled regression provides a preliminary picture of associations, secondly, panel regression models take individual-specific effects and autocorrelation into consideration, and thirdly panel regression models offer rigorous policy analysis by correcting for unobserved factors.

Data Envelopment Analysis (DEA)

This study uses the DEA approach following the method of Ali (2015) to measure the technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE). DEA method is used to determine the efficiency of various homogeneous businesses with many inputs or outputs, known as Decision Making Units (DMU). In order to quantify technical efficiency by solving the Linear Programming (LP) equation, Charnes, Cooper, and Rhodes (CCR) formally established DEA in 1978 under the assumption of constant returns to scale (CRS). The original DEA model was expanded by Banker, Charnes, and Cooper (BCC) in 1984 to quantify pure technical efficiency under the assumption of variable returns to scale (VRS) (Ali, 2015).



committees at the branch level who are responsible for identifying the types and sources of credit risk. In most of the banks, the policies regarding credit risk are formulated by the credit risk management committee. But in PBL, the board of directors formulates the policy. Considering regulatory compliance, risk management strategy, and industry best practices, the board chair authorises the main policy guidelines, growth plan, and exposure limitations for certain industries, products, businesses, and groups. These policies are then executed by the management officials in the lending procedure. All of the banks have well-documented credit risk management policies in compliance with the Bangladesh Bank policy guidelines. DBBL annually changes those policies, and the rest of the banks change as and when necessary, depending on the situation that arises.

Table – 1: Strategy of Credit Risk Identification and Policy Formulation in Selected Banks

Sl. No.	Items	IBBL	DBBL	PBL	BRAC	BAL
1.	Risk identification level	Risk management committee	Branch	Branch and departmental	Departmental	Branch
2.	Personnel/ committee involved in risk identification	Risk management wing	Branch credit committee and credit risk management division	Credit risk management division, along with branches	Credit risk management division	Credit Risk Management Committee
3.	Responsible for formulating policy	Credit risk management committee	Credit risk management committee	Board of Directors	Credit risk management committee	Credit Risk Management Committee
4.	Well-established policy for managing credit risk	Yes	Yes	Yes	Yes	Yes
5.	Approval of the overall credit risk management policy	Chair of the board	Chair of the board	Chair of the board	Chair of the board	Chair of the board
6.	Change in policy	As and when necessary	Annually	As and when necessary	As and when necessary	As and when necessary

Source: Field Survey (2019)

Credit Risk Management

Table - 2 shows the various aspects of credit risk management of the banks. The structure of the credit risk management committee is different in different banks. In DBBL, the meeting of the committee is held monthly. In the other banks, the meeting of the committee is held as required. DBBL provides training on credit risk management to the newly recruited officials. All the other banks arrange training when the management thinks it is necessary. Credit risk grading is an essential tool for credit risk management as it allows banks and other financial institutions to understand the various dimensions of risk linked to specific credit transactions. Since risk grading is a crucial indicator of a bank's asset quality, a reliable grading procedure is necessary. The risk grade given to a borrower and its facilities should be promptly modified when a decline in risk is observed.

Table – 2: Credit Risk Management Aspects Commonly Practised in Selected Banks

Sl. No.	Items	IBBL	DBBL	PBL	BRAC	BAL
1.	Type of credit risk management division	Independent	Independent	Independent	Independent	Independent
2.	Member of the risk management committee	Directors of the board	Chairman, CEO and head of CRM unit	Chairman along with 4 other members	CEO and divisional heads	Directors of board and senior management team
3.	Meeting of risk management committee	As and when required	Monthly	As per requirement	As per requirement	As per requirement
4.	Training on credit risk management	As per requirement	One time to the newly recruited officials	As per requirement	As per requirement	As per requirement
5.	Credit limit	Yes	Yes	Yes	Yes	Yes
6.	Credit risk grading	As per Bangladesh Bank guidelines	As per Bangladesh Bank guidelines	As per Bangladesh Bank guidelines	As per Bangladesh Bank guidelines	As per Bangladesh Bank guideline and bank's own policy

Source: Field Survey (2019)

Factors and Tools in Loan Appraisal, Approval, and Reducing Losses

When evaluating and approving loans, the five C's of borrowers are examined. They are the borrower's capacity, condition, collateral, capital, and character. Analysis of specific borrower's repayment capacity is done through the review of financial statements. Table - 3 shows that all the banks place supreme importance on the borrower's repayment capacity. The bank may take possession of the collateral and sell it to cover some or all of its losses if the borrower doesn't make loan payments as agreed.

Table – 3: Factors Considered by the Selected Banks in Loan Appraisal and Approval

Important considerations for loan approval and appraisal (the five Cs)	Responses (%)					Mean score
	Not at all	Somewhat	Neutral	Much	Very much	
Capacity	0	0	0	0	100	5.0
Character	0	0	0	60	40	4.4
Condition	20	0	20	20	40	3.6
Credit history	0	0	0	20	80	4.8
Collateral	0	0	20	20	60	4.4

Source: Author's Calculation Using Field Data

The results also demonstrate that, with a mean score of 5, the borrower's capacity is the most significant aspect taken into account when evaluating and approving a loan.

Additionally, the respondents were asked to rate the significance of the instruments taken into consideration for loss reduction. The lender experiences a credit loss when a borrower defaults on payments, which mean that projected future cash flows are lost. Table - 4 presents a summary of the responses.

Table – 4: Instruments Used by the Selected Banks for Reducing Credit Losses

Instruments for Reducing Credit Losses	Responses (%)					Mean score
	Not at all	Somewhat	Neutral	Much	Very much	
Covenants	0	0	20	80	0	3.8
Collateral	0	0	0	20	80	4.8
Credit rationing	0	20	0	20	60	4.2
Loan securitization	0	40	0	40	20	3.4
Loan syndication	20	60	0	20	0	2.2

Source: Author's Calculation Using Field Data

The findings show the highest mean score for collateral (4.8), indicating that collateral is used very much by the respondent banks in controlling credit losses.

Monitoring and Dealing with Problem Loans

All the banks maintain regular communications with debtors. The branch credit committee of IBBL, DBBL, PBL, and BAL is responsible for performing monitoring activities. In BRAC, there is a credit monitoring and recovery team for this purpose. They make an onsite visit, periodically review the borrower's rating assigned while the credit was being given, and update the borrower's credit file. All the banks under study make frequent contacts and visits. If it does not work, they liquidate the collateral security. Finally, they go for legal action. DBBL hands over the problem loan to the third-party recovery agency and provides a certain commission to that party for recovering the loan. The respondents were asked how much activity each of their banks carried out to keep an eye on borrowers. Table - 5 presents a summary of the responses.

Table – 5: Aspects regarding the Monitoring of Loan of Selected Banks

Monitoring related activities	Responses (%)					Mean score
	Not at all	Somewhat	Neutral	Much	Very much	
Regular communications with debtors	0	0	0	20	80	4.8
Solving the borrower's problem	0	0	0	80	20	4.2
Supportive to borrowers in their difficulties	0	20	0	40	40	4.0
Monitoring the flow of the borrower's business	0	0	0	40	60	4.6
Proper review of borrowers' reports and making onsite visits	0	0	0	0	100	5.0
Updating borrowers' credit files	0	0	0	40	60	4.6

Source: Author's Calculation Using Field Data

The results express that the most crucial action for keeping an eye on the borrower is the proper review of borrowers' reports and making onsite visits, which has a mean value of 5.0

CREDIT RISK MANAGEMENT AND PROFITABILITY

Descriptive Statistics

Descriptive data for the variables used in the analysis of the five commercial banks in Bangladesh from 2008 to 2018 (11 years) with 55 observations are shown in Table - 6.



Table – 6: Descriptive Statistics

Variables	ROA	ROE	NPLR	BS	LR	LER	CAR
N	Valid	55	55	55	55	55	55
	Missing	-	-	-	-	-	-
Mean	1.25	16.48	4.13	12.28	82.36	15.25	12.50
Std. Deviation	0.53	7.56	1.70	0.66	6.65	9.00	1.57
Minimum	0.35	4.24	1.18	10.89	66.70	6.45	8.11
Maximum	2.37	35.30	7.82	13.81	94.20	50.10	17.04

Source: Author’s Calculation Using STATA

Where N is the number of observations. Table - 6 shows that the average value of ROA (profitability) is 1.25%. It meant that during the period, the total assets generated a 1.25% return. Further, the average value for ROE (profitability) is 16.48%, indicating that the equity generated a 16.48% return. The minimum CAR is 8.11%. However, the average CAR is 12.50%. The average NPLR for 2008-2018 is 4.13%. The standard deviation column shows the degree to which the variable deviates from the mean. In this case, LER has the biggest standard deviation, whereas ROA and BS have the lowest. The factor's variability increases with the standard deviation.

Pooled Regression Analysis

A pooled regression study shows that profitability is impacted by credit risk management. With the associated probability value of the f-statistic of 0.0000 for both ROA and ROE, Table - 7 demonstrates that both models are statistically significant at the 5% level of significance. The regression model's fit to the data is indicated by R². According to the results in the table, the explanatory factors account for 80% of the changes in ROE and 69% of the variation in ROA.

Table – 7: Results of Pooled Regression Analysis

Independent variables	Dependent variables					
	ROA			ROE		
	Coef.	t-test	p-value	Coef.	t-test	p-value
NPLR _{it}	-0.1993**	-6.70	0.000	-2.5753**	-7.57	0.000
CAR _{it}	0.0141	0.48	0.635	-0.4788	-1.42	0.163
LER _{it}	-0.0069**	-4.37	0.026	-0.1313	-1.27	0.327
BS _{it}	-0.3961**	-5.86	0.000	-5.9106**	-7.64	0.000
LR _{it}	-0.0034	-0.44	0.663	-0.0514	-0.58	0.568
Constant	7.150**	6.38	0.000	107.931**	8.41	0.000
F-statistic	21.59	-	0.000	38.27	-	0.000
R ²	0.6878			0.7961		
Adjusted R ²	0.6559			0.7753		

Source: Author’s Calculation Using STATA

Note: ** significant at 5% level

Table - 7's adjusted R² shows that ROE is 0.78 and ROA is 0.66. ROA and ROE will be the first and second findings to be discussed, respectively.

Determinants of ROA

The most crucial element in controlling credit risk and ensuring banks' financial viability is NPLR. At the five percent significance level, Table - 7 demonstrates that NPLR has a statistically significant negative impact on ROA. It also follows that ROA rises when NPLR falls. The result is similar to those of Aduda and Gitonga (2011), Zou and Li



(2014), Bhattarai (2014), Kaaya and Pastory (2013), and Ndoka and Islami (2016). CAR assesses banks' ability to cover potential losses. Banks with strong CAR are more likely to absorb potential loan losses, preventing failure or insolvency. Table - 7 indicates an insignificant positive relationship of CAR with ROA of the studied commercial banks at a 5% level of significance. Abdelrahim (2013), Afriyie and Akotey (2012), Bhattarai (2014), Kurawa and Garba (2014), and Ogboi and Unuafe (2013), all found a favourable correlation between CAR and bank profitability. LER and ROA have a negative and statistically significant relationship, as Table - 7 demonstrates. This inverse association aligns with the research conducted by Tuladhar (2017) and Alshatti (2015). Large banks are probably going to make less money than small banks because of the strong negative correlation between BS and ROA. Given that banks are getting bigger and their performance is getting worse, the negative relationship implies that banks are becoming less lucrative as a result of management's inability to employ resources effectively. The results of this study are comparable to those of Abdelrahim (2013), who discovered that BS had a detrimental effect on credit risk management's efficacy.

The LR should be maintained appropriately by banks so that it is neither excessively high, which would indicate inefficient use of money, nor too low, which would indicate inability to meet short-term obligations. Table - 7 shows that there is a negligible inverse association between LR and ROA, indicating that LR has no discernible impact on the ROA of the commercial banks that are the subject of the study. The results of Tuladhar (2017), Adeusi et al. (2014), and Ogboi and Unuafe (2013), who similarly discovered a detrimental effect of LR on bank's financial performance, are likewise in line with this finding.

Determinants of ROE

According to the results in Table - 7, there is a statistically significant negative correlation between NPLR and ROE. It suggests that NPLR has a major impact on the chosen commercial banks' ROE. The negative outcome is consistent with the hypothesis and conclusions of Li and Zou (2014), Bhattarai (2014), Kaaya and Pastory (2013), Ndoka and Islami (2016), and Aduda and Gitonga (2011). Table - 7 indicates an insignificant negative relationship between CAR on ROE in the study. The results of Alshatti (2015) and Li and Zou (2014) are likewise in line with this inverse association.

A negative but negligible correlation between LER and ROE is displayed in Table - 7. This indicates that the profitability of particular institutions is not much impacted by LER. This outcome is in line with Alshatti's (2015) findings. The model results show a substantial inverse link between BS and ROE. This table shows that there is a negligible negative correlation between LR and ROE, indicating that LR has no discernible impact on the ROE of the commercial banks that are the subject of the study. This result is in line with the findings of Adeusi et al. (2014) and Tuladhar (2017).

Diagnostic tests

Table - 8 presents the results of the diagnostic tests conducted after the estimation.

Table – 8: Post Estimation Diagnostic Tests

Tests		ROA	ROE
VIF	NPLR	1.41	1.41
	CAR	1.19	1.19
	LER	1.14	1.14
	BS	1.10	1.10
	LR	1.48	1.48
Breusch-Pagan heteroskedasticity test		$\chi^2(1) = 1.15$	$\chi^2(1) = 0.78$
		Prob > $\chi^2 = 0.2842$	Prob > $\chi^2 = 0.376$



Post Estimation Diagnostic Tests (Contd.)		
Tests	ROA	ROE
White test	$\chi^2(20) = 15.45$	$\chi^2(20) = 14.5$
	Prob > $\chi^2 = 0.7501$	Prob > $\chi^2 = 0.8039$
Durbin-Watson autocorrelation test	1.61	1.75
AIC	33.98	302.10
BIC	46.02	314.14

Source: Author's Calculation Using STATA

For both models, the explanatory variables' Variance Inflation Factor (VIF) is smaller than 10. Therefore, the models do not exhibit multicollinearity. According to the results of the Breusch-Pagan test, neither model has a heteroskedasticity issue. For both models, the white test yields the same outcome. The Durbin-Watson test result indicates that the models do not have an autocorrelation issue. For ROA, the Bayesian Information Criterion (BIC) is 46.02, and the Akaike's Information Criterion (AIC) is 33.98. Similarly, ROE has AIC and BIC values of 30.10 and 314.14, respectively. The model with the lower information criteria value is regarded as superior when two models fit the same data. So, the ROA model fits the data better.

Results of Panel Data Analysis

Panel data analysis on ROA

Table - 9 displays the findings of the ROA panel data study. It is implied that a fixed-effect model is superior to a random-effect model since the computed p-value of 0.0034 is less than 0.05.

Table – 9: Results of Panel Data Analysis on ROA

Variable	Fixed effect model			Random effect model		
	Coefficient	t-test	p-value	Coefficient	z-test	p-value
NPLR	-0.2576**	-8.29	0.000	-0.1993**	-6.70	0.000
CAR	0.0047	0.17	0.865	0.0141	0.48	0.633
LER	-0.0070	-1.05	0.299	-0.0069	-1.37	0.170
BS	-0.2322**	-2.37	0.022	-0.3961**	-5.86	0.000
LR	-0.0065	-0.78	0.441	-0.0034	-0.44	0.661
Constant	5.8667**	4.00	0.000	7.1500**	6.38	0.000
F-statistic	29.65	-	0.000	-	-	-
R ²	0.7671			0.7413		
Hausman test	15.71 Prob> $\chi^2 = 0.0034$					

Source: Author's Calculation Using STATA

Note: ** significant at 5% level

Table - 9's result shows that NPLR is statistically significant and negative. It shows that, while all else is held constant, a 1% increase in NPLR results in a 0.2576% drop in ROA. When compared to ROA, CAR is positive but statistically insignificant. It suggests that the ROA of the chosen banks is not much impacted by CAR. The findings show that LER is, in fact, negative but negligible with ROA, indicating that LER has no significant effect on the ROA of the commercial banks from 2008 to 2018. The BS is statistically significant and negative, indicating that it has a significant impact on the return on assets (ROA) of banks. According to the results, LR is negative but insignificant concerning ROA.

Panel data analysis on ROE

The fixed effect model is a superior model specification than the random effect model, according to the Hausman test for ROE, which determined the p-value to be 0.0061, which is less than 0.05. An essential component of bank credit risk management has been shown to be NPLR. The result in Table - 10 shows that NPLR is negative and statistically significant. This indicates that, while all else is held constant, a 1% increase in NPLR results in a 3.0181 percent drop in ROA.



Table – 10: Results of Panel Data Analysis on ROE

Variable	Fixed effect model			Random effect model		
	Coefficient	t-test	p-value	Coefficient	z-test	p-value
NPLR	-3.0181**	-8.32	0.000	-2.5753**	-7.57	0.0000
CAR	0.4574	1.44	0.158	-0.4788	-1.42	0.156
LER	0.0653	0.84	0.404	0.1313**	2.27	0.023
BS	-5.5392**	-4.84	0.000	-5.9106**	-7.64	0.0000
LR	-0.1064	-1.09	0.282	-0.0514	-0.58	0.565
Constant	110.4703**	6.46	0.000	107.9306**	8.41	0.000
F-statistic	42.69	-	0.000	-	-	-
R ²	0.8259			0.8171		
Hausman test	14.40 Prob>chi ² = 0.0061					

Source: Author’s Calculation Using STATA

Note: ** significant at 5% level

Table - 10 demonstrates that BS is statistically significant and negative, suggesting that it is a critical determinant influencing Bangladesh's commercial banks' return on equity. In particular, while all other variables remain the same, a 1% rise causes ROE to drop by 5.5392 percent in BS.

EFFICIENCY OF THE BANKS

Technical Efficiency (TE)

At first, the input-oriented CCR (Charnes, Cooper, and Rhodes) model, which does not account for scale efficiencies, was used (Charnes *et al.*, 1978). The result of this model has been presented in Table - 11 for the period 2008-2018.

Table – 11: Input-Oriented CRS: Technical Efficiency (TE) Score of Selected Banks

Bank name	TE Score											Mean
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
IBBL	1	0.99	0.95	1	1	0.96	0.96	0.93	0.90	0.89	0.92	0.95
DBBL	1	1	1	1	1	1	1	1	1	1	1	1
PBL	1	1	1	1	1	1	0.45	0.45	0.48	0.39	0.46	0.75
BRAC	1	1	1	1	0.95	1	0.74	0.55	0.63	1	1	0.89
BAL	1	1	1	0.99	1	1	1	1	1	1	1	0.99
Mean	1	0.99	0.99	0.99	0.99	0.99	0.83	0.78	0.80	0.85	0.87	0.91

Source: Author’s calculation using DEA software

Table - 11 shows year-wise technical efficiency scores of the banks under study. With 100% TE, DBBL was the top performer, followed by BAL with 99% TE, IBBL with 95% TE, BRAC with 89% TE, and PBL with 75% TE for the study period 2008-2018. TE scores of the banks were 100%, 99%, 99%, 99%, 99%, 99%, 83%, 78%, 80%, 85%, and 87% in the years 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018, respectively.

Pure Technical Efficiency (PTE)

The BCC (Banker, Charnes, and Cooper) model is employed to estimate the overall technical and scale efficiency. Table - 12 presents the PTE scores of the banks under study for the years 2008-2018.



Table 12. Input-Oriented VRS: Pure Technical Efficiency (PTE) Score of Selected Banks

Bank name	PTE Score											Mean
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
IBBL	1	1	1	1	1	1	1	1	1	1	1	1
DBBL	1	1	1	1	1	1	1	1	1	1	1	1
PBL	1	1	1	1	1	1	0.69	0.86	0.95	1	1	0.95
BRAC	1	1	1	1	0.96	1	1	1	1	1	1	0.99
BAL	1	1	1	1	1	1	1	1	1	1	1	1
Mean	1	1	1	1	0.99	1	0.93	0.97	0.99	1	1	0.99

Source: Author’s calculation using DEA software

The average PTE scores for each bank are displayed in Table - 12, with IBBL, DBBL, and BAL having 100% PTE, BRAC having 99% PTE, and PBL having 95% PTE during the 2008–2018 study period. For BRAC and PBL, there was 1% and 5% pure technical inefficiency, respectively. PTE scores were 100%, 100%, 100%, 100%, 99%, 100%, 93%, 97%, 99%, 100%, and 100% in the years 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018, respectively. So, there was 1%, 7%, 3%, and 1% pure technical inefficiency in the years 2012, 2014, 2015, and 2016, respectively.

Scale Efficiency (SE)

Table - 13 presents the banks' SE scores under study for the years 2008-2018.

Table – 13: Scale Efficiency (SE) Score of Selected Banks

Bank name	SE = (TE ÷ PTE)											Mean
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
IBBL	1	0.99	0.95	1	1	0.96	0.96	0.93	0.90	0.88	0.92	0.95
DBBL	1	1	1	1	1	1	1	1	1	1	1	1
PBL	1	1	1	1	1	0.48	0.65	0.53	0.50	0.39	0.46	0.73
BRAC	1	1	1	1	0.99	1	0.74	0.55	0.63	1	1	0.90
BAL	1	1	1	0.99	1	1	1	1	1	1	1	0.99
Mean	1	0.99	0.99	0.99	0.99	0.88	0.87	0.80	0.81	0.85	0.87	0.91

Source: Author’s calculation using DEA software

The only one with 100% efficiency from the perspective of SE was DBBL, which was followed by BAL (99%), IBBL (95%), BRAC (90%), and PBL (73%).

The chosen banks' mean efficiency scores for TE, PTE, and SE are 0.91, 0.99, and 0.96, respectively. These results show that the banks' overall efficiency is quite high, with 9%, 1%, and 4% of improvement potential for TE, PTE, and SE, respectively. When it comes to TE, PTE, and SE, only DBBL is on the efficient frontier. IBBL and BAL are efficient under VRS but far from the efficient frontier with reference to TE and SE, since they are only on the efficient frontier from the PTE. In terms of TE, PTE, and SE, BRAC is near the efficient frontier. When it comes to TE, PTE, and SE, PBL is far from the efficient frontier.

Profitability and Efficiency

ROE and ROA were employed as the profitability metrics in this study. The higher the figure, the better a company's management is in managing its balance sheet to generate profits. Fig. 3 represents the year-wise ROA of the banks under this study.

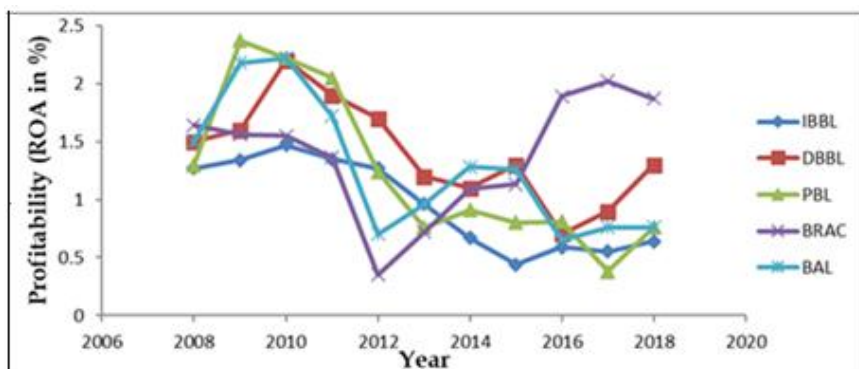


Fig. 3. Year-wise profitability (ROA) of selected Banks: 2008-2018

From the figure, it can be observed that the ROA of all the banks for the year is close to each other. In 2009, the ROA of PBL and BAL were very high. In 2012, there was a drastic fall in the ROA of BRAC and BAL. In 2018, the ROA of BRAC was the highest, and the ROA of IBBL was the lowest. For the period 2008-2018, there were fluctuations in ROA of all banks, but DBBL had a more or less stable ROA. PBL had a more unstable ROA over the year. Fig. 4 represents the year-wise ROE of the banks under this study. DBBL was in a good position compared to the other banks in terms of ROE for the period 2008-2018. At first, BAL was in a better position, but over the years, its ROE has declined. ROE of IBBL was also declining over the years, and it increased in 2018. There was also a fluctuation in the ROE of BRAC. In 2016, the ROE of BRAC was the highest. The ROE of PBL was in a worse position compared to other banks during the period.

Fig. 5 shows the NPLR of the banks under this study. NPLR has an inverse relationship with profitability. The bank that has a lower NPLR is more efficient in credit risk management and more profitable compared to the banks that have a higher NPLR. The NPLR of BRAC was the highest initially. Over time, it was decreasing, and in 2018, it was minimum compared to the other banks. On the other hand, the NPLR of PBL was the lowest among the banks in 2008, and it reached its highest position in 2018. On an average, the NPLR of DBBL remained lower during the period 2008-2018.

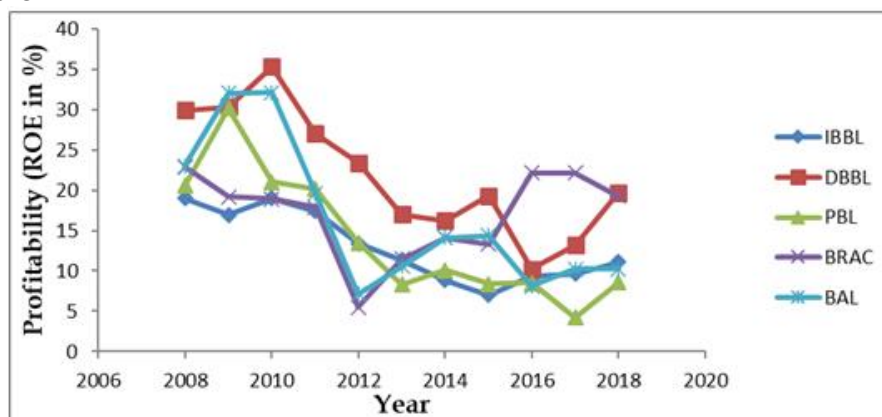


Fig. 4. Year-wise profitability (ROE) of selected Banks: 2008-2018

From the figures, it can be concluded that DBBL was more profitable and PBL was less profitable compared to other banks during the study period, 2008-2018. DBBL had a stable ROA, ROE, and lower and stable NPLR in comparison with the rest of the banks. Additionally, DEA found that PBL is distant from the efficient frontier in terms of TE, PTE, and SE, while only DBBL is on the efficient frontier regarding TE, PTE, and SE. So, it can be seen that efficient banks are more profitable compared to others that are far from the efficient frontier.



Fig. 5. Year-wise credit risk management indicator (NPLR) of selected Banks: 2008-2018

CONCLUSION

The national economic growth of any country depends heavily on its banks. For the country to grow, financial operations must run smoothly. Regretfully, there are still risks in this industry. These risks could significantly lower their earnings. This study has been done in 2019. The result shows that banks have several risk management strategies for loan appraisal and approval, monitoring, controlling credit losses, dealing with problem loans, etc. The panel data analysis's findings demonstrated that BS and NPLR significantly and negatively impact banks' profitability. The chosen banks' mean efficiency scores for TE, PTE, and SE show that the banks' overall efficiency was extremely high. Because risk management greatly increases bank profitability, it is recommended that banks give it more attention. Banks must monitor and regulate non-performing loans (NPLs) to keep their levels as low as feasible, maintain an optimal level of CAR, and boost management effectiveness as BS rises. To guarantee steady efficiency, they must place a strong emphasis on the effective use of input and output variables. However, the study only examines data from five private commercial banks, which could restrict how broadly its conclusions can be applied to Bangladesh's 61 banks. Because the study is limited to a certain time frame, results may differ in various economic contexts. Political factors, economic conditions, and managerial quality are excluded here. Adding more banks, especially state-owned and foreign commercial banks, and increasing independent variables or using dynamic panel models might advance this investigation. To fully understand the variation in profitability, additional pertinent dependent variables could be added to create a profitability indicator.

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CONFLICT OF INTEREST

The authors affirm that there is no conflict of interest associated with this paper's publication.

AUTHOR CONTRIBUTIONS

Tanjima Akter: For developing ideas of research, coordinating research activities, collecting data, data analysing, writing – review & editing, validation, fund acquisition. **Md. Rais Uddin Mian:** For developing ideas of research, coordinating research activities, writing – review & editing, supervision, fund acquisition. **Mohammad Ataur Rahman:** For developing ideas of research, coordinating research activities, writing – review & editing, supervision, fund acquisition. **Tamanna Yesmine:** For writing–review & editing, validation.



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