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Unveiling Bank-Specific and Macroeconomic Factors Driving Non-Performing Loans: Insights from Commercial Banks of Bangladesh

Humaira Begum[1]*, A H M Ziaul Haq[2]

Abstract

Non-performing loans (NPLs) pose a continual threat to the stability and expansion of Bangladesh's banking industry. The bank-specific and macroeconomic factors influencing non-performing loans in commercial banks listed on the Dhaka Stock Exchange were the key focus of this study. Secondary data from annual reports and financial statements to examine factors including CAR, EIR, ROA, ROE, LR, ADR, size, age, leverage, GDP, inflation, unemployment rate, and lending rate were used in this study. The study examines 34 banks over a period of 11 years (2013–2023) and utilizes descriptive statistics, correlation analysis, panel ordinary least squares regression, random effects regression, and feasible generalized least squares (FGLS). The results indicate that CAR substantially decreases NPLs, highlighting the importance of capital reserves in alleviating default risk. ROE adversely impacts NPLs, suggesting that increased equity efficiency results in less defaults. Likewise, ADR adversely affects NPLs, indicating enhanced credit risk management. Macroeconomic factors produce varied outcomes, GDP growth has a negligible impact, whereas inflation markedly elevates NPLs. Established and larger banks typically exhibit higher NPLs, possibly attributable to more hazardous lending practices and operational inefficiencies. Leverage is positively correlated with NPLs, highlighting the impact of excessive debt on heightened default risk. The research emphasizes the necessity of improving capital reserves, strengthen credit risk management, and rectify structural inefficiencies within the banking industry. The research provides empirical insights into the bank-specific and macroeconomic factors influencing NPLs, with practical and policy implications for financial institutions and policymakers to enhance the stability and sustainability of the financial sector.

Keywords: Non-Performing Loans, Bank-Specific Factors, Macroeconomic Factors, Commercial Banks, Feasible Generalized Least Square (FGLS)

1. Introduction

Banks are widely acknowledged as key contributors to economic development and are expected to exhibit stability and prudence. Bangladesh is a growing nation that greatly depends on the banking sector for efficient financial intermediation. Through effective and efficient lending, banks support economic growth. Through the mobilization of excess money ranging from micro to macro units and the provision of loans and advances to potentially productive units, the banking sector promotes economic development (Alamgir *et al.,* 2023). Giving credit to people, businesses, and other entities is one of financial institutions' primary responsibilities. Financial institutions can increase their profitability and growth by providing loans, but there are hazards involved that need to be carefully considered (Dimitrios *et al.,* 2016).

[1] Ph.D Fellow, Institute of Bangladesh Studies, University of Rajshahi, Rajshahi 6205 Bangladesh; E-mail: humaira.begum@hstu.ac.bd * Corresponding Author

[2] Professor, Department of Finance, University of Rajshahi, Rajshahi 6205 Bangladesh; E-mail: zia_haq2001@yahoo.com

Despite numerous reform initiatives, the banking industry is currently dealing with a serious issue of NPLs, which are an indication of poor lending practices. In the banking sector of Bangladesh, the aggregate amount of NPLs was Tk.1011.50 billion in September 2021. From December 2021 the NPL amount of the banking sector rose from Tk. 1032.74 billion to Tk. 1134.41 billion in March 2022. At the end of June 2022, the NPL amount stood at Tk.1252.57 billion, drastically increasing up to September 2022 with an amount of Tk.1343.96 billion. After a slight decrease in December 2022 by an amount of Tk. 137.39 billion, it again began to increase. At the end of March 2023, it was Tk. 1316.21 billion, however the highest recorded amount of NPLs occurred in June 2023 reaching Tk. 1560.39 billion. By September 2023 the total amount of NPLs in Bangladesh's banking sector was Tk. 1553.98 billion. As of December 2023, it decreased to Tk. 1456.33 billion but then began to rise again. By March 2024, the NPLs had surged to Tk. 1822.95 billion, further increasing to Tk. 2113.92 billion in June 2024. The most alarming figure was recorded in September 2024, when NPLs reached Tk. 2849.77 billion. This shows that from September 2021 to September 2024, the NPLs increased by Tk. 1838.27 billion or approximately 181.7%, which is extremely concerning (Financial Stability Assessment Report, 2024). From the South Asian perspective as of September 2024, India's NPL ratio was approximately 2.5%, Pakistan's banking sector stood at around 7.6%, Sri Lanka's banking sector at around 12.8%, and Bangladesh at around 16.9% (CEIC Data, 2024).

NPLs have a significant impact on all bank stakeholders, including directors, shareholders, employees, borrowers, depositors, and the overall economy. NPL lowers bankable assets, which lowers lending capacity in addition to the bank's profit margin (Patwary and Tasneem, 2019). Reduced revenue, financial instability, decreased liquidity, and even the financial institutions' viability may happen because of NPLs (Bellotti, 2021). Thus, it is critical to comprehend the causes of the rise in NPLs. Previous studies provide valuable insights into the common causes and patterns of NPLs across different contexts, helping to identify consistent determinants. High NPLs might result from internal problems such as declining borrower income, operational difficulties, or poor institution management. In addition to the status of the economy, the two primary risk factors that increase NPLs are lending interest risk and business risk. Another factor that must be taken into account is the overall status of the economy, which includes GDP growth, increased inflation, increased unemployment, and a decline in industrial operations (Radivojević, 2019).

One major threat to bank stability is NPLs. Bangladesh's banking sector has been troubled by high NPL levels, which has detrimental effects on the sector's operational and financial stability. Therefore, it is thought to be crucial to look at the factors that have influenced the prevalence of NPL, and some policy recommendations may also be based on these aspects. Therefore, the aim of this study was to determine the macroeconomic and bank-specific factors that affect NPLs in Bangladesh. This study contributes to the existing literature by incorporating both bank-specific and macroeconomic variables of all DSE listed commercial banks of Bangladesh over an extended period (2013–2023), unlike the recent work, which usually concentrates on a few numbers of banks or shorter sample periods. This study utilizes the robust econometric methods like FGLS method rather than using only the static panel data models to deal with the problems of heteroscedasticity and autocorrelation to obtain

more reliable results. The practical implication of the findings lies in guiding policymakers and regulators in Bangladesh to enhance the strength of capital adequacy requirement, risk management in credit, and mitigate macroeconomic pressures that aggravate NPLs.

2. Literature Review and Hypothesis Development

NPLs are those for which the borrower is not repaying any principal or interest. Due to its impact to generate serious financial instability, its pose a serious threat to banks and the larger financial system. Identifying the reasons for NPLs aids in risk management and mitigation.

2.1. Bank-Specific Factors

The research on NPL drivers has revealed many bank characteristics with varying degrees of impact. There is an enormous amount of research on the key variables that lead to NPLs, such as bank size, capital adequacy, management efficiency, and revenue diversification. Waqas et al. (2017) and Ferreira (2022) revealed that inefficiency, profitability, capital ratio, and leverage have a significant impact towards credit risk. While Khanam and Hasan (2021) revealed that operating inefficiency, bank size, liquidity, capital adequacy ratio, and profitability are found to control the NPL levels significantly. Capital adequacy ratio, Expenditure income ratio, Return on Asset, Return on Equity, and Liquidity ratio were used in a study to determine influencing factors behind the cause of NPLs (Islam and Yasmin, 2021; Zabin *et al.,* 2024 & Odebode *et al.,* 2024). Whereas a study's findings showed that high lending volume (Advance Deposit Ratio-ADR), profitability as measured by return on assets, capital adequacy in relation to risk-weighted assets, and high deposit liquidity percentage, have a substantial impact on the rise in non-performing loans in Bangladesh (Haq and Kamruzzaman, 2020; Salam, 2023 & Abdioglu, 2016).

2.1.1. CAR (Capital Adequacy Ratio)

Solvency is the natural indicator of a sound banking system, and solvency of a bank is measured by the Capital Adequacy Ratio (Koju *et al.,* 2018). Sound banking system can potentially protect depositors against any undesirable situation (Khan *et al.,* 2020). A study on the concern area finds that there is a negative relationship between CAR and NPL (Makri *et al.,* 2014). Empirically, previous studies applying bank-level panels shows that there exists a significantly negative relation between CAR and NPL (Khan *et al.,* 2020; Alnabulsi *et al.,* 2022; Salas *et al.,* 2024). Also, tighter internal control lowers the chances of gambling and increase the likelihood of the originations of risky loans that result as NPLs (Pancotto *et al.,* 2024). In addition, also in Malaysia, the relationship is defined as concave, that is, increasing capital at the beginning have higher NPLs levels because of overarching moral hazard and, following a threshold point, extra capital mitigates NPLs, which points out a tedious relationship between capital and loan quality (Hajja, 2017). Taken together, these works collectively highlight the adverse linkage of CAR with NPL and the significance of NPL in managing sound capital adequacy and financial stability across banking systems. Thus, the following hypothesis has been developed:

H_{1a}: The relationship between Capital Adequacy Ratio and the NPL is expected to be negative.

2.1.2. Expenditure income ratio (EIR)

A bank's Operating expenses are a share of the sum of net interest revenue and other operating income. It is also known as the cost-to-income ratio (%) and is used as a measure of efficiency. Studies conducted by Bardhan and Mukherjee (2016) found that EIR has a

positive impact on NPLof Indian banks. Messai and Jouini (2013) showed that NPLs were relatively higher in Italian, Greek and Spanish banks with relatively higher cost-to-income ratios. Cross-national studies also support this association by the study of Makri et al. (2014) which states that inefficiency is a major cause of NPLs in Eurozone banks, while Kjosevski and Petkovski (2019) find a significant positive relationship between inefficient cost structures and loan defaults in Baltic states. Louzis et al. (2012) also stressed that low quality management and efficiency ratios have a significant effect on NPL behavior in the Greek banks. Hence, the following hypothesis has been developed:

H_{1b}: The association between the Expenditure income ratio (EIR) and NPL is expected to be positive.

2.1.3. ROA (Return on Assets) and ROE (Return on Equity)

Profitable banks enjoy more comfort while investing in risky projects. ROA and ROE are widely used to measure bank profitability, where a large value indicates a stable banking environment (Khan *et al.,* 2020). Empirical studies consistently show a negative association between profitability and NPLs. Louzis et al. (2012) showed that ROA and ROE, respectively, attenuated NPLs of Greek banks over loans. Likewise, Messai and Jouini (2013) found that the higher the profitability of banks in Italy, Greece and Spain, the lower the number of defaults. Makri et al. (2014) also showed that ROA and ROE were significantly negatively related to NPLs in Eurozone banks while Beck et al. (2015) using 75 countries data found that credit risk is globally reduced by profitability. More recently, Kjosevski and Petkovski (2019) found that higher profitability declined NPL rates in the Baltic countries. Overall, these results indicate that profitability is conducive to a bank's soundness and loan quality preservation which leads to the following hypothesis.

H_{1c}: The relationship between Return on Assets (ROA) and NPLs is expected to be negative.

H_{1d}: The relationship between Return on Equity (ROE) and NPLs is expected to be negative.

2.1.4. Liquidity ratio (LR)

A bank liquidity ratio is a measure of a bank's ability to meet its short-term obligations. It compares a bank's liquid assets, such as cash and cash equivalents, to its short-term liabilities. Empirical evidence supports a negative relationship between liquidity and NPLs. Louzis et al. (2012) demonstrated that Greek bank with more solid liquidity positions held lower NPL ratios, confirming the stabilizing effect of liquidity cushions. Makri et al. (2014) also highlighted that liquidity helps in ameliorate NPL accumulation in the banks of the Eurozone. Koju et al. (2018) studying Nepalese banks verified that higher credit risk is mitigated if the bank is highly liquid as debtor repayment capacity increases. Islam and Yasmin (2021) observed the same for Bangladeshi banks and argued that banks with strong liquidity profile mitigates loan default risk. It is, therefore, anticipated that increased liquidity would have a strong negative effect on non-performing loans.

H_{1e}: Liquidity ratio (LR) has a significant negative impact on NPLs

2.1.5. Advance to Deposit Ratio (ADR)

The advance to deposit ratio measures advances as a percentage of deposits. The ratio indicates the extent to which deposits are used by a bank to fund its advances. It is also called LTD ratio or loans to deposits (Haq and Kamruzzaman, 2020). If the ratio is too high, the bank will not have enough money to meet any unexpected funding needs. If the percentage is too poor, the bank will not be making as much money as it should (Muhammad and Siddiqui,

2021).Empirical evidence has shown that ADR and NPLs are positively related. Waqas et al. (2017), studying South Asian banks, identified that ADR were the most important factor that leaded to high NPL ratio. Haq and Kamruzzaman (2020) found the same relationship among Bangladeshi banks; a greater ADR increased credit risk. Likewise, Koju et al. (2018) found that in the case of Nepal, high level of loan to deposit ratio affected the quality of loan portfolio. This pattern is also confirmed by international evidence of Makri et al. (2014) reported that increased lending and high lending ratios were positively associated with NPL of Eurozone banks. Therefore, the relationship between the higher ADR and the non-performing loans is anticipated to be substantial.

H_{1f}: Advance to Deposit Ratio (ADR)has a significant positive impact on NPL.

Bank size reflects the extent of a bank's strength in relation to its skilled workforce and financial resources. Larger banks are unlikely to experience failure in the long term. In accordance with the research conducted by Tarchouna et al. (2022) and Niroula and Singh, (2024), bank size was quantified as the natural logarithm of the total assets of a bank for a specific year. The duration of operation following the listing year is regarded as the firm's age, while firm leverage is defined as the ratio of debt to equity (Khatun and Ghosh, 2019&Nguyen, 2022). The incorporation of control variables, including firm size, age, and leverage, is critical, as these factors may independently affect non-performing loans (NPLs). The literature establishes these variables as significantly impacting NPLs (Faruq *et al.,* 2023).

2.2. Macroeconomic factors

Macroeconomic factors are defined as those characteristics that tell us about non-controlling failures faced by banks due to changes occurring in them. Apart from business and financial aspects, the macroeconomic environment has drawn much attention as a crucial determinant of the degree of NPLs. Macroeconomic variables such as GDP growth, inflation, unemployment, and lending rate significantly influence NPL levels. Understanding how these factors interact within the regional economic environment is essential for effective credit risk management and ensuring financial stability.

Empirical evidence shows that there is a negative relationship between GDP growth and NPLs since a growing economy increases the borrowers' repayment capacity and decrease their default probability. Studies consistently confirm this link across different contexts, showing that stronger growth improves cash flows, borrower solvency, and credit market stability (Anita *et al.,* 2022; Rahman and Hamid, 2019; Balgova *et al.,* 2016; & Nor *et al.,* 2021).Although NPL growth is much influenced by unemployment, lending interest rates, public debt, bad management, and economic growth as well (Annas *et al.,* 2024). While certain variables such as unemployment rate, and inflation rate can help to explain the variation in the NPL rate (Nwonye *et al.,* 2023; Anita *et al.,* 2022 & Raddatz *et al.,* 2024) when assessing the effect of financial stability and economic development on NPLs. Particularly, NPL is quite low during the fast economic development of credit-sourced firm boom, but inflation and unemployment shows an opposite pattern (Lee *et al.,* 2020). Whereas study found that increase in non-performing loans impacted negatively on the Gross Domestic Product in Nigeria and that an increase in lending rate and inflation rate caused non-performing loans to increase (MohdAmil *et al.,* 2023).Hence the following hypothesis has been considered:

H_{2a}: GDP growth rate has a negative significant impact on NPLs
H_{2b}: Inflation has a significant positive impact on NPLs
H_{2c}: Unemployment rate has a positive significant impact on NPLs
H_{2d}: Lending rate has a positive significant impact on NPLs

Despite extensive global research on the bank specific and macroeconomic determinants of non-performing loans, there remains a relative scarcity of comprehensive studies that analyze these relationships specifically within the context of Bangladesh. Although prior studies examined bank-specific or macroeconomic determinants of NPLs separately, very few have integrated both categories in the context of all listed commercial banks in Bangladesh. This study addresses the gap by conducting an integrated, country specific analysis. Moreover, earlier works used only panel static models that often ignored econometric concerns such as heteroscedasticity and autocorrelation, while this study addresses this gap by using FGLS. Utilizing recent panel data and robust econometric techniques, this study offers nuanced insights into the region's credit risk landscape, contributing to a more context-sensitive understanding of NPL dynamics in Bangladesh's banking sector.

3. Methodology

3.1. Data and Sample

The study followed a quantitative approach. This is a post facto study since it is based on event that has already been occurred, and secondary data is readily available. The yearly data were collected from the sample banks' annual reports and IMF. Bangladesh has been selected as it is a developing country and one of the thriving economies countries in the world meanwhile adversely dealing with the problem of NPLs. This study covers the banks that are listed on the Dhaka Stock Exchange (DSE). There are 36 banks enlisted in DSE this study considered 34 banks. These banks' choosing criteria were based on data availability, capitalization, and their economic relevance within Bangladesh. These factors ensure the sample's representativeness, so offering information on NPLs' causes in Bangladesh's banking industry. With an 11 fiscal year spanning from 2013 to 2023, the study generates a total of 374 firm-year observations.

3.2. Model Specification and Variable Description

According to the above-mentioned literature review, several authors have found various macro and micro-level factors of NPLs. To empirically test the hypotheses, following Khan et al. (2020), Waqas et al. (2017) and Haq and Kamruzzaman (2020) while considering some additional variables followed by the literature the following baseline panel data model is used in this study to examine the impact of bank specific factors on non-performing loans (NPLs) in Bangladesh. This study uses the several bank specific components and macro-economic variables as the explanatory elements.

$$NPLR_{it} = \alpha_i + \beta_1 BSV_t + \beta_2 MEF_{it} + \beta_3 Z_{it} + \varepsilon_{it} \quad \text{.....(i)}$$

The intercept is denoted by symbol α; the slope by symbol β; the error term by λ. The dependent variable, or non performing loan ratio, is NPLR. The several bank-specific and macro-economic variables used in this research help to explain things. Age, size, and leverage are also engaged as control variables because their likely relevance in gauging the bank specific determinants of NPLR. The variable "i" stands for the cross-section identification

numbers, which match distinct companies. Here "t" denotes the time units, more precisely, years. The panel data model is estimated using the following specific equations:

$$NPLR_{it} = \beta_0 + \beta_1 CAR_{it} + \beta_2 EIR_{it} + \beta_3 ROA_{it} + \beta_4 ROE_{it} + \beta_5 LIQ_{it} + \beta_6 ADR_{it} + \beta_7 GDP_{it} + \beta_8 INF_{it} + \beta_9 UNEP_{it} + \beta_{10} LR_{it} + \beta_{11} SIZE_{it} + \beta_{12} AGE_{it} + \beta_{13} LEV_{it} + \varepsilon_{it} \quad (1)$$

4. Results and Interpretation

4.1. Unit Root Test

Table 1: Unit Root Test_ LLC Test and ADF-Fisher Test

	LLC		ADF-Fisher	
	Statistic	*p*	Statistic	*p*
NPLR	-4.6673	0.0000***	137.4878	0.0000***
Bank Specific				
CAR	-73.9338	0.0000***	546.7390	0.0000***
EIR	-6.9129	0.0000***	148.7306	0.0000***
ROA	-7.3531	0.0000***	118.2437	0.0002***
ROE	-7.5824	0.0000***	115.9298	0.0003***
LIQ	-27.6424	0.0000***	528.5885	0.0000***
ADR	-8.7963	0.0000***	167.8699	0.0000***
Macroeconomic				
GDP	-21.3608	0.0000***	419.9870	0.0000***
INF	-20.4847	0.0000***	339.4467	0.0000***
UNEP	-3.9360	0.0000***	108.7418	0.0012***
LR	-10.9427	0.0000***	103.9769	0.0033***
Control				
SIZE	-12.0904	0.0000***	365.8089	0.0000***
AGE	-49.9909	0.0000***	2126.5843	0.0000***
LEV	-5.2465	0.0000***	275.7428	0.0000***

Note: The symbol *** indicates significance at the 1% level, (**Source:** Researchers Compilation)

Unit root tests were conducted to ensure that the variables used in the regression analysis are stationary or not. Following Ntarmah et al. (2019) both the Levin–Lin–Chu and Augmented Dickey–Fuller–Fisher tests are conducted either at the level or at first difference. The LLC test statistic ranges from -3.9021 to -73.9338, with connected p-value of 0.0000, suggesting strong rejection of the null hypothesis of unit roots. Similarly, the ADF-Fisher test statistics ranges from 115.9298 to 2126.5843, with linked p-values all below 0.05, further confirming the rejection of the unit root hypothesis. These imply that the data for all indicators are stationary rather than exhibiting non-stationary behavior, which is crucial for accurate modeling and forecasting.

4.2. Descriptive Statistics

The descriptive statistics of all the study variables are presented in Table 2.It summarizes key insights about the dependent variable (nonperforming loan ratio), independent variables (bank specific variables, macroeconomic variables and control variables).

Table 2: Descriptive Statistics of all variables

Variables	Mean	Std. Dev.	Min	Max	VIF	1/VIF
NPLR	5.124	3.846	0.000	33.070		
Bank Specific						
CAR	13.468	2.257	10.296	19.069	1.930	0.517
EIR	52.598	9.868	37.943	75.311	1.380	0.724
ROA	0.841	0.402	0.147	1.663	3.960	0.253
ROE	10.712	4.125	1.926	17.45	3.160	0.316
LIQ	1.192	0.379	0.161	3.020	1.450	0.692
ADR	87.035	9.313	68.093	103.554	1.420	0.705
Macroeconomic						
GDP	6.436	1.119	3.448	7.882	1.850	0.540
INF	6.535	1.322	5.514	9.884	1.140	0.877
UNEP	4.828	0.547	4.350	5.828	4.040	0.247
LR	9.792	2.113	7.121	13.593	3.850	0.259
Control Variables						
SIZE	21.644	6.389	7.870	27.426	1.200	0.836
AGE	22.028	12.123	1.700	51.000	1.870	0.536
LEV	13.226	4.393	6.373	26.629	2.050	0.489

Note: The number of observations =374 (**Source:** Researchers Compilation)

The analysis shows a mean Non-Performing Loan Ratio (NPLR) of 5.124, spanning from 0.505 to 33.070, with a standard deviation of 3.846, reflecting disparities in credit risk management, loan quality, and borrower creditworthiness among banks. The average Capital Adequacy Ratio (CAR) is 13.468, indicating that several banks were newly founded during the study period and upheld adequate capital levels. The average expenditure-income ratio is 52.598, indicating that interest expenses constitute over fifty percent of operational income. The average Return on Assets (ROA) is 0.841, with a standard deviation of 0.402, highlighting profitability variations among banks. The mean Return on Equity (ROE) is 10.712, with a standard deviation of 4.125, demonstrating effective equity utilization despite the capital-intensive characteristics of banking. The average liquidity ratio is 1.192, indicating a standard ratio of liquid assets to liabilities, while the advance-to-deposit ratio averages 87.035, implying that the majority of banks dedicate a significant share of their deposits to lending operations.

The analysis shows an average GDP growth rate of 6.436%, with modest variability. The average inflation rate of 6.535% is characteristic of developing countries, however fluctuations (Min = 5.514%, Max = 9.884%) indicate intervals of both low and high inflation. The average unemployment rate of 4.828% indicates comparatively low levels of unemployment. The average lending rate of 9.792% underscores the expense of borrowing, exhibiting significant variety (Minimum = 7.121%, Maximum = 13.593%). Concerning control variables, the minimum value of company age is under two years, signifying the existence of nascent enterprises. The average firm size, quantified by the natural logarithm of total assets, is 21.644. Firm leverage (LEV), denoted by the debt-equity ratio, has an average of 13.226 and a standard deviation of 4.393, reflecting variability in banks' management of debt capital.

4.3. Cross-Sectional Independence

Pesaran's Cross-Sectional Dependency (CSD) test is applied to search for cross-sectional dependency. These are the outcomes for the models applied to identify the factors influencing NPLs. Strong evidence not to reject the null hypothesis of cross-sectional independence is shown by the results, which reveal that the model tests provide insignificant p values above 0.05. Table 3 shows These results demonstrate that banks are not quite linked in terms of their NPLR performance since the model does not show statistically significant cross-sectional dependency. Therefore, particular bank management strategies, regional economic conditions drive NPLR more than shared, systemic risks, for which banks could confront risks and obstacles unique to their operations rather than general systemic concerns.

Table 3:Pesaran CSD for cross-sectional dependence

Pesaran CSD	
Test statistic	***p***
1.515	0.1297

Source: Researchers Compilation

4.4. Heteroscedasticity

To assess the presence of heteroscedasticity in the model, three widely used statistical tests were conducted: the White test, the Breusch-Pagan/Cook-Weisberg test, and the Modified Wald test. The results are presented in Table 4. For the selected model of the study all three tests strongly indicate the presence of heteroscedasticity. The White test reported a Chi-squared value of 159.16 with a p-value of 0.0002, while the Breusch-Pagan/Cook-Weisberg test had a Chi-squared value of 213.21 and a p-value of 0.0000. With a Chi-squared value of 400,000 and a p-value of 0.0000 the modified Wald test likewise verified notable heteroscedasticity. This proves that the variance of the error components is not constant across data, thereby supporting the application of robust estimating methods to reduce the consequences of heteroscedasticity and improve the model accuracy.

Table 4: White, BPCW, MW test for heteroscedasticity.

White test		Breusch–Pagan/Cook–Weisberg test		Modified Wald test	
Chi^2	Prob> Chi^2	Chi^2	Prob> Chi^2	Chi^2	Prob> Chi^2
159.16	0.0002	213.21	0.0000	400,000	0.0000

Source: Researchers Compilation

4.5. Pairwise Correlations and Multicollinearity

The pairwise correlations presented in Table 5 reveals several significant correlations between the dependent variable (NPLR) and the independent, macroeconomic and control variables. Table 6 shows that, NPLR connects strongly with capital adequacy ratio (CAR), expenditure income ratio (EIR), return on asset (ROA), return on equity (ROE), advance to deposit ratio (ADR), company size, age, leverage inflation and lending rate. Following Salmerón-Gómez et al. (2020) and Tamura et al. (2019), the correlation coefficients between the independent variables are all below 0.80, therefore suggesting no multicollinearity issues in the dataset. The variance inflation factor (VIF) values shown in Table 2, which are all below the critical threshold of 5.00, further help to establish that multicollinearity is not a problem in this study.

Table 5: Correlation matrix of NPLR, Bank Specific, Macro Economic and Control Variables

Variables	NPLR	CAR	EIR	ROA	ROE	LIQ	ADR	Size	Age	Lev	GDP	INF	UNEP	LR
NPLR	1.000													
CAR	-0.261***	1.000												
	(0.000)													
EIR	0.190***	0.207***	1.000											
	(0.000)	(0.000)												
ROA	-0.345***	-0.101**	-0.427***	1.000										
	(0.000)	(0.052)	(0.000)											
ROE	-0.345***	-0.249***	-0.381***	0.741***	1.000									
	(0.000)	(0.000)	(0.000)	(0.000)										
LIQ	0.034	0.288***	0.080	-0.032	-0.071	1.000								
	(0.517)	(0.000)	(0.122)	(0.537)	(0.168)									
ADR	-0.136***	-0.322***	-0.099*	-0.014	0.174***	-0.202***	1.000							
	(0.009)	(0.000)	(0.055)	(0.781)	(0.001)	(0.000)								
Size	0.021	0.013	-0.126***	0.088*	-0.017	0.235***	-0.037	1.000						
	(0.680)	(0.798)	(0.015)	(0.090)	(0.744)	(0.000)	(0.470)							
Age	0.452***	-0.501***	-0.079*	-0.096*	0.164***	0.105**	0.183***	-0.054	1.000					
	(0.000)	(0.000)	(0.127)	(0.064)	(0.001)	(0.043)	(0.000)	(0.297)						
Lev	0.416***	-0.343***	0.218*	-0.447***	-0.065	-0.142***	0.138***	-0.009	0.405***	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.212)	(0.006)	(0.008)	(0.862)	(0.000)					
GDP	0.064	-0.047	-0.107**	0.044	0.046	-0.014	0.097*	0.000	0.001	-0.005	1.000			
	(0.220)	(0.367)	(0.038)	(0.393)	(0.374)	(0.783)	(0.062)	(1.000)	(0.986)	(0.922)				
INF	0.078*	0.086*	0.086*	-0.060	-0.013	-0.087*	0.043	0.009	0.037	0.046	-0.191***	1.000		
	(0.134)	(0.098)	(0.095)	(0.247)	(0.795)	(0.093)	(0.411)	(0.856)	(0.472)	(0.372)	(0.000)			
UNEP	0.047	-0.057	0.138***	-0.224***	-0.062	-0.043	0.200***	0.051	0.216***	0.255***	-0.438***	0.037	1.000	
	(0.361)	(0.268)	(0.008)	(0.000)	(0.229)	(0.411)	(0.000)	(0.325)	(0.000)	(0.000)	(0.000)	(0.479)		
LR	-0.134***	0.171***	-0.109**	0.210***	-0.003	0.142***	-0.406***	-0.071	-0.302***	-0.352***	0.011	-0.076	-0.740***	1.000
	(0.010)	(0.001)	(0.035)	(0.000)	(0.952)	(0.006)	(0.000)	(0.169)	(0.000)	(0.000)	(0.837)	(0.143)	(0.000)	

**** p<0.01, ** p<0.05, * p<0.1*

Source: Researchers Compilation

4.6. Autocorrelation

Table 6: BGLM, DW, and Wooldridge test for Autocorrelation

Breusch–Godfrey LM		Durbin–Watson test	Wooldridge test	
Chi^2	Prob> Chi^2	D-W Statistic	F (1, 33)	Prob> Chi^2
94.009	0.0000	1.007224	24.302	0.0000

Source: Researchers Compilation

The Breusch-Godfrey LM test, Durbin-Watson (DW) test, and Wooldridge test were used to look at the models' autocorrelation presence. Table 6 shows the Breusch-Godfrey LM test findings with a Chi-squared value of 94.009 and a p-value of 0.0000 showing considerable autocorrelation. This model's Durbin-Watson score, 1.007, is below the threshold value of 2.00 and indicates positive autocorrelation. Confirming autocorrelation, the Wooldridge test also revealed an F-statistic of 24.302 and a p-value of 0.0000. Robust estimation is, therefore, necessary to correct autocorrelation and get impartial estimates since this autocorrelation shows that residuals from one time period are linked with residuals from prior periods.

4.7. Model Selection

Table 7: Hausman and Breusch and Pagan Lagrangian multiplier test for model selection

Hausman specification		Breusch and Pagan Lagrangian multiplier test	
Chi^2	Prob> Chi^2	Chi^2	Prob> Chi^2
18.44	0.1415	134.85	0.0000

Source: Researchers Compilation

Breusch and Pagan Lagrangian multiplier (LM) test and Hausman specification test were performed to ascertain the suitable models for study. With a p-value of 0.1415 and a Chi-squared value of 18.44 the Hausman specification test indicated that the random effects model is suitable since the p-value is higher than 0.05. With a Chi-squared value of 134.85 and a p-value of 0.0000, the Breusch and Pagan LM test however indicated random effect model is preferred over pooled OLS. Nevertheless, the Feasible Generalized Least Squares (FGLS) estimation method is applied to address heteroscedasticity and autocorrelation to provide consistent and efficient estimates and results to satisfy the research objectives of this particular research by means of their presence. The problems of heteroskedasticity, autocorrelation, and cross-sectional dependency were satisfactorily solved by the FGLS model. When the model encounters such similar problems, it generates consistent projections (Chatha *et al.,* 2025). This study also presents a comparison among the models using OLS, random effects model and robust estimation.

4.8. Regression Results

Table 8: Regression results of NPLR, BSV and Control Variables

	OLS		**Random**		**FGLS**	
NPLR	**Coef.**	***p***	**Coef.**	***p***	**Statistic**	***p***
Bank Specific Variables (BSV)						
CAR	-0.048*** (0.015)	0.001	-0.025** (0.013)	0.043	-0.015** (0.007)	0.048
EIR	0.023* (0.013)	0.093	0.019 (0.013)	0.135	0.011 (0.009)	0.204
ROA	1.953*** (0.451)	0.000	1.231** (0.594)	0.038	0.457 (0.394)	0.246
ROE	-0.476*** (0.076)	0.000	-0.326*** (0.108)	0.003	-0.145*** (0.037)	0.000
LIQ	0.037 (0.338)	0.913	0.188 (0.512)	0.714	0.016 (0.274)	0.953
ADR	-0.076*** (0.013)	0.000	-0.042 (0.030)	0.170	-0.035*** (0.010)	0.001
Macroeconomic Factors (MEF)						
GDP	0.234 (0.156)	0.135	0.210*** (0.061)	0.001	0.181*** (0.061)	0.003
INF	0.239* (0.014)	0.088	0.216** (0.089)	0.015	0.136** (0.064)	0.033
UNEP	-0.802 (0.501)	0.111	-0.697 (0.430)	0.105	-0.391 (0.264)	0.139
LR	-0.173 (0.124)	0.161	-0.095 (0.021)	0.651	-0.002 (0.071)	0.983
Control Variables (Z)						
SIZE	0.010 (0.028)	0.707	0.012 (0.065)	0.849	0.001 (0.019)	0.947
AGE	1.907*** (0.226)	0.000	2.060*** (0.267)	0.000	1.671*** (0.174)	0.000
LEV	0.187*** (0.040)	0.000	0.146** (0.070)	0.038	0.079** (0.034)	0.018
Constant	9.020* (5.283)	0.089	3.769 (7.137)	0.597	2.444 (2.891)	0.398
Number of obs.	374		374		374	
R^2	0.513		0.679		N/A	
F-test	23.460					
Prob> F	0.000					
Chi^2			241.392			
Wald Chi^2					238.56	
Prob> chi^2			0.000		0.000	
**** p<0.01, ** p<0.05, * p<0.1*						

Source: Researchers Compilation

Table 8 presents the regression results analyzing the impact of bank-specific variables (BSV), macroeconomic factors (MEF), and control variables (Z) on the non-performing loan ratio (NPLR) using three estimation methods: OLS, Random Effects, and FGLS. However, given the presence of heteroscedasticity and autocorrelation, the Feasible Generalized Least Squares (FGLS) estimation techniques results are used to interpret the results to address heteroscedasticity and auto correlation to provide consistent and efficient estimates and to satisfy the research objectives of this particular research.

This study reveals several important findings on the factors influencing Bangladesh's banking sector's non-performing loan ratio (NPLR). The considerable negative effect of the capital adequacy ratio (CAR) on the non-performing loan ratio (NPLR) implies that higher capital reserves extend to lower default rates. This result is supported by the existing study of Salam (2023) and Abdioglu (2016). Still, the non-performance loan ratio (NPLR) shows no appreciable change depending on the expenditure-to-income ratio (EIR).This finding contrasts with the results of previous studies that suggest a positive relationship between EIR and NPLR (Waqas *et al.,* 2017 and Ferreira, 2022). However, this indicate that other factors, such as economic stability or banking sector regulations, may be mitigating the expected relationship between EIR and NPLR in Bangladesh. The results of this study indicate that ROA positively influencing NPLR indicating aggressive lending practices and higher risk-taking behavior which also highlights the complexity of the banking sector's risk management and profitability strategies in the banking sector of Bangladesh, contrasts with the results of previous study of Zabin et al. (2024).Whereas ROE negatively affecting it, indicating that increased equity efficiency decreases loan defaults consistent with the study findings of Odebode et al. (2024). The loan-to-deposit ratio (ADR) has a negative impact on the non-performing loan ratio (NPLR) in the FGLS model, likely attributable to enhanced credit risk management and focused lending practices, while Salam (2023) found that ADR has a positive but insignificant effect on NPLR. Macroeconomic factors present inconclusive outcomes, as GDP growth has an insignificant impact on NPLR, yet inflation demonstrates a significant positive impact on NPLR also evident in the study result of Anita et al. (2022) and Raddatz et al.(2024). Larger banks and older institutions generally have elevated NPLRs, presumably attributable to riskier lending practices and inefficiencies in loan oversight as supported by Niroula and Singh, (2024). Leverage demonstrates a notable positive impact, underscoring the influence of debt in augmenting default risk supported by Nguyen (2022).The results show that reducing NPLs in the banking industry depends critically on improving capital buffers, improving credit risk management, and fixing structural issues in the industry. The overall regression result indicates that 67.9% fluctuations in the non-performing loan ratio of DSE listed commercial banks in Bangladesh can be accounted for by macroeconomic variables, control variables and bank-specific factors. With significant chi-squared statistics (241.392 and 238.56) in the Random and FGLS model verifying an overall fit with a p-value of 0.000, the diagnostic tests show the robustness of the results. It also demonstrates how much the variables work together to impact DSE listed commercial banks' non-performance loan ratio in Bangladesh.

5. Conclusion

Bangladesh's ongoing problem of high Non-Performing Loan (NPL) ratios compromises the stability and expansion of the banking sector driven by internal bank issues and macroeconomic pressures resulting in higher default rates. Focusing on the need for strong capital management, good credit risk management, and efficient lending techniques to reduce default risks, this study underlines the necessity of maintaining required capital. According to the study, NPL ratios are mostly influenced by macroeconomic variables including inflation and economic development as well as by bank-specific elements such capital adequacy, profitability, and lending practices. Nevertheless, positive trends in economic growth and programs for financial inclusion, systematic problems in the banking industry continue to aggravate high default rates. The findings of this study carry important implications for both practitioners and policymakers. For the banks, results suggest that bank management should install sophisticated mechanisms for screening the credit risk, enhance the assessment criteria of the borrowers and internal governance of the bank so that the bankers can issue the loans in an extremely sound manner. Training staff in risk monitoring and early warning systems can also minimize risks of default. Policymakers should underline how best to create a more favorable economic environment by controlling inflation, improving financial governance, and supporting bank diversification of loan portfolios to reduce risks. Attaining continuous stability and growth in Bangladesh's banking sector requires a complete plan including efficient regulatory frameworks, improved risk management practices, and targeted economic strategies. Taken together, these measures can serve to reduce NPL ratios, strengthen the banking sector and promote a more sustainable financial stability in Bangladesh. This paper identifies particular limitations; it largely relies on secondary data. By combining primary data from surveys and interviews, later studies could enhance analytical depth and offer a more complex knowledge of the variables influencing NPLs. The geographic extent and time span of the study define its limitations also. Later studies could look at the long-standing effects of these elements in other countries to assess its worldwide relevance and use.

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