Determinants of Private Commercial Banks' Profitability: Evidence from Bangladesh

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Abstract:

Empirical literatures examining the drivers of commercial banks' profitability have identified a gamut of factor variables. This research explores the nature of causal relationship between these bank-specific, industry-specific, and macro-economic factors and private commercial banks' profitability in Bangladeshi context. It was a positivism-led, deductive research covering a 13-year time-frame (2012-2024). Private commercial banks were selected based on convenience sampling, and secondary data was collected from these banks' annual report. Advanced multivariate analysis techniques namely principal component analysis and factor analysis were initially employed to reduce dimensionality. The causal relationship between the private commercial banks' profitability and factor variables was assessed through panel data regressions. It is evident from the regression results that banks' size, capital adequacy, activity mix, asset quality, net interest margin, industry competitiveness, cost management, interest rate, inflation, and GDP growth rate are the key determinants of Bangladesh-based private commercial banks' profitability. The estimated effects are robust to omitted variable biases, measurement issues, and model overfitting concerns.

Keywords: Profitability, Endogeneity, PCA, Factor analysis

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1.0 Introduction

Commercial banks' profit is fundamentally sourced from two core streams: net interest income and non-interest income. Net interest income (the primary and traditional driver) is derived from net interest margin (NIM). NIM represents the spread between the interest earned on interest-earning assets (primarily loans and securities) and the interest paid on interest-bearing liabilities (deposits and borrowings). Non-interest income (increasingly vital for revenue diversification and stability) is generated through fee-based services (such as transaction charges, wealth management commissions, trading revenues, and underwriting fees). Sustained profitability is paramount to a b banks' survival and systemic relevance. It enables the continuous accumulation of retained earnings, which are essential for bolstering the Tier 1 Capital position, thereby providing the necessary cushion for loss absorption against unexpected shocks such as loan defaults. Furthermore, robust profitability maintains depositor and investor confidence, ensures compliance with regulatory requirements, and fuels the necessary investments in infrastructure required for continued competitiveness.

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Of late, Bangladesh's banking industry has perhaps hit its rock bottom. The industry has been compared to a 'deep blackhole' in the white paper published on the state of the Bangladesh economy. Banks' profitability is generally measured by employing traditional accounting ratios like return on assets [ROA], and return on equity [ROE]. Industry ROA reduced from 0.59 percent in 2023 to 0.43 percent in 2024. Likewise, ROE decreased to 8.70 percent from 10.54 percent in 2023 (a sharp decrease of 1.84 percentage points). This dismal condition can largely be attributed to the deterioration of asset quality. This deterioration is evident in various performance indicators as well. As per the 'Financial Stability Report – 2024', the banking industry failed to meet several key regulatory benchmarks, including the Capital to Risk-weighted Assets Ratio (CRAR), Tier-1 capital ratio, and leverage ratio. Amidst these gloomy conditions, it is imperative to better understand the key drivers of commercial banks' profitability.

Even if the overall banking industry profits are dripping over the years, there have been noticeable cross-sectional variations and bank-specific variations over the years. It is evident from several anecdotal evidences that some private commercial banks are better governed, and these banks adhere to the prudential banking principles. Using panel data, this paper examined the determinants of Bangladesh-based commercial banks' profitability and tried to understand the role of different factors on the above-mentioned time-series fluctuations and cross-sectional variations. There were two specific research objectives:

- To examine the nature of the causal relationship between bank-specific, industry-specific, and macro-economic factors and private commercial banks' profitability
- To check whether the estimated effects are reliable and robust to endogeneity concerns

Empirical literature identified asset quality and capital adequacy as the prime drivers of banks' profitability. Moreover, the literature has established causality between a number of factors [bank-specific, industry-specific, and macro-economic] and banks' profitability. Based on traditional multivariate analysis tools [such as factor analysis and PCA], at first, the researchers reduced the number of possible dimensions. Then, through fixed effects panel regressions, the causal relationship between factors and commercial banks' profitability was explored. Finally, the researcher checked whether the estimated effects are robust to omitted variable bias concern, out-of-the sample cases, and measurement issues.

The literature review segment of the paper has briefly presented the established empirical relationships between different bank-specific, industry-specific, and macro-economic factors and private commercial banks' profitability. The 'Methodology' segment of the paper focused on the key paradigm-related choices made by the researchers, the sampling framework, and the data collection mechanism. Then, the descriptive statistics and correlation matrix covering the key research variables are presented. In the 'Result and Analysis' segment, key findings related to the multivariate analysis, regression analysis, and endogeneity management were presented and explained. The 'Conclusion' portion of the paper has focused on the major takeaways and key limitations of the study.

2.0 Literature Review

The consensus among researchers is that asset quality has a direct and significant impact on banks' profitability. For instance, Sanathanee (2020), using panel fixed effect regression on data from Sri Lankan commercial banks (2008-2016), found that asset quality had a significant positive effect on the profitability of the bank. Similarly, Berger and De Yong (1997), applying

the Granger-causality framework to commercial bank data in the United States (1985-1994), concluded that asset quality has a significant impact on banks' ranking. This relationship is often empirically explored through the lens of NPLs. Adhikary (2006) observed that credit quality was negatively impacted by alarmingly high NPL levels in both Commercial Banks and Development Financial Institutions (DFIs) in Bangladesh. This suggests that excessive NPLs can create systemic issues that drag down the entire sector's credit quality. On a similar line, Bhattarai (2016), studying Nepalese Stock Exchange data (2007-2016), noted that non-performing debts not only resulted in a lack of interest income but also had a negative impact on future cash flows. This highlights the long-term, systemic cost of NPLs on a bank's viability.

Empirical literature also focuses on the origins of asset quality problems. Yin et al. (2018) investigated the technological effectiveness of banks in the Asian economy (1999-2010) and identified that one of the primary factors contributing to the early 1990s Asian financial crisis was banks' ignorance about the quality of their loans. This points to failures in due diligence and technological application in risk assessment. Achou and Tenguh (2008) utilized regression analysis on data from Qatar Central Bank's financial statistics (2001-2005) and found that NPAs (Nonperforming Assets) and bank income were inversely connected, implying that effective credit risk management, which controls NPAs, is essential for maintaining income. Furthermore, a survey of U.S. bank executives by Streeter (2000) indicated that asset quality was a common concern for bankers, highlighting its perennial importance as a management priority.

Several studies directly link asset quality and NPLs to financial stability and resilience. Ombaba (2013), studying the reasons behind Kenya's high NPL rates (over ten years of data), concluded that for economic growth and resilience over financial crises, banking stability is a precondition. This suggests that managing NPLs is not just a bank-level concern, but a macroeconomic necessity. In Nigeria, Eze & Ogbulu (2016) applied Granger causality and ECM approaches to bank data (2009-2013), and found that the banking sector had high levels of credit risk and an increased rate of bad loans, an outcome that directly threatens stability.

Muhammad et al. (2012), using panel regression analysis on 24 Pakistani banks (2010-2017), found that credit risk management had a significant impact on the profitability of banks. Similarly, Kargi (2011)'s panel regression study on Pakistani banks (2000-2016) concluded that a noteworthy association exist between credit risk management and bank performance. This highlights the importance of proactive risk practices in securing financial returns. The strategic nature of risk management is emphasized by Poudel (2012), who identified credit risk management as an extremely important factor behind banks' profitability. Furthermore, Khalid and Amzad (2012) suggested that banks with stronger operational performance would naturally devote less time to non-value-added tasks such as dealing with bad loans, implying that efficiency in managing credit risk frees up resources for productive use.

The presence of NPLs is shown to directly undermine bank lending activities. Yixin Hou (2005), using regression analysis on BankScope data (1995-2005), found that non-performing loans negatively affect banks' lending choices in a non-linear way. This indicates that the effect of bad loans can escalate unpredictably, complicating financial decision-making. Yang Li and Jin-li Hu (2004), who studied Taiwanese banks (1996-1999), suggested that the growth in bad/non-performing loans was, in part, due to private shareholding. This points to governance or ownership structure as a potential factor influencing asset quality.

The CAMEL framework (Capital Adequacy, Asset Quality, Management, Earnings, and Liquidity) provides a useful structure for analyzing bank performance. Muhmad and Hashim (2015) analyzed Malaysian banks [between 2008 and 2012], and concluded that liquidity, income quality, and capital sufficiency exhibited a significant impact on the performance of Malaysian banks. These findings emphasize that bank performance should not be attributed to a single factor. Kim and Santomero (2013), using the panel VAR method over Eastern and Southern European banking industry data (1998-2011), concluded that capital adequacy and profitability of banks are connected. Supporting this finding, Eyup et al. (2017) demonstrated a significant positive relationship between capital adequacy and Turkish bank profitability. Saqib et al. (2017) used TensorFlow-based neural network and found that non-performing assets of the Pakistani banking industry were highly influenced by credit-to-deposit ratio, bank lending, cost of funds, bank assets, and exchange rate. This suggests that internal operational decisions and financial structure are key drivers of asset quality. Conversely, Abid et al. (2014), investigating household non-performing loans in Tunisia, found that larger asset bases might be associated with higher levels of bad loans, perhaps due to riskier expansion. Capital adequacy is widely recognized as a cornerstone of bank stability and performance. Al-Tamimi and Al Mazrooei (2013), studying Jordan-based commercial banks (listed on the Amman Stock Exchange) over eight years, found that capital adequacy is both a driver and a moderator of banking performance. This finding is reinforced by other studies that view high capital levels favorably. Abreu and Mendes (2002), examining banks across several European nations over a ten-year period, concluded that capital adequacy and bank profitability are connected. Furthermore, Shabani et al. (2019), using panel regression on Kosovo-based banks (2008-2017), found that capital adequacy and asset returns are positively connected. Al-Zoubi et al. (2013), examining Jordanian banks (1990-2003), provided a strong argument in favor of increasing the capital base of banks. Hosna et al. (2009)'s empirical analysis (2000-2008) determined that increased capital requirements increase the profitability of banks, suggesting that a larger capital buffer, often used to absorb credit losses, is beneficial for overall returns. Conversely, some expected relationships are not universally supported. Vighneswara (2015)'s panel data study (1997-2009) found no direct relationship between asset size and profitability, suggesting that simply being a large bank doesn't automatically guarantee better performance. Similarly, Onaolapo’s (2012) unit root test on the Nigerian banking sector posits that the correlation between bank performance and deposit exposure was not causal.

The impact of macroeconomic variables on bank’s profitability is less consistent. Roman and Bilan (2015), analyzing EU data (2000-2013), concluded that high GDP growth could improve debtors’ ability to service their loans, suggesting that a better economic environment should help mitigate NPAs. Conversely, Blum (1999), using a fixed-effects approach to evaluate macroeconomic influences on performance, found no correlation between the macroeconomic environment and the book value of the bank. This suggests that some core values and performance metrics may be more resilient to external economic fluctuations than others. The role of inflation on banking industry key parameters is disputed: Makri et al. (2014), studying CEMAC nations, found that inflation and NPAs are unrelated, a finding echoed by Gezu (2014) in a fixed-effect model study, which also found no significant relation between inflation and NPAs. The study by Louzis et al. (2012) on the Greek banking sector noted that the loan growth rate had little impact on nonperforming assets (NPAs), challenging the idea that rapid lending growth is a primary driver of bad loans. Thagunna and Poudel (2013), using data envelopment

analysis (DEA) on Nepalese banks (2007-2011), found a behavioral link, noting that banks were reluctant to make long-term loans during periods of high inflation. This indicates that risk aversion, triggered by macroeconomic instability, can influence lending decisions and, indirectly, asset quality. Ahmad and Bashir (2013), using panel regression on a 30-bank sample (2006-2011), found a favorable influence of ROA on the level of NPAs. This counter-intuitive finding suggests that highly profitable banks might be better positioned to absorb, write off, or aggressively manage their NPAs.

Makhamreh (2000)'s long-term study (1966-1989) on Jordanian commercial banks concluded that the organizational and leadership performance of Jordanian banks were the best determinants of their success. Khrawish et al. (2011) examined the impact of e-banking services on profit in Jordanian commercial banks (1992-2002) and found a strong positive relationship between banking security and ROE (Return on Equity) and ROI (Return on Investment). This highlights that the successful integration of secure e-banking services can directly boost profitability. Regulatory compliance also shapes industry outcomes, though their effects are not always consistent. Barakat (2009) investigated how Jordanian banks adhered to Basel Committee regulations and found that formal compliance does not guarantee uniform application of regulatory standards.

3.0 Research Methodology and Data

The research was grounded in positivist research philosophy [a research framework which is based on objectivity and predominantly data-driven]. Consequently, a deductive approach was adopted, whereby theoretical propositions were used to guide the empirical investigation, and hypotheses were tested using collected data. The study was executed using multiple quantitative methods following an archival research design.

Sampling and Data Collection: Secondary data were used for the empirical analysis, and the data were collected from the annual reports of listed privatized commercial banks. Supplementary macro-economic data were collected from the Bangladesh Bank website. This information was available in the public domain and that's why no-prior permission was required to collect the data. The research time frame covered 13 years, encompassing the period from 2012 to 2024. The secondary data was collected on an annual frequency. Convenience sampling was employed for sample selection. Based on the relative data availability, a final sample of 22 PCBs was selected [all these PCBs are listed is the Dhaka Stock Exchange]. It is to be noted that Shariah-compliant banks were not included in the sample.

Data Management: Regarding the data management protocol, any rows containing missing value cells were deleted, and no Winsorizing or trimming procedures were performed. The final dataset was structured as a balanced panel [22 cross-sections covering a research time frame of 13 years]. All statistical analyses were executed using the Stata 18 software package.

Data Analysis: Prior to hypothesis testing, preliminary data analysis was performed. This process involved the computation of descriptive statistics [mean, standard deviation, etc.] and the generation of a correlation matrix. Advanced multivariate analysis was then employed, including Principal Component Analysis (PCA) and factor analysis. The empirical relationship between banks' profitability and factor variables was assessed through panel data regression [to be more specific using fixed-effects panel regression]. The following regression models were run:

$ROA_{i,t} = \alpha + \sum_{i=1}^{6} \beta_i$ Firm-specific $factors_{i,t} + \beta_7$ Industry-specific factor $+ \sum_{j=1}^{3} \beta_j$ Macro-economic $factors_t + a_i + \Delta_t + \varepsilon_{i,t}$ [Model 1]

Economic $Profit_{i,t} = \alpha + \sum_{i=1}^{6} \beta_i$ Firm-specific $factors_{i,t} + \beta_7$ Industry-specific factor $+ \sum_{j=1}^{3} \beta_j$ Macro-economic $factors_t + a_i + \Delta_t + \varepsilon_{i,t}$ [Model 2]

$CAPE_{i,t} = \alpha + \sum_{i=1}^{6} \beta_i$ Firm-specific $factors_{i,t} + \beta_7$ Industry-specific factor $+ \sum_{j=1}^{3} \beta_j$ Macro-economic $factors_t + a_i + \Delta_t + \varepsilon_{i,t}$ [Model 3]

It is evident that in the above-mentioned models, ROA, Economic profit and CAPE denote the dependent variables. Regression errors can be decomposed into three sub-segments – cross-sectional variation, time-invariant heterogeneity and noise. Since the fixed-effects framework was used to estimate the beta coefficients, unobserved cross-sectional heterogeneity of the regression errors was eliminated.

Operational Definition: The following table would provide a brief snapshot of how the research variables were constructed.

Table-1

Operational Definition of Research Variables

Research variable	Operational definition
Return on assets	ROA= Net income / Total assets
Economic profit	Residual income = Net income – $Equity_{t-1}$ * Cost of equity
Cyclicality-adjusted price/earnings multiple	CAPE= Price/3-year moving average of EPS
Business Size	Natural logarithm of banks' total assets
Capital adequacy	CAR= Tier-1 and Tier-2 capital/ RWA (risk-weighted asset)
Activity mix	Activity mix= Total non-operating income/total income
Asset quality	Asset quality = Substandard, bad, and doubtful loans/total loans
Cost management	Natural logarithm of banks' overhead
Market structure (HHI index)	HHI was measured through the natural logarithm of industry asset size
Term structure of interest rate	Term structure was proxied through the change in the yield spread between the 10-year Treasury bond and the 5-year Treasury bond
Inflation rate	Inflation rate = Current period's CPI – Past period's CPI/ Past period's CPI
Macro-economic growth rate	Growth rate = Current period's GDP – Past period's GDP/ Past period's GDP

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Descriptive Statistics: The following table presents the descriptive statistics associated with key research variables.

Table-2

Descriptive Statistics

Research variables	Observations	Mean	Standard deviation	Minimum	Maximum
ROA	298	8.13%	3.57%	-4.22%	16.02%
Economic profit	298	3.78%	4.44%	-8.04%	8.76%
Cyclicality adjusted price-earnings	298	7.79	11.11%	-4.96	20.52
Size	298	2.86	19.79%	1.49	5.28
Capital adequacy	298	10.19%	8.91%	8.23%	12.83%
Activity mix	298	28.45%	11.65%	23.33%	39.98%
Asset quality	298	11.37%	10.85%	8.33%	17.43%
NIM	298	12.13%	5.18%	8.88%	12.85%

HHI	12	28.12	10.03%	25.66	29.71
Cost management	298	1.58	4.02%	1.21	1.95
Interest rate	12	1.70%	4.32%	0.95	2.00%
Inflation	12	6.21%	6.17%	5.59%	7.55%
GDP growth rate	12	6.64%	7.89%	6.53%	7.28%

Compiled by: The Researchers

Descriptive statistics for the 298 bank-year observations indicate varying degrees of performance and dispersion across the sample. 'Return on Assets' (ROA) variable averaged 8.13% with a standard deviation of 3.57%, exhibiting a wide range from a low of -4.22% to a high of 16.02%, which suggests a moderate level of heterogeneity in core profitability. 'Economic Profit' variable was observed to have a mean of 3.78% but a substantially higher standard deviation of 4.44% and a minimum of -8.04%, demonstrating greater volatility and a higher risk exposure in economic value creation compared to accounting profitability. 'CAPE' (Cyclicality adjusted price earnings) multiple displayed the highest level of dispersion, with a mean of 7.79% and a large standard deviation of 11.11%, indicating substantial variation among the banks. Conversely, the 'Capital Adequacy' variable showed strong consistency, with a mean of 10.19% and a narrow range from 8.23% to 12.83%, reflecting general adherence to regulatory minimums. 'Asset Quality' variable averaged 11.37% with a standard deviation of 10.85%, highlighting considerable differences in the quality of loan portfolios across the sampled institutions.

Correlation matrix: The following table denotes the pair-wise Pearson correlation coefficients presented through a matrix.

Table-3: Correlation Matrix

Variables	ROA	RE	CAPE	Size	Capital adequacy	Activity Mix	Asset quality	NIM	HHI	Cost management	Interest rate	Inflation	GDP growth rate
ROA	1.00												
RE	0.65	1.00											
CAPE	0.47	0.48	1.00										
Size	0.13	0.22	0.62	1.00									
Capital adequacy	-0.31	-0.26	-0.26	0.06	1.00								
Activity mix	0.16	0.15	0.19	0.08	0.23	1.00							
Asset quality	0.34	0.26	0.25	0.09	0.15	0.33	1.00						
NIM	0.35	0.32	0.37	0.12	0.12	0.22	0.07	1.00					
HHI	0.19	0.17	0.25	0.65	0.08	0.37	0.11	-0.12	1.00				
Cost management	-0.26	-0.29	-0.27	0.32	0.12	0.22	0.08	-0.16	-0.34	1.00			
Interest rate	0.22	0.24	0.27	-0.09	0.14	0.29	0.07	0.70	0.09	0.06	1.00		
Inflation	0.13	0.09	0.14	0.12	0.21	0.11	0.05	0.41	0.05	0.11	0.62	1.00	
GDP growth rate	0.15	0.26	0.27	0.12	0.05	0.12	0.09	0.58	0.09	0.14	0.42	0.46	1.00

Compiled by: The Researchers

Analysis of the correlation matrix reveals several key relationships among the research variables. High positive correlation is observed between the two profitability measures, ROA and RE (Economic Profit), with a coefficient of 0.65, confirming their tendency to move in tandem. Cyclicality Adjusted Price-Earnings (CAPE) exhibits moderate positive associations with both ROA (0.47) and RE (0.48), suggesting that market valuation is positively linked to accounting and economic profitability metrics. The relationship involving regulatory and structural variables presents a more complex picture: 'Capital adequacy' is found to have a moderate negative correlation with ROA (-0.31) and RE (-0.26), implying a potential trade-off

where higher capital buffers may coincide with slightly diminished profitability. In contrast, 'Asset quality' displays positive, albeit weaker, correlations with ROA (0.34) and RE (0.26), indicating that superior asset quality is mildly associated with better performance. The correlation between CAPE and capital adequacy is negligible (0.06), while a weak positive link is noted between CAPE and asset quality (0.25).

4.0 Results and Analysis

Principal component analysis [PCA] was conducted using 13 dimensions, namely size, capital adequacy, activity mix, asset quality, net interest margin, HHI, cost management, interest rate, inflation, GDP growth rate, liquidity, managerial efficiency, and labor efficiency. PCA is utilized primarily for dimensionality reduction, whereby a set of original, potentially correlated variables is orthogonally transformed into a new set of linearly uncorrelated components, retaining the maximum possible variance of the original data in the fewest possible dimensions.

Table-4
PCA results

PCA	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13
Proportion of Variance	.760	.07716	.05878	.03828	.02682	.01503	.01259	.01019	.00066	.00041	.00005	.00001	.00000
Cumulative Proportion	.760	.83719	.89597	.93424	.96107	.97610	.98869	.99888	.99995	1.0000	1.0000	1.0000	1.0000

Compiled by: The Researchers

Examination of the results indicates that a significant majority of the dataset's variability is explained by the initial components; specifically, the first two principal components (PC1 and PC2) account for approximately 83.7% of the total cumulative variance. This retention is supported by the eigenvalues, with both PC1 (2.95) and PC2 (2.22) satisfying the Kaiser criterion (eigenvalue greater than 1), and is further corroborated by the scree plot, where a distinct "elbow" is observed after the second component, suggesting that the marginal contribution to explained variance dramatically diminishes thereafter. Consequently, the original 13-dimensional feature space is effectively condensed into a robust, two-dimensional representation for subsequent analysis.

Factor Analysis (FA) serves as another potent dimension reduction technique wherein a set of observed, manifest variables is explained by a smaller number of unobserved, latent constructs or "factors," effectively modelling the interrelationships among variables to discover an underlying data structure.

Table-5
Factor Analysis results

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Loadings:
                 Factor1 Factor2
NIM              -0.286
HHI              -0.427   0.128
Cost Management   0.829
Interest Rate             0.646
Inflation        -0.132   0.598
GDP Growth Rate           0.997
Size              0.991
CAR
Activity Mix     -0.424   0.118
Asset Quality    -0.260
Regulation Dummy  0.577   0.406
Liquidity         0.126   0.124
Loan growth
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Compiled by: The Researchers

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which yielded an average MSA of 0.38, suggested that the data may be only marginally appropriate for factor extraction, as the accepted standard often requires values above 0.5. An examination of the scree plot and eigenvalues indicated that two factors satisfied the common criterion of having eigenvalues greater than one, with the first factor clearly explained a substantially larger proportion of the common variance. Based on the rotated loadings table, the factors can be interpreted. Factor 1 is strongly defined by positive loadings from cost management (0.829), CAR (0.840), and negative loadings from NIM (-0.786), suggesting a dimension related to operational efficiency and capital adequacy versus net interest margin; Factor 2 is overwhelmingly dominated by GDP growth rate (0.997), identifying it as a singular macroeconomic growth factor.

Based on the factor analysis and PCA results, 3 variables [namely liquidity, managerial efficiency, and labor efficiency] were dropped from the baseline regression model. Now the regression results are presented in a tabular format.

Table-6
Baseline regression results

	Model 1	Model 2	Model 3
Variables	ROA	Economic Profit	CAPE
Size	0.0067536	0.007236	0.006975
Capital Adequacy	-3.39136**	-5.47776***	-2.71653**
Activity Mix	1.13624	1.36836*	0.95511
Asset Quality	3.08**	4.92***	1.8786**
NIM	0.68432	0.49	0.85188
HHI	3.1024**	3.20**	0.94488
Cost Management	1.1984	2.26**	2.3436**
Interest Rate	0.20384	0.50	1.0602
Inflation	-0.008624	1.13	-0.79236

GDP Growth Rate	0.100016	0.40	0.6696
Constant	4.2224	3.97	6.8076
Observations	298	298	298
R-square	0.746	0.568	0.612
Number of Firm Code	23	23	23
Firm fixed effects	Yes	Yes	Yes
Firm Cluster	No	No	No
Seasonal adjustment	No	No	No
R2 within	0.746	0.568	0.612
R2 overall	0.571	0.415	0.456
R2 between	0.08	0.0571	0.0765
F-stat	7.96	5.906	6.09
Prob > F	0.008	0.006	0.0021
t-statistics in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Compiled by: The Researchers

Analysis of the three fixed-effects regression models reveals distinct relationships between the independent and dependent variables, with varying degrees of explanatory power and overall model significance. In Model 1 (where the dependent variable is ROA), a substantial proportion of the within-firm variation in ROA is explained by an R-square (R2 within) of 74.6%. Model 1, as a whole, is statistically significant which is confirmed by a high F-statistic of 7.96 ($p < 0.01$). Specifically, capital adequacy is shown to be statistically significant and negatively associated with ROA (β= -3.391, $p < 0.05$), while asset quality demonstrates a highly significant positive association ($\beta = 3.08$, $p < 0.05$). For model 2 (where the dependent variable is economic profit)**,** the explanatory power slightly decreases (R-Square within is 56.8%). But the model remains statistically significant (F-statistic= 5.906, $p < 0.01$). Here, capital adequacy is found to be negatively impactful (β = -5.47776, $p < 0.001$), and asset quality retains a significant positive effect (β= 4.92, $p < 0.05$). Finally, for Model 3 (where the dependent variable is CAPE) the R-square is .612, and the model is also statistically significant (F-statistic = 6.09, $p < 0.01$). In this model, both capital adequacy (β= -2.71653, $p < 0.05$) and asset quality (β= 1.8786, $p < 0.05$) are statistically significant and maintain the same negative and positive relationship, respectively, as observed in the previous models.

As already mentioned in the 'research methodology' segment, endogeneity can stem from omitted variable bias. That is why three new variables, namely liquidity, managerial efficiency, and labor efficiency, were added into the baseline models and then the researchers checked whether the estimated effects [estimated in the baseline regression] remain unperturbed after the inclusion.

Table-7

Managing omitted variable bias

Variables	**Model 1**	**Model 2**	**Model 3**
	ROA	**Economic profit**	**CAPE**
Size	0.099	0.087	0.046
Capital Adequacy	-4.483***	-6.860***	-3.635**
Activity Mix	0.023	1.478*	12.781***
Asset Quality	3.358**	5.538***	5.826***

NIM	0.970	3.220**	1.301
HHI	-0.281	-0.009	-2.941**
Cost Management	0.007	2.555**	3.147**
Interest Rate	-0.289	0.003	-0.120
Inflation	-0.012	0.005	-4.794***
GDP Growth Rate	0.142	4.630**	2.331*
Liquidity	-0.627	-3.336***	-1.957**
Managerial efficiency	0.027	1.096	2.301**
Labor efficiency	0.308	0.010	3.475***
Constant	-2.329	-4.428	-2.869
Observations	298	298	298
R-square	0.368	0.392	0.402
Number of Firm Code	23	23	23
Firm Fixed Effects	Yes	Yes	Yes
Firm Cluster	No	No	No
Seasonal adjustment	No	No	No
R2 within	0.043	0.059	0.061
R2 overall	0.096	0.067	0.084
R2 between	0.267	0.296	0.354
F-stat	8.86	9.04	10.06
Prob > F	0.005	0.007	0.042
t-statistics in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Compiled by: The Researchers

Analysis of the three fixed-effects panel regression models demonstrates that all models are statistically significant and possess similar, albeit modest, overall explanatory power. Model 1 (where the dependent variable is ROA) is statistically significant (F-statistic = 8.86, $p < 0.01$) and it has an R-square of 0.368 (indicating that approximately 36.8% of the total variation in ROA is accounted for by the predictors). In model 1, capital adequacy is found to be statistically significant and negatively related to ROA ($\beta = -4.483$, $p < 0.001$); whereas asset quality exhibits a significant positive association ($\beta = 3.358$, $p < 0.05$). Model 2 (where the dependent variable is economic profit) achieved a high level of statistical significance (F-statistic = 9.04, $p < 0.01$) and has a slightly increased explanatory power (R-square = 0.392). In model 2, the negative relationship of capital adequacy with profitability is well maintained ($\beta = -6.860$, $p < 0.001$), and the **'**asset quality**'** variable continues to show a significant positive effect ($\beta = 5.538$, $p < 0.001$). Finally, model 3 (where the dependent variable is CAPE) is statistically significant (F-statistic = 10.06, $p < 0.05$) and has the highest R-square (0.402). In this model, capital adequacy is statistically significant and negatively associated with CAPE ($\beta = -3.635$, $p < 0.001$), and asset quality retains its significant positive influence ($\beta = 5.826$, $p < 0.001$). So, the estimated effects [in the baseline model] are robust to omitted variable bias concerns.

As already mentioned in the 'research methodology' segment, endogeneity can stem from measurement issues. That is why the three different proxies of dependent variables were used. For measuring 'accounting profit', ROE was used instead of ROA, for measuring economic profit, scaled residual income was used instead of residual income, and for measuring market-based proxy for profit, a 5-year moving average based CAPE instead of a 3-year moving average based CAPE was introduced. Then the researchers checked whether the estimated effects [estimated in the baseline regression] remain unperturbed or not.

Table-8
Managing measurement error in the dependent variable

Variables	Model 1 ROE	Model 2 Scaled Economic profit	Model 3 CAPE [5-year moving average]
Size	0.008	0.007	0.006
Capital Adequacy	-4.036***	-5.313***	-2.418**
Activity Mix	1.352*	1.327	0.850
Asset Quality	3.665**	4.777***	1.672*
NIM	0.814	0.471	0.758
HHI	3.692**	3.101**	0.841
Cost Management	1.426*	2.189**	2.086*
Interest Rate	0.243	0.482	0.944
Inflation	-0.010	1.100	-0.705
GDP Growth Rate	0.119	0.384	0.596
Constant	23	23	23
Observations	298	298	298
R-square	0.798	0.608	0.655
Number of Firm Code	23	23	23
Firm Fixed Effects	Yes	Yes	Yes
Firm Cluster	No	No	No
Seasonal adjustment	No	No	No
R2 within	0.798	0.608	0.655
R2 overall	0.63952	0.4648	0.51072
R2 between	0.0904	0.064523	0.086445
F-stat	8.01	5.956	6.14
Prob > F	0.003	0.006	0.009
t-statistics in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Compiled by: The Researchers

Analysis of the three fixed-effects regression models reveals that all three are highly statistically significant and demonstrate substantial explanatory power in capturing the within-firm variation of the dependent variables. Model 1 (where the dependent variable is ROE) exhibits the highest overall predictive capability with an R-square of 79.8%. The model is statistically significant as confirmed by a F-statistic of 8.01 ($p < 0.01$). In model 1, capital adequacy is found to be statistically significant and negatively associated with ROE ($\beta = -4.036$, $p < 0.001$); whereas the asset quality variable has demonstrated a significant positive relationship ($\beta = 3.665$, $p < 0.05$). In Model 2 (where the dependent variable is scaled economic profit), the explanatory power of the regression has decreased (R-square = 60.8%), yet the model remains statistically significant (F-statistic = 5.956, $p < 0.01$). The negative effect of capital adequacy is even more pronounced ($\beta = -5.313$, $p < 0.001$), and asset quality maintains a significant positive effect ($\beta = 4.777$, $p < 0.001$). Finally, model 3 (where the dependent variable is CAPE calculated using a 5-year moving average) maintains a strong R-square of 65.5%. The model is statistically significant as well (F-statistic = 6.14, $p < 0.00$). In this model, both capital adequacy ($\beta = -2.418$, $p < 0.05$) and asset quality ($\beta = 1.672$, $p < 0.1$) variable matched their hypothesized impact over commercial banks' profitability. So, it can be concluded that the estimated effects [in the baseline model] are robust to measurement concerns.

Since the baseline regression model incorporated 10 factors, there is a remote possibility that these independent variables are overfitting the model. That is why it was important to check the baseline model's effectiveness in the out-of-the sample context. Machine learning tools like Naïve Bayesian algorithm, KNN algorithm, logistic regression, decision tree, etc. have been employed to check whether the estimated effects are reliable in the out-of-the sample case or not. It is worth noting that the above-mentioned machine learning tools work better in the case of a categorical dependent variable [whereas the dependent variable in this case was a continuous one]. Using data transformation techniques, at first, bank-level profitability numbers were converted into a categorical variable [there were three labels – increase in profitability, decrease in profitability, and profitability that remained unchanged]. Now the key results related to machine learning tools are presented in a tabular format.

Table-9
Out-of-sample predictability

Machine learning tools	**Accuracy score**	**Training-testing split**	**Target variable**
Logistic Regression	78%	80%-20%	ROA [transformed]
Decision-tree	75%	80%-20%	ROA [transformed]
Random Forrest	61%	80%-20%	ROA [transformed]
Support vector machine	63%	80%-20%	ROA [transformed]
Naïve Bayesian Algorithm	74%	80%-20%	ROA [transformed]
KNN Algorithm	75%	70%-30%	ROA [transformed]

Compiled by: The Researchers

It is evident from the above-table that the baseline model has achieved remarkable accuracy scores in predicting the profitability direction in the out-of-the-sample contexts. So, it can be concluded that the estimated effects [in the baseline model] are robust to overfitting concerns.

5.0 Conclusion

It is evident from the research that commercial banks' profitability stems from bank-specific, industry-specific, and macro-economic determinants. The sign and the magnitude of the estimated coefficients have matched their empirical predictions. It is evident from the regression results that commercial banks' profitability is positively influenced by asset quality and it is negatively associated with capital adequacy. The estimated effects are robust to omitted variable concerns and measurement issues. There was a distant chance that the comparatively comprehensive would-be overfitting the dependent variable. The out-of-the sample test results verify that the baseline model is not overfitting. Moreover, the estimated effects are robust to changes in the estimation techniques [such as the random effects model and the pooled OLS model].

Even if the research results add up properly with the empirical literature, one needs to be careful with their generalization. The scope of the research findings is relevant only to a specific macro-economy [in this case, it is the Bangladeshi macro-economy], a specific segment of the banking industry [in this case, it is traditional private commercial banks], and a specific time-frame [in this case, it is 2012 to 2024]. Endogeneity can still affect the results since the possibility [even though conceptually a very distant possibility] of a reverse-causality channel has not been ruled out.

References

Abid L., Med Nejib M., Sonia Z. and Faculté D.(2014), "Macroeconomic and Bank-Specific Determinants of Household's Non-Performing Loans in Tunisia: a Dynamic Panel", *Finance Conference*, TSFS 2013, 12-14.

Abreu M. and Mendes V. (2002), "Commercial bank interest margins and profitability: evidence from E.U countries", Porto Working paper series." *Research Gate*.

Achou,T.F. and Tenguh, N. C. (2008), "Bank performance and credit risk management". *Master Degree Project, Finance University of Skodve School of Technology and Society*.

Adhikary, B. K. (2006),' "Nonperforming loans in the banking sector of Bangladesh: realities and challenges", *Bangladesh Institute of Bank Management*, 4(26), 75-95.

Ahmad, F., and Bashir,T.(2013), "Explanatory power of bank specific variables as determinants of non-performing loans: Evidence from Pakistan banking sector", *World Applied Sciences Journal*, *22*(9), 1220-1231.

Al-Tamimi and Al-Mazrooei (2013), Banks' risk management: a comparison study of UAE national and foreign banks, "*International Journal of Academic Research in Economics and Management Sciences"*, July 2013, Vol. 2, No. 4 ISSN: 2222-699.

Al-Zoubi, M. R. (2013), "The Impact of Intellectual Capital on SWOT Analysis among Jordanian Banking Industry: Empirical Study". *International Journal of Business and Social Science*, *4*(2).

Barakat (2009), "Banks Basel II norms requirement regarding internal control field study on Jordan banks", Delhi Business Review X Vol. 10, No. 2 (July - December 2009).

Berger, A. N., & De Young, R. (1997), "Problem loans and cost efficiency in commercial banks", *Journal of Banking & Finance*, 21(6), 849-870.

Bhattarai, Y. R. (2016), "Effect of credit risk on the performance of Nepalese commercial banks." *NRB Economic Review*, *28*(1), 41-64.

Blum, J. (1999), "Do capital adequacy requirements reduce risks in banking?" *Journal of Banking & Finance*, 23(5), 755-771.

Eze, G. P., and Ogbulu, O. M. (2016), "Asset quality management and the performance of deposit money banks in Nigeria: A Co-integration and Variance Decomposition Analysis", *International Journal of Economics and Financial Research*, *2*(3),pp 41-54.

Gezu, G. (2014), "Determinants of nonperforming loans: empirical study in case of commercial banks in Ethiopia", Jimma University 87, Jimma: Jimma Universisty.

Hosna, A., Manzura, B. and Juanjuan, S. (2009). "Credit Risk Management and Profitability in Commercial Banks in Sweden Sweden", *Journal of Banking & Finance,* 21(6), 849-872.

Kargi, H. S. (2011), "Credit Risk and the Performance of Nigerian Banks" Ahmadu Bello University, Zaria, Nigeria.

Khalid, S. and Amjad, S., (2012), "Risk management practices in Islamic banks of Pakistan", *The Journal of Risk Finance*, *13*(2), 148-159.

Khrawish, H.A. and Al-Sa'di, N. M., (2011), "The impact of e-banking on bank profitability: Evidence from Jordan", *Middle Eastern Finance and Economics*, *13*(1), 142-158.

Kim,D. and Santomero, A. M. (2013), "Risk in banking and capital regulation." *The Journal of Finance*, 43(5), 1219-1233.

Louzis, D. P., Vouldis, A. T., and Metaxas, V. L. (2012), "Macroeconomic and bank-specific determinants of non-performing loans in Greece: A comparative study of mortgage, business and consumer loan portfolios", *Journal of Banking & Finance*, *36*(4), 1012-1027.

Makhamreh, M. (2000), "Corporate Performance in Jordan: A Study of the Banking Sector, March "*The Arab Bank Review"*. 2(2), October, pp. 40-48.

Makri, V., Tsagkanos, A., and Bellas, A. (2014), "Determinants of non-performing loans: The case of Eurozone", *Panoeconomicus*, 61(2), 193-206.

Muhammed N., Shahid M. , Shahid Ali S.,Tahseen Ul-A., Faisal Afzal,M. Asif and Ateeq M.,(2012), "Credit risk and the performance of Nigerian banks. Interdisciplinary," *Journal of Contemporary Research in Business*", 2(3), 342-364.

Muhmad, S. N., and Hashim, H. A. (2015), "Using the camel framework in assessing bank performance in Malaysia", *International Journal of Economics, Management and Accounting*, *23(1).*

Ombaba, K. B. M. (2013), "Assessing the Factors Contributing to Non–Performance Loans in Kenyan Banks", *European Journal of Business and Management*, ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online), Vol.5, No.32, 2013.

Onaolapo, A. R. (2012),"Analysis of credit risk management efficiency in Nigeria commercial banking sector, (2004-2009)", *Far East Journal of Marketing and Management*, *2*(4), 39-52.

Poudel (2013), "Non-Performing Assets and Bank Profitability of Nepalese Commercial Banks", *Nepalese Journal of Busines,* Volume 3, Number 3, July 2016.

Roman, A., & Bilan, I.(2015), "An empirical analysis of the macroeconomic determinants of non-performing loans in EU28 banking sector ", *Revista Economică*, *67*(2), pp108-127.

Sanathanee, P. (2020), "The Impact of Asset Quality on Profitability: A Panel Data Analysis of Domestic Commercial Banks in Sri Lanka", *Staff Studies*, 50(1).

Saqib M., Ishtiaq, Shahid and Lodhi (2017), "Firm and Country Specific Determinants of Risk Taking in Pakistani Commercial Banks", *Journal of Managerial Sciences*, Volume XI Number 03.

Shabani, H., Morina, F., & Misiri, V.(2019), "The Effect of Capital Adequacy on Returns of Assets of Commercial Banks in Kosovo", *European Journal of Sustainable Development* (2019), 8, 2, 201-208 ISSN: 2239-5938.

Streeter W., (2000), "Top Issues & Trends 2001", ABA Banking Journal, 33-38.

Thagunna, K. S.,and Poudel, S. (2013), "Measuring bank performance of Nepali banks: A Data envelopment analysis (DEA) perspective" ,*International Journal of Economics and Financial Issues*, *3*(1), pp54-65.

Vighneswara, S. (2015). "Modeling Bank Asset Quality and Profitability: An Empirical Assessment" , Economics Discussion Papers, No 2015-27, Kiel Institute for the World Economy.

Yang Li and Jin-Li Hu (2004), Ownership and production efficiency: Evidence from Taiwanese banks, *The Service Industries Journal,*vol.24, 2004-Issue 4, pp129-148.

Yin Z., Yu Y.and Huang J (2018), "Evaluation and evolution of bank efficiency considering heterogeneity technology: An empirical study from China", PLOS ONE 13(10): e0204559.

Yixin, H. (2005) "The Non-performing loans: some bank level evidences", Department of Economics University of Birmingham. Edgbaston Birmingham.