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THE IMPACT OF CREDIT RISK MANAGEMENT ON THE FINANCIAL PERFORMANCE OF THE BANKS LISTED ON THE DHAKA STOCK EXCHANGE: A TWO-STEP SYSTEM GENERALIZED METHOD OF MOMENTS PANEL DATA ANALYSIS

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ABSTRACT

Prior Bangladeshi studies on the relationship between credit risk management and the financial performance of listed banks suffered from a dynamic endogeneity bias, which led to misleading conclusions. As a result, this study examines the impact of credit risk management on the financial performance of banks listed on the Dhaka Stock Exchange for the period from 2011 to 2018. The equity multiplier ratio (EMR), capital adequacy ratio (CAR), non-performing loan (NPL) ratio, interest coverage ratio (ICR), and provision for credit losses to total credit (PCLTC) are proxies for credit risk management. The study characterizes banks' financial performance from three perspectives: bank management, as indicated by return on equity (ROE); the market, as indicated by Tobin's Q (TQ); and shareholder value, as indicated by economic value added (EVA-ln). The study sample comprises 29 of the 30 listed banks, and the two-step system generalized method of moments (GMM) model is used to test the hypotheses. This study finds mixed results, i.e., none of the credit risk variables used in this study, with the exception of ICR, affect the sampled banks' performance equally from each of the three perspectives. Particularly, the results show that ICR has a significant positive impact on all measures of banks' financial performance, whereas PCLTC has no impact on any measure of financial performance. The EMR has a significant positive impact on ROE but does not affect TQ and EVA-ln. CAR has been shown to improve ROE and TQ while having an insignificant effect on EVA-ln. The NPL ratio has a negative effect on ROE but does not affect TQ and EVA-ln.

Contribution/Originality: Unlike prior Bangladeshi studies, this study examines the impact of credit risk management and financial performance in the listed banks in Bangladesh from the market and shareholder value perspectives, along with bank management's perspective, and after controlling for dynamic endogeneity bias.

1. INTRODUCTION

Credit risk in the banking sector in Bangladesh is the most pressing issue for the government, the banking regulatory authority, and the banks' management. This is because the overall credit quality in the banking sector of the country has deteriorated significantly in recent years, which has witnessed a significant amount of non-performing loans (NPL). According to the CEIC (2019), the NPL ratio in Bangladesh was 12.0% at the end of the third quarter of 2019, up from 11.7% the previous quarter. All government-owned banks and some private and specialized banks bear the most responsibility for this disastrous situation. At the end of the 2017–2018 fiscal year,

the proportion of NPL for government-owned commercial banks was 28.2%, with the five largest government-owned banks accounting for 47%, the highest rate in the last decade (Bangladesh Bank, 2018). The non-performing loans figure in Bangladesh is much higher than in some of the banking sectors in South Asian countries. A cross-country analysis shows that Bangladesh ranked second among Asian and Asia-Pacific countries in terms of NPL (9.3%), behind only India (10%) (Dey, 2019). This large volume of NPL affected the performance and growth of Bangladeshi banks, and even some commercial banks (e.g., Agrani Bank, Sonali Bank, Janata Bank, BASIC Bank, Farmers' Bank, and ICB Islamic Bank) have been experiencing acute existential crises. This terrible state of affairs in loan management is brought on, among other things, by insufficient risk diversification, poor credit appraisal, fraudulent practices, and lax regulatory oversight (Hossain, 2020).

Given the current fragile credit risk management in the banking sector in Bangladesh, researchers, academics, regulators, and the banks' management have been investigating the effect of credit risk on bank performance. Accordingly, studies have been undertaken on the link between credit risk management and the performance of Bangladesh's listed commercial banks. For example, Hasan, Farid, and Mamun (2014) examined the association between credit risk management and profitability, measured by return on equity (ROE), for four commercial banks from 2007–2011. Noman, Pervin, Chowdhury, and Banna (2015) studied the impact of credit risk on banks' ROE and return on assets (ROA) using a sample of 18 private commercial banks from 2003 to 2013. Similarly, Islam, Sarker, Rahman, Sultana, and Prodhan (2017) explore the determinants of profitability, measured by ROE, for 11 commercial banks for 2014–2015. Recently, Noor, Das, and Banik (2018) examined how credit risk management affects financial performance, such as return on investments (ROI), ROA, and ROE, of the four state-owned commercial banks from 2000 to 2015. Jahan and Rahman (2017) studied the effect of credit risk management on the ROE of 12 banks for the period from 2011 to 2015.

Previous Bangladeshi studies, however, can be criticized in three ways. Firstly, the relationship between credit risk management and banks' performance suffers from an endogeneity bias that may emanate from unobserved time-invariant heterogeneity across banks, simultaneity, and dynamic endogeneity. Almost all prior studies on credit risk management and listed banks' performance in Bangladesh (e.g., Noman et al. (2015)), employed the ordinary least squares (OLS) model or panel data regression models (i.e., fixed or random effects models). These are commonly used econometric methods to address endogeneity bias resulting from unobserved heterogeneity and/or simultaneity (Thrikawala, Locke, & Reddy, 2017). These models, however, cannot address dynamic endogeneity bias; banks' past performance affects their current performance. The dynamic endogeneity bias can result in a misleading relationship between the relevant variables, mistaken theoretical interpretations (Ullah, Akhtar, & Zaefarian, 2018), and incorrect coefficient signs (Ketokivi & McIntosh, 2017). It is, therefore, a credible hypothesis that prior Bangladeshi studies on the impact of credit risk management on bank performance were not sensitive to this dynamic endogeneity bias, leading to misleading conclusions.

Secondly, all prior studies looked into the effect of credit risk management on banks' performance by using accounting return-based methods, such as EPS (earnings per share), ROI, ROE, and ROA. Researchers in accounting, economics, and finance have questioned the validity of these measures (Chen & Lee, 1995) because these performance indicators may be unable to provide evidence of the true financial performance of banks in many respects (BPP, 2019). To begin with, the accounting return-based methods determine banks' performance from the internal or bank management's perspective rather than from market and shareholder perspectives (Hossain, Salam, & Sen, 2017). Also, these performance indicators are accounting return-based historical performance indicators, which emphasize short-term outcomes (Farooque, Van Zijl, Dunstan, & Akm, 2007). Moreover, it is possible to manipulate them within the framework of accounting principles and standards and tax laws (Mollah, Farooque, & Karim, 2012). Finally, these measures have been criticized for not taking into consideration the total cost of equity (Chen & Dodd, 1997). It can, therefore, be presumed that the existing studies may have drawn erroneous conclusions regarding the impact of credit risk management on banks' performance.

Thirdly, earlier studies included only a small number of listed banks in their samples, so the results may not be generalizable. This situation opens up a new research avenue in credit risk management and financial performance in the banking sector in Bangladesh.

Unlike prior studies on Bangladesh, this study aims to examine the impact of credit risk management and financial performance in the listed banks in Bangladesh from the market and shareholder value perspectives, along with the bank management perspective, and after controlling for dynamic endogeneity bias. This study differs from those previous works in three ways. Firstly, it employs the two-step system generalized method of moments (GMM) model to address the dynamic endogeneity bias. To demonstrate how dynamic endogeneity bias leads to inaccurate estimations, this study also employs the best-fitting model for the panel data (i.e., any of the pooled OLS, fixed effects, and random effects models depending on the estimations of the *F*-test, Breusch–Pagan (BP), Lagrange Multiplier (LM), and Hausman tests) and compares them with the GMM estimations.

Secondly, for comparison, this study examines the impact of credit risk management on bank performance from the bank's management, the market, and the shareholder value perspectives, measured by return on equity (ROE), Tobin's Q (TQ), and economic value added (EVA), respectively. TQ assesses the performance of firms considering market insight (Ntim, 2009), which is superior to ROE as it is free from the distortion introduced by accounting principles, standards, and tax laws (Chen & Lee, 1995).

Meanwhile, EVA measures the true performance of firms using a value-based approach (BPP, 2019). This performance indicator shows how much a firm has created true value for its shareholders over a specific accounting period (Chen & Dodd, 1997), that is, "EVA allows investors to evaluate whether the return being earned on invested capital exceeds its cost as measured by the returns from alternative capital uses". As value creation is the principal goal for investors, the EVA has been contended to be the sole performance metric directly linked to a share's intrinsic value (Stewart, 1991), i.e., the value created for shareholders is ultimately reflected in the EVA measure (Chen & Dodd, 1997). This measure also avoids the typical problems related to various accounting principles, standards, and tax laws. However, no existing studies have investigated the impact of credit risk management and the performance of the listed banks in Bangladesh from the market and shareholder value perspectives, so this constitutes a new avenue for research. Finally, this study includes most of the listed banks (29 of 30, or 97% of the population) in the sample to make the results generalizable.

The study is expected to contribute to the growing body of relevant research exploring the relationship between these two factors. The findings are also expected to be useful for policymakers for the banking sector in Bangladesh, the regulatory body, the credit departments of respective banks, and the country's government, as they all need to revise policies to reduce the extent of credit risk to create true value for shareholders.

The rest of this paper is organized as follows: Section 2 reviews theoretical and empirical literature related to credit risk management and performance, Section 3 presents the methodology used in this study, Section 4 presents and discusses the findings, and Section 5 concludes.

2. LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESES

This study examines the impact of credit risk management on the financial performance of the listed banks in Bangladesh. Credit risk management is estimated by five credit risk variables – equity multiplier ratio, capital adequacy ratio, non-performing loan ratio, interest coverage ratio, and provision for credit losses to total credit. The financial performance of banks is estimated by return on equity, Tobin's Q, and economic value added. Each credit risk management variable is expected to have contrasting, directional effects on the different measures of bank performance. Hence, this study has reviewed existing theoretical premises (e.g., agency theory, signaling theory, pecking order theory, information asymmetry theory, and trade-off theory) and prior empirical literature on the impact of each credit risk management variable on banks' performance in isolation rather than combined.

2.1. Impact of Equity Multiplier Ratio on Banks' Financial Performance

The equity multiplier is a risk pointer that reports how leveraged a firm is to its investors and creditors (Ahamed, 2017). Theoretically, a high equity multiplier ratio is detrimental for firms, as it shows the over-dependence of a firm on debt, which translates to more financial leverage for that firm. This situation leads a firm to generate greater cash flows to sustain optimal operating conditions. Conversely, "a low equity multiplier implies that the firm is loathed to take on debt, which is usually seen as a positive as their debt servicing costs are lower; but it could also mean that the company is unable to entice lenders to loan them money, which would be a negative" (Ganti, 2019). However, due to the nature of the banking business, the relationship between the equity multiplier ratio and bank performance is expected to be positive, as the banking business depends heavily on a high volume of core deposits that are considered as debts for banks. This means that a high volume of core deposits extends lending capacity, generating high earnings volumes. Therefore, the equity multiplier ratio predicts a significant positive effect on banks' performance. Ahamed (2017) empirically revealed a positive impact of the equity multiplier ratio on financial performance, as indicated by ROA, by taking a sample of commercial banks in India for the 1998–2014 period. The theoretical and empirical arguments lead to the following hypothesis.

H_1: The equity multiplier ratio has a significant positive impact on banks' financial performance, as indicated by ROE, TQ, and EVA.

2.2. Impact of Capital Adequacy Ratio on Banks' Financial Performance

The capital adequacy ratio is a variable relevant to credit risk management, which indicates whether banks have enough reserves to sustain a reasonable amount of losses before going bankrupt (Li & Zou, 2014). It is one of the widely accepted measures of financial strength used to protect depositors from losing their money (Hamza, 2017). Theoretically, a high capital adequacy ratio helps a bank reduce its chances of losses from failure or insolvency; thus, it is considered safe (Ashcraft, 2001). Banks with a high capital adequacy ratio are less financially exposed and more dependent on domestic financial resources, and it could lead to a decrease in a bank's cash costs, thus increasing its performance.

Empirically, there are inconclusive findings with regard to the impact of the capital adequacy ratio on various measures of banks' performance. For example, employing time series and cross-sectional data from Nigerian commercial banks for the 2004–2009 period, Ogboi and Unuafe (2013) documented a significant positive effect of capital adequacy ratio on banks' financial performance, as measured by ROA. Similar findings were also found by Isanzu (2017) on a sample of the five largest Chinese commercial banks between 2008 and 2014. Many Bangladeshi studies have documented insignificant results. For example, Lalon (2015) found an insignificant impact of capital adequacy ratio on ROA for BASIC Bank for the 2008–2012 period, and Islam et al. (2017) revealed a similar association between capital adequacy ratio and ROE, taking a sample of 11 commercial banks for the 2014–2015 period. These results, therefore, lead to the following hypothesis:

H_2: The capital adequacy ratio has no significant impact on banks' financial performance, as indicated by ROE, TQ, and EVA.

2.3. Impact of Non-Performing Loans on Banks' Financial Performance

The efficiency of credit risk management is affected by non-performing loans, which are closely linked to banks' credit risk (Li & Zou, 2014). Hypothetically, high non-performing loans limit new lending capacity and diminish the overall credit quality, resulting in a bank's return on assets and return on equity being lower (Dey, 2019). According to information asymmetry theory, non-performing loans may arise because of adverse selection and moral hazards, resulting from information failure that takes place when borrowers do not have better knowledge (e.g., terms and conditions) about loans and advances than the bank's management (Mismana, Bhattib, Loub, Samsudina, & Rahman, 2015). It may also happen because of an agency problem, specifically when a bank grants loans and advances to weak borrowers at the cost of bribes or other personal interests that enhance the bank's

management interests to the detriment of shareholders. Consequently, and according to signaling theory, the high volume of non-performing loans warns existing depositors that they should withdraw their money from banks. It also warns potential depositors not to deposit their savings in banks. In this circumstance, banks experience a crisis of funds that poses a barrier to further lending, reducing interest revenues and negatively affecting the banks' performance. Moreover, and according to bad management theory, as non-performing loans increase, banks' management tends to employ more resources to manage and monitor bad loans, which results in operating expenses greater than the increase in interest revenue, leading to worse overall performance (Mismana et al., 2015).

Many empirical studies (e.g., (Bhattarai, 2016; Hamza, 2017; Hosna, Manzura, & Juanjuan, 2009; Kolapo, Ayeni, & Oke, 2012; Li & Zou, 2014; Nduku, 2016; Uwuigbe, Ranti, & Babajide, 2015)) have revealed the results supporting these theoretical premises. For example, employing a sample of Nigerian commercial banks for the 2000–2010 period, Kolapo et al. (2012) found a negative relationship between non-performing loans and banks' performance, as measured by ROA. Later, Uwuigbe et al. (2015) also documented similar results for listed Nigerian banks for the 2007–2011 period. Equally, Bhattarai (2016) revealed that a high volume of non-performing loans in Nepalese commercial banks decreased ROA, and Li and Zou (2014) provided evidence of similar results for the relationship between non-performing loans and ROE in the 47 largest commercial banks in Europe from 2007–2012. Many earlier Bangladeshi studies have also found similar evidence; for example, Lalon (2015) revealed that as the number of non-performing loans increased, ROA for BASIC Bank decreased during the study period (2008–2012); Noman et al. (2015) found a similar association between non-performing loans and ROE and ROA using a sample of 18 private commercial banks for the 2003–2013 period; and Islam et al. (2017) documented a negative impact of non-performing loans on ROE, employing a sample of 11 listed banks on the Dhaka Stock Exchange during the study period (2014–2015). Therefore, the theoretical premises and empirical results lead to the following hypothesis:

H_5: The high volume of non-performing loans significantly reduces banks' financial performance, as indicated by ROE, TQ, and EVA.

2.4. Impact of Interest Coverage Ratio on Banks' Financial Performance

In line with the pecking order theory, banks that have a high-interest coverage ratio are likely to have the ability to generate relatively high levels of earnings, which can increase their lending capacity. Along the lines of the trade-off theory, banks with a high-interest coverage ratio have higher earnings, which means they can easily meet their interest obligations. Consistent with signaling theory, banks with increased earnings give a positive signal to potential depositors that they have sufficient cash flows to pay future interest payments. Consequently, the volume of bank deposits increases, resulting in a high lending volume, from which banks earn greater interest revenue. Hence, a positive impact of interest coverage on banks' financial performance is established.

Empirically, Lalon (2015) documented that a high-interest coverage ratio enhanced ROA, taking a sample from the Nigerian oil and gas industry over the 2008–2012 study period. However, some studies yielded a mixed relationship between the interest coverage ratio and various measures of banks' performance. For example, Ashraf, Ameen, and Shahzadi (2017) revealed that a high-interest coverage ratio contributed to enhanced ROA but not to enhanced ROE for 18 companies listed on the Karachi Stock Exchange for the 10-year time series from 2006 to 2015. Also, Ahmed, Awais, and Kashif (2018) documented a significant positive relationship of interest coverage ratio with ROE, but an insignificant relationship with TQ, for securities listed on the Karachi Stock Exchange for the 2005–2014 period. The following hypothesis will be tested given the theoretical premises and empirical results:

H_6: The interest coverage ratio has a significant impact on banks' financial performance, as indicated by ROE, TQ, and EVA.

2.5. Impact of Provision for Credit Losses to Total Credit on Banks' Financial Performance

The provision for credit losses to total credit is an estimation of potential losses that a bank might experience due to credit risk. A positive impact of non-performing loans on the provision for credit losses to total credit is predicted. This is due to the fact that high levels of potential non-performing loans compel the bank's management to maintain a high volume of provision for credit losses (Li & Zou, 2014). A high volume of provision for credit losses indicates that credit risk has increased and the quality of loans is deteriorating, which adversely affects bank performance (Ahmed, Takeda, & Thomas, 1999).

Several empirical studies (e.g., (Ahamed, 2017; Alshatti, 2015; Kolapo et al., 2012; Tan, 2015)) have provided evidence supporting the theoretical argument. For example, taking a sample of Nigerian commercial banks for the 2000–2010 period, Kolapo et al. (2012) found a negative impact of the provision for credit losses to total credit and banks' financial performance, as measured by ROA. Ahamed (2017) also revealed the same association between the provision for credit losses to total credit and Indian commercial banks' ROA for the 1998–2014 period. Consistent with Kolapo et al. (2012) and Ahamed (2017), Alshatti (2015) documented a similar relationship between the provision for credit losses and the performance of Jordanian commercial banks, as measured by ROA and ROE, for the 2002–2011 period. Equally, employing a one-step GMM system estimator, Tan (2015) found the same relationship between the provision for credit losses to total credit and ROA and ROE of Chinese banking firms for the 2003–2011 period. These results lead to the following hypothesis:

H_5: The large proportion of provision for credit losses to total credit significantly lowers banks' financial performance, as indicated by ROE, TQ, and EVA.

3. DATA AND METHODOLOGY

3.1. Sample and Data Collection

The sample of this study comprises 29 of 30 listed commercial banks, of which six are Islamic and 23 are traditional commercial banks. Two criteria were used in the selection of banks for the sample, namely (i) the required data must be available for the study period (2011–2018); and (ii) a bank must have a positive equity value. Accordingly, one bank was excluded from the sample due to its negative equity value during the study period. Data was collected from the corresponding banks' annual reports.

3.2. Variables and Measurements

Banks' Financial Performance: The dependent variable in this study is the financial performance of the listed banks in Bangladesh, which is measured from three perspectives. Firstly, from the bank management perspective, indicated by return on equity (ROE); secondly, from the market perspective, indicated by Tobin's Q (TQ); and finally, from the shareholder value perspective, indicated by economic value added (EVA).

ROE measures how effectively the bank's management uses its assets to generate profits. TQ estimates whether a bank is overvalued or undervalued in the market. The existing corporate finance literature suggests that a value greater than 1.0 for a bank's TQ indicates that the bank's shares are overvalued in the market, as its performance is satisfactory. In contrast, a TQ value lower than 1.0 implies that the bank's shares are undervalued in the market, as its performance is worse (Wang, Ali, & Al-Akra, 2013). EVA (economic profit) assesses the banks' true performance, indicating the value banks create for their shareholders in a specific accounting period. A positive EVA implies that a bank is generating value for its shareholders' investments, while a negative EVA indicates that the bank is not adding value to the shareholders' investments (Chen, 2019).

Credit Risk Management: Credit risk management, proxied by five key indicators, is the independent variable in this study. These indicators are: the equity multiplier ratio, which is a risk pointer that determines the portion of a bank's assets financed by its shareholders' equity; the capital adequacy ratio that assesses a bank's financial strength used to protect its depositors from losing their deposited money; non-performing loans, a risk indicator

that refers to the ratio of a bank's total non-performing loans to its gross loans and advances; interest coverage ratio that assesses a bank's ability to settle its interest obligations on core deposits and other debt obligations; and provision for credit losses to total credit, which ensures adequate levels of allowance to absorb all future credit risks.

Control Variables: The study also controls for five variables, namely bank size – total assets owned by a bank; bank age – the number of years since a sampled bank began its operations; technological impact – ATM (automated teller machine) booth services provided by a sampled bank; net revenue growth – current year increment of net revenue for a sampled bank compared to the previous year; and finally bank type – whether a sampled bank is a conventional commercial bank or an Islamic bank. The variables used in this study are listed in Table 1 along with their measurement methods.

Table 1. List of variables and measurements.

	Variable	Label	Measurement
Dependent Variable: *Banks' Performance*	Return on equity	ROE	Profit after tax to total equity for each sampled bank.
	Tobin's Q	TQ	Total market value of a sampled bank to its total book value of assets[1].
	Economic value added	EVA-ln	Natural logarithm of net operating profit after tax minus costs of funds used to fund an investment.
Independent Variable: *Credit Risk*	Equity multiplier ratio	EMR	Total assets divided by total shareholders' equity for each sampled bank.
	Capital adequacy ratio	CAR	Available capital to risk-weighted assets for each sampled bank.
	Non-performing loans	NPL	The ratio of a bank's total non-performing loans to its gross loans and advances.
	Interest coverage ratio	ICR	EBIT (earnings before interest and taxes) to total interest expenses for each sampled bank.
	Provision for credit losses to total credit	PCLTC	Provision for credit and off-balance sheet exposures to total credit for each sampled bank.
Control Variables	Bank size	BSize-ln	Natural logarithm of total assets of each sampled bank.
	Bank age	BAge	The total number of years since a sampled bank began its operations.
	Technological impact	BTimpact	Number of ATM booths deployed by each bank in each financial year.
	Net revenue growth	Growth	The proportion of the difference between net income from the current year and net income from the prior year is divided by the net income from the prior year of a bank at the end of its financial year (Ullah et al., 2018).
	Bank type	BType	A binary number with a value of 1 if the bank is a conventional commercial bank, and 0 if it is an Islamic bank.

3.3. Model Specification

Firstly, this study employed the fixed effects regression model to examine the impact of credit risk management on banks' financial performance for the listed banks in Bangladesh. The *F*-test (Baltagi, 1995), the Breusch–Pagan Lagrange Multiplier (BP LM) test (Breusch and Pagan, 1980), and the Hausman specification test

[1] TQ refers to the ratio of the market value of a bank's assets to the replacement cost of those assets (Wolfe & Sauaia, 2005). However, it is difficult, or in some cases, impossible, to obtain the replacement cost of a bank's assets; thus, following Ntim (2009), asset book values serve as proxies for a bank's current replacement costs. TQ is then computed by dividing a bank's total market value by its entire book value of assets.

Hausman (1978) were performed resulting in the selection of this model over the pooled OLS and random effects models. The fixed effects model addresses unobserved heterogeneity and captures firm-specific effects (Ullah et al., 2018). As the study examined the impact of credit risk management on banks' financial performance from three perspectives, the following three models were estimated.

$$ROE_{it} = \alpha_i + \beta_1 EMR_{it} + \beta_2 CAR_{it} + \beta_3 NPL_{it} + \beta_4 ICR_{it} + \beta_5 PCLTC_{it} + \beta_6 BSize - ln_{it} + \beta_7 BAge_{it} + \beta_8 BTimpact_{it} + \beta_9 Growth + \beta_{10} BType + u_{it} \quad (1)$$

$$TQ_{it} = \alpha_i + \beta_1 EMR_{it} + \beta_2 CAR_{it} + \beta_3 NPL_{it} + \beta_4 ICR_{it} + \beta_5 PCLTC_{it} + \beta_6 BSize - ln_{it} + \beta_7 BAge_{it} + \beta_8 BTimpact_{it} + \beta_9 Growth + \beta_{10} BType + u_{it} \quad (2)$$

$$EVA - ln_{it} = \alpha_i + \beta_1 EMR_{it} + \beta_2 CAR_{it} + \beta_3 NPL_{it} + \beta_4 ICR_{it} + \beta_5 PCLTC_{it} + \beta_6 BSize - ln_{it} + \beta_7 BAge_{it} + \beta_8 BTimpact_{it} + \beta_9 Growth + \beta_{10} BType + u_{it} \quad (3)$$

Where ROE = return on equity; TQ = Tobin's Q; EVA-ln = natural logarithm of economic value added; EMR = equity multiplier ratio; CAR = capital adequacy ratio; ICR = interest coverage ratio; NPL = non-performing loans; PCLTC = provision for credit losses to total credit; BSize-ln = natural logarithm of bank size; BAge = bank age; BTimpact = banks' technological impact; Growth = net revenue growth; and BType = bank type. β_1–β_{10} represent the coefficients of the independent variables; α = entity-specific intercepts that capture heterogeneities across entities; and u = error term. Equations 1, 2, and 3 are employed to measure the impact of credit risk management on banks' financial performance after addressing the unobserved heterogeneity and capturing firm-specific effects. However, these equations are unable to control for the time-invariant unobserved heterogeneity, simultaneity, and dynamic endogeneity issues.

Before running the regression, outliers in the dataset were checked using a box plot technique, and all variables affected by severe outlier problems were winsorized at 10% and 90% levels to reduce their influence. Different diagnostic tests were also performed to check the goodness-of-fit model. First, Pearson's correlation test was performed to verify the linearity between two independent variables; second, variance inflation factors (VIF) and tolerance (TOL) statistics were calculated to check for the presence of multicollinearity problems between two independent variables; third, the Modified Wald test (Greene, 2003) was performed to verify the presence of heteroscedasticity; and finally, the Wooldridge test (Wooldridge, 2002) was conducted to check for autocorrelation problems.

Secondly, the traditional fixed effects panel model provides inconsistent and incorrect conclusions in the event of a dynamic relationship between credit risk management and performance. In this situation, the two-step system GMM model produces a more reliable estimation than fixed effects or static panel data models. This is because, unlike the fixed effects model, GMM effectively controls time-invariant unobserved heterogeneity, simultaneity, and dynamic endogeneity by incorporating lagged performance variables (e.g., ROE, TQ, and EVA-ln in this study) as the independent variables (Ullah et al., 2018). Therefore, this study employed a two-step system GMM model as follows:

$$ROE_{it} = \alpha_i + \beta_1 ROE_{it-1} + \beta_2 EMR_{it} + \beta_3 CAR_{it} + \beta_4 NPL_{it} + \beta_5 ICR_{it} + \beta_6 PCLTC_{it} + \beta_7 BSize - ln_{it} + \beta_8 BAge_{it} + \beta_9 BTimpact_{it} + \beta_{10} Growth + \beta_{11} BType + u_{it} + \varepsilon_{it} \quad (4)$$

$$TQ_{it} = \alpha_i + \beta_1 TQ_{it-1} + \beta_2 EMR_{it} + \beta_3 CAR_{it} + \beta_4 NPL_{it} + \beta_5 ICR_{it} + \beta_6 PCLTC_{it} + \beta_7 BSize - ln_{it} + \beta_8 BAge_{it} + \beta_9 BTimpact_{it} + \beta_{10} Growth + \beta_{11} BType + u_{it} + \varepsilon_{it} \quad (5)$$

$$EVA - ln_{it} = \alpha_i + \beta_1 EVA - ln_{it-1} + \beta_2 EMR_{it} + \beta_3 CAR_{it} + \beta_4 NPL_{it} + \beta_5 ICR_{it} + \beta_6 PCLTC_{it} + \beta_7 BSize - ln_{it} + \beta_8 BAge_{it} + \beta_9 BTimpact_{it} + \beta_{10} Growth + \beta_{11} BType + u_{it} + \varepsilon_{it} \quad (6)$$

Where ROE_{it-1} = lagged ROE, TQ_{it-1} = lagged TQ, and $EVA - ln_{it-1}$ = lagged EVA-In. By including lagged financial performance variables (e.g., ROE_{it-1}, TQ_{it-1}, $EVA - ln_{it-1}$) as independent variables, Equations 4, 5 and 6 are expected to measure the impact of credit risk management on banks' financial performance after controlling for the time-invariant unobserved heterogeneity, simultaneity, and dynamic endogeneity issues.

After fitting the GMM model, this study performed two post-estimation tests to assess the appropriateness of the model used. Firstly, the Sargan test was performed to check whether the instruments included in the model are exogenous, if the model is valid, and if the instruments are correctly specified (Ullah et al., 2018). Secondly, a strong exogeneity assumption in the model was also checked using the Arellano–Bond test. That is, in the credit risk management–performance model, the lagged performance variables do not have a correlation with the error terms [AR(1) and AR(2)].

4. RESULTS AND DISCUSSION

The findings begin with checking the for presence of outliers in the dataset. The box plot technique showed extreme outlier problems with almost all variables: ROE, TQ, EVA, EMR, CAR, NPL, ICR, PCLTC, BTimpact, and Growth. To minimize the effect of these outlier problems, this study winsorized all variables affected by severe outlier problems at 10% and 90% levels. Accordingly, the 24th and 209th values of the dataset were used to replace the top and bottom 23 values of the variables affected by the outliers, respectively.

The descriptive statistics of all dependent, independent, and control variables are presented in Table 2. The average (standard deviation) ROE of the listed banks for the study period was 13.42% (5.28), with a minimum of 0.13% and a maximum of 25.52%. These results indicate high volatility in ROE among the sampled banks; some of the sampled banks even earned less than 1% ROE during the study period. The average value of the TQ ratio was 1.03, with a range of 0.92–1.25, indicating that the market value of the sampled banks was higher than the replacement costs of their assets during the study period. However, the minimum TQ (0.92) indicates that the replacement costs for some of the sampled banks' assets were greater than the value of their shares; consequently, they were undervalued in the market.

Table 2. Descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Return on equity (ROE), %	232	13.42	5.280	0.130	25.52
Tobin's Q (TQ)	232	1.030	0.076	0.920	1.250
Economic value added (EVA-ln)	232	20.53	1.080	17.45	22.14
Equity multiplier ratio (EMR), times	232	12.62	2.750	6.480	18.95
Capital adequacy ratio (CAR), %	232	11.90	1.480	9.010	15.70
Non-performing loans (NPL), %	232	5.030	2.920	0.230	13.65
Interest coverage ratio (ICR), times	232	1.400	0.210	1.010	1.950
Provision for credit losses to total credit (PCLTC), %	232	2.070	1.400	0.030	5.960
Bank size (BSize-ln)	232	178.41	80.87	54.66	389.19
Bank age (BAge), years	232	24.40	11.84	10	56
Technological impact (BTimpact)	232	130.68	127.32	0	487
Net revenue growth (Growth), %	232	9.930	12.89	-20.56	37.37

The average (standard deviation) for EVA is 20.53 (1.08) (BDT[2] 1187.89 million and BDT 1250.62 million[+], respectively), with a minimum of 17.45 and a maximum of 22.14 (BDT -1694 million[+] and BDT 4257 million[+]). These results imply that, on average, the banks in the study created true value for their shareholders. However, there was a high level of inconsistency in adding true value for shareholders among the sampled banks. The minimum negative EVA (BDT -1694 million[+]) indicates that the funds invested by shareholders of some sampled banks decreased during the study period.

The average EMR is 12.62, with a minimum of 6.48 and a maximum of 18.95, suggesting that the sampled listed banks used equity to finance only 7.93% of their loans, and core deposits financed the remaining 92.07% over

[2] BDT stands for Bangladeshi Taka, the country's official currency.

[+] Figures are not in log form.

the study period. However, high volatility was noticed among the listed sampled banks, as suggested by the range values. The average CAR was 11.90%, indicating that the listed sampled banks maintained a capital adequacy ratio well above the minimum requirement suggested by Basel II and Basel III.[3] The results suggest that, overall, the sampled banks are considered safe, and the sector is unlikely to become insolvent if unexpected losses are incurred. This is because there was good protection for depositors' assets throughout the study period. However, some of the sampled listed banks failed to maintain the minimum requirements suggested by Basel III during the study period, as evidenced by the minimum value of 9.01%.

For the NPL indicator, the average non-performing loans is 5.03%, with a minimum of 0.23% and a maximum of 13.65%. The high volume of NPL reveals low-quality credit management among the sampled banks in Bangladesh. The average ICR of the sampled banks is 1.40, with a minimum of 1.01 and a maximum of 1.95. These results imply that listed banks are capable of meeting the interest payments on deposits due by their current earnings. As for potential credit losses, the average PCLTC was 2.07%, with a minimum of 0.03% and a maximum of 5.96%.

The average bank size, as proxied by the natural logarithm form of total assets, is 2.41 (BDT 178.41[+]), with a minimum of 2.37 (BDT 54.66[+]) and a maximum of 2.46 (BDT 389.19[+]). These results indicate that banks in the sample were not equally sized. The mean and the standard deviation of the sampled bank age are 24.40 and 11.84 years, respectively, with a minimum of 10 years and a maximum of 56 years. The statistics suggest a significant difference in the length of time the banks have been in operation, with some of the sampled banks being relatively new compared to others. Descriptive statistics report a significant variation in the provision of technological facilities, particularly ATMs, among the sampled banks. Finally, the average and the standard deviation of net revenue growth are 9.93% and 12.89, respectively, with a range of -20.56%–37.37%. Therefore, it is reasonable to assume that, over the study period, the net revenue growth of the sampled banks varied significantly.

Table 3 shows that, except BTimpact, all continuous credit risk management and control variables are significantly correlated with the ROE performance variable. Similarly, except for BTimpact, BAge, and EMR, all other continuous variables correlate significantly with the TQ performance variable. All continuous variables are also significantly correlated with the EVA-ln performance variable, except for EMR and PCLTC. With regard to linearity, Table 3 also shows that the range of coefficients of correlation between the independent variables extends from a minimum of 0.009 to a maximum of 0.6157, indicating that the independent variables in this study are linearly correlated.

Regarding the presence of multicollinearity, Table 4 shows that the TOL statistics are closest to the cut-off value of 1, and the VIF statistics for all independent variables are much below the cut-off value of 10, indicating that the regression models used in this study do not have a serious multicollinearity problem. As shown in Table 4, while the Breusch and Pagan (1980) Lagrange Multiplier test (BP LM test (χ^2)) in a random effects model is insignificant, the *F*-test estimation in a fixed effects model related to regression Model 1 is significant. Therefore, the fixed effects model is favored over the pooled OLS model (Park, 2011). In relation to regression Models 2 and 3, the estimations of the *F*-test and the BP LM test (χ^2) are found to be significant, suggesting that the *F*-test favors the fixed effects model. In contrast, the BP LM test favors the random effects model over the pooled OLS model. Therefore, the Hausman specification test is run to compare the fixed and random effects models. The estimations of the Hausman specification test (χ^2) are significant, suggesting that the individual effects of between-entity errors (u_i) are significantly correlated with at least one regressor in the models, so the random effects model is problematic for regression Models 2 and 3. Therefore, the dataset for this study favors the fixed effects model rather than its random effects counterpart.

[3] Under Basel II and Basel III, the required minimum capital to risk-weighted assets is 8% and 10.5%, respectively.

Table 3. Pearson's correlation matrix.

Variables	ROE	TQ	EVA-ln	EMR	CAR	NPL	ICR	PCLTC	BSize-ln	BAge	BTimpact	Growth
ROE	1											
TQ	0.464***	1										
EVA-ln	0.383***	0.101	1									
EMR	0.236***	0.056	0.094	1								
CAR	-0.148**	-0.205***	0.143*	-0.170**	1							
NPL	-0.435***	-0.268***	-0.142*	0.122*	0.024	1						
ICR	0.701***	0.503***	0.342***	-0.382***	0.055	-0.301***	1					
PCLTC	-0.398***	-0.219***	-0.085	0.189***	0.034	0.616***	-0.250***	1				
BSize-ln	-0.408***	-0.327***	0.129*	0.303***	0.135**	0.316***	-0.278***	0.314***	1			
BAge	-0.261***	-0.084	-0.152**	-0.033	0.033	0.219***	-0.009	0.212***	0.188***	1		
BTimpact	-0.054	0.051	0.161**	0.143**	0.289***	-0.084	0.232***	0.078	0.200***	-0.047	1	
Growth	0.348***	0.370***	0.116*	-0.101	-0.163**	-0.188***	0.271***	-0.184***	-0.256***	-0.107	-0.129**	1

Note: ***, **, and * denote statistically significant p-values at the 1%, 5%, and 10% levels, respectively. ROE = return on equity; TQ = Tobin's Q; EVA-ln = natural logarithm of economic value added; EMR = equity multiplier ratio; CAR = capital adequacy ratio; ICR = interest coverage ratio; NPL = non-performing loans; PCLTC = provision for credit losses to total credit; BSize-ln = natural logarithm of bank size; BAge = bank age; BTimpact = banks' technological impact; Growth = net revenue growth; and BType = bank type.

Table 4. Estimations for the fixed effects model: Credit risk management and banks' performance.

Variables and Estimators	Multicollinearity test estimations		Estimations of regression		
	VIF	TOL	Model 1 (Dep. Var: ROE)	Model 2 (Dep. Var: TQ)	Model 3 (Dep. Var: EVA-ln)
EMR	1.41	0.709	0.003*(0.002)	0.010***(0.003)	-0.025(0.040)
CAR	1.19	0.841	-0.278(0.224)	0.109(0.382)	-7.653(5.158)
NPL	3.58	0.279	-0.415**(0.190)	-0.097(0.323)	-0.360(4.199)
ICR	1.46	0.684	0.188***(0.015)	0.145***(0.026)	1.906***(0.340)
PCLTC	3.40	0.294	0.111(0.369)	-0.567(0.628)	-0.545(8.177)
BSize-ln	1.36	0.733	0.040*(0.020)	-0.079**(0.035)	0.472(0.454)
BAge	1.10	0.912	-0.012***(0.003)	-0.003(0.006)	0.137*(0.076)
BTimpact	1.43	0.698	6.16E-1(0.000)	0.001(0.001)	-0.003**(0.005)
Growth	1.22	0.818	0.016(0.021)	0.049(0.036)	0.783*(0.483)
BType	1.32	0.756	(omitted)	(omitted)	(omitted)
_cons			-0.845*(0.449)	2.818***(0.765)	3.722(10.008)
R^2 (within/between/overall)			0.664/0.168/0.149	0.461/0.037/0.211	0.263/0.081/0.139
F (9, 194)			42.63***	18.46***	7.68***
No. of observations			232	232	232
No. of groups			29	29	29
F-test (28, 194)			1.58***	1.91***	8.12***
BP LM test (χ^2)			0.60	8.90***	227.04***
Hausman test (χ^2)				45.61***	31.72***
Modified Wald test (χ^2)			42.77***	23.98***	34.25***
Wooldridge test			21.360***	17.09***	19.45***

Note:
(i) ***, **, and * denote statistically significant p-values at the 1%, 5%, and 10% levels, respectively.
(ii) Coefficients are outside the parentheses, and the cluster robust standard errors are in parentheses.
(iii) VIF refers to the variance inflation factor, and TOL refers to the tolerance statistics.
(iv) F-test refers to the F-test in the fixed effects model.
(v) The BP LM test (χ^2) refers to the Breusch and Pagan (1980) Lagrange Multiplier test.
(vi) The Hausman test (χ^2) refers to the Hausman specification test.
(vii) The estimation of Btype on performance is unmeasurable, as it is a time-invariant dummy variable.
(viii) ROE = return on equity; TQ = Tobin's Q; EVA-ln = natural logarithm of economic value added; EMR = equity multiplier ratio; CAR = capital adequacy ratio; ICR = interest coverage ratio; NPL = non-performing loans; PCLTC = provision for credit losses to total credit; BSize-ln = natural logarithm of bank size; BAge = bank age; BTimpact = banks' technological impact; Growth = net revenue growth; and BType = bank type.

As seen in Table 4, the Modified Wald test (χ^2) and the Wooldridge test estimations are significant, suggesting that all panel data regression models have a heteroscedasticity problem and a first-order autocorrelation problem. Therefore, the fixed effects (within) regression model with the cluster (bank) robust standard errors was used to minimize the effect of heteroscedasticity and autocorrelation problems.

Table 4 presents fixed effects (within) estimations with cluster (bank) robust standard errors. However, following Wintoki, Linck, and Netter (2012) and Ullah et al. (2018), before interpreting the results from the fixed effects model, the Durbin–Wu–Hausman test was performed to confirm the presence of endogeneity bias and to conclude whether or not the results produced under the fixed effects model are inconsistent.

Table 5. Durbin–Wu–Hausman test for endogeneity of regressors.

Estimators	ROE	TQ	EVA-ln
Durbin–Wu–Hausman test statistics	20.735	34.571	8.496
P-value	0.000	0.000	0.014
Degrees of freedom	2	2	2

As shown in Table 5, the Durbin–Wu–Hausman test statistics are significant in all cases, confirming the endogeneity bias. Therefore, the results produced under the fixed effects model are inconsistent, which leads to the dynamic system GMM panel model being employed for estimation. Further, all the first-stage regression statistics for testing the validity of the instruments, reported in Table 6, are significant, rejecting the null hypothesis that the

instruments are weak for the endogenous variables. Therefore, this study discusses the results reported under the system GMM.

Table 6. First-stage regression summary statistics

Variable	Partial R^2	F-statistic	Prob > F
EMR	0.229	5.313	0.000
CAR	0.298	7.606	0.000
NPL	0.147	3.075	0.004
ICR	0.498	17.756	0.000
PCLTC	0.122	2.485	0.002

Notes: EMR = equity multiplier ratio; CAR = capital adequacy ratio; ICR = interest coverage ratio; NPL = non-performing loans; and PCLTC = provision for credit losses to total credit.

Table 7 reveals that all banks' past performance indicators under analysis significantly explain ($p < 0.01$) their current performance, indicating the presence of dynamic endogeneity. The ICR is found to have a statistically significant positive ($p < 0.01$) impact on all banks' financial performance measures (ROE, TQ, and EVA-ln) for the study period. The findings, therefore, fail to reject H_0. The results suggest that the sampled banks have a high capacity to pay the interest due on their different categories of deposits, contributing to increasing the return on equity, impressing the market and adding true value for shareholders. Theoretically, these results are in line with the pecking order, trade-off, and signaling theories. Consistent with the pecking order theory, the sampled banks with a high-interest coverage ratio during the study period had a high volume of deposits at a low interest rate. This meant that the high lending volume was extended, which caused a reasonably high level of income, thereby enhancing the banks' performance. Likewise, and in line with the trade-off and signaling theories, banks with a high-interest coverage ratio achieved higher earnings more easily and met their interest obligations. This situation signaled confidence to potential depositors that the banks had sufficient cash flows to make their interest payments. Consequently, the volume of deposits increased, which caused a high volume of loans and advances to be extended, from which the banks earned more interest revenue and a higher return on equity. Also, the market perceived that the banks had enough earnings against their promised interest payments and were at low risk of bankruptcy; consequently, their market value increased. These results are consistent with those estimated by the fixed effects model reported in Table 4. Empirically, these results support those of Enekwe (2015); Ashraf et al. (2017), and Ahmed et al. (2018), who found a significant positive relationship between interest coverage ratio and ROA, ROE, and EPS.

Regarding the relationship between EMR and banks' performance, as indicated by ROE, TQ, and EVA-ln, the results show that EMR does not affect the sampled banks' performance equally from all three perspectives. For example, EMR is statistically significantly and positively associated with TQ ($p < 0.01$), but not with ROE and EVA-ln. Therefore, the TQ result fails to reject H_0, but the ROE and EVA-ln results reject the same hypothesis. These results suggest that a high equity multiplier ratio is favorable for a high market value among the sampled banks. However, it is a non-value-adding factor for the performance of the sampled banks from the bank management and shareholder value perspectives. It seems that the positive TQ is inconsistent with the widespread theoretical premise that a high equity multiplier ratio is detrimental for banks, as it indicates the banks' over-reliance on debt, which translates into greater financial leverage. However, the result is not surprising in the context of the banking business, as it depends heavily on a high volume of core deposits, which are considered to be debts for banks. It is credible to hypothesize from the positive results that the sampled banks collected a high volume of core deposits, leading to a high volume of lending, which impressed the market during the study period. Consequently, the market value of the sampled banks increased. The results relating to ROE and EVA-ln cancelled out those estimated by the fixed effects model presented in Table 4, and the result related to TQ sustained a similar estimation.

Table 7. Estimations for the two-step system GMM: Credit risk management and banks' performance.

Variables and Estimators	Model 4 (Dep. Var: ROE)	Model 5 (Dep. Var: TQ)	Model 6 (Dep. Var: EVA-ln)
L.ROE	0.177***(0.038)		
L.TQ		0.408***(0.024)	
L.EVA-ln			0.325***(0.051)
EMR	9.47e-0(0.001)	0.006***(0.002)	0.004(0.040)
CAR	0.759*(0.407)	0.626*(0.368)	2.194(7.652)
NPL	-0.631***(0.226)	-0.496(0.336)	-10.419(7.235)
ICR	0.129***(0.026)	0.066***(0.008)	0.966***(0.252)
PCLTC	0.617(0.453)	0.778(0.845)	12.546(10.951)
BSize-ln	-0.028**(0.013)	0.022**(0.010)	1.025***(0.348)
BAge	-0.003(0.002)	-0.001(0.001)	-0.049**(0.022)
BTimpact	0.001(0.001)	-0.001(0.001)	0.001(0.001)
Growth	0.032*(0.018)	0.054***(0.010)	0.016(0.462)
BType	0.037***(0.013)	-0.006(0.018)	-1.007(0.887)
_Cons	0.643**(0.287)	0.323(0.228)	-12.001(6.979)
Wald χ^2 (12)	718.660***	1211.650***	7076.980***
Observations	203	203	203
Sargan test χ^2 (77)	12.365	22.839	19.898
Arellano–Bond AR(1)	-1.798*	-1.755*	-2.459**
Arellano–Bond AR(2)	-0.114	-0.068	0.263

Note:
(i) ***, **, and * denote statistically significant p-values at the 1%, 5%, and 10% levels, respectively.
(ii) Coefficients are outside the parentheses, and WC robust standard errors are within the parentheses.
(iii) ROE = return on equity; TQ = Tobin's Q; EVA-ln = natural logarithm of economic value added; EMR = equity multiplier ratio; CAR = capital adequacy ratio; ICR = interest coverage ratio; NPL = non-performing loans; PCLTC = provision for credit losses to total credit; BSize-ln = natural logarithm of bank size; BAge = bank age; BTimpact = banks' technological impact; Growth = net revenue growth; and BType = bank type.

As with EMR and banks' performance, this study also reveals an unequal effect of CAR and NPL on banks' financial performance. For instance, CAR has a positive and statistically significant relationship with ROE and TQ ($p < 0.10$) but not with EVA-ln. Therefore, the ROE and TQ results reject H_2, but the EVA-ln result fails to reject the same hypothesis. The positive results suggest that the sampled banks with a high capital adequacy ratio decreased their level of financial risk and that they relied heavily on domestic financial resources, which led to decreased cash costs for the banks. Thus, the return on equity and the market value of the sampled banks increased. However, the insignificant relationship between CAR and EVA-ln suggests that the high capital adequacy ratio was unable to add true value to shareholders' investments. The regression results relating to ROE and TQ support the descriptive statistics reported in Table 3. The results suggest that the sampled banks were safe from the risk of insolvency and that there was good protection for depositors' assets throughout the study period. These results cancelled out those of the fixed effects model reported in Table 4 as dynamic endogeneity bias was controlled. The results related to CAR and ROE empirically contradict those of other Bangladeshi studies, rendering them suspect; for example, Lalon (2015) and Islam et al. (2017) found an insignificant effect of the capital adequacy ratio on ROA and ROE, respectively, among Bangladeshi banks.

This study reveals a significant negative relationship ($p < 0.01$) between NPL and ROE, thus failing to reject H_3. This result is expected and consistent with the theoretical argument that the high volume of NPL led to a low return on equity, suggesting weak credit management among the sampled banks in Bangladesh. This result also empirically supports those of many earlier studies, for example, Hosna et al. (2009); Kolapo et al. (2012); Li and Zou (2014); Uwuigbe et al. (2015); Bhattarai (2016); Nduku (2016) and Hamza (2017). However, the insignificant effect of NPL on TQ and EVA-ln rejects H_3 and is inconsistent with the relevant theoretical assumption. The results with regard to NPL and TQ might be interpreted to indicate that the Bangladesh securities market is not externally efficient, which means that the market does not respond rapidly to new information; current market share prices do not represent all relevant information. The coefficient for the correlation between PCLTC and banks' financial performance is found to be statistically insignificant, irrespective of the indicators used to assess banks' financial performance, rejecting H_5. The results provide empirical evidence that the provision for credit losses to total credit

has an effect on the return on equity, the market value, and the true value of their shareholders' investments in the sampled banks. The results concerning PCLTC and TQ validate the previous plausible explanation that the securities market in Bangladesh is not externally efficient.

Concerning the relationship between the control variables and banks' performance, BSize-ln is found to have a positive and statistically significant effect on TQ ($p < 0.05$) and EVA-ln ($p < 0.01$), but a negative and statistically significant effect on ROE ($p < 0.05$). These results suggest that large banks can appear positively in the market, leading to a higher market valuation of the sampled banks and adding to the true value of shareholders' investments. However, they are detrimental to shareholders' return on equity. These results render those estimated under the fixed effects model (see Table 4) suspect. There is evidence that BAge is negatively and statistically significantly related to EVA-ln ($p < 0.05$) but insignificantly related to ROE and TQ. The results related to BAge and EVA-ln imply that relatively new banks can add true value to shareholders' investments compared to their older counterparts. However, both older and newer banks are unable to enhance the return on equity and influence the market value of the sampled banks. The results concerning BAge, ROE, and TQ provide evidence questioning those derived under the fixed effects method reported in Table 4.

BTimpact is statistically insignificantly associated with ROE, TQ, and EVA-ln. The results suggest that the use of technology in banking services, particularly the deployment of ATMs, was unable to enhance banks' performance. The results relating to BTimpact and EVA-ln cancelled out those of the fixed effects model reported in Table 4. BType has a statistically significant positive impact on ROE ($p < 0.01$) but has no impact on TQ and EVA-ln. These results suggest that the financial performance of the listed traditional commercial banks in Bangladesh is better than that of their counterpart Islamic banks from the bank management perspective. However, they do not outperform Islamic banks in terms of market and shareholder value, and *vice versa*. The fixed effects model was unable to measure the effect of the BType on performance, as it is a time-invariant dummy variable. Growth was shown to have a significant positive link with ROE and TQ but an insignificant relationship with EVA-ln. The positive results indicate that high sales growth enhances shareholder equity returns while also impressing the market (Hossain, 2020). However, the insignificant result implies that the high revenue growth fails to add true value to the shareholders' investment over the study period. These results also cancelled out those of the fixed effects method reported in Table 4. Finally, and as shown in Table 7, the estimations of the Sargan test are insignificant in all models. The test estimations suggest that the model employed is valid and that the instruments are correctly specified. The estimations of the Arellano–Bond AR(1) are significant, and the AR(2) estimations are insignificant (reported in Table 7), suggesting that the lagged performance variables were not correlated with the error terms in the credit risk management banks' performance model. Therefore, the two-step system GMM is valid and has produced consistent results for credit risk management and bank performance.

5. CONCLUSION

This study examined the impact of credit risk management on the performance of a sample of listed banks in Bangladesh for the 2011–2018 period using the two-step system GMM. Unlike prior studies on credit risk and banks' performance in Bangladesh, this study employed the system GMM over more traditional models, such as the pooled OLS, fixed effects, and random effects models, in order to address the dynamic endogeneity bias, which leads to misleading results regarding the relationship between the variables of interest, and which cannot be dealt with by traditional models. Credit risk management was the independent variable proxied by five key indicators: equity multiplier ratio, capital adequacy ratio, interest coverage ratio, non-performing loans, and provision for credit losses to total credit. Additionally, five control variables (bank size, bank age, technological impact, growth, and bank type) were also included in the model. Banks' performance, the dependent variable in this study, was measured from three perspectives: the bank management perspective, the market perspective, and the shareholder value perspective, as indicated by ROE, TQ, and EVA-ln, respectively.

This study provides evidence of mixed results, i.e., every credit risk variable incorporated in this study, except for the interest coverage ratio, does not affect the sampled banks' performance equally from all three perspectives. For example, the interest coverage ratio is found to have a credible positive effect on banks' performance from all three perspectives, while the equity multiplier ratio explains banks' performance positively from the market perspective. However, the same credit risk variable is found to have an insignificant effect on banks' performance from the bank management and shareholder value perspectives. This study also finds a significant positive effect of the capital adequacy ratio on banks' performance from the bank management and market perspectives but an insignificant effect from the shareholder value perspective. In contrast, there is credible evidence that non-performing loans negatively explain banks' performance from the bank management perspective. However, they do not affect the market and shareholder value perspectives of banks' performance. Meanwhile, there is no evidence of any effect of the provision for credit losses on total credit on banks' performance from any perspective.

The outcomes of this study have some policy implications. For example, these findings are expected to be helpful for policymakers in Bangladesh's banking industry and the related regulatory bodies (e.g., Bangladesh Bank, and the Ministry of Commerce and Finance) in understanding the influence of various credit risk variables on three perspectives of bank performance. This is because the study has found that each credit risk variable does not explain banks' performance equally well from each perspective. In practice, every perspective on bank performance is unequally important to all types of stakeholder. Therefore, policymakers and the regulatory body need to explore the relevant perspective of banks' performance for each set of key stakeholders in order to take the necessary steps to make the banks attractive to them. The findings are also important for the credit departments of the respective banks, as they need to revise strategies to minimize the extent of credit risk to create true value for shareholders. Moreover, the government of Bangladesh could enact the necessary legal framework to reduce the magnitude of credit risk. However, this study is not free from limitations. Firstly, it is based on data from 2011 to 2018, which is short in range. Secondly, it only covers five credit risk variables, and finally, it restricts the technological impact of banks only to the yearly number of ATM booths deployed by the sampled banks; other technological facilities (e.g., online and mobile banking facilities, and facilities for debit and credit cards) are not included in this study. Therefore, further studies could be conducted with more expansive time horizons and include a wider range of credit risk variables and other technological facilities.

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