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DO CAPITAL REGULATIONS AND RISK-TAKING BEHAVIOR AFFECT BANK PERFORMANCE? EVIDENCE FROM BANGLADESH

Aklima Akter[1]
Md. Tofael Hossain Majumder[2+]
Mohammad Jashim Uddin[3]

[1]*Lecturer, Department of Business Administration, Port City International University, Chattogram, Bangladesh*
Email: aklima3rd@yahoo.com
[2]*Associate Professor, Department of Accounting and Information Systems, Comilla University, Cumilla-3506, Bangladesh*
Email: tofael_cou@yahoo.com
[3]*Assistant Professor, Department of Finance and Banking, Comilla University, Cumilla-3506, Bangladesh*
Email: jashimrumi@gmail.com


(+ Corresponding author)

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ABSTRACT

This study develops and estimates a dynamic panel model to examine the simultaneous relationship between capital regulations and bank risk-taking in the Bangladeshi banking sector. Furthermore, the study investigates the impact of capital regulations and bank risk-taking on performance. The study investigates on 30 commercial banks of Bangladesh over the period 2002-2016 using two-step system GMM estimator. The study also uses two-stage least squares regression to check the robustness of the findings. The empirical evidence is found showing the significant negative association between capital regulations and risk-taking simultaneously. The study also finds evidence that there is a significant positive impact of capital regulations on bank performance. In contrast, the findings show that bank risk-taking has significant negative impacts on performance. The study expects that the results of this study will add value to the existing literature and will be significant for the future researcher and policymaker to decide in this regard.

Contribution/ Originality: This study contributes to the existing literature by investigating the simultaneous relationship between capital regulations and bank risk-taking on the emerging economy like Bangladesh. The study further examines the impact of capital regulations and bank risk-taking on performance. The study empirically uses dynamic panel model with two-step system GMM estimator which provides consistent results by overcoming the issue of endogeneity, serial correlation, and heteroscedasticity.

1. INTRODUCTION

Basel capital accord was introduced firstly in 1988. It was introduced to ensure the two principle aims: i) to ensure that banks have an adequate level of capital, ii) to create a level playing field in a competitive perspective. Due to some limitation of Basel-I and II, later in 2010, Basel-III was introduced by the Basel Committee on Banking Supervision (BCBS). To maintain the minimum capital requirement and liquidity holding by the banks for recovering the unexpected losses is the main objectives of the Basel-III (Eubanks, 2010). According to the guideline of Basel III, Banks need to have not only more capital but also better quality of capital (Lee and Hsieh, 2013). The old accord mainly focused on capital regulation, but the new mechanism consists of three mutually reinforcing pillars: capital requirement, supervisory review process, and market discipline. But, the minimum capital

requirements still a focusing pillar. Higher capital leads to higher capital buffers, thereby reducing the probability of insolvency (Stolz, 2002). Regulators in most of the countries around the world are going to implement the Basel-III step by step with varying timelines and methodologies. For example, Monetary Authority of Singapore (MAS) compliant with Basel-III in March 2013; China compliant in June 2013; Switzerland, Brazil, Australia, Canada compliant with Basel-III in June 2013, December 2013, March 2014, June 2014 respectively[1]. In 15th June 2015, India and South Africa provide a press release about the Basel III implementation. In Bangladesh, Basel-I and II had been adopted in 1996 and 2010 respectively. On March 31, 2014, Bangladesh Bank (BB) declared a roadmap for the implementation of Basel-III. Again, On December 21, 2014, a revised roadmap up to 2020 circulated by the BB. Prior literature suggests that the banking sector of developed countries is more stable than developing countries (Beck and Rahman, 2006; Sufian and Habibullah, 2009; Uddin and Suzuki, 2011). In today's developed economy like USA-UK-EU countries, most of the banks have reported their regulatory capital with the direction of Basel III. But, the implementation process of Basel-III in the emerging economy in Asia still on process.

Needless to say, due to the recent financial crisis 2007-09, nowadays, in the banking sector there are some questions like a buzz word. Does regulatory capital requirement can prevent the bank from taking excessive risk? Is there any bi-directional relationship between capital regulations and bank risk-taking? How bank capital regulations and risk-taking behavior affect the performance? Actually, these questions proliferated after the recent financial crisis. Answer of these questions helps the policy maker and potential investors to stay on the right track. To find out the answer to those questions, some empirical studies focus on the relationship between capital and risk, or capital and performance, or risk and performance. But, the few studies have considered the three terms (capital, risk, and performance) together (Altunbas *et al.*, 2007; Deelchand and Padgett, 2009; Guidara *et al.*, 2013; Lee and Hsieh, 2013; Tan and Floros, 2013; Bitar *et al.*, 2016; Witowschi and Luca, 2016). It is observed that the most of the prior studies were related to US or European countries. There is scant research in the Asian countries, more specifically on Bangladesh. The recent some studies of Bangladesh indicate the association between capital and risk (Rahman *et al.*, 2015; Abedin and Dawan, 2016; Zheng and Moudud-Ul-Huq, 2017; Zheng *et al.*, 2017; Rahman *et al.*, 2018) and the association between capital and performance (Zheng *et al.*, 2017). But, the prior studies on Bangladesh has not considered the three terms (capital, risk, and performance) together as well as missing the association between risk and performance. Moreover, Bangladesh is a developing and emerging economy which the banking sector plays a significant role to develop the money market. This banking system creates attraction for job seekers, customers, business people and potential investors in Bangladesh (Rahman *et al.*, 2015).

By considering the above fact, this study is an endeavor to examine the simultaneous relationship between capital regulations and risk-taking on Bangladeshi banking sector. The study further aims to investigate the impact of capital regulations and risk-taking on bank performance in Bangladesh. This research is predicted to add several contributions to the existing literature. Thus, it is expected that it will have significant value for the relevant policy maker, academician, and future researcher in the following ways:

Firstly, it is the pioneering research on the emerging economy like Bangladesh whereas the most of the previous research focuses on the US or European banking industry. We select an emerging economy because the significance of emerging economies in the world is growing. For example, emerging economies represent 80% of the world population and produce over 45% of the world gross domestic product (GDP) (European Central Bank, 2014)[2].

Secondly, this study investigates the simultaneous relationship between capital regulations and bank risk-taking on Bangladeshi Banks. The study further examines the impact of capital regulations and bank risk-taking on performance. It has observed that the existing literature focuses on the association between capital and risk or

[1] http.//www.bis.org/bcbs/pub/d345.htm

[2] European Central Bank, 2014. Emerging economies. <http://www.ecb.europa.eu/ecb/tasks/international/emerging/html/index.en.html> (accessed 20.02.18.).

capital and performance or risk and performance. But, there is little evidence regarding the objective of this research. Therefore, this research will be the complements of the prior studies.

Thirdly, the study uses the large panel data set of 30 sample banks over 15 years from 2002 to 2016. In addition, it uses two measures of capital, two measures of risk, and one measure of performance. The study uses some new control variables which were not used earlier. Moreover, the unit root for each variable is applied here to test the data stationary.

Finally, this study applies a dynamic panel model and uses the two-step system GMM estimator for data analysis. The dynamic panel with system GMM provides consistent results by overcoming the issue of endogeneity, serial correlation, and heteroscedasticity (Roodman, 2006). The study also uses TSLS to examine the robustness of the findings.

The remaining section of this study proceeds as follows. The second section provides about related literature. The third section shows the research methodology. Section 4 includes the results and discussion. The last part summarizes the study findings, theoretical and practical significance, policy issues, concluding remarks, and avenues for the future research scope.

2. LITERATURE REVIEW

2.1. The relationship between Capital Regulations and Bank Risk-taking

There is a debate has been arisen around the world about the relationship between capital and bank risk and the topic has considered an important one for the banking sector (Lee and Hsieh, 2013). It is deemed that the prime objective of introducing Basel accord to strengthen the capital position of a bank and reduction of risks, but the empirical results indicate mixed results. Some of the researcher's claim that the reason for introducing capital regulations is referred to in the Moral Hazard Hypothesis (Asli and Kane, 2002; Hussain and Hassan, 2005). The Moral Hazard Hypothesis (MHH) indicates that bank risk-taking increases due to decreases in capital adequacy (Altunbas *et al*., 2007). Some of the empirical studies support the MHH that a negative relationship exists between capital regulations and bank risk (Jacques and Nigro, 1997; Agusman *et al*., 2008; Deelchand and Padgett, 2009; Agoraki *et al*., 2011; Lee and Hsieh, 2013; Lee and Chih, 2013). Another group of the researcher has found the negative association between capital regulations and risk in the State Preference Model (Sharpe, 1978; Furlong and Keeley, 1989; Lin, 1994; Liu *et al*., 1996). In contrast, the Regulatory Hypothesis (RH) refers the positive association between capital regulations and bank risk; this evidence in line with Jokipii and Milne (2011); Laeven and Levine (2009); Altunbas *et al*. (2007); González (2005) and Rime (2001). Some empirical studies have not found any relationship between capital regulations and bank risk (Aggarwal and Jacques, 2001; Hussain and Hassan, 2005; Guidara *et al*., 2013). Blum (1999) finds that bank capital requirements may induce to increase risk-taking behavior. Also, Calem and Rob (1999) find the U-shaped relationship between bank capital and risk. Thus, there is no prior expectation of the relationship between capital regulations and bank risk-taking. Table 2.1 shows a snapshot of the literature survey in a scientific way regarding the relationship between capital regulations and bank risk-taking.

2.2. The relationship between Capital Regulations and Bank Performance

The second proposition of the theory of Modigliani and Miller (1958) suggest that investors' return on market equity is a negative linear function of the equity to debt ratio, the reason behind this as leverage increases then the return demanded by the shareholder also increases. Some researchers argue that the deviations from the Modigliani and Miller theorems are relevant for the banks, and thus banks have an optimum capital ratio which maximizes their value (Berger, 1995). Tan (2016) suggests that a high capital ratio represents a high bank creditworthiness; which leads to increase performance by reducing risk. However, Berger (1995) claims that higher capital induces to lower the risk position of a bank which in turns leads to lower performance as like as the risk-return trade-off. This

is in line with Modigliani and Miller (1963) and Dietrich and Wanzenried (2011). Some researchers claim that the association between bank capital regulations and risk-taking is affected by the level of bank performance (Moon and Hughes, 1997; Hughes and Mester, 1998; Altunbas *et al.*, 2007; Larbi-Siaw and Lawer, 2015).

Table-2.1. The literature on the Relationship between Capital Regulations and Bank Risk-taking

Authors	Time period	Countries	Methods	Empirical Findings
Rahman *et al.* (2017)	2000-2014	Bangladesh	GMM	Capital adequacy ratios have a negative association with bank risk
Bitar *et al.* (2018)	1999-2013	OECD countries	Quantile regressions and PCA	Risk-based capital ratios fail to decrease bank risk.
Zheng and Moudud-Ul-Huq (2017)	2000-2014	Bangladesh	GMM	Capital has a significant negative impact on risk.
Zheng *et al.* (2017)	2006-2014	Bangladesh	2SLS	Higher capital regulations enhance bank stability when it combats with credit risk.
Bitar *et al.* (2016)	1999-2013	MENA	OLS	Basel capital requirements enhance bank protection against risk.
Ashraf *et al.* (2016)	2005-2012	Pakistan	System GMM	A stringent risk-based capital requirement reduce bank portfolio risk
Baselga-Pascual *et al.* (2015)	2001-2012	Europe	Dynamic Panel Data Model	Capitalization and bank risk are negatively associated.
Rahman *et al.* (2015)	2005-2013	Bangladesh	GMM and unbalanced dynamic panel data	The negative relation between cred risk and capital regulation and the mixed relation between overall risk and capital regulation.
Rahman *et al.* (2015)	2008-2012	Bangladesh	GMM	The large bank holds a lower amount of capital and takes a highe level of risk, and there is a reverse relationship between bank capital levels and bank risk-taking.
Ghosh (2014)	1996-2011	GCC banks	3SLS	There is a positive association between capital and risk.
Guidara *et al.* (2013)	1982-2010	Canada	2SGMM	There is no relationship between risk and capital buffers.
Lee and Hsieh (2013)	1994-2008	Asian banks	GMM	Bank capital is negatively related t risk.
Lee and Chih (2013)	2004-2011	China	DEA, Tobit and OLS Regression	The CBRC regulates the current ratio to reduce the risk of the bank.
Zhou (2013)	-	-	Static Model	Capital regulations minimize bank risk.
Klomp and Haan (2012)	2002-2008	OECD countries		The banking supervision and regulation has strong impact on th risk-taking behavior of high-risk bank, but the impact is not significant for low-risk banks.
Jokipii and Milne (2011)	1986-2008	USA	Panel data model	The adjustment of capital buffer an portfolio risk is positively related.
Agoraki *et al.* (2011)	1998-2005	Europe	GMM	Requirements of capital reduce risk in general, but for banks with market power this effect significantly weakens or can even b reversed.

Liu and Wilson (2010)	2000-2007	Japan	2SGMM and fixed effect regression	Higher capital leads to lower bank credit risks and vice-versa.
	1996-2006	Taiwan	OLS	CAR has a positive impact on banks' risky investment strategies.
Ho and Hsu (2010)	1993–2004	USA	3SLS	Capital is positively related to risk and profitability
Shim (2010)	2003-2006	Japan	2SLS with fixed effects estimation	There is a negative relationship between risk and the level of capital.
Deelchand and Padgett (2009)	1995-2002	Malaysia	OLS	Bank capital and risk are positively associated.
Ahmad *et al.* (2008)	After the introduction of Basel I in 1988.	G-10 countries		Weakly capitalized quick bank response to capital regulation, while capital regulation did not change the behavior of well-capitalized U.S. banks. Market discipline is the important tool for capital build-up.
Roy (2008)	1998–2003	Asian banks	Panel data model	Equity capital to the total asset is negatively related to risk.
Agusman *et al.* (2008)	2004-2006	China	GMM	The higher capital ratio effectively reduces the bank portfolio risk.
Zhang *et al.* (2008)	-	-	Seminal model	To reduce risk and implement capital regulations monitoring and supervision is important tool
Silva (2007)	1999–2004	European banks	Panel data model	Capital is positively related to risk and profitability.
Iannotta *et al.* (2007)	1992-2000	Europe	Seemingly Unrelated Regression	There is a positive association between risk and bank capital.
Altunbas *et al.* (2007)	1991-2006	Developing Countries	GMM & 3SLS	Bank capital ratio reduces portfolio risk.
Hussain and Hassan (2005)	1993-2000	Taiwan	Ordinary Least Square (OLS)	There is a positive association between capital adequacy ratio and bank risk.
Lin *et al.* (2005)	1995-1999	36 countries banks	Panel data model	Higher regulatory restrictions increase bank risk-taking.
González (2005)	-	-	Dynamic model	In competitive banking industries, capital regulations are effective in reducing bank risk-taking
Repullo (2004)	1991-1996	USA	3SLS	Higher credit risk indicates a higher capital ratio.
Aggarwal and Jacques (2001)	1989-1995	Swiss Bank	3SLS	A positive association exists between the changes in bank capital and changes in risk.

Source: The lists prepared by Authors.

The existing literature shows inconclusive results on the relationship between bank capital regulations and performance. Some studies find a positive association between capital regulations and bank performance (Berger, 1995; Jacques and Nigro, 1997; Goddard *et al.*, 2004; Lin *et al.*, 2005; Iannotta *et al.*, 2007; Pasiouras and Kosmidou, 2007; Naceur and Kandil, 2009; Naceur and Omran, 2011; Mbizi, 2012; Demirguc-Kunt *et al.*, 2013; Lee and Hsieh, 2013; Kofarmata *et al.*, 2016; Zheng *et al.*, 2017). Goddard *et al.* (2013) and Altunbas *et al.* (2007) find a negative association between capital regulations and bank performance. However, Guidara *et al.* (2013) find no significant relationship between capital and bank performance. Table 2.2 represents the comprehensive literature on the relationship between capital and bank performance.

Table-2.2. The literature on the Relationship between Capital Regulations and Bank performance

Authors	Time period	Countries	Methods	Empirical Findings
Oino (2018)	2001-2005	Europe	Structural Equation Modelling	A negative association exists between tier 1 capital and bank performance.
Zheng *et al.* (2017)	2000-2015	Bangladesh	GMM	Higher regulatory capital ratios increase bank profitability.
De Bandt *et al.* (2016)	2007-2014	French	OLS, Fixed effects, and 2SGMM	Regulatory capital affects bank performance positively.
Bitar *et al.* (2018)	1999-2013	OECD countries	Quantile regressions and PCA	Risk-based and non-risk based capital ratios improve bank performance.
Zheng *et al.* (2017)	2000-2015	Bangladesh	GMM	The higher the bank regulatory capital ratios higher the profitability.
Tran *et al.* (2016)	1996-2013	US	Vector autoregressive model	Regulatory capital is negatively related to bank profitability for higher capitalized banks but positively related to profitability for lower capitalized banks.
Bitar *et al.* (2016)	1999-2013	MENA	OLS	Bank capital has Significant positive relation with profitability.
Berger and Bouwman (2013)	1984-2010	USA	Logit regressions and OLS	Capital and profit positively associated in case of the medium and large banking sector.
Lee and Hsieh (2013)	1994-2008	Asian banks	GMM	Capital positively impacts on bank profitability.
Guidara *et al.* (2013)	1982-2010	Canada	GMM	There is no association between capital and profitability.
Mbizi (2012)	–	Zimbabwe	Description Correlation Method	A significant positive association between the bank's capital and its performance.
Naceur and Omran (2011)	1989-2005	African banks	GMM	A significant positive association between the bank's capital and its profitability.
Dietrich and Wanzenried (2011)	1999-2009	Switzerland	GMM	There is no relationship between capital and performance before the financial crisis (2007-2008). But, a negative relationship has found during the crisis.
Shim (2010)	1993-2004	USA	3SLS	Bank capital and profitability are positively associated.
Liu and Wilson (2010)	2007-2007	Japan	2SGMM and fixed effect regression	Well-capitalized bank leads to higher profitability and vice-versa.
	1989-2004	Egypt	GMM	Higher capital leads to higher profitability.
Naceur and Kandil (2009)	2004-2006	China	GMM	There is no relationship between changes in capital and changes in profitability.
Zhang *et al.* (2008)	1995-2001	European banks	Fixed Effects Regression	There is a positive relationship between Capital and profitability.
Pasiouras and Kosmidou (2007)	1993-2000	Taiwan	OLS	Financial performance and CAR are positively related.
Lin *et al.* (2005)	1992-1998	European banks	Dynamic panel model	The capital-to-assets ratio is positively associated with Profitability.
Goddard *et al.* (2004)	-	-	Panel OLS regression	Higher capital leads to lower performance.
Chiuri *et al.* (2002)	1989-1995	Swiss Banking sector	3SLS	Capital has a positive impact on earnings.
Rime (2001)	1990-1997	Developing and Developed countries	Panel data model	There is a positive relationship between lagged equity variable and the profitability of the bank.

Source: The lists prepared by Authors.

2.3. The relationship between Bank Risk-taking and Performance

The literature on the association between bank risk and performance is still in its infancy. The empirical studies have examined the association of bank performance with different types of risks, including credit risk, liquidity risk,

capital risk, operational risk, market risk, and overall risk (Berger and DeYoung, 1997; Altunbas *et al.*, 2007; Brissimis *et al.*, 2008; Fiordelisi *et al.*, 2011). The bad luck hypothesis suggests that bank risk and performance is negatively associated (Berger and DeYoung, 1997). Brissimis *et al.* (2008) argue that bank credit risk has negative impacts on performance, whereas liquidity risk has positive impacts on performance. Lin *et al.* (2005) have found a significant negative association between insolvency risk and the performance in Taiwan's banking industry. Banks taking a lower level of risk perform better compared to banks with a higher level of risk-taker (Zhang *et al.*, 2013). Some studies find a negative association between bank risk and performance in the US banking sector (Berger and DeYoung, 1997; Kwan and Eisenbeis, 1997).

Table-2.3. The literature on the Relationship between Bank Risk-taking and Performance

Authors	Time period	Countries	Methods	Empirical Findings
Isanzu (2017)	2008-2014	China	Panel data regression	There is a significant negative impact of non-performing loan on performance.
Saeed and Zahid (2016)	2007-2015	UK	Multiple statistical analyses	Credit risk indicators have a positive association with banks Profitability.
Bhattarai (2016)	2010-2015	Nepal	Pooled data regression	The non-performing loan ratio' has negative effect on bank performance.
Ekinci (2016)	2002-2015	Turkey	GARCH model	Credit risk has negative impacts on bank profitability.
Almekhlafi *et al.* (2016)	1998-2013	Yemen	Quantitative approach	The non-performing loan has a negative impact on performance.
Noman *et al.* (2015)	2003-2013	Bangladesh	System GMM, GLS	A robust significant negative association between risk and bank performance.
Ly (2015)	2001-2011	EU27	Panel regression	Liquidity risk is negatively associated with bank performance.
Uwuigbe *et al.* (2015)	2007-2011	Nigeria	Panel linear regression	The ratio of non-performing loans has a significant negative effect on the performance.
Samuel (2015)	-	Nigeria	OLS	Improper credit risk management reduces the bank profitability.
Mamatzakis and Bermpei (2014)	1997-2010	G7 and Switzerland	SFA	There is a strong positive effect of zscore on performance; indicating a negative association between bank risk and performance.
Fan and Yijun (2014)	2007-2012	Europe	Multiple regressions	Credit risk management has positive effects on the profitability of the commercial bank.
Kaaya and Pastory (2013)	2005-2011	Tanzania	Multiple regressions	Higher credit risk lowers the bank performance.
Zhang *et al.* (2013)	2003-2010	BRIC banks	SFA and DEA	The lower the risk-taking by the bank indicates higher performance.
Boahene *et al.* (2012)	2005-2009	Ghana	Fixed and random effects regression	Credit risk (non-performing loan rate) has a significant positive relationship with profitability.
Arif and Nauman (2012)	2004-2009	Pakistan	Multiple regressions	Liquidity risk negatively affects bank profitability.
Naceur and Omran (2011)	1988-2005	MENA countries	GMM	There is a significant positive impact of credit risk on the bank's profitability.
Aduda and Gitonga (2011)	2000-2009	Kenya	OLS	Higher credit risk lowers the bank performance.
Hosna *et al.* (2009)	2000-2008	Sweden	Multiple regressions	Basel II application has strengthened the negative impact of non-performing loans to total loans ratio on ROE.
Tafri *et al.* (2009)	1996-2005	Malaysia	Fixed and random effect regression	Credit risk has a significant negative impact on ROA and ROE for the conventional as well as the Islamic banks.
Lin *et al.* (2005)	1993-2000	Taiwan	OLS	There is a negative relationship between insolvency risk and bank financial performance.

Source: The lists prepared by Authors.

In contrast, some of the studies have found a positive association between risk and performance which supports the risk-return trade-off theory (Naceur and Omran, 2011; Boahene *et al*., 2012; Fan and Yijun, 2014; Saeed and Zahid, 2016). It has been observed that the existing literature shows mixed results on the association between bank risk-taking and performance. Table 2.3 shows a snapshot of the literature survey in a scientific way regarding the relationship between bank risk-taking and performance.

3. RESEARCH METHODOLOGY

3.1. Sample and Data

The sample banking data includes 30 commercial banks of Bangladesh (2 State-owned commercial banks, 28 Private commercial banks including 22 Conventional and 6 Islamic banks) over the period 2002-2016. At present, 56 banks are working in Bangladesh. Due to unavailability of data and some newly operated banks, 26 banks are excluded from the study. The final sample includes 419 bank-year observations for the investigation. As a source of data, the study uses secondary sources of data which are collected from the audited financial statements of banks. Financial statements are collected from the Dhaka Stock Exchange (DSE) as well as the websites of Banks. Some macroeconomic and industry-related data are collected from the Bangladesh Bank[3] and World Bank[4] database. For the desk and extensive study, the study also uses journals, books, and online sources.

3.2. Variables

3.2.1. Main Variables

Performance

This study uses the return on average total assets, i.e., the ratio of profit before tax on average total assets as a measure of performance. ROA represents the generation of profits by employing per unit of asset and reflects the capability of the management to utilize the resources for generating profits (Hassan and Bashir, 2003). ROA is the key ratio for evaluating performance and widely used in the previous literature (Athanasoglou *et al*., 2008; García-Herrero *et al*., 2009; Golin and Delhaise, 2013).

Capital Regulations

Bank capital plays as a safety measure in case of adverse economic development (Athanasoglou *et al*., 2008). The prior empirical literature uses two types' capital ratios such as actual capital and regulatory capital ratio. Here, the actual capital ratio indicates the ratio of shareholders equity to total assets; which is widely used in the literature (Athanasoglou *et al*., 2008; García-Herrero *et al*., 2009; Dietrich and Wanzenried, 2011). The regulatory capital ratio shows the ratio of regulatory capital (Tier-I capital plus Tier-II capital) to risk-weighted assets; which is also known as the capital adequacy ratio (CAR). Many recent studies use this ratio as a measure of capital (Rahman *et al*., 2017; Zheng and Moudud-Ul-Huq, 2017; Zheng *et al*., 2017; Zheng *et al*., 2017). The study uses capital regulations variable as a main variable as well as an independent variable in the risk and performance equation.

Risk-Taking

The study uses two risk variables as a main variable as well as an independent variable in the capital regulations and performance equation. The study uses the ratio of non-performing loans to total loans as a proxy of credit risk; which uses by the other authors (Shrieves and Dahl, 1992; Berger, 1995; Barth *et al*., 2000; Agoraki *et al*., 2011). The higher the ratio of non-performing loans to total loans represents higher credit risk (Barth *et al*., 2004;

[3] www.bb.org.bd

[4] data.worldbank.org

Berger *et al.*, 2005; González, 2005). The study also uses the natural logarithm of zscore to measure the default risk or financial stability; where zscore is the ratio of the sum of return on assets and the ratio of shareholders equity to total assets over the standard deviation of return on assets. The higher zscore represents higher financial stability with lower risk and vice-versa (Tan, 2016). The measure has used by the several empirical studies as a measure of risk or stability (Iannotta *et al.*, 2007; Liu and Wilson, 2013; Tan, 2016).

3.2.2. Bank-Specific Variables

Cost of Intermediation

It is measured by the ratio of net interest income to average total earning assets. In this study, this variable has used in the performance and risk equation. It is expected that the high net interest income increases performance decreases risk. Thus, a positive relationship expected with performance and a negative relationship with bank risk.

Management Efficiency

It is the ratio of total earning assets to total assets. The study applies this ratio to the capital equation. The higher ratio shows the higher the management efficiency. As managers strive to earn more, it will enhance performance and leads to generate capital. However, the most efficient bank can be the least profitable (Casu and Girardone, 2004). Therefore, a positive or negative impact on management efficiency on capital is expected.

Bank Size

It is measured by taking the natural logarithm of total assets. The study uses this variable in the capital and performance equation. The higher the assets of a bank indicate large size. Large banks take more advantages rather than small banks such as easy access to capital, economies of scale, and opportunities for diversification (Zhang *et al.*, 2008). Rahman *et al.* (2017) claim that a large bank may operate its business with the low amount of capital ratios because of easy access to capital. Some studies find a negative association between bank size and capital (Tan and Floros, 2013; Rahman *et al.*, 2017; Zheng and Moudud-Ul-Huq, 2017). Hence, a negative impact of bank size on capital is expected. Some authors use bank size to observe the impact of it on performance. They claim that a large bank can reduce costs due to economies of scale which in turns leads to higher profit (Bikker and Hu, 2002; Goddard *et al.*, 2004; Iannotta *et al.*, 2007; Mercieca *et al.*, 2007; Elsas *et al.*, 2010). On the other hand, Athanasoglou *et al.* (2008) argue that performance initially increases with size but declines in future due to bureaucratic and other reasons. Thus, there is no prior expectation of the bank size and performance relationship.

Leverage

It is the ratio of total liabilities to total assets. This variable has been used in the capital, risk, and performance equation. The high ratio of leverage indicates high financial risk. So, a positive relationship expected between leverage and risk (Rahman *et al.*, 2017). Higher risk may reduce profits, but the risk-return trade-off indicates no risk any return. Hence, high leverage may generate high profit which leads to high capital and vice-versa. Therefore, no prior expectation of the association between leverage and performance as well as leverage and capital.

Risk-Weighted Assets to Total Assets

It is the ratio of risk-weighted assets to total assets (rwata). It is an important determinant of capital regulations and bank risk-taking. This study includes this variable in the capital and risk equation. A high ratio of risk-weighted assets to total assets indicates the higher capital requirement (i.e., lower capital adequacy) which

leads to higher risk-taking (Avery and Berger, 1991). Thus, the study expects a positive association between rwata and bank risk as well as a negative association between rwata and capital regulations.

Labor Efficiency

It is measured as the net profit after tax per employee. The study uses this variable in the performance equation as like as other empirical studies (Athanasoglou *et al.*, 2008; Tan and Floros, 2012; Tan and Floros, 2012; Tan and Floros, 2012; Tan, 2016; Zheng *et al.*, 2017). The high ratio of labor efficiency indicates not only the efficient management of the bank but also increases the bank's performance. Therefore, the study expects a positive association between labor efficiency and bank performance.

Financial Intermediation

It is the ratio of total loans to total deposits. The study includes this variable in the capital equation. The ratio shows the capabilities of the bank to convert its deposits into higher earning loans (Majumder and Rahman, 2016). It also measures liquidity (Naceur and Kandil, 2009) where a high ratio indicates low liquidity. The high ratio of financial intermediation indicates high profits (Zheng *et al.*, 2017) which leads to high capital. Hence, the study expects a positive association between financial intermediation and bank risk-taking.

Implicit Cost

It is the ratio of non-interest expenses to non-interest income. This variable is included in the performance equation. The high ratio indicates a low profit (Naceur and Kandil, 2009). Thus, the study expects a negative association between implicit cost and bank performance.

Cost Inefficiency

The study uses the cost to income ratio as a measure of cost inefficiency. This variable is included in the performance and risk equation. Higher the ratio lowers the efficiency. The variable has been widely used in the existing literature (Kosmidou, 2008; García-Herrero *et al.*, 2009; Liu and Wilson, 2010; Dietrich and Wanzenried, 2011; Baselga-Pascual *et al.*, 2015). Athanasoglou *et al.* (2008) claim that the cost-efficient bank increases bank performances. This evidence is supported by Jiang *et al.* (2003) and Bourke (1989). However, Molyneux and Thornton (1992) find a positive impact of cost inefficiency on profitability. Thus, there is no prior expectation of the relationship between cost inefficiency and performance.

Cost inefficiency is a source of bank risk (Baselga-Pascual *et al.*, 2015). Cost inefficiency is positively related to bank risk (Louzis *et al.*, 2012). The study expects a positive relationship between cost inefficiency and bank risk.

Income Diversification

It is the ratio of non-interest income to total income. This variable is included in the performance equation. Tan and Floros (2012) argue that a bank can generate more income when it engaged with diversified businesses. (Jiang *et al.*, 2003) find positive impacts of income diversification on performance. However, Demirgüç-Kunt and Huizinga (1999) and Gischer and Juttner (2001) suggest a negative association between income diversification and performance. This result has been explained by the fact that there is a strong competition for generating free-income compared to traditional interest generation activity. Therefore, there is no prior expectation of the relationship between income diversification and performance.

3.2.3. Industry-Specific Variables

Industry Concentration

The study uses the Herfindahl-Hirschman Index (HHI) to measure the degree of market concentration through the analysis of market power in the capital and risk equation. HHI is the most widely used measures of concentration in the existing literature. HHI is the sum of the squares of all banks market shares regarding banks total assets within a country (Bikker and Haaf, 2002). The greater the market concentration indicates, the lower competition within the banks and vice-versa (Rahman *et al*., 2017). The greater concentrated market leads to greater market power which in turns increases profits and capital to take excessive risks (Park and Peristiani, 2007). Boyd and Nicolo (2005) claim that the monopolistic banks may charge high amount of lending interests rates to their clients. As a result, the clients may involve in the riskier projects to meet their high financing costs. Therefore, this situation creates more loan defaulters, which increases bank risk and decreases capital. Hence, the empirical literature shows the positive or negative impact of industry concentration on bank capital and risk.

Bank-Level Lending Rate

It measures the ratio of interest income to total loan and advances. This ratio is included in the capital and risk equation. The high ratio indicates higher earnings and lowers the bank risk. Thus, the study expects a positive relationship between the lending rate and capital, whereas a negative association expects between lending rate and bank risk.

3.2.4. Macroeconomic Variables

Economic Growth

It indicates an annual GDP growth rate (%). The study uses this variable in the performance equation. Some researchers find a positive association between GDP growth rate and performance (Bikker and Hu, 2002; Athanasoglou *et al*., 2008). However, Majumder and Uddin (2017) and Tan and Floros (2012) finds a negative association between GDP growth and performance. Thus, the study has no prior expectation of the association between economic growth and performance.

Inflation

It indicates annual rate inflation (GDP deflator). The study has been included this variable in the risk equation. The higher the rate of inflation deteriorates bank risks (Baboucek and Jancar, 2005). On the other hand, Hussain and Hassan (2005) find a positive association between inflation and bank risk. Thus, the study expects a positive or negative association between inflation and bank risk-taking.

3.3. Empirical Methodology and Models

This study applies the dynamic model and two-step system GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (2000). The study uses system GMM because of the following reasons. Firstly, It is an appropriate measure for addressing potential endogeneity, serial correlation, and heteroscedasticity problem (Baltagi, 2001; Doytch and Uctum, 2011). Secondly, Bond (2002) argues that the system GMM technique addresses the unit root property issues and gives more precise results as compared to difference GMM. Finally, another important reason for using GMM rather than ordinary least squares (OLS), the later one provides biased results in case of dynamic model (Nickell, 1981). The study also uses two-stage least squares regression for checking the robustness of the results estimated by GMM.

The present study seeks to investigate the simultaneous relationship between capital regulations and bank risk-taking in the banking sector of Bangladesh. The study also seeks to find out the impact of capital regulations and

risk-taking on bank performance. The investigation is using an empirical model which includes measures of capital regulations, risk-taking, and bank performance as dependent variables plus some independent variables. The summary of the variables used in the study is shown in Table 3.1.

The empirical model specification is as follows:

$$Y_{ij,t} = C + \delta Y_{ij,t-1} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{----------(1)}$$

Where i indicate to year and t indicates to individual bank. $Y_{ij,t}$ represents capital regulations, risk-taking, and performance indicators for the specific bank at a specific year. $Y_{ij,t-1}$ is the one period lagged capital regulations, risk-taking, and performance indicators. C is a constant term, δ represents the speed of adjustment to equilibrium, X_{it} with superscripts k, l and m represent bank-specific, industry-specific and macroeconomic variables respectively. v_{it} and u_{it} indicate the unobserved bank-specific effect and idiosyncratic error respectively. β_k, β_l, and β_m represents the coefficients to be estimated.

The study uses two measures of capital regulations such as the ratio of regulatory capital to risk-weighted assets (car) and the ratio of shareholder's equity to total assets (ear). The risk-taking variable represents by two measures such as the ratio of non-performing loan to total loans (npltl) and the natural logarithm of zscore (lnzscore); where zscore = (roa+ear)/standard deviation of roa. The bank performance is measured by return on average total assets, i.e. the ratio of profit before tax to average total assets.

To measure the impacts of bank risk-taking on capital regulations, the study uses the following empirical models:

Model 1 with the capital regulations (car) and bank risk-taking (npltl):

$$car_{ij,t} = C + \delta car_{ij,t-1} + \lambda npltl_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{---------(2)}$$

Model 2 with the capital regulations (car) and bank risk-taking (lnzscore):

$$car_{ij,t} = C + \delta car_{ij,t-1} + \lambda lnzscore_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{------(3)}$$

Model 3 with the capital regulations (ear) and bank risk-taking (npltl):

$$ear_{ij,t} = C + \delta ear_{ij,t-1} + \lambda npltl_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{----------(4)}$$

Model 4 with the capital regulations (ear) and bank risk-taking (lnzscore):

$$ear_{ij,t} = C + \delta ear_{ij,t-1} + \lambda lnzscore_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{------(5)}$$

The above models 1 to 4 includes bank-specific variables such as return on average total assets (roa), management efficiency (meff), bank size (bsize), leverage (lvr), risk-weighted assets to total assets (rwata), financial intermediation (finim); Industry concentration (hhiic) and bank-level lending rate (bllr) includes as industry-specific variable; the macroeconomic variables includes economic growth (aggr) and inflation (infr).

To measure the impacts of capital regulations on bank risk-taking, the study uses the following empirical models:

Model 1 with the bank risk-taking (npltl) and capital regulations (car):

$$npltl_{ij,t} = C + \delta npltl_{ij,t-1} + \lambda car_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{-------(6)}$$

Model 2 with the bank risk-taking (npltl) and capital regulations (ear):

$$npltl_{ij,t} = C + \delta npltl_{ij,t-1} + \lambda ear_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{-------(7)}$$

Model 3 with the bank risk-taking (lnzscore) and capital regulations (car):

$$lnzscore_{ij,t} = C + \delta lnzscore_{ij,t-1} + \lambda car_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{----------(8)}$$

Model 4 with the bank risk-taking (lnzscore) and capital regulations (ear):

$$lnzscore_{ij,t} = C + \delta lnzscore_{ij,t-1} + \lambda ear_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{l=1}^{l} \beta_l X_{it}^l + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{-----(9)}$$

Table-3.1. Summary of the Variables used in the Study

Variables	Symbol	Measurement	References
Main variables			
Performance	roa	Return on average total assets, i.e., the ratio of profit before tax to average total assets.	Djalilov and Piesse (2016)
Capital regulations	car	Capital adequacy ratio i.e. the ratio of regulatory capital (Tier-1 + Tier-2 capital) to risk-weighted assets.	Soedarmono and Tarazi (2016)
	ear	The ratio of shareholder's equity to total assets.	Bougatef and Mgadmi (2016)
Risk-taking	npltl	The ratio of non-performing loans to total loans.	Agoraki *et al.* (2011)
	lnzscore	Natural logarithm of zscore; where zscore = (roa+ear)/standard deviation of roa.	Iannotta *et al.* (2007)
Bank-specific variables			
Cost of intermediation	nim	The ratio of net interest income to average total earning assets.	Rahman *et al.* (2017)
Management efficiency	meff	The ratio of total earning assets to total assets.	Rahman *et al.* (2017)
Bank size	bsize	Natural logarithm of total assets.	(Tan and Floros, 2013; Tan, 2016)
Leverage	lvr	The ratio of total liabilities to total assets.	(González, 2005; Aysen, 2013; Rahman *et al.*, 2017)
Risk-weighted assets to total assets	rwata	The ratio of risk-weighted assets to total assets.	(Rahman *et al.*, 2017; Zheng *et al.*, 2017)
Labor efficiency	leff	Net profit after tax divided by the total number of employees.	Authors' idea
Financial intermediation	finim	The ratio of total loans to total deposits.	Naceur and Kandil (2009)
Implicit cost	impc	The ratio of non-interest expenses to non-interest income.	Naceur and Kandil (2009)
Cost inefficiency	cineff	Total cost to total income ratio.	(Poghosyan and Čihak, 2011; Rahman *et al.*, 2015)
Income diversification	indiv	The ratio of non-interest income to total income.	Jiang *et al.* (2003)
Industry-specific variables			
Industry□concentration	hhiic	Herf□ndahl-Hirsch□an Index	(Uhde and Heimeshoff, 2009; Rahman *et al.*, 2017)
Bank-level lending rate	bllr	The ratio of interest income to total loans & advances.	Geng *et al.* (2016)
Macroeconomic variables			
Economic growth	aggr	GDP growth (annual %)	Tan and Floros (2012)
Inflation	infr	Inflation, GDP deflator (annual %)	Zheng and Moudud-Ul-Huq (2017)

Source: Author's own preparation

The above models 1 to 4 includes bank-specific variables such as return on average total assets (roa), cost of intermediation (nim), leverage (lvr), risk-weighted assets to total assets (rwata), cost inefficiency (cineff); Industry

concentration (hhiic) and bank-level lending rate (bllr) includes as industry-specific variable; and inflation (infr) includes as the macroeconomic variable.

To measure the impact of capital regulations and risk-taking on bank performance, the study uses the following empirical models:

Model 1 with the capital regulations (car) and risk-taking (npltl) on the effect of bank performance (roa):

$$roa_{ij,t} = C + \delta roa_{ij,t-1} + \lambda car_{i,t} + \lambda npltl_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{----------(10)}$$

Model 2 with the capital regulations (car) and risk-taking (lnzscore) on the effect of bank performance (roa):

$$roa_{ij,t} = C + \delta roa_{ij,t-1} + \lambda car_{i,t} + \lambda lnzscore_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{--------(11)}$$

Model 3 with the capital regulations (ear) and risk-taking (npltl) on the effect of bank performance (roa):

$$roa_{ij,t} = C + \delta roa_{ij,t-1} + \lambda ear_{i,t} + \lambda npltl_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{----------(12)}$$

Model 4 with the capital regulations (ear) and risk-taking (lnzscore) on the effect of bank performance (roa):

$$roa_{ij,t} = C + \delta roa_{ij,t-1} + \lambda ear_{i,t} + \lambda lnzscore_{i,t} + \sum_{k=1}^{k} \beta_k X_{it}^k + \sum_{m=1}^{m} \beta_m X_{it}^m + v_{it} + u_{it} \text{-------(13)}$$

The above models 1 to 4 includes bank-specific variables such as cost of intermediation (nim), bank size (bsize), leverage (lvr), labor efficiency (leff), implicit cost (impc), cost inefficiency (cineff), income diversification (indiv); and economic growth (aggr) includes as the macroeconomic variable.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

The descriptive statistics of all the study variables are presented in Table 4.1. To remove the influence of outliers, all variables are winsorized at the 5% level. The average performance (roa) of the Bangladeshi banks is 2.5% whereas the minimum value is 0.70%, reflecting that some banks are performing very poor.

Table-4.1. Descriptive Statistics

Variables	Observations	Mean	Standard Deviation	Minimum	Maximum
Performance (roa)	419	0.025	0.010	0.007	0.044
Capital Regulations (car)	419	0.114	0.017	0.084	0.150
Capital Regulations (ear)	419	0.075	0.021	0.042	0.117
Risk-taking (npltl)	419	0.052	0.041	0.007	0.175
Risk-taking (lnzscore)	419	2.310	0.403	1.401	2.872
Cost of Intermediation (nim)	419	0.031	0.011	0.012	0.053
Management Efficiency (meff)	419	0.841	0.046	0.732	0.909
Bank Size (bsize)	419	11.267	0.916	9.694	12.705
Leverage (lvr)	419	0.924	0.021	0.882	0.958
Risk-weighted Assets to Total Assets (rwata)	419	0.728	0.148	0.482	1.032
Labor Efficiency (leff)	419	0.628	0.402	0.052	1.531
Financial Intermediation (finim)	419	0.837	0.093	0.639	1.001
Implicit Cost (impc)	419	0.819	0.293	0.439	1.518
Cost Inefficiency (cineff)	419	0.724	0.064	0.606	0.857
Income Diversification (indiv)	419	0.265	0.076	0.125	0.407
Industry Concentration (hhiic)	419	0.002	0.002	0.000	0.009
Bank-level Lending Rate (bllr)	419	0.119	0.018	0.087	0.154
Economic Growth (aggr)	419	6.026	0.862	3.800	7.100
Inflation (infr)	419	6.412	1.203	3.900	8.200

As per Basel-III, Bangladeshi banks have to maintain a minimum capital requirement at 10% of risk-weighted assets. The average value of capital regulations (car) is 11.4%, indicating that it is higher than the required minimum capital as per Basel-III accord. The minimum value of capital regulations (car) 8.4% represents that some banks have maintained below the minimum capital requirements. The average value of other measures of capital regulations (ear), i.e., shareholder's equity to total assets ratio is 7.5%, whereas the minimum value 4.2% indicates that some bank maintains with low capital. The mean value of non-performing loans to total loans (npltl) is 5.20%, whereas the maximum value is 17.5% reflecting that some bank has a higher amount of non-performing loans. The risk-taking measures lnzscore indicates high financial stability (low risk) when the ratio is high and vice-versa. Here, the standard deviation of 0.40 indicates a wide deviation of this variable.

4.2. Diagnostic Tests

The study applies the Fisher-type unit-root test for all the study variables based on augmented Dickey-Fuller tests for checking the stationary of data[5]. The study applies this test because it is appropriate for unbalanced panel data. To check the multicollinearity problem, the study uses Pearson correlation[6]. Durbin-Wu-Hausman endogeneity test applies to test endogeneity[7]. For the serial correlation test, the study uses the Breusch Godfrey LM test[8]. Then the study applies the White test for checking heteroscedasticity[9]. Finally, to test whether fixed or random effect regression model is appropriate, the study applies Hausman test[10].

4.3. Correlation Analysis

Table 4.2 shows the Pearson's correlation coefficient matrix. The findings indicate that the highest correlation among the independent variables is -0.65 between risk-weighted assets to total assets (rwata) and leverage (lvr). Hence, the study suggests non-existence of multicollinearity issues.[11]

[5] See more at Appendix A, Table A1.

[6] See details at Table 4.2.

[7] See details at Tables 4.3 to 4.8.

[8] See details at Tables 4.3 to 4.8.

[9] See details at Tables 4.3 to 4.8.

[10] See details at Tables 4.6 to 4.8.

[11] Barako and Tower (2007) suggest that multicollinearity is a serious problem when the correlation value of the two independent variables are above 0.80. Thus, the multicollinearity problem does not appear in this study.

Table-4.2. Pearson Correlation Matrix

	roa	car	ear	npltl	lnzscore	nim	meff	bsize	lvr	rwata	leff	finim	impc	cineff	indiv	hhiic	bllr	aggr	infr
Roa	1.00																		
Car	0.23***	1																	
Ear	0.41***	0.58***	1																
Npltl	(0.49)***	(0.20)***	(0.28)***	1															
Lnzscore	0.50***	0.40***	0.57***	(0.50)***	1														
Nim	0.43***	0.23***	0.21***	(0.22)***	0.33***	1													
Meff	0.39***	0.13***	0.17***	(0.74)***	0.35***	(0.14)***	1												
Bsize	(0.20)***	0.19***	0.36***	0.03	0.06	0.04	(0.29)***	1											
Lvr	(0.40)***	(0.56)***	(0.97)***	0.25***	(0.54)***	(0.22)***	(0.14)***	(0.37)***	1										
Rwata	0.31***	0.02	0.66***	(0.37)***	0.42***	0.12**	0.24***	0.35***	(0.65)***	1									
Leff	0.56***	0.28***	0.57***	(0.49)***	0.47***	0.04	0.41***	0.24***	(0.56)***	0.56***	1								
Finim	0.31***	0.23***	0.40***	(0.35)***	0.34***	0.34***	0.26***	0.06	(0.38)***	0.49***	0.39***	1							
Impc	(0.41)***	0.08*	(0.15)***	0.04	(0.08)	0.46***	(0.34)***	0.22***	0.15***	(0.16)***	(0.34)***	0.06	1						
Cineff	(0.56)***	(0.16)***	(0.31)***	0.15***	(0.35)***	(0.47)***	(0.08)	0.10**	0.32***	(0.19)***	(0.34)***	(0.25)***	0.41***	1					
Indiv	0.13***	(0.08)	0.09*	0.40***	(0.18)***	(0.29)***	(0.21)***	0.10**	(0.10)**	0.05	0.02	(0.22)***	(0.53)***	(0.30)***	1				
Hhiic	(0.23)***	(0.23)***	(0.27)***	0.42***	(0.29)***	(0.06)	(0.45)***	0.30***	0.24***	(0.30)***	(0.34)***	(0.24)***	0.04	(0.07)	0.15***	1			
Bllr	0.12**	0.15***	0.13***	(0.32)***	0.26***	0.13***	0.26***	(0.14)***	(0.12)**	0.03	0.13***	(0.18)***	0.01	0.23***	(0.40)***	(0.40)***	1		
Aggr	(0.05)	0.18***	0.21***	(0.18)***	0.11**	0.03	0.02	0.43***	(0.21)***	0.22***	0.14***	0.18***	0.10**	0.13***	(0.05)	(0.11)**	(0.04)	1	
Infr	0.19***	0.24***	0.39***	(0.22)***	0.25***	0.17***	0.01	0.50***	(0.39)***	0.40***	0.28***	0.15***	(0.01)	(0.03)	(0.01)	(0.09)*	0.29***	0.39***	1

Notes: Total number of observations 419; ***Correlation is significant at 1% level (2-tailed); **Correlation is significant at 5% level (2-tailed); *Correlation is significant at 10% level (2-tailed); All variables are winsorized at the 5% level.

4.4. Regression Analysis

This section derives the regression results of the baseline models after taking several diagnostics tests.

4.4.1. The Impacts of Bank Risk-Taking on Capital Regulations

Table 4.3 reports the empirical results of the impact of the bank risk-taking on capital regulations. Here two measures of capital (car & ear) and two measures of risk (npltl & lnzscore) have been used for model 1-4.

All models represent the significant positive coefficient of the lagged dependent variable (cart-1 & eart-1), which confirms the degree of persistence exists in all models and the dynamic character for specifying the models.

The study finds a significant negative relationship between credit risks (npltl) and capital ratios (car & ear) in models 1 & 3. The study results also confirm that bank's financial stability (lnzscore) is positively associated with capital regulations (car & ear) in models 2 & 4; which further indicates the negative association between risk and capital as higher the financial stability indicates lower the bank risk. The study results consistent with the findings of Zheng *et al.* (2017); Zheng and Moudud-Ul-Huq (2017); Lee and Hsieh (2013); Lee and Chih (2013); Agoraki *et al.* (2011); Zhang *et al.* (2008) and Jacques and Nigro (1997) but inconsistent with Altunbas *et al.* (2007); Lin *et al.* (2005); Rime (2001); Blum (1999) and Shrieves and Dahl (1992).

Turning to other explanatory variables, the coefficient of bank performance (roa) is significant and positive, suggesting that there is a positive impact of bank performance (roa) on capital regulations (car & ear). This evidence is in line with Lee and Hsieh (2013); Mbizi (2012); Naceur and Omran (2011); Naceur and Kandil (2009) and Pasiouras and Kosmidou (2007).

Management efficiency (meff) is found to be significantly and positively related to capital regulations (car & ear) in all models except the model 4, indicating the higher the efficiency of management higher the bank capital, but inconsistent with the finding of Rahman *et al.* (2017).

The study finds that bank size (bsize) has a significant and negative impact on capital (car & ear), indicating that the large banks may operate with low capital; which supports the study of Rahman *et al.* (2017); Zheng and Moudud-Ul-Huq (2017) and Tan and Floros (2013).

Concerning the impact of leverage (lvr), it is negatively and significantly related to capital regulation (car & ear), showing that the higher the liabilities lower the bank capital; which is consistent with the study of Rahman *et al.* (2017).

Risk-weighted assets to total assets (rwata) have a significant negative impact on capital regulations (car & ear). The results suggest that the high risk-weighted assets of a bank deteriorate its capital; this evidence is in line with Zheng *et al.* (2017).

Financial intermediation (finim) is found to be positively and significantly associated to capital regulations (car & ear) of Bangladeshi commercial banks, indicating a higher amount of loans generates more interest income which leads to higher capital; the results supported by the study of Naceur and Kandil (2009).

The study noticed that bank-level lending rate (bllr) is positively and significantly impact on capital regulations (car & ear), showing the higher the interest income generation on loans leads to higher capital. This result is in line with expectation.

The study further reports that industry concentration (hhiic) is highly significant and positively associated with capital regulations (car & ear), indicating that lower competition due to highly concentrated markets leads to hold more capital to obtain more profits. This evidence is consistent with Rahman *et al.* (2017) and Tan and Floros (2013).

Table-4.3. The Impacts of Bank Risk-taking on Capital Regulations

Variables	Model-1 car & npltl		Model-2 car & lnzscore		Model-3 ear & npltl		Model-4 ear & lnzscore	
	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.
car_{t-1}	0.129*	0.070	0.149**	0.064	-	-	-	-
ear_{t-1}	-	-	-	-	0.249*	0.128	0.216*	0.108
npltl	-0.160**	0.060	-	-	-0.189***	0.042	-	-
lnzscore	-	-	0.010***	0.003	-	-	0.009*	0.005
roa	0.459***	0.134	0.236**	0.103	0.496***	0.107	0.309***	0.104
meff	0.145***	0.042	0.076**	0.034	0.130***	0.045	0.030	0.033
bsize	-0.010***	0.002	-0.009***	0.002	-0.007***	0.002	-0.006***	0.001
lvr	-0.188***	0.039	-0.103***	0.031	-0.239***	0.058	-0.122**	0.045
rwata	-0.069***	0.010	-0.072***	0.010	-0.024**	0.009	-0.029**	0.011
finim	0.054***	0.012	0.044***	0.012	0.030**	0.014	0.043**	0.016
bllr	0.181***	0.047	0.126**	0.047	0.222***	0.056	0.127**	0.059
hhiic	1.972*	1.097	1.615***	0.444	1.362**	0.527	1.034**	0.355
F-Test	1768.91***		1135.69***		1342.40***		441.16***	
Hansen Test[1]		P = 0.142		P = 0.392		P = 0.241		P = 0.130
AR(1)[2]	Z = -3.49	P = 0.000	Z = -3.90	P = 0.000	Z = -3.25	P = 0.001	Z = -3.46	P = 0.001
AR(2)[3]	Z = 0.46	P = 0.644	Z = 0.50	P = 0.619	Z = 0.73	P = 0.468	Z = 1.46	P = 0.144
No. of instruments	14		14		14		14	
Observations	389		389		389		389	
Diagnostic Tests								
Endogeneity Test (Durbin-Wu-Hausman)[4]		P = 0.032		P = 0.001		P = 0.011		P = 0.023
Serial correlation Test (Breusch-Godfrey LM)[4]		P = 0.000		P = 0.000		P = 0.000		P = 0.000
Heteroscedasticity Test (White)[4]		P = 0.000		P = 0.000		P = 0.000		P = 0.000

Note: The estimation technique is a two-step system GMM dynamic panel estimators. The dependent variable is capital regulations measured by car and ear. Bank risk-taking is considered as endogeneous variable. *, **, *** denote significance at 10%, 5%, and 1% levels respectively. [1]Test of over-identifying restrictions (H_o: over-identifying restrictions are valid). The tests accept the null hypothesis that over-identifying restrictions are valid. [2]Arellano-Bond test for the first-order autocorrelation (Ho: no autocorrelation). [3]Arellano-Bond test for the second-order autocorrelation (Ho: no autocorrelation). The tests results of AR(1) and AR(2) indicates there is autocorrelation exists in the first-order but not in the second-order. [4]The study rejects the null hypothesis that there is no endogeneity, serial correlation, and heteroscedasticity in all models. All variables are winsorized at the 5% level.

4.4.2. The Impacts of Capital Regulations on Bank Risk-Taking

Table 4.4 reports the empirical results of the impact of capital regulations on bank risk-taking. Here two measures of capital (car & ear) and two measures of risk (npltl & lnzscore) have been used for model 1-4.

All models represent the significant positive coefficient of the lagged dependent variable (npltlt-1 & lnzscoret-1), which confirms the degree of persistence exists in all models and the dynamic character for specifying the models.

The study finds a significant negative relationship between capital regulations (car & ear) and bank risk-taking (npltl) in models 1 & 2. The study results also confirm that capital regulations (car & ear) are positively associated with bank's financial stability (lnzscore); which further indicates the negative association between capital and risk as higher the capital indicates higher the financial stability (lower risk). The study results consistent with the findings of Zheng *et al.* (2017); Zheng and Moudud-Ul-Huq (2017); Rahman *et al.* (2017); Lee and Chih (2013); Lee and Hsieh (2013); Agoraki *et al.* (2011); Zhang *et al.* (2008) and Jacques and Nigro (1997) but inconsistent with the study of Altunbas *et al.* (2007); Lin *et al.* (2005); Rime (2001); Blum (1999) and Shrieves and Dahl (1992).

Turning to other explanatory variables, the coefficient of bank performance (roa) is significant and negative, suggesting that there is a negative impact of bank performance (roa) on risk-taking (npltl & lnzscore). This evidence is in line with Rahman *et al.* (2015).

Cost of intermediation (nim) is found to be significantly and negatively related to bank risk-taking (npltl & lnzscore) in model 1 & 2, indicating the higher the generating of net interest income lower the bank risks; which is consistent with the finding of Rahman *et al.* (2017).

The study finds that leverage (lvr) has a significant and positive impact on bank risk-taking (npltl & lnzscore), indicating that the higher the liabilities higher the risk-taking; which supports the study of Rahman *et al.* (2017).

Concerning the impact of risk-weighted assets to total assets (rwata), it is positively and significantly related to risk-taking (npltl & lnzscore), showing that the higher the risk-weighted assets, the higher the bank risk-taking; which is consistent with the study of Rahman *et al.* (2017).

Cost inefficiency (cineff) has significant positive impacts on risk-taking (npltl & lnzscore). The results suggest that the higher the cost of a bank generates higher risks; this evidence is in line with Baselga-Pascual *et al.* (2015).

Bank-level lending rate (bllr) is found to be negatively and significantly associated to risk-taking (npltl & lnzscore) of Bangladeshi commercial banks, indicating a higher amount of loans generate more interest income which leads to lower the bank risk; the results supported by the study of Geng *et al.* (2016).

The study noticed that industry concentration (hhiic) is positively and significantly impact on bank risk-taking (npltl & lnzscore) in models 1, 3, & 5; showing that higher the concentration ratio higher the bank risks. This result is in line with Tan and Floros (2013).

The study further reports that inflation (infr) is significantly and negatively associated with bank risk-taking (npltl & lnzscore), indicating that higher inflation in Bangladesh leads to taking lower risks by the banks. The evidence is consistent with Zheng and Moudud-Ul-Huq (2017) and Baboucek and Jancar (2005).

Table-4.4. The Impacts of Capital Regulations on Bank Risk-taking

Variables	Model-1 npltl & car		Model-2 npltl & ear		Model-3 lnzscore & car		Model-4 lnzscore & ear	
	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.
$npltl_{t-1}$	0.935***	0.058	0.890***	0.047	-	-	-	-
$lnzscore_{t-1}$	-	-	-	-	0.473***	0.086	0.504***	0.113
car	-0.133**	0.057	-	-	4.438***	0.679	-	-
ear	-	-	-0.105*	0.056	-	-	5.204***	1.366
roa	-0.768**	0.300	-0.896***	0.279	7.686***	2.708	6.352**	3.069
nim	-0.282***	0.090	-0.237***	0.086	0.330	2.213	0.500	2.217
lvr	0.113**	0.042	0.147***	0.037	-0.396**	0.190	-0.175***	0.049
rwata	0.512***	0.108	0.301**	0.128	-0.411***	0.137	-0.220*	0.124
cineff	0.091**	0.044	0.103**	0.042	-0.331	0.524	-0.357	0.626
bllr	-0.396***	0.061	-0.373***	0.064	2.276***	0.670	1.532*	0.775
hhiic	0.595**	0.251	0.389	0.357	-3.870**	1.720	-1.122***	0.350
infr	-0.012*	0.007	-0.042*	0.025	0.021**	0.018	0.002*	0.010
F-Test	3136.23***		1864.59***		1822.10***		2173.30***	
Hansen Test[1]		P = 0.796		P = 0.657		P = 0.392		P = 0.143
AR(1)[2]	Z =-3.04	P = 0.002	Z = -3.01	P = 0.003	Z = -3.65	P = 0.000	Z = -3.37	P = 0.001
AR(2)[3]	Z = -0.89	P = 0.372	Z = -0.94	P = 0.348	Z = -0.09	P = 0.926	Z = -0.61	P = 0.540
No. of instruments	14		14		14		14	
Observations	389		389		389		389	
Diagnostic Tests								
Endogeneity Test (Durbin-Wu-Hausman)[4]		P = 0.002		P = 0.011		P = 0.000		P = 0.000
Serial correlation Test (Breusch-Godfrey LM)[4]		P = 0.000		P = 0.000		P = 0.000		P = 0.000
Heteroscedasticity Test (White)[4]		P = 0.000		P = 0.000		P = 0.000		P = 0.000

Note: The estimation technique is a two-step system GMM dynamic panel estimators. The dependent variable is bank risk-taking as measured by npltl and lnzscore. Capital regulations are considered as endogeneous variable. *,**,*** denote significance at 10%, 5%, and 1% levels respectively. [1]Test of over-identifying restrictions (H_o: over-identifying restrictions are valid). The tests accept the null hypothesis that over-identifying restrictions are valid. [2]Arellano-Bond test for the first-order autocorrelation (Ho: no autocorrelation). [3]Arellano-Bond test for the second-order autocorrelation (Ho: no autocorrelation). The tests results of AR(1) and AR(2) indicates there is autocorrelation exists in the first-order but not in the second-order. [4]The study rejects the null hypothesis that there is no endogeneity, serial correlation, and heteroscedasticity in all models. All variables are winsorized at the 5% level.

4.4.3. The Impact of Capital Regulations and Risk-Taking on Bank Performance

Table 5. 5 reports the empirical results of the impact of capital regulations and risk-taking on bank performance. Here two measures of capital (car & ear) and two measures of risk (npltl & lnzscore), and one measure of bank performance (roa) have been used for model 1-4.

All models represent the significant positive coefficient of the lagged dependent variable (roat-1), which confirms the degree of persistence exists in all models and the dynamic character for specifying the models.

The study finds a significant positive relationship between capital regulations (car & ear) and bank performance (roa) in all models. The results are indicating that higher capital induces higher performance. The findings supported the study of Zheng *et al.* (2017); Naceur and Kandil (2009); Casu *et al.* (2017); Berger *et al.* (1995); Jacques and Nigro (1997); Demirgüç-Kunt and Huizinga (2000); Rime (2001); Iannotta *et al.* (2007); Lee and Hsieh (2013) and Bougatef and Mgadmi (2016).

Bank risk-taking (npltl & lnzscore) has significant negative impacts on bank performance (roa); indicating the higher the risk ratio to lower the performance. The study indicates similar findings with Isanzu (2017); Almekhlafi *et al.* (2016); Ekinci (2016); Samuel (2015); Zhang *et al.* (2013) and Lin *et al.* (2005) but inconsistent with the findings of Guidara *et al.* (2013) and Naceur and Omran (2011).

Turning to other explanatory variables, the coefficient of the cost of intermediation (nim) is significant and positive, suggesting that there is a positive impact of the cost of intermediation (nim) on bank performance (roa). The higher interest income generates higher profits for the banks. This evidence is in line with Zheng *et al.* (2017).

Leverage (lvr) is found to be significantly and negatively related to bank performance (roa) in all models, indicating the higher the liabilities lower the bank performance. The findings are consistent with Aysen (2013).

The study finds that labor efficiency (leff) has a significant and positive impact on bank performance (roa), indicating that the more efficient of a human resource leads to high performance; which supports the study of Tan (2016).

Concerning the impact of implicit cost (impc), it is negatively and significantly related to performance (roa) in model 1 & 3, showing that the higher the non-interest expenses lower the bank performance; which is consistent with the study of Zheng *et al.* (2017).

Cost inefficiency (cineff) has a significant negative impact on bank performance (roa). The results suggest that the higher the cost of a bank deteriorates its performance; this evidence is in line with Rahman *et al.* (2015).

Income diversification (indiv) is found to be positively and significantly associated to performance (roa) of Bangladeshi commercial banks in model 1 & 3, indicating that higher amount of non- interest income leads to higher performance as a diversified income; the results supported by the study of Jiang *et al.* (2003).

The study noticed that bank size (bsize) is negatively and significantly impact on bank performance (roa) showing the higher the assets of a bank lower the performance. The reason is that smaller banks are easier to manage than large banks which leads to high performance as compared to large banks (Tan, 2016). This result is in line with Tan (2016) and Majumder and Uddin (2017).

The study further reports that economic growth (aggr) is significantly and positively associated with bank performance indicating that higher the GDP growth in Bangladesh higher the performance. The reason is that the demand for loans increases during the economic boom period, which in turns leads to increases in bank performance. The evidence is consistent with Tan (2016).

Table-4.5. The Impact of Capital Regulations and Risk-taking on Bank Performance

Variables	Model-1 roa, car & npltl		Model-2 roa, car & lnzscore		Model-3 roa, ear & npltl		Model-4 roa, ear & lnzscore	
	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.
roa_{t-1}	0.340***	0.064	0.422***	0.076	0.333***	0.074	0.427***	0.076
car	0.035**	0.017	0.042**	0.020	-	-	-	-
ear	-	-	-	-	0.067**	0.033	0.080**	0.038
npltl	-0.059***	0.014	-	-	-0.059***	0.020	-	-
lnzscore	-	-	0.062***	0.013	-	-	0.033***	0.010
nim	0.262***	0.059	0.217***	0.067	0.204***	0.059	0.213***	0.059
lvr	-0.064***	0.008	-0.064***	0.010	-0.078***	0.010	-0.066***	0.011
leff	0.007***	0.001	0.008***	0.001	0.005***	0.002	0.008***	0.001
impc	-0.003*	0.002	-0.003	0.002	-0.004**	0.002	-0.003	0.002
cineff	-0.036***	0.009	-0.041***	0.012	-0.046***	0.010	-0.042***	0.011
indiv	0.026***	0.007	0.010	0.007	0.020***	0.007	0.010	0.007
bsize	-0.012***	0.003	-0.022***	0.005	-0.002***	0.001	-0.002***	0.001
aggr	0.003***	0.001	0.002*	0.001	0.002***	0.001	0.002*	0.001
F-Test	1212.52***		912.57***		1433.49***		1190.51***	
Hansen Test[1]		P = 0.527		P = 0.105		P = 0.213		P = 0.191
AR(1)[2]	Z =-3.51	P = 0.000	Z = -3.75	P = 0.000	Z = -3.20	P = 0.001	Z = -3.77	P = 0.000
AR(2)[3]	Z = -1.38	P = 0.166	Z = -1.24	P = 0.214	Z = -1.48	P = 0.138	Z = -1.26	P = 0.207
No. of instruments	17		17		17		17	
Observations	389		389		389		389	
Diagnostic Tests								
Endogeneity Test (Durbin-Wu-Hausman)[4]		P = 0.000		P = 0.043		P = 0.021		P = 0.001
Serial correlation Test (Breusch-Godfrey LM)[4]		P = 0.000		P = 0.000		P = 0.000		P = 0.000
Heteroscedasticity Test (White)[4]		P = 0.000		P = 0.000		P = 0.000		P = 0.000

Note: The estimation technique is a two-step system GMM dynamic panel estimators. The dependent variable is bank performance measured by roa. Capital regulations and bank risk-taking are considered as endogeneous variables. *,**,*** denote significance at 10%, 5%, and 1% levels respectively. [1]Test of over-identifying restrictions (H_0: over-identifying restrictions are valid). The tests accept the null hypothesis that over-identifying restrictions are valid. [2]Arellano-Bond test for the first-order autocorrelation (Ho: no autocorrelation). [3]Arellano-Bond test for the second-order autocorrelation (Ho: no autocorrelation). The tests results of AR(1) and AR(2) indicates there is autocorrelation exists in the first-order but not in the second-order. [4]The study rejects the null hypothesis that there is no endogeneity, serial correlation, and heteroscedasticity in all models. All variables are winsorized at the 5% level.

4.5. Robustness Check

To examine the robustness of the regression results, the study has introduced a two-stage least square regression instead of GMM in Table 4.6, 4.7, & 4.8. The study also applies the Hausman test to identify whether fixed or random effects regression appropriate for all models of table 4.6, 4.7 & 4.8. By applying the new methods of regression, the study finds almost the same results as presented in table 4.3, 4.4 & 4.5 of our base line models. Hence, the study results show the consistent estimation in spite of switching method. In summary, the results of this study confirm that as bank risk-taking increases, capital decreases; the capital regulations impact on risk-taking negatively; and capital has a significant positive impact on performance, whereas risk has significant negative impact on performance. Overall, the findings will be beneficial for the policy maker and future researcher.

4.5.1. The Impacts of Bank Risk-taking on Capital Regulations

Table-4.6. The Impacts of Bank Risk-taking on Capital Regulations

Variables	Model-1 car & npltl		Model-2 car & lnzscore		Model-3 ear & npltl		Model-4 ear & lnzscore	
	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.
Intercept	0.690***	0.096	0.949*	0.558	0.893***	0.030	0.949***	0.029
car_{t-1}	0.143***	0.036	0.153***	0.037	-	-	-	-
ear_{t-1}	-	-	-	-	0.029*	0.017	0.033*	0.018
npltl	-0.132***	0.023	-	-	-0.102***	0.024	-	-
lnzscore	-	-	0.016***	0.005	-	-	0.004***	0.001
roa	0.375**	0.164	0.170***	0.019	0.339***	0.036	0.141***	0.041
meff	0.152**	0.052	0.117***	0.027	0.022*	0.012	0.012*	0.007
bsize	-0.006***	0.002	-0.004***	0.001	-0.005***	0.001	-0.004***	0.001
lvr	-0.720***	0.048	-0.883*	0.473	-0.923***	0.019	-0.958***	0.029
rwata	-0.102***	0.006	-0.104***	0.006	-0.102***	0.006	-0.102**	0.045
finim	0.049***	0.010	0.049***	0.012	0.032**	0.015	0.042***	0.012
bllr	0.160***	0.039	0.146***	0.039	0.120*	0.065	0.122***	0.018
hhiic	3.624**	1.798	2.549*	1.379	2.005***	0.137	1.066*	0.588
R^2	0.5670		0.5143		0.9645		0.9603	
Wald χ^2	61□08□91***		□7□83.15***		10167□00***		9194.39***	
Observations	389		389		389		389	
Diagnostic Tests								
Endogeneity Test (Durbin-Wu-Hausman)[1]		P = 0.022		P = 0.000		P = 0.031		P = 0.040
Serial correlation Test (Breusch-Godfrey LM)[1]		P = 0.000		P = 0.000		P =□0.000		P = 0.000
Heteroscedasticity Test (White)[1]		P = 0.000		P = 0.000		P = 0.000		P = 0.000
Fixed/random effect test (Hausman)[2]		P = 0.000		P = 0.000		P = 1.000		P = 1.000

Note: The estimation technique is Two-stage least squares regression. The dependent variable is capital regulations measured by car and ear. Bank risk-taking is considered as endogeneous variable. *, **, *** denote significance at 10%, 5%, and 1% levels respectively. [1]The study rejects the null hypothesis that there is no endogeneity, serial correlation, and heteroscedasticity in all models. [2]The study results reject the null hypothesis that there exists a random effect among the study variables except model 3 & 4. All variables are winsorized at the 5% level.

4.5.2. The Impacts of Capital Regulations on Bank Risk-Taking

Table-4.7. The Impacts of Capital Regulations on Bank Risk-taking

Variables	Model-1 npltl & car		Model-2 npltl & ear		Model-3 lnzscore & car		Model-4 lnzscore & ear	
	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.
Intercept	1.722***	0.492	1.069**	0.530	5.764***	2.097	5.343*	2.874
$npltl_{t-1}$	0.557***	0.062	0.688***	0.069	-	-	-	-
$lnzscore_{t-1}$	-	-	-	-	0.791***	0.027	0.152**	0.064
car	-1.690***	0.528	-	-	3.118***	0.384	-	-
ear	-	-	-0.315**	0.122	-	-	0.880***	0.181
roa	-1.462***	0.262	-0.960**	0.423	6.959***	1.418	9.544***	1.512
nim	-0.148**	0.060	-0.696**	0.345	0.558	0.967	1.067	1.325
lvr	1.391***	0.417	0.176*	0.100	-4.977***	1.852	-1.267*	0.740
rwata	0.172***	0.051	0.114***	0.029	-0.457**	0.225	-0.148***	0.037
cineff	0.130***	0.038	0.110*	0.059	-0.087	0.245	-0.196	0.282
bllr	-0.265**	0.112	-0.341**	0.167	0.410***	0.126	0.315***	0.105
hhiic	1.691*	0.978	1.586	1.344	-1.076***	0.309	-2.234***	0.407
infr	-0.005***	0.002	-0.003***	0.001	0.021**	0.010	0.024**	0.010
R^2	0.6543		0.3552		0.8564		0.4320	
Wald χ^2	801.42***		245.14***		2098.53***		104160.16***	
Observations	389		389		389		389	
Diagnostic Tests								
Endogeneity Test (Durbin-Wu-Hausman)[1]		P = 0.000		P = 0.001		P = 0.002		P = 0.0□0
Serial correlation Test (Breusch-Godfrey LM)[1]		P = 0.000		P = 0.000		P = 0.□00		P = 0.000
Heteroscedasticity Test (White)[1]		P = 0.000		P = 0.000		P = 0.000		P = 0.000
Fixed/random effect test (Hausman)[2]		P = 1.000		P = 1.000		P = 1.000		P = 0.000

Note: The estimation technique is Two-stage least squares regression. The dependent variable is bank risk-taking as measured by npltl and lnzscore. Capital regulations are considered as endogeneous variable. *, **, *** denote significance at 10%, 5%, and 1% levels respectively. [1]The study rejects the null hypothesis that there is no endogeneity, serial correlation, and heteroscedasticity in all models. [2]The study results reject the null hypothesis that there exists a random effect among the study variables except the model 1, 2 & 3. All variables are winsorized at the 5% level.

4.5.3. The Impact of Capital Regulations and Risk-Taking on Bank Performance

Table-4.8. The impact of capital regulations and risk-taking on bank performance

Variables	Model-1 roa, car & npltl		Model-2 roa, car & lnzscore		Model-3 roa, ear & npltl		Model-4 roa, ear & lnzscore	
	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.	Coefficient	Robust S.E.
Intercept	0.050**	0.022	-0.557***	0.105	-0.588***	0.158	-0.968**	0.402
roa_{t-1}	0.126***	0.029	0.062*	0.037	0.109***	0.037	0.158**	0.043
car	0.043**	0.021	0.058**	0.024	-	-	-	-
ear	-	-	-	-	0.070***	0.012	0.082**	0.029
npltl	-0.081***	0.013	-	-	-0.061***	0.021	-	-
lnzscore	-	-	0.056***	0.009	-	-	0.048***	0.014
nim	0.373***	0.050	0.178**	0.079	0.380***	0.064	0.127**	0.059
lvr	-0.043**	0.019	-0.529***	0.089	-0.067*	0.038	-0.957**	0.412
leff	0.011***	0.001	0.007***	0.001	0.011***	0.001	0.007***	0.002
impc	-0.006***	0.002	-0.004**	0.002	-0.006***	0.002	-0.005**	0.002
cineff	-0.026***	0.007	-0.024***	0.008	-0.033***	0.010	-0.028***	0.010
indiv	0.021***	0.006	0.001	0.007	0.019***	0.007	0.002	0.009
bsize	-0.004***	0.001	-0.002***	0.001	-0.004***	0.001	-0.002***	0.001
aggr	0.024**	0.010	0.002*	0.001	0.003***	0.001	0.002*	0.001
R^2	0.8112		0.2552		0.7785		0.3021	
Wald χ^2	21516.24***		17422.36***		13615.83***		11828.90***	
Observations	389		389		389		389	
Diagnostic Tests								
Endogeneity Test (Durbin-Wu-Hausman)[1]		P = 0.000		P = 0.001		P = 0.024		P = 0.000
Serial correlation Test (Breusch-Godfrey LM)[1]		P = 0.000		P = 0.000		P = 0.000		P = 0.000
Heteroscedasticity Test (White)[1]		P = 0.000		P = 0.000		P = 0.000		P = 0.000
Fixed/random effect test (Hausman)[2]		P = 0.000		P = 0.000		P = 0.000		P = 0.000

Note: The estimation technique is Two-stage least squares regression. The dependent variable is bank performance measured by roa. Capital regulations and bank risk-taking are considered as endogeneous variables.*, **, *** denote significance at 10%, 5%, and 1% levels respectively. [1]The study results reject the null hypothesis that there is no endogeneity, serial correlation, and heteroscedasticity in all models. [2]The study results reject the null hypothesis that there exists a random effect among the study variables. All variables are winsorized at the 5% level.

5. CONCLUSIONS

5.1. Summary

This paper aims to examine the simultaneous association between capital regulations and bank risk-taking and the impact of capital regulations and bank risk-taking on performance in the banking sector of Bangladesh. The study checks the robustness of the findings by using different measures of risk-taking and capital regulations. To be more specific, the study uses two measures of capital regulations such as capital adequacy ratio, i.e., the ratio of risk-weighted assets to total assets and the ratio of shareholder's equity to total assets. There are two measures of risk-taking variables have been included in this study such as the ratio of non-performing loans to total loans and the natural logarithm of zscore. Bank performance is measured by the ratio of profit before tax as a fraction of average total assets.

The study further uses some bank specific, industry-specific and macroeconomic variables. In the capital equation, to measure the impacts of bank risk-taking on capital regulations, the study uses some control variables

such as performance, management efficiency, bank size, leverage, risk-weighted assets to total assets, financial intermediation, bank-level lending rate, and industry concentration.

In the risk-taking equation, to measure the impacts of bank capital regulations on risk-taking, the study uses some control variables such as performance, cost of intermediation, leverage, risk-weighted assets to total assets, cost inefficiency, bank-level lending rate, industry concentration, and inflation.

In the performance equation, to measure the impact of capital regulations and risk-taking on bank performance, the study uses the control variables such as the cost of intermediation, leverage, labor efficiency, implicit cost, cost inefficiency, income diversification, bank size and economic growth. With regards to the econometric model estimation, the study applies a dynamic panel model and a two-step system GMM estimator. The study further applies two-stage least squares regression for checking the robustness of the findings.

Using an unbalanced panel data set of 30 Bangladeshi commercial banks during the period 2002-2016, the study finds a bi-directional negative relationship between capital regulations and bank risk-raking. The study further investigates that capital regulations are significantly and positively impacts on bank performance, whereas risk-taking impacts negatively on the bank performance.

Among the control variables have been used in the capital equation; performance, management efficiency, financial intermediation, bank-level lending rate, and industry concentration indicates positive impacts on capital regulations. In contrast, bank size, leverage, and risk-weighted assets to total assets indicate a negative association with capital regulations.

Concerning the control variables have been used in the risk-taking equation; leverage, risk-weighted assets to total assets, cost inefficiency, and industry concentration are positively impacted on risk-taking; while bank performance, cost of intermediation, bank-level lending rate, and inflation have a negative impact on risk-taking.

The control variables have been used in the performance equation show that cost of intermediation, labor efficiency; income diversification and economic growth are positively associated with bank performance. However, leverage, implicit cost, cost inefficiency, and bank size are negatively related to bank performance.

Finally, the robust results using the two-stage least square regression support the same results, and the same sign of co-efficient has been estimated by the GMM estimator as like as baseline models of this study.

5.2. Suggestions and Implications

Due to the global financial crisis 2007-2009, the policymakers around the world urged to strengthen international banking system for maintaining a stable financial position. Basel Accord I, II and III are adopted in this regard. The main objective of the Basel accord is to strengthen banks capital position and reduce risk. The study results indicate that capital regulations and bank risk-taking are simultaneously negatively related to Bangladesh. The study finds some banks have lower capital adequacy compared to the minimum capital requirement of Basel accord. Thus, bank regulators should implement the Basel-III strictly as soon as possible. The findings of this study also show that capital regulations are positively and risk-taking negatively impact on performance. Hence, policymaker should look forward to strengthening the capital position by following good corporate mechanisms. The government, as well as private authorities, should monitor to establish effective corporate governance in this regard. The findings of this study have several policy implications to the Government of Bangladesh, regulatory authority, and bank management to improve bank capital position, reduction of risk-taking behavior, and maximization of performance. Management efficiency positively impacts on capital; indicating authority should recruit experienced and productive staffs and give more opportunities for development and training of existing staffs. Financial intermediation is positively impacted on capital, indicating that deposits should be given as loans to advances by following the proper project appraisals. The bank-level lending rate is positively affected capital and negatively on risks. So, the appropriate policies should be taken so that the lending project will be a profitable one and generate more interest income. The higher cost of intermediation reduces bank risk and

increases performance. So, the bank should handle the deposits in such a way so that earnings from loan greater than the cost of deposit. The study results show that leverage is negatively affected by the capital and performance, whereas positively impact on risk. The bank should minimize liabilities and have to aware of the contingent events liabilities. The asset portion of the banks should include risky assets as minimum as possible because risk-weighted assets reduce capital and increase bank risk. The bank should invest other diversified sources of income besides interest income as it increases performance. The non-interest expenses should be kept as minimum as possible because higher the implicit cost lower the bank performance. Finally, Government should take relevant fiscal and monetary policies for the Bangladeshi banking industry to control inflation and boost up the GDP, i.e., economic growth.

5.3. Avenues for Future Research

Overall, the study results are significant for the policy-making of the banking industry and the development of the financial stability in Bangladesh. The future researchers may take advantages of the limitations of this study in various ways. Firstly, future researchers may take more samples and can compare within the industry or outside the industry with other country's banks. For example, a comparison can be made between private banks and public banks, or conventional banks and Islamic banks, or domestic banks and foreign banks, etc. Secondly, in future, large samples with the recent study period may be taken into consideration. Thirdly, the study considers capital regulations, risk-taking, and performance as main variables. But, the further researcher may add other variables like corporate governance, corporate social responsibility variables with different alternative measures. Fourthly, this study uses GMM and TSLS with E-views and Stata software. In future, another econometric model like structural equation modeling (SEM), mediation effect modeling, and moderator effect modeling with the updated software can be used. Finally, the study expects that this study results will add value to the existing literature and will be significant for the future researcher and policymaker.

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Appendix: A

Table A1.

Test of Non-stationary

Variables	χ^2	P-value
Performance (roa)	178.2884	0.0000
Capital regulations (car)	1□6.6089	0.0000
Capital regulations (ear)	163.2850	0.0000
Ri□k-taking (npltl)	240.6772	0.0000
Risk-taking (lnzscore)	17□.7541	0.0000
Cost of intermedi□tion(nim)	178.3302	0.0000
Management efficiency (meff)	184.4604	0.0000
Bank size (bsize)	180.4349	0.0000
Leverage (lvr)	167.4030	0.0000
Risk weighted assets to total assets (rwata)	155.7603	0.0000
Labor efficiency (leff)	154.2096	0.0000
Financial intermediation (finim)	152.3392	0.0000
Implicit cost (impc)	141.2363	0.0000
Cost inefficiency (ceff)	161.0187	0.0000
Income diversification (indiv)	153.2096	0.0000
Industry concentration (hhiic)	242.7237	0.0000
Bank-level lending rate (bllr)	154.3480	0.0000
Economic growth (aggr)	178.2441	0.0000
Inflation (infr)	184.5410	0.0000

Note: The table reports Fisher-typer unit-root test for all the study variables based on augmented Dickey-Fuller tests (Ho: all panels contain unit roots or non-stationary). The tests results reject the null hypothesis at 1% level of significance. Therefore, at least one panel is stationary, i.e., the data set is stable for the study.