Bank risk and performance in an emerging market setting: the case of Bangladesh

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Received 27 July 2017
Accepted 31 October 2017

Abstract

Purpose – This study aims to investigate the impacts of bank capital requirements on the performance and risk of the emerging economy, i.e. Bangladeshi banking sector.

Design/methodology/approach – The study applies an unbalanced panel data which comprises 30 banks yielding a total of 413 bank-year observations over the period 2000 to 2015.

Findings – Using generalized methods of moments, the empirical results of this research reveal that bank capital is positively and significantly impressive on bank performance, whereas negatively and significantly impact on risk. The study also finds the inverse relationship between risk and performance in both the performance and risk equations. The results also indicate that there is a persistence of performance and risk from one year to the next year.

Originality/value – This is the unique investigation on Bangladeshi bank industry that considers the simultaneous effect of bank capital requirements on risk and performance. Therefore, it is predicted that the empirical evidence of this research shows policy implications to the regulatory authority of Bangladeshi banking industry to determine relevant policies.

Keywords Performance, Bangladesh, Capital, Bank risk, Generalized methods of moments

Paper type Research paper

1. Introduction

Over the past 20 years, several banking crises have taken place and increased concerns to the regulators about the financial stability system. Academicians, researchers and regulators

This paper has been adopted from the author's unpublished Master thesis. The authors acknowledge the very constructive insights from the thesis committee members, reviewers of the thesis and to the Supervisor Dr Xiaojing Li of the Donlinks School of Economics and Management at the University of Science and Technology Beijing on earlier versions of this paper.

Journal of Economics, Finance and Administrative Science
Vol. 23 No. 46, 2018
pp. 199-229
Emerald Publishing Limited
2077-1886
DOI 10.1108/JEFAS-07-2017-0084

identified several causes for maintaining the financial stability and urged for the stringent prudential regulation. The capital adequacy regulations play a prominent role for the prudential purposes compared to other tools proposed by the regulators (Altunbas *et al.*, 2007).

To maintain the stable position in the international financial system, Basel Capital Accord named Basel I was introduced first in 1988. Because of the weaknesses of the Basel I, Basel II introduced in 2004. The prime objective of Basel Accord is to strengthen the bank's capital position and minimization of risks. Investigations into whether the Basel Capital Accord work effectively or not proliferated after the global financial crisis 2007-2008. As a result, in response to the global financial crisis, Basel III was introduced in 2010 by the Basel Committee on Banking Supervision. Regulators in most of the countries around the world are going to implement the Basel III step by step with varying timelines and methodologies. Already, many countries were adopted Basel II, for example, the European Union in 2008, Singapore in 2008, India in 2009 and Bangladesh in 2010. Needless to say, the recent financial crisis raised questions to the mind of the policy maker about the effectiveness of capital regulation and its effect on the bank risk and performance. It is thus no surprise to increase the concern about the investigation on the linkage between bank capital, risk and performance. Most of the empirical literature focuses on the relationship between capital, risk and profitability in US and European contexts (Demirguc-Kunt *et al.*, 2013; Altunbas *et al.*, 2007). However, the recent empirical research provides novel insights into the banking sector of alternative countries or regions, for example, the MENA (Middle Eastern and North African) regions (Bitar *et al.*, 2016; Naceur and Omran, 2011), the Sub-Saharan African (Flamini *et al.*, 2009), the Tunisia banking sector (Bennaceur and Goaied, 2008), the Egypt banking sector (Ben Naceur and Kandil, 2009) and the Asian banking sector (Zheng *et al.*, 2017; Tan and Floros, 2013; Lee and Hsieh, 2013; Lee *et al.*, 2015).

Despite the ongoing debate on the necessity of financial reforms, there is scant research on this topic, particularly in Asian countries. The research in the banking sector of the Asian countries is very important because banks are the main source of finance in the private sector of this region Lee and Hsieh (2013) and Deesomsak *et al.* (2004). Therefore, the banking sector of the Asian countries is the key laboratory for the investigation. To extend the research on Asian countries, this study endeavors to investigate the impact of bank capital on bank performance and risk in the banking sector of emerging economy. This investigation has considered Bangladesh as an ideal laboratory to examine the impact of bank capital on bank performance and risk. The study has considered Bangladesh as a benchmark economy for the investigations as it is one of the emerging economies. The study acknowledges with the study of Khan *et al.* (2013) that the definition of an "emerging economy" is problematic. However, Bangladesh has considered being the largest economies in the twenty-first century as one of the "next 11" emerging economies along with the BRIC countries by the global asset management company (Goldman Sachs) in 2005 (www.goldmansachs.com). In Bangladesh, several capital regulations reform has undergone over the last two decades, and the country achieved a consistent economic growth over six per cent after the millennium period (Zheng *et al.*, 2017). Thus, the study recommends the significance of the country selection as Bangladesh. In addition, the investigation claims that the differences of national culture give different banking practices with different research findings (Zheng and Ashraf, 2014; Ashraf, 2017; Ashraf *et al.*, 2016b). Therefore, the findings from Bangladesh will contribute to the existing literature significantly and will be effective for the other countries with a similar culture. To the best of my knowledge, this is the unique investigation on Bangladesh.

The previous empirical literature shows mixed results on the association between bank capital and risk. Some of the prior studies indicate there is a positive association between capital and risk, means the higher the capital ratio leads to the higher risk which is

supported by the regulatory hypothesis (Iannotta *et al.*, 2007; Demirgüç-Kunt and Huizinga, 2000). Existing theories suggest that the vital reason for introducing capital regulations is referred in the point of Moral Hazard Hypothesis (Demirgüç-Kunt and Kane, 2002; Hussain and Hassan, 2005). According to this hypothesis, there is a negative relationship between capital regulations and risk (Agusman *et al.*, 2008; Jacques and Nigro, 1997). The State Preference Model uses by Liu *et al.* (1996) and Lin (1994) also finds a negative association between capital and risk. They claim that the level of risk exposures is reduced because of stricter capital management. In contrast, Lin *et al.* (2005), Blum (1999) and Keeley and Furlong (1990) used portfolio theory and questioned regarding the effectiveness of the capital management. They argue that banks are forced to have a greater level of risk exposures when the capital regulations tend to be strict. However, the puzzle between capital and risk, as suggested by Altunbas *et al.* (2007) and Hughes and Mester (1998), is that the association between Capital regulation and bank risk-taking is affected by the amount of profitability. Goddard *et al.* (2004) claim that the high ratio of capitalized bank earns a high profit and faces less risk.

From the above theoretical literature, it has observed that there is a puzzle between the bank capital, risk, and performance. The literature also shows inconclusive results on the relationship. Hence, there is still debate whether bank capital positively or negatively impacts the bank performance and risk. By considering the above fact, thus, this study attempts to find out the answer to the two questions. What is the impact of bank capital on the bank performance of Bangladesh? What is the impact of bank capital on the bank risk of Bangladesh?

This study is expected to play significance role for the academician, researcher, and policy maker because it contributes to the existing literature in several ways to fill the gap. First, this is the unique study addressing the impacts of capital requirement on both risk and performance simultaneously in the Bangladeshi banking sector. Also, this study is different from other studies because it uses two measures of capital, i.e. risk-based capital and non-risk-based capital. The existing literature indicates a debate about the capital requirements effectiveness. For example, Anginer and Demirgüç-Kunt (2014) and Demirguc-Kunt *et al.* (2013) argue what types of capital should use by the bank and what would be the structure of it. This is supported by the other researchers, Cathcart *et al.* (2015) and Dermine (2015), who shed doubts on the effectiveness of the risk-weighted assets in determining risk exposure of the bank. So, this paper adds value to the extant literature on highlighting the capital requirements effectiveness by examining the effect of risk-based and non-risk-based capital on bank risk and performance in Bangladesh. The study uses various measures of risk as well such as default risk, credit risk and overall risk.

Second, the prior literature on Bangladesh indicates a traditional association between capital and risk, risk and performance, but this study extends by adding capital and profit relationship with risk. The study is the complements of the recent studies of Bitar *et al.* (2016), Zheng *et al.* (2017), Lee *et al.* (2015) and Lee and Hsieh (2013).

Third, this research considers long period (2000-2015) of unbalanced panel data set of 30 commercial banks of Bangladesh.

Fourth, the study uses simultaneous equation modeling with generalized methods of moments (GMM) technique for the regression analysis to examine the simultaneous effect of bank capital requirement on risk and performance and testing the robustness of the results by using two-stage least squares (TSLS) regression.

Finally, the study trying to draw some suggestions regarding the influence of bank capital on the performance and risk in Bangladesh which will be beneficial not only for

Bangladesh but also for other countries of similar economic nature as well as for the academicians, researcher, and policy maker.

The remaining section of this study proceeds as follows. Section 2 provides about related literature. Section 3 shows the research methodology. Section 4 includes the analysis and findings. Section 5 summarizes the concluding remarks and indicates directions for the future researchers.

2. Literature review

This study divides the existing literature into three parts. The first part displays the existing literature related to the linkage between bank capital and performance. The second part of the study focuses on the related literature based on the association between bank capital and risk. Finally, the third part provides the literature related to variables used in the study.

2.1 Nexus between bank capital and performance

The prior literature indicates that bank performance is considered as an influential factor in the relationship between risk and capital (Lee and Hsieh, 2013; Moon and Hughes, 1997; Altunbas *et al.*, 2007). Many researchers finds a positive association between capital and bank performance (Jacques and Nigro, 1997; Lin *et al.*, 2005; Goddard *et al.*, 2004; Rime, 2001; Lee and Hsieh, 2013; Naceur and Omran, 2011; Ben Naceur and Kandil, 2009; Mbizi, 2012). The positive relationship of prior literature emphasizes to hold more capital to increase bank performance. For example, Iannotta (2006) claims that banks are required to increase their capital ratios commensurably with the amount of risk taken by following the Basel guidelines. The author has mentioned that higher capital ratios diminish banks' leverage taking behavior and thus leads to their expected profits. Fiordelisi *et al.* (2011) argue that lower return induce bank management to choose a higher point on the efficiency frontier to improve their profits which leads to investments in riskier portfolios. As a result, a positive association should be expected between bank capital and performance. Zhang *et al.* (2008a) suggest that commercial banks, under the constraint of capital, should allocate resources and augment their business to increase liquidity and profitability. In contrast, differing from the positive relationship, Altunbas *et al.* (2007) find that inefficient European banks appear to hold more capital. Goddard *et al.* (2013) also concluded a negative association exists between profitability and capital in banks of nations from European Union member for the period 1992 to 2007. In addition, Guidara *et al.* (2013) conclude that there is no strong evidence that changes in capital buffer affect the profitability measured by ROE. Therefore, mixed results have found in the previous literature. Table I summarizes the previous literature in a more scientific way as follows.

2.2 Nexus between bank capital and risk

In the context of the implications of regulatory policies from the regulator, examination of the associations between risk and capital is considered as one of the important issues today (Lee and Hsieh, 2013). It is assumed that higher capital will have a positive impact on risk of the banking sector (Lee and Chih, 2013), but empirical results are mixed. Findings of some research reveal that there is a positive association between risk and capital (Shrieves and Dahl, 1992; Blum, 1999; Rime, 2001; Altunbas *et al.*, 2007; Laeven and Levine, 2009; Kim and Santomero, 1988; Koehn and Santomero, 1980; Kahane, 1977; Lin *et al.*, 2005). On the other hand, some studies find a negative relationship between risk and capital (Lee and Hsieh, 2013; Lee and Chih, 2013; Ho and Hsu, 2010; Zhang *et al.*, 2008; Agoraki *et al.*, 2011). Demirgüç-Kunt and Kane (2002)

Table I.
Literature on the linkage between bank capital and performance

References	Country	Data period	Methodology	Findings
Zheng *et al.* (2017)	Bangladesh	2000-2015	GMM	There is a positive and significant relationship between capital regulations and profitability
Bitar *et al.* (2016)	MENA	1999-2013	OLS	Significant positive relationship between capital and profit
Berger and Bouwman (2013)	US banking sector	1984-2010	Logit survival regressions and OLS	Capital significantly increases the profitability of medium and large banking sector
Lee and Hsieh (2013)	Asian Banking Sector	1994-2008	GMM	Capital significantly and positively effects on profitability
Mbizi (2012)	Zimbabwe banking sector	–	Description Correlation Method	Significant positive relationship between bank's capital and its Performance
Naceur and Omran (2011)	Africa banking sector	1989-2005	GMM	There is a significant positive relationship between bank capital and its profitability
Shim (2010)	US banking sector	1993-2004	3SLS	Significant positive associations between bank capital and profitability
Liu and Wilson (2010)	Japanese banking sector	2007-2007	GMM two-step system and fixed effect estimator	Well-capitalized bank leads to higher profitability, and lower capital leads to lower profitability
Ben Naceur and Kandil (2009)	Egypt banking sector	1989-2004	GMM	Higher capital leads to higher profitability of the bank significantly
Pasiouras and Kosmidou (2007)	Europe banking sector	1995-2001	Fixed Effects Regression	There is a positive relationship between capital and profitability
Lin *et al.* (2005)	Taiwan banking sector	1993-2000	OLS	A significant positive association between financial performances and CAR of the bank
Goddard *et al.* (2004)	European banking sector	1992-1998	Dynamic panel model	Profitability and capital-to-assets ratio are positively associated with each other
Rime (2001)	Swiss Banking sector	1989-1995	3SLS	Capital has a positive impact on earnings
Demirgüç-Kunt and Huizinga (2000)	Developing and Developed countries	1990-1997	Panel data model	There is a positive relationship between Lagged equity variable and profitability of the bank
Dietrich and Wanzenried (2011)	Switzerland banking sector	1999-2009	GMM	Before global crisis (2007-2008), there is no link between capital and performance. During the crisis, there is a negative relationship between bank capital and performance

(*continued*)

Table I.

References	Country	Data period	Methodology	Findings
Chiuri *et al.* (2002)	–	–	OLS panel regression	Higher capital leads to a reduction in performance
Guidara *et al.* (2013)	Canada Banking Industry	1982-2010	GMM	There are no significant positive or negative relationships between capital and profitability
Dietrich and Wanzenried (2011)	Switzerland banking sector	1999-2009	GMM	Before global crisis (2007-2008), there is no link between capital and performance. During the crisis, there is a negative relationship between bank capital and performance
Zhang *et al.* (2008)	China banking sector	2004-2006	GMM	There is no significant association between changes in capital and changes in profitability

Note: Own elaboration

argue that the negative association between capital and risk may be referred as moral hazard hypothesis (MHH) which implies that banks with undercapitalized value take more risk to take advantage of existing horizontal deposit insurance schemes. Altunbas *et al.* (2007) and Agusman *et al.* (2008) found that inefficiency is positively related with risk-taking which advocates the MHH, i.e. banks with a low-performance level are more vulnerable than banks with a high-performance level. However, no relationship between bank capital and risk has been found by Guidara *et al.* (2013). By using a mean-variance approach, Kim and Santomero (1988) and Koehn and Santomero (1980) showed that single capital ratio regulation is not enough to control risk. For ignoring the option value of deposit insurance, the mean-variance is not appropriate (Keeley and Furlong, 1990; Furlong and Keeley, 1989). They used a contingent-claims model and showed that enlarged capital would not raise portfolio risk of banks. The reason behind this is that the value of the deposit insurance reduces as the capital increases. Table II summarizes the prior literature.

2.3 Literature related to variables used under the study

2.3.1 Bank performance variable. Prior literature uses various measures of performance such as return on assets (ROA), return on equity (ROE), net interest margin, earning per share, Tobin's Q, etc. Previous literature also indicates that performance measures can be calculated in various ways. For example, ROA can be calculated by considering before tax profit, or after-tax profit, or total assets, or average total assets, or total earning assets or average earning assets. This study uses ROA before tax as a measure of performance by following the study of Tan (2016), Demirgüç-Kunt and Huizinga (1999) and others.

2.3.2 Bank risk variables. This study uses three types of risk, namely default risk, credit risk and overall risk. The study measures default risk by following the study of Iannotta *et al.* (2007), where they measure default risk using natural logarithm of *Z*-score. The *Z*-score is used by a number of empirical studies as the risk or stability indicator in the banking sector (Liu and Wilson, 2013; Liu *et al.*, 2013; Tan, 2016) and it is calculated by using the sum of a bank's ROA and equity to total assets ratio (ETAR) over the standard deviation of the bank's ROA. A higher *Z*-score indicates that there is a higher stability and lower risk (Tan, 2016). By following (Agoraki *et al.*, 2011), the study measures credit risk by the non-performing loans to total loans. The higher non-performing loans to total loans ratio indicate that there is more risk for losses from loans defaults (Zhang *et al.*, 2013). This investigation also measures overall risk by the loan loss provision to net interest revenue ratio, used by Baselga-Pascual *et al.* (2015).

2.3.3 Bank capital variables. This study uses two types of capital measures:

(1) the traditional non-risk-based capital (total shareholders' ETAR) which is known as actual capital; and

(2) the risk-based capital (capital adequacy ratio [CAR]) which is known as regulatory capital.

Many prior empirical studies use non-risk-based capital (Shrieves and Dahl, 1992; Altunbas *et al.*, 2007; Lee and Hsieh, 2013; Tan and Floros, 2013; Iannotta *et al.*, 2007; Sufian and Habibullah, 2009; Sufian, 2012; Amidu and Hinson, 2006; Athanasoglou *et al.*, 2008; Dietrich and Wanzenried, 2011). Many studies use regulatory capital measures (Aggarwal and Jacques, 2001; Jacques and Nigro, 1997; Ediz *et al.*, 1998).

Table II.
Literature on the linkage between bank Capital and risk

References	Country	Data period	Methodology	Findings
Literature based on positive relationship between bank capital and risk				
Bitar *et al.* (2016)	MENA	1999-2013	OLS	Significant positive association between capital and risk
Ghosh (2014)	GCC banks	–	3SLS	Positive association between capital ratio and risk
Shim (2010)	US banking sector	1993-2004	3SLS	High capital requirement increases the risk of the bank
Ho and Hsu (2010)	Taiwan banking sector	1996-2006	OLS	Restrictions on CAR have positive impact on banks' risky investment strategies
Ahmad *et al.* (2008)	Malaysia	1995-2002	OLS	There is a positive relationship between risk and capital
Iannotta *et al.* (2007)	European banking sector	1999-2004	Panel data model	Significant positive association between capital and risk
Altunbas *et al.* (2007)	Europe banking sector	1992-2000	Seemingly Unrelated Regression	There is a Positive association between risk and capital of the bank
Lin *et al.* (2005)	Taiwan banking sector	1993-2000	Ordinary Least Square (OLS)	A positive relationship is found between CAR and risk
Aggarwal and Jacques (2001)	US banking sector	1991-1996	3SLS	Higher credit risk increases the higher capital ratio of the bank
Rime (2001)	Swiss Bank	1989-1995	3SLS	There is a positive relationship between the changes in capital and changes in risk of the bank
Ashraf *et al.* (2016a)	Pakistan	2005-2012	System GMM	Either lower or higher bank risk-based capital ratios have decreased portfolio risk
Baselga-Pascual *et al.* (2015)	Europe	2001-2012	Dynamic Panel Data Model	There is an inverse association between capitalization and bank risk
Lee and Hsieh (2013)	Asian countries banking sector	1994-2008	GMM	Commercial banks reveal the significantly inverse relationship between capital and risk
Lee and Chih (2013)	China banking sector	2004-2011	OLS	Stricter regulations can reduce risk but not well for efficiency. CAR attempts to reduce risk
Zhou (2013)	–	–	–	CR can reduce risk
Agoraki *et al.* (2011)	Europe banking sector	1998-2005	GMM	Higher Capital requirements of the bank decrease the risk of the bank
Liu and Wilson (2010)	Japanese banking sector	2007-2007	GMM two-step system estimator and fixed effect estimator	Well-capitalized bank leads to lower credit risks of the banking industry and lowers capitalized bank leads to higher credit risks
Agusman *et al.* (2008)	Asian banking sector	1998-2003	Panel data model	There is an inverse relationship between risk and equity-to-TA. But this is not significantly existed

(*continued*)

Table II.

References	Country	Data period	Methodology	Findings
Zhang *et al.* (2008)	China banking sector	2004-2006	GMM	There is a negative relationship which indicates that increasing capital ratio is effectively reducing the portfolio risk of the bank
Hussain and Hassan (2005)	Developing Countries	1991-2006	–	Capital ratio reduces portfolio risk of banks. So, there is an inverse relationship between capital and risk
Guidara *et al.* (2013)	Canada banking sector	1982-2010	2SGMM	There is no strong association between risk and capital buffers

Note: Own elaboration

2.3.4 Bank-specific control variables

2.3.4.1 Liquidity. This study uses the ratio of total loans to total assets as a measurement of liquidity in the performance equation by following the study of Goddard *et al.* (2013). The largest ratio indicates a lower level of liquidity. Thus, a large amount of loans to the customer indicates more interest revenue from them. Hence, the negative impact of liquidity on bank performance is expected. In contrast, Bourke (1989) argues that the higher liquidity level of a bank generates higher profit. The higher volume of loans sometimes leads to decline the bank performance if the bank does not have a good risk management system. Therefore, it is expected that there may be a positive or negative impact of liquidity on bank performance.

2.3.4.2 Cost inefficiency. The study uses operating expenses to total assets as cost inefficiency measurements by following the study of Dietrich and Wanzenried (2011). These measures have been used extensively in the existing literature (Liu and Wilson, 2010; Kosmidou, 2008; García-Herrero *et al.*, 2009). The existing literature shows mixed results. For example, Molyneux and Thornton (1992) find the positive impact of cost inefficiency on bank performance. Naceur (2003) also find a positive relationship between cost inefficiency and bank performance in the Tunisian banking industry. The positive relationship between cost inefficiency and performance also supports the efficiency wage theory. The existing literature also indicates that there is a negative relationship between cost inefficiency and bank performance. For example, Athanasoglou *et al.* (2008) claim that well-managed banks have the ability to reduce operating costs, which in turn increases bank performance. This opinion is supported by the study of Bourke (1989) and Jiang *et al.* (2003a). Therefore, it is expected that there may be a positive or negative impact of cost inefficiency on bank performance.

The prior literature indicates cost inefficiency is a source of risk (Poghosyan and Čihak, 2011; Männasoo and Mayes, 2009). Louzis *et al.* (2012), in their bad management hypothesis, suggest that cost inefficiency is positively associated with the increases of future non-performing loan which ultimately leads to bad management and thus poor skills in credit scoring. Therefore, a positive relationship is expected between cost inefficiency and bank risk.

2.3.4.3 Labor productivity. This investigation uses net profit after tax over a total number of employees as a measurement of labor productivity. This variable has been widely used by the researcher in the prior literature to investigate its impact on bank performance (Tan and Floros, 2013; Tan and Floros, 2012b; Tan and Floros, 2012a, Tan and Floros, 2012c; Athanasoglou *et al.*, 2008). The higher the labor productivity ratio indicates banks efficient management which reflects banks performance. Therefore, this study predicts a positive association with performance.

2.3.4.4 Non-traditional activity. This study uses off-balance sheet items to total assets as non-traditional activity measures. This variable has been included in the performance equation. Bank can increase their sources of income by the off-balance sheet activities without changing the capital structure which ultimately affects the performance (Apergis, 2014; Deelchand and Padgett, 2009). Rahman *et al.* (2015) find a significant negative association between non-traditional activity and bank profitability. Hence, no prior expectation of this variable.

2.3.4.5 Income diversification. The study uses the ratio of non-interest income to total income as a measure of income diversification. A bank engaged in different types of businesses is able to generate more income (Tan and Floros, 2012b). In addition, the more diversified banks can reduce their costs easily from economies of scope. Jiang *et al.* (2003b) find a positive association between income diversification and performance. However,

others find (Demirgüç-Kunt and Huizinga, 1999; Gischer and Jüttner, 2001) negative association of income diversification with performance because there is stronger competition to generating free income compared to traditional interest income activity which ultimately reduces bank performance. Thus, the study finds mixed results and no prior expectation regarding the relationship between income diversification and performance.

2.3.4.6 Deposit ratio. This study includes deposit ratio in the risk equation and total deposit to total assets has considered as a measure of deposit ratio. As deposits are insured, a higher deposit ratio raises moral hazard of banks to fund in risky investments (Soedarmono *et al.*, 2010). In addition, the higher deposit ratio increases leverage risk. Therefore, a positive relation is predicted between deposit ratio and bank risk.

2.3.4.7 Leverage. This study uses total liabilities to total assets as a measure of leverage and includes this variable in the risk equation. Higher leverage may be both beneficial and cost to the banks. For example, the high leverage ratio indicates more debt in the capital structure which indicates higher interest payments and thus create pressure on the bank income (Zheng *et al.*, 2017), as well as increase risk. On the other hand, the higher leverage may increase profit by reducing risk because interest payments provide a tax shield. Chaibi and Ftiti (2015) claim that risk is affected by capital structure. Highly leveraged capital leads to a tendency to a higher risk-taking because of the need to produce higher returns with lower capital. Thus, no prior expectation of this variable on the impact of bank risk.

2.3.5 Industry and macro-economic variables

2.3.5.1 Market power. This study used concentration ratio as a measure of market power and included in the performance equation. According to structure conduct performance (SCP) hypothesis, the banks' behavior is affected by market power, while the market structure plays a decisive role in bank performance. The idea of this hypothesis is based on the fact that in a more concentrated market where significant shares are occupied by a few banks, the competitive condition is lower, while higher concentration leads to greater market power, and the resultant increase in the collusive behavior leads to higher profits. These indicators were recently used by (Fu *et al.*, 2014; Al-Muharrami *et al.*, 2006) to measure competition in the banking industry.

2.3.5.2 Economic growth. The study measures economic growth by the annual GDP growth rate. Because of increasing the demand for lending during the cyclical upswings, some researchers claims GDP growth rate has a positive impact on the bank performance (Athanasoglou *et al.*, 2008; Bikker and Haaf, 2002; Demirgüç-Kunt and Huizinga, 1999). However, Tan and Floros (2012a) investigate the association between GDP growth and bank profitability in China and finds a negative association between both variables. They argue that the economic growth improves the environment of the business, and which lowers the entry barriers of banks. As a result, the competition increased dampens the performance of banks. Thus, this study has no prior expectation regarding this variable.

2.3.5.3 Bank lending interest rate. This study uses a bank lending interest rate variable in the risk equation. Geng *et al.* (2016) examine the effects of the interest rates on bank risk in China by using the ratio of interest income to total loans as a measure of lending interest rate. Their findings indicate the lower level of bank lending interest shows lower interest income from loans, which causes reduction of bank earnings. They also claim that the low lending interest rate shows that some loans fail to be recovered and become non-performing loans, which causes an increasing risk. Therefore, to achieve the target profit, banks have to invest in high risky projects or financial instruments. Hence, the study expects a negative relation between bank lending interest rate and bank risk.

2.3.5.4 Inflation. This study uses annual inflation rate to see the effect of it on the bank risk. Arpa *et al.* (2001) argue that if inflation increases then the banking sector share of risk provisions in the total loans also increases. Hussain and Hassan (2005) also find a positive association between inflation and bank risk.

3. Research methodology

3.1 Data sources, sample, and sample characteristics

This study mainly uses secondary sources of data. As sources of data, the study uses Bankscope database (Bitar *et al.*, 2016; Demirguc-Kunt *et al.*, 2013). Also, to fill up the missing data, the investigation relied on the annual audited financial statement of each bank collected from the bank websites and Dhaka Stock Exchange, Bangladesh. The industry and macroeconomic data have gathered from the Bangladesh Bank website (www.bb.org.bd) and World Bank database (data.worldbank.org). The study also uses journals, books, different websites, library facility for the desk and extensive study as secondary sources of data.

To meet the desired objectives, the study has considered an unbalanced panel data of 30 sample banks of Bangladesh during the period from 2000-2015. The details about the sample have shown in Table III.

3.2 Empirical models and specification of variables

The study investigates the effect of risk-based capital and traditional non-risk based capital on the bank risk and performance of Bangladesh. For this purpose, the study uses two simultaneous equations by following the previous literature (Zheng *et al.*, 2017; Tan and Floros, 2013; Vollmer and Wiese, 2013; Francis and Osborne, 2012; Fiordelisi *et al.*, 2011; Ben Naceur and Kandil, 2009; Altunbas *et al.*, 2007; Nier and Baumann, 2006; Lee and Hsieh, 2013; Hussain and Hassan, 2005; Ayuso *et al.*, 2004; Jacques and Nigro, 1997) as follows:

$$P_{it} = \beta_0 + \beta_1 P_{it-1} + \beta_2 C_{it} + \beta_3 R_{it} + \beta_4 LIQD_{it} + \beta_5 OETA_{it} + \beta_6 LP_{it} + \beta_7 OFBSTA_{it} + \beta_8 INCD_{it} + \beta_9 CONC3_{it} + \beta_{10} GGR_t + \varepsilon_{it} \quad \text{(i)}$$

Panel A: Sample size	
Number of banks	56
Less: banks without available information	26
Total banks under the study	30
Panel B: Category-wise distribution	
State-owned commercial bank	2
Conventional private commercial bank	22
Islamic private commercial bank	6
Total banks under the study	30
Panel C: Bank-year observations	
Bank-year observations consideration for the study: 30 banks × 16 years (2000-2015)	480 bank-years
Less: bank-year observations without available information	67 bank-years
Final total bank-year observations under the study	413 bank-years

Table III.
Sample descriptions

Note: Author development

$$R_{it} = \gamma_0 + \gamma_1 R_{it-1} + \gamma_2 C_{it} + \gamma_3 P_{it} + \gamma_4 OETA_{it} + \gamma_5 DPR_{it} + \gamma_6 LEV_{it} + \gamma_7 BLINT_{it} + \gamma_8 INFLR_t + \varepsilon_{it} \quad \text{(ii)}$$

In the above two equations, the subscript i indicates the cross-sectional dimension across banks, t refers to years and ε_{it} denotes the random error term which includes the unobserved bank-specific effect and idiosyncratic error.

The first equation uses to tests whether the performance of banks is affected by the bank capital. In the equation, P_{it} indicates bank performance using ROA before tax (ROAB); β_0 is the constant term; P_{it-1} is the one period lagged performance variable; C_{it} is the bank capital has measured by the CAR and Total Shareholder's ETAR; R_{it} is the Bank Risk has measured by the default risk (LNZSCORE), credit risk (Non-performing loans to Total loans, NPLTL), and overall risk (Loan loss provision to Net interest revenue, LLPNIR); $LIQD_{it}$ is the liquidity has measured by the total loans to total assets ratio; $OETA_{it}$ is the cost inefficiency measures has calculated by the operating expenses to total assets ratio; LP_{it} is the labor productivity has calculated by the net profit after tax to total number of employees; $OFBSTA_{it}$ is the non-traditional activity measures by the off-balance sheet items to total assets ratio; $INCD_{it}$ is the income diversification has calculated by the ratio of non-interest income to total income; $CONC3_{it}$ is the market power has measured by the concentration ratio of the three largest bank assets to total assets; and GGR_t is the annual GDP rate (per cent).

The second equation uses to tests whether the risk taking the behavior of banks are affected by the bank capital. In the equation, $R_{it,}$ $C_{it,}$ and P_{it} indicates same meaning as defined in the first equation; γ_0 is the constant term; $R_{it\text{-}1}$ is the one period lagged risk variable ($LNZSCORE_{it-1}$, $NPLTL_{it-1}$, $LLPNIR_{it-1}$); $OETA_{it}$ is the cost inefficiency measures has calculated by the operating expenses to total assets ratio; DPR_{it} is the deposit ratio has measured by the total deposit to total assets ratio; LEV_{it} is the leverage has calculated by the total liabilities to total assets ratio; $BLINT_{it}$ is the bank lending interest rates (per cent); $INFLR_t$ is the annual inflation rate (per cent).

The descriptions of the variables and their expected effects on the bank performance and risk have shown in Tables IV and V.

3.3 Methods of data analysis

The previous empirical literature uses a variety of methods to solve the simultaneous equation, but not all methods are appropriate for all cases. The study examines the impact of bank capital on performance and risk by using Two-Step system GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (2000). GMM estimator has applied here because some problems have faced by the simultaneous equations, namely, endogeneity issue, serial correlation and heteroscedasticity. Lee and Hsieh (2013) argue GMM technique is more effective compared to OLS technique. OLS technique provides biased results in the estimation of a dynamic model (Nickell, 1981). To be more specific, two types of variants observed in the GMM: differenced GMM estimator and system GMM estimator. The study prefers the later one compared to the previous one because the system GMM estimator provides more precise results than difference GMM by solving the critical issues. GMM has considered superior to dynamic panel model because it provides estimates of fixed effects and OLS (Bond, 2002).

To run the regression using GMM with Eviews-8, the study first tests the identification of simultaneous equation to see whether the equation is over-identified or not because it is one of

Variables	Acronym	Definitions	References
Main variables			
Bank performance	ROAB	Profit before tax as a fraction of total assets	(Demirgüç-Kunt and Huizinga, 1999; Tan, 2016)
Bank risk	LNZSCORE	Natural logarithm of zscore; where zscore = (ROA plus the ratio of shareholders equity to total assets)/standard deviation of ROA	(Iannotta *et al.*, 2007)
	NPLTL	It is the ratio of non-performing loans to total loans	(Agoraki *et al.*, 2011)
	LLPNIR	The ratio of loan loss provision to net interest revenue	(Baselga-Pascual *et al.*, 2015)
Bank capital	CAR	It is the sum of tier-1 and tier-2 capital as a percentage of risk-weighted assets	(Bitar *et al.*, 2016)
	ETAR	The ratio of total shareholders' equity to total assets	(Zheng *et al.*, 2017)
Bank-specific control variables			
Liquidity	LIQD	The ratio of total loans to total assets	(Goddard *et al.*, 2013)
Cost inefficiency	OETA	The ratio of operating expenses to total assets	(Dietrich and Wanzenried, 2011)
Labor productivity	LP	Net profit after tax generated by per employee	Author Idea
Non-traditional activity	OFBSTA	Off balance sheet items as a fraction of total assets	(Rahman *et al.*, 2015)
Income diversification	INCD	The ratio of non-interest income to total income	(Tan, 2016; Majumder *et al.*, 2018)
Deposit ratio	DPR	Total deposit as a fraction of total assets	(Ashraf *et al.*, 2016a)
Leverage	LEV	Total liabilities to total assets ratio	(Doyran, 2013)
Industry and macro-economic variables			
Market power	CONC3	The total assets of the largest three banks as a fraction of total assets of the banking sector	(Tan, 2016)
Economic growth	GGR	Annual GDP growth rate (%)	(Baselga-Pascual *et al.*, 2015; Majumder and Uddin, 2017)
Interest rate	BLINT	Bank lending interest rate (%)	(Geng *et al.*, 2016)
Inflation	INFLR	Annual Inflation Rate (%)	(Tan and Floros, 2013; Akter *et al.*, 2018)

Note: Author development

Table IV.
Descriptions of the variables used in the study

the pre-condition of using GMM. The investigation also seeks whether the models of each equation suffers from endogeneity, serial correlation and heteroscedasticity issues. For these issues, the study employs Durbin–Wu–Hausman endogeneity test, Breusch–Godfrey serial correlation LM test and white heteroscedasticity test. The study also considers Hausman test for fixed/random effect to see which is appropriate for the model. Also, to test the validity of the instruments and over-identifying restrictions the Sargan j-test applies here.

The study also provides the descriptive statistics like mean, minimum, maximum, and standard deviation value to know the depth understanding about the study variables. The Pearson's correlation provides here to confirm that the study variables have not suffered any multicollinearity issues.

Finally, this study has applied robustness checks by introducing TSLS instead of GMM to justify the findings whether the results of the two methods are consistent or not.

Variables	Bank performance	Bank risk
Bank capital (CAR, ETAR)	+/−	+/−
Bank risk (LNZSCORE, NPLTL, LLPNIR)	−	
Bank performance (ROAB)		−
Liquidity (LIQD)	+/−	
Cost inefficiency (OETA)	+/−	+
Labor productivity (LP)	+	
Non-traditional activity (OFBSTA)	+/−	
Income diversification (INCD)	+/−	
Deposit ratio (DPR)		+
Leverage (LEV)		+
Market power (CONC3)	+/−	
Economic growth (GGR)	+/−	
Interest rate (BLINT)		−
Inflation (INFLR)		+

Note: Author development

Table V. Summary of expected effects of the study variables on bank performance and risk

4. Empirical results and discussion

This chapter has divided into four different sections. The first section highlights the descriptive statistics of all variables of the total sample year observations. The second section provides Pearson correlation matrix among the independent variables used in the study. The third section indicates regression analysis. Finally, the fourth section provides evidence of the accuracy of study findings by the robustness check.

4.1 Descriptive statistics

Table VI shows the descriptive statistics of the study variables which includes the minimum value, maximum value, mean value, standard deviation value and the number of observations of the sample variables. Among the study variables, it has been observed that the bank lending interests rate (BLINT) has a greater amount of variation among the samples (standard deviation = 0.977) followed by economic growth (GGR) with a standard deviation of 0.834, bank risk (LNZSCORE) with a standard deviation of 0.504, and others. The only performance variable ROA before tax (ROAB) shows a mean value of 0.023 with a maximum value of 0.065, the minimum value of 0.001, and standard deviation of 0.010. There is not so much variation of ROAB among the samples. Among the three risk measures of LNZSCORE, NPLTL and LLPNIR, LNZSCORE shows the greater variations among the samples indicate variations of risk or financial stability. The minimum value of NPLTL (0) indicates one or some of the sample has no non-performing loan which is a good sign and the evidence finds it for the one bank. The ratio of LLPNIR indicates a minimum value of negative figure (−1.331) which means one or some of the samples have a shortage of provision or negative net interest revenue. The average CAR (11.28 per cent) indicates higher capital adequacy has maintained by the sample banks on an average as per requirements of the BASEL II accord. But, the minimum value (5.65) indicates one or some of the banks has not maintained the minimum capital requirements of 10 per cent as per BASEL II accord. The equity to capital ratio (ETAR) indicates a mean value of 0.074 which is far from the maximum value of 0.154 and a minimum value of 0.002. So, there is a greater deviation from the average value of ETAR.

Variables	Mean	Maximum	Minimum	Standard deviation	Observations
ROAB	0.023	0.065	0.001	0.010	413
LNZSCORE	2.793	3.927	0.980	0.504	413
NPLTL	0.060	0.396	0.000	0.064	413
LLPNIR	0.300	2.413	−1.331	0.309	413
CAR	11.280	24.170	5.650	2.315	413
ETAR	0.074	0.154	0.002	0.024	413
LIQD	0.669	0.837	0.444	0.075	413
OETA	0.022	0.047	0.008	0.007	413
LP	0.608	2.584	0.008	0.440	413
OFBSTA	0.312	2.694	0.030	0.165	413
INCD	0.264	0.562	0.030	0.083	413
CONC3	0.278	0.463	0.206	0.053	413
GGR	5.897	7.100	3.800	0.834	413
DPR	0.812	0.935	0.615	0.053	413
BLINT	12.489	13.940	10.400	0.977	413
INFLR	6.202	8.200	3.300	1.402	413
LEV	0.914	1.013	0.046	0.105	413

Note: Author calculations

Table VI.
Descriptive statistics of the sample variables

4.2 Correlation

Table VII shows the degree of relationships among the independent variables used in the study. This study uses Pearson correlation matrix to examine whether any multicollinearity issues exists between independent variables.

Among the study variables, the highest correlation is 0.61 between the two capital ratios CAR and total shareholders' ETAR. Kennedy (2003) claims that the correlation value above 0.70 indicates multicollinearity problem exists between the variables. Another academician, Gujarati (2009), states that the correlation value above 0.80 between the two variables creates serious multicollinearity problem. Thus, this study indicates the correlations among the variables are not so strong, which suggest non-existence of multicollinearity issues.

4.3 Regression

4.3.1 The impact of bank capital on performance. Table VIII reports the empirical results of the equation one where six model uses for the regression analysis. The table provides the impact of bank capital on the performance of the Bangladeshi banking sector. The first three models (1-3) depict the simultaneous effect of bank capital (CAR) and risk (default risk, LNZSCORE; credit risk, NPLTL; and overall risk, LLPNIR) on the bank performance (ROA before tax, ROAB) of Bangladesh. The second three models (4-6) show the simultaneous effect of bank capital (ETAR) and risk (default risk, LNZSCORE; credit risk, NPLTL; and overall risk, LLPNIR) on the bank performance (ROA before tax, ROAB) of Bangladesh. The regression findings indicate that the lag dependent variable ($ROAB_{t-1}$) is positively and statistically significant with the performance across all the six models. Thus, it is evidence that there is a persistence of performance from one year to next year. The study highlights that the main independent variable bank capital (CAR; and ETAR) has a significant and positive impact on bank performance (ROAB) using all the three types of risk measures across all the six models. Thus, the higher the capital ratio indicates higher the bank performance. The findings of the study are in line with Psillaki and Mamatzakis (2017), Zheng *et al.* (2017), Casu *et al.* (2017), Bougatef and Mgadmi (2016), Lee and Hsieh (2013),

Table VII. Pearson correlation matrix between independent variables

Variables	CAR	ETAR	LIQD	OETA	LP	OFBSTA	INCD	CONC3	GGR	DPR	BLINT	INFLR	LEV
CAR	1												
ETAR	0.61***	1											
LIQD	0.02	0.24***	1										
OETA	0.05	0.09*	−0.18***	1									
LP	0.25***	0.6***	0.32***	−0.2***	1								
OFBSTA	−0.08	−0.01	0.09*	−0.09*	0.19***	1							
INCD	−0.07	0.07	−0.32***	0.44***	0.07	0.15***	1						
CONC3	−0.09*	−0.4***	−0.19***	−0.15***	−0.3***	0.17***	0.06	1					
GGR	0.11**	0.24***	0.21***	0.09*	0.14***	−0.01	−0.06	−0.4***	1				
DPR	−0.31***	−0.43***	0.1**	−0.28***	−0.18***	0.04	−0.22***	0.05	−0.01	1			
BLINT	0.19***	0.29***	−0.08	0.07	0.17***	−0.16***	−0.15***	−0.17***	0.02	−0.15***	1		
INFLR	0.19***	0.46***	0.24***	0.14***	0.32***	−0.17***	−0.03	−0.61***	0.44***	−0.06	0.59***	1	
LEV	−0.09*	−0.22***	−0.05	−0.02	−0.18***	0.01	−0.06	0.14***	−0.11**	0.09*	−0.04	−0.12**	1

Notes: Total number of observations 413; ***correlation is significant at 1 per cent level (two-tailed); **correlation is significant at 5 per cent level (two-tailed); *correlation is significant at 10 per cent level (two-tailed); Author calculations

Table VIII.
The impact of bank capital on performance

Variables	Model-1 CAR and LNZSCORE	Model-2 CAR and NPLTL	Model-3 CAR and LLPNIR	Model-4 ETAR and LNZSCORE	Model-5 ETAR and NPLTL	Model-6 ETAR and LLPNIR
$ROAB_{t-1}$	0.51*** (6.37)	0.403*** (5.34)	0.463*** (5.89)	0.495*** (9.17)	0.419*** (7.15)	0.458** (7.30)
CAR	0.002** (2.50)	0.002** (2.21)	0.002** (2.4)			
ETAR				0.159*** (3.98)	0.110*** (3.16)	0.113*** (3.37)
LNZSCORE	0.002* (1.76)			0.002** (2.20)		
NPLTL		−0.047*** (−5.21)			−0.039*** (−4.82)	
LLPNIR			−0.005** (−2.53)			−0.005*** (−3.54)
LIQD	0.020*** (4.99)	0.015*** (3.84)	0.023*** (5.94)	0.028*** (4.83)	0.021*** (3.58)	0.027*** (4.50)
OETA	0.265*** (3.62)	0.214*** (2.91)	0.179** (2.11)	0.219*** (4.52)	0.181*** (3.52)	0.133** (2.12)
LP	0.012*** (8.51)	0.011*** (10.72)	0.011*** (10.55)	0.013*** (11.94)	0.012*** (14.67)	0.012*** (13.63)
OFBSTA	−0.011*** (−7.03)	−0.010*** (−7.75)	−0.010*** (−6.53)	−0.008*** (−8.16)	−0.008*** (−10.51)	−0.008*** (−6.23)
INCD	0.014*** (4.39)	0.022*** (5.30)	0.021*** (5.74)	0.023*** (5.40)	0.027*** (7.96)	0.028*** (7.85)
CONC3	0.086*** (6.37)	0.082*** (9.25)	0.079*** (6.40)	0.057*** (5.50)	0.059*** (6.51)	0.055*** (5.14)
GGR	0.0001 (0.11)	0.0002 (0.43)	0.000007 (0.01)	0.0003 (1.12)	0.0001 (0.47)	0.0002 (0.54)
Intercept	−0.020** (−1.97)	−0.0121* (−1.38)	−0.019** (−1.97)	−0.035*** (−8.00)	−0.021*** (−4.36)	−0.027*** (−4.70)
Adjusted R^2	0.43	0.57	0.55	0.60	0.65	0.64
Sargan test (P-Value)	0.22	0.20	0.30	0.24	0.19	0.20
Bank-year observations	413	413	413	413	413	413
Number of banks	30	30	30	30	30	30

Notes: ***Significance at 1 per cent level; **Significance at 5 per cent level; *Significance at 10 per cent level. Numbers in parentheses are t-statistics; Author calculations using GMM system in Eviews

Mbizi (2012), Naceur and Omran (2011), Ben Naceur and Kandil (2009), Pasiouras and Kosmidou (2007), Lin *et al.* (2005), Goddard *et al.* (2004), Rime (2001) and Jacques and Nigro (1997). The findings are inconsistent with the views that higher capital requires higher opportunity cost of holding and thus jeopardize the performance of the banks (Goddard *et al.*, 2013; Karels *et al.*, 1989; Brewer III and Lee, 1986). The study finds that all the three measures of risk across the six models indicate a negative impact on bank performance. Among all control variables, all the variables significantly affect the bank performance except economic growth (annual GDP growth rate, GGR). The study includes this variable as excluding it weaken the model. The study finds liquidity ratio (LIQD) is positively and significantly impact on bank performance. Higher liquidity ratio indicates a lower level of liquidity. Thus, the study finds a negative relationship of liquidity with a performance which indicates higher the loans leads to higher interest revenue and improve bank performance. The result is consistent with the findings of Molyneux and Thornton (1992) and Goddard *et al.* (2013); it is inconsistent with Bourke (1989). Cost inefficiency (OETA), i.e. the ratio of operating expenses to total assets, is positively and significantly affects the bank performance which means more expenditure on salary, wages to the staff increases their productivity and thus performance increases. The findings have supported the efficiency wage theory (Tan, 2016) and also consistent with the findings of Naceur (2003) and Molyneux and Thornton (1992). However, the negative impact of cost inefficiency on performance has found by Dietrich and Wanzenried (2011), Athanasoglou *et al.* (2008) and Bourke (1989). Labor productivity is positively and significantly impact on bank performance. The higher level of labor productivity indicates a higher level of bank efficiency and which leads to higher profit. The findings are supported by the study of Zheng *et al.* (2017). The non-traditional activity (off balance sheet items to total assets, OFBSTA) implies negative and significant impact on profitability which means as off balance sheet items increases then performance decreases. The results is consistent with Rahman *et al.* (2015), but the findings of Apergis (2014) has found positive impact of non-traditional activity on bank performance. This study finds that income diversification (INCD) has a significant and positive impact on performance which indicates the more diversified of a bank faces less risk and increases performance. The findings are consistent with Jiang *et al.* (2003b), but opposite of the findings of Tan (2016), Gischer and Jüttner (2001) and Demirgüç-Kunt and Huizinga (1999). The findings of this study provide that Market power (CONC3) i.e. the concentration ratio is positively and significantly impact on the bank performance which supports the market SCP hypothesis (Tan, 2016).

4.3.2 The impact of bank capital on risk. Table IX reports the empirical results of the equation two where six model uses for the regression analysis. Table IX provides the impact of bank capital on the risk of the Bangladeshi banking sector. The first three models (1-3) depict the simultaneous effect of bank capital (CAR) and performance (ROA before tax, ROAB) on three measures of risk (default risk, LNZSCORE; credit risk, NPLTL; and overall risk, LLPNIR). The second three models (4-6) show the simultaneous effect of bank capital (ETAR) and performance (ROA before tax, ROAB) on three measures of risk (default risk, LNZSCORE; credit risk, NPLTL; and overall risk, LLPNIR).

The regression findings indicate that the lag dependent variable ($LNZSCORE_{t-1}$, $NPLTL_{t-1}$, $LLPNIR_{t-1}$) is positively and statistically significant with the risk across all the six models. Thus, it is evidence that there is a persistence of risk from one year to next year.

The study highlights that the main independent variable bank capital (CAR) has a significant and negative impact on bank risk using all the three types of risk measures across the first three models (1-3). Thus, the higher the CAR indicates lower the bank risk. The findings of the study are in line with Soedarmono and Tarazi (2016), Lee and Chih

Table IX.
The impact of bank capital on risk

Variables	Model-1 CAR and LNZSCORE	Model-2 CAR and NPLTL	Model-3 CAR and LLPNIR	Model-4 ETAR and LNZSCORE	Model-5 ETAR and NPLTL	Model-6 ETAR and LLPNIR
$LNZSCORE_{t-1}$	0.779*** (37.77)			0.757*** (33.29)		
$NPLTL_{t-1}$		0.767*** (33.07)			0.747*** (21.78)	
$LLPNIR_{t-1}$			0.627*** (11.20)			0.631*** (11.22)
CAR	0.020*** (3.20)	−0.005*** (−3.80)	−0.053** (−2.35)			
ETAR				4.061*** (13.14)	−0.128** (−1.55)	−1.228*** (−2.96)
ROAB	6.975*** (7.06)	−0.502*** (−2.82)	−1.791*** (−2.80)	4.948*** (4.45)	−0.441*** (−2.33)	−0.885*** (−2.02)
OETA	−2.263*** (−2.83)	1.122** (1.80)	2.521** (2.027)	−1.578* (−1.70)	0.063* (1.54)	2.386* (1.89)
DPR	−1.263** (−1.46)	0.050* (1.63)	1.347*** (4.23)	−0.248** (−2.44)	0.013** (1.31)	0.847*** (3.29)
LEV	−0.067 (−1.28)	0.006 (0.06)	0.178** (2.12)	−0.141*** (−3.67)	0.002 (0.22)	1.109** (2.38)
BLINT	0.019** (2.26)	−0.003*** (−2.50)	−0.005 (−0.01)	0.013* (1.78)	−0.007*** (−4.24)	−0.016* (−2.30)
INFLR	−0.028*** (−3.86)	0.002* (1.64)	0.007* (1.67)	−0.006* (−1.07)	0.005*** (2.90)	0.006** (1.52)
Intercept	0.530* (0.86)	−0.099*** (−3.13)	2.027*** (3.82)	0.149* (1.53)	−0.062* (−2.11)	1.172*** (4.03)
Adjusted R^2	0.81	0.82	0.55	0.82	0.84	0.63
Sargan test (*P*-Value)	0.16	0.27	0.24	0.16	0.15	0.15
Bank-year observations	413	413	413	413	413	413
Number of banks	30	30	30	30	30	30

Notes: ***Significance at 1 per cent level; **significance at 5 per cent level; *significance at 10 per cent level; Numbers in parentheses are *t*-statistics; Author calculations using GMM system in Eviews

(2013), Agoraki *et al.* (2011), Zhang *et al.* (2008), Hussain and Hassan (2005), Jacques and Nigro (1997). The findings are contrary to the studies of Bitar *et al.* (2016), Lin *et al.* (2013), Altunbas *et al.* (2007), Lin *et al.* (2005), Bichsel and Blum (2004), Rime (2001), Blum (1999) and Shrieves and Dahl (1992).

The shareholder's ETAR is negatively and significantly impact on bank risk using all the three types of risk measures across the last three models (4-6). This result indicates the higher the capital ratio tends to lower the risk. This finding is supported by the studies of Bougatef and Mgadmi (2016), Hao and Zheng (2016) and Tan and Floros (2013). However, the positive relationship between ETAR and bank risk finds by the study of Bitar *et al.* (2016).

The study also provides evidence that bank performance negatively and significantly affects the bank's risk taking behavior across all models, which indicate that the higher the performance of a bank, the lower the risk and vice-versa.

Among the control variables, cost inefficiency (OETA) is positively and significantly impact on risk across all the models which indicate higher the operating expenses leads to high risk. The findings are consistent with the study of Baselga-Pascual *et al.* (2015). Deposit (DPR) is positively and significantly affects the risk across all the models which indicate higher the deposit leads to higher risk. This result is supported by the study of Ashraf *et al.* (2016a) and Soedarmono and Tarazi (2016). Leverage (LEV) is positively and significantly impact on risk across the models three, four, and six which indicates the higher the liabilities leads to higher risk. Bank lending interest (BLINT) is significantly and negatively associated with risk except for model-3 which means higher the percentage of lending rate lower the risk. This result supported by the study of Geng *et al.* (2016). The findings indicate that annual inflation rate (INFLR) has a positive and significant impact on bank risk across all the models which mean that as the rate of inflation increases in an economy, the risk also increases. The result is consistent with the findings of Arpa *et al.* (2001), but Tan and Floros (2013) have found an insignificant negative impact of inflation on bank risk.

4.4 Robustness checks

Robustness checking indicates check the robustness of the main study findings by using different techniques such as changing the dependent variable with an alternative measure, changing the methods of regression analysis, changing the alternatives control variables. In this study, I have used 2SLS methods instead of GMM to check the results effectiveness. Table X shows the robust results of the impact of bank capital on performance using 2SLS with random effects model. The robust finding of the study indicates that all of the variables are significant except GGR. Table XI shows the impact of bank capital on risk using the 2SLS methods with random effects. The study finds that all the variables are significant and the results largely remain same with the main findings.

5. Conclusions

5.1 Summary of the findings

After the implementation of BASEL I, BASEL II and BASEL III in the international arena, the empirical research on Bangladesh failure to give the answers to the following questions: What is the impact of bank capital on the bank performance? andWhat is the impact of bank capital on the bank risk taking behavior? To the best of my knowledge, little attention has given by the researcher to give the answer of these questions on Bangladesh. Thus, to search the answer of the above questions, this study will be a complement study of other studies and add value to the existing literature.

Table X.
The impact of bank capital on performance

Variables	Model-1 CAR and LNZSCORE	Model-2 CAR and NPLTL	Model-3 CAR and LLPNIR	Model-4 ETAR and LNZSCORE	Model-5 ETAR and NPLTL	Model-6 ETAR and LLPNIR
$ROAB_{t-1}$	0.555*** (5.76)	0.432*** (5.01)	0.512*** (4.86)	0.512*** (7.10)	0.419*** (5.62)	0.480*** (5.55)
CAR	0.002** (2.48)	0.001* (1.63)	0.001** (2.09)			
ETAR				0.136*** (3.37)	0.074* (1.76)	0.093** (2.47)
LNZSCORE	0.003** (2.24)			0.002** (2.10)		
NPLTL		−0.048*** (−6.01)			−0.043*** (−5.53)	
LLPNIR			−0.005* (−1.65)			−0.004* (−1.88)
LIQD	0.016*** (2.71)	0.014*** (3.22)	0.0195*** (3.74)	0.025*** (4.38)	0.019*** (3.49)	0.026*** (4.90)
OETA	0.242*** (2.76)	0.170** (1.96)	0.164 (1.56)	0.205*** (3.44)	0.155** (2.19)	0.141* (1.76)
LP	0.011*** (7.17)	0.0096*** (8.01)	0.011*** (8.09)	0.013*** (8.75)	0.010*** (7.94)	0.012*** (9.93)
OFBSTA	−0.009*** (−4.20)	−0.009*** (−5.93)	−0.008*** (-3.67)	−0.007*** (−6.84)	−0.008*** (−9.15)	−0.006*** (−4.77)
INCD	0.012** (2.39)	0.023*** (4.51)	0.018** (2.25)	0.023*** (5.09)	0.028*** (7.10)	0.026*** (4.48)
CONC3	0.076*** (5.01)	0.071*** (6.66)	0.068*** (5.03)	0.052*** (5.36)	0.058*** (6.21)	0.051*** (5.22)
GGR	0.00002 (0.03)	0.001 (1.06)	0.0001 (0.18)	0.0002 (0.33)	0.0006 (1.17)	0.0002 (0.48)
Intercept	−0.018* (−1.82)	−0.011* (−1.37)	−0.0148* (−1.60)	−0.031*** (−5.79)	−0.019*** (−3.69)	−0.025*** (−4.25)
Adjusted R^2	0.68	0.57	0.57	0.62	0.68	0.67
F-statistic	86.64***	92.73***	87.59***	86.21***	92.49***	87.26***
Bank-year observations	413	413	413	413	413	413
Number of banks	30	30	30	30	30	30

Notes: ***Significance at 1 per cent level; **significance at 5 per cent level; *significance at 10 per cent level; Numbers in parentheses are *t*-statistics; Author calculations using TSLS in Eviews

Table XI. The impact of bank capital on risk

Variables	Model-1 CAR and LNZSCORE	Model-2 CAR and NPLTL	Model-3 CAR and LLPNIR	Model-4 ETAR and LNZSCORE	Model-5 ETAR and NPLTL	Model-6 ETAR and LLPNIR
$LNZSCORE_{t-1}$	0.779*** (11.83)			0.755*** (10.11)		
$NPLTL_{t-1}$		0.752*** (21.79)			0.724*** (17.19)	
$LLPNIR_{t-1}$			0.570*** (7.76)			0.600*** (8.76)
CAR	0.021*** (3.05)	−0.005*** (−2.18)	−0.050*** (−2.33)			
ETAR				4.235*** (3.07)	−0.117** (−1.48)	−1.374*** (−2.65)
ROAB	5.906*** (4.62)	−0.708* (−1.71)	−1.822** (−2.90)	3.715* (1.81)	−0.638*** (−2.85)	−1.140*** (−2.36)
OETA	−2.680** (−3.11)	1.164** (1.27)	2.551** (2.08)	-1.408* (−1.66)	0.131** (1.60)	2.419** (1.95)
DPR	−1.177* (−1.41)	1.036** (2.11)	1.107** (2.26)	−0.332** (−2.03)	0.004* (1.06)	0.771* (1.90)
LEV	−0.012 (−0.101)	0.0008 (0.1028)	0.126** (1.99)	−0.107** (−3.49)	0.002 (0.20)	1.111** (2.15)
BLINT	0.029** (2.32)	−0.005* (−1.67)	−0.006 (−0.34)	0.025* (1.93)	−0.006*** (−3.13)	−0.012* (−2.80)
INFLR	−0.024 (−3.96)	0.003* (0.002)	0.008* (1.71)	−0.006* (−1.01)	0.003* (2.39)	0.010** (1.59)
Intercept	0.691* (0.91)	−0.100*** (−2.95)	1.704** (2.06)	0.182* (1.60)	−0.034* (−2.50)	1.112*** (2.73)
Adjusted R^2	0.81	0.82	0.58	0.83	0.85	0.56
F-statistic	204.77***	258.27***	26.87***	221.19***	255.25***	26.17***
Bank-year observations	413	413	413	413	413	413
Number of banks	30	30	30	30	30	30

Notes: ***Significance at 1 per cent level; **significance at 5 per cent level; *significance at 10 per cent level; Numbers in parentheses are t-statistics; Author calculations using two-stage least squares (TSLS) in Eviews

This paper examines whether bank capital affects to the bank performance and risk of Bangladeshi Banking Sector. To achieve the predetermined objectives, the study uses an unbalanced panel data set of 30 banks from 2000 to 2015 yielding 413 bank-year observations. The study has considered two capital measures of bank, namely, CAR and total shareholder's ETAR; ROA before tax has considered as performance measurement tools; three measures of risk such as default risk (natural logarithm of score), credit risk (non-performing loans to total loans) and overall risk (loan loss provision to net interest revenue) have been considered. The study also has considered some bank control measures, and industry and macro-economic factors to see the effect of those factors on capital. Liquidity ratio, cost inefficiency, labor productivity, off-balance sheet items to total assets ratio, income diversification, market power (concentration ratio) and economic growth (annual GDP growth rate) have been considered as significant determinants of bank performance. Bank cost inefficiency, deposit ratio, leverage, bank lending interest rates and the annual inflation rate has considered detecting the effect of those factors on bank risk. Using two-step system GMM, the regression analysis results solve the endogeneity issues, serial correlation problems, heteroscedasticity issues and other unobserved bank-specific issues. The study findings suggest that bank capital is positively and significantly affect the bank performance which means the higher the capital of a bank leads to higher performance. The regression results also indicate that bank capital has a significant and negative impact on bank risk which means the higher capitalized banks have a lower risk. The study also has observed that the simultaneous result indicates a significant and negative impact of risk on performance and vice-versa. Among the bank control, and industry and macroeconomic factors, cost inefficiency, labor productivity, income diversification and market power have significant and positive impact on bank performance. Bank off balance sheet items and liquidity also significantly affect the performance, but the study has found a negative impact on performance. The study has not found any significant impact of economic growth, i.e. annual GDP growth rate on bank performance. The regression result also displays that cost inefficiency, deposit ratio, leverage and the annual inflation rate is positively and significantly impact on bank risk. Bank lending interest rate also has a significant impact on bank risk but has a negative impact on risk. This investigation has also found that some of the state-owned banks were not maintained minimum capital requirements as per BASEL Capital Accord, and not maintained enough provisions against bank risk exposures.

5.2 Recommendations and policy implications

The main objectives of introducing the BASEL Capital Accord I, II and III are to strengthen the bank capital position to maintain financial stability through reducing risk and improving performance. This investigation also aims whether this study supports with the objective of BASEL regulations. The study finds that capital is a significant and positive factor for the bank performance and reduces bank risk of Bangladesh which supports the initiatives of BASEL regulations as well as the Central Bank of Bangladesh policy decisions to implement the BASEL guidelines. Thus, the study suggests implementing the BASEL III as soon as possible. As the higher capital ratio increases performance and reduces risk, so the banks of Bangladesh should maintain the minimum capital requirements as per BASEL guidelines and Bangladesh Bank should have to set strict decision to follow the BASEL requirements. Cost inefficiency (Operating expenses), labor productivity and income diversification significantly and positively affect the bank performance. Thus, the bank policy maker should consider those factors properly. Liquidity also significantly and negatively impact on performance which indicates more loans to customers more profit

generation but at the same time bank should aware about the ability and project selection of the customer. The study finds a significant negative relation of off-balance sheet items on bank performance, so, the bank should be aware of off-balance sheet items. Specially, the Government of Bangladesh should give more attention to the state-owned banks properly, as this investigation finds those banks were not maintained capital adequacy properly and also faces negative net revenue and negative provisions against loans. The government also should take necessary steps to reduce inflation, as the study finds a significant and positive correlation between inflation and bank risk. Each bank should report the capital adequacy as per BASEL requirements and should also measure and report the different measures of risk and performance results in the annual report. Finally, the study suggests that higher capital ratio leads to a bank to set up careful investment strategies through reducing risk and improving performance.

5.3 Direction for future research

Although this study is the unique study for examining the impact of bank capital on bank performance and risk, the study faces limitations as well. The future researcher may consider the following avenues for the further study by considering the limitations of this study: first, this study has considered 30 sample banks on Bangladesh; the future researcher may consider more sample banks. Second, this study has taken data during 2000-2015, in future the latest data period may consider. Third, this investigation has been done only on one country named Bangladesh; the future researcher may include other countries which are similar nature of economic and political conditions like South Asian or African countries. Fourth, the study has considered one measure of performance, two measures of capital, and three measures of risk; in future, other measures of performance such as ROA after tax, return on average assets, return on average earning assets, ROE, NIM, earnings per share, Tobin's Q, etc. may be considered. The future researcher may also consider other capital measures such as tier-1 capital to risk-weighted assets, tier-2 capital to risk-weighted assets besides total regulatory capital to risk-weighted assets. The other measures of risk such as market risk, liquidity risk may consider in future. Fifth, the future studies may include more bank-specific, industry and macro-economic factors besides this study such as taxation, cost of intermediation, management efficiency, reserve, bank size, unemployment rate, Herfindahl index of industry concentration and revenue diversification, Lerner index of industry competition, banking sector development measure, stock market development measure, etc. Sixth, this investigation includes three main variables capital, risk, and performance; in future efficiency, competition, politics and globalization factors may add as main variable. Finally, this study has used GMM and TSLS with Eviews software for the regression analysis; in future, other best-fit methods with the best software may consider. Also, regardless of limitations, this investigation predicts that the empirical findings of this study will be beneficial for the future researcher and policymaker to develop the theory on the link between bank capital, risk and performance.

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