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*Research article*

# The impact of monetary policy on banks' risk-taking behavior in an emerging economy: The role of Basel II

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**Abstract:** The main goal of this study is to investigate the impact of monetary policy (MP) on the risk-taking behavior of Bangladeshi banks. It also attempts to examine the role of Basel II in the association between MP and bank risk-taking pre- and post-2010. This study analyzes data from 33 commercial banks in Bangladesh over the 20 years from 2002 to 2021 and uses the two-step system generalized method of moments to address heteroscedasticity and autocorrelation issues. Unlike previous research, this study confirms the significant effect of Basel II on the relationship between MP and banks' risk-taking behavior. The main findings are first that a non-linear U-shaped relationship exists between MP and banks' risk-taking behavior, implying that when bank rate (BR) and cash reserve ratio (CRR) increase, bank credit risk first decreases, then later increases. Second, bank-level characteristics such as liquidity, regulatory capital, and size have a significant effect on risk, whereas bank age has an insignificant effect on risk-taking behavior. Third, MP and Basel II jointly influence risk-taking so that banks take higher risks before implementing Basel II. Overall, thisstudy offers significant practical implications for academics, researchers, and regulators interested in leveraging the findings.

**Keywords:** monetary policy; risk-taking behavior; Basel II, Bangladesh

**JEL Codes:** E44, E52, G21, G32

**Abbreviations:** MP: Monetary policy; BR: Bank rate; CRR: Cash reserve ratio; BB: Bangladesh Bank; BRPD: Banking Regulation and Policy Department; RBCA: Risk-based Capital Adequacy; BRPD: Banking Regulation and Policy Department; MCR: Minimum Capital Requirement; SRP: Supervisory Review Process; RWATA: Risk-Weighted Assets to total assets; GMM: Generalized method of moments; OMO: Open Market Operations; SLR: Statutory Liquidity Ratio; PSTM: Panel smooth transition regression model; CAR: Capital adequacy ratio; OLS: Ordinary least squares; NPLTL: Non-performing loan to total loans; GDP: Gross Domestic Product; INF: Inflation; EQTA: Total equity to total assets

## 1. Introduction

The banking industry is facing numerous challenges due to its rapid expansion. The global financial crises in 2007–2008 exposed weaknesses in the global regulatory framework and banks' risk management practices. The Basel Council on Banking Supervision has developed Basel laws to promote financial stability. To safeguard themselves against credit, operational, and trading book risks, banks are required by Basel to keep a specific amount of capital. To tackle the challenges and make bank capital more risk-absorbent and shock-resilient, the Banking Regulation and Policy Department (BRPD) issued Circular No. 14 on December 30, 2007, to implement Basel II in Bangladesh. As a result, guidelines on Risk-Based Capital Adequacy (RBCA) were introduced on January 1, 2009, in parallel to existing BRPD Circular No. 10 dated November 25, 2002. These guidelines are based on Basel II, which came into force on January 1, 2010, and its successive supplements. Under Basel II, banks in Bangladesh are required to maintain a Minimum Capital Requirement (MCR) or Capital Adequacy Ratio (CAR) of 10% of Risk Weighted Assets (RWA) or Taka 4,000 million in capital, whichever is higher. According to the Supervisory Review Process (SRP), banks are directed to maintain a level of capital greater than the minimum required amount to cover all possible risks in their business. Consequently, it is necessary to consider the effect of Basel on the association between MP and risk-taking. Basel III was implemented very recently; as a result, we have concentrated on Basel II, as it was introduced in 2010 in Bangladesh, and have divided the dataset into two parts, pre- and post-Basel II.

Scholars and policymakers have recently focused more on the association between monetary policy (MP) and bank risk-taking. The main objectives of MP have always been to maintain price stability and control economic cycles. It is an effective macroeconomic tool for achieving such stability, full employment, and economic expansion. These tools are included within the framework of national objectives based on economic stability and development. MP is intended to keep prices stable by controlling inflation based on a low, stable, and steady rate that is compatible with output growth (Acharya et al., 2020; Bekaert et al., 2013; Jung, 2023; Mahrous et al., 2020). Monetary authorities throughout the globe implement MP by taking various approaches, including the operation of open markets, federal fund rates, the ratio of reserve requirements, discounting rates, and monitoring inflation. A low rate of interest may encourage banks to take unjustified risks, but in many nations, this has been disregarded for two primary reasons. First, while inflation control and economic expansion are the monetary authorities' top priorities, they have neglected to emphasize

the importance of financial stability objectives. Second, when establishing MP, financial stability was not given any weight; financial innovation was viewed as the foundation of strong financial institutions (Acharya et al., 2020; Delis et al., 2017).

However, it is interesting to note that, unlike advanced economies, Bangladesh implements MP through a mix of price-based and quantity-based tools. The cash requirement ratio (CRR) and bank rate (BR) are the basis of the MP stance in the country. This is because during the sample period of 2002 to 2021, the monetary authorities widely used these tools to monitor MP effectiveness. The CRR is a particularly effective tool in the Bangladeshi banking sector and was also used in the study by Hussain et al. (2021). Moreover, it is not clear how the CRR promotes financial stability in the banking sector of Bangladesh. To investigate this, this study uses the CRR and BR and compares their effectiveness in a bank risk context. The distinctive features of MP in Bangladesh provide a unique testing ground for the effectiveness of such a tool, which may not be possible in other countries that use single MP instruments.

In this paper, we empirically consider the relationship between MP and banks' willingness to take risks in an emerging country. The prime aim is to examine the effect of MP on the risk-taking intention of banks in Bangladesh. In addition, we investigated the contribution of the Basel II capital accord to the association between MP and banks' risk-taking. This research is unique in that it studies the effects of macro-level data and credit indicators of an emerging country context such as Bangladesh. Consequently, it is essential to assess how the central bank utilizes lending policy to control credit risk by adopting efficient MP. Banking crises have detrimental consequences not only on the major national economies of the nations in which they originate, but, because of the increased interconnection caused by globalization, they also tend to contaminate other economies, harming the financial stability of the entire world. In recent years, greater emphasis has been placed on enhancing the international regulatory framework for banking, which has had a significant effect on national banks' supervisory activities.

The majority of related studies, such as those of Altavilla et al. (2020), Berger and Bouwman (2017), Hussain et al. (2021), Mahrous et al. (2020) and Olivero et al. (2011), have shown how MP and banks' risk-taking behavior are correlated. However, no evidence has been found to support the association between the three issues of MP, Basel II, and risk-taking practices. Moreover, the relationship between Basel II and banks' risk-taking motives remains unclear. Borio and Zhu (2012), Ge et al. (2023), de Moraes and de Mendonça (2019) and Agur and Demertzis (2010) analyzed the relationship between MP and banks' risk-taking. Using a panel dataset from a sample of different Bangladeshi banks from the period 2002 to 2021, we adapted the two-step system generalized method of moments (GMM) developed by Arellano and Bond (1991) and Arellano and Bover (1995). Some studies have demonstrated that MP and bank risk are significantly and favorably correlated. The non-linear link between MP and risk is also supported by evidence from (Brana et al., 2019). This study also shows that the size, capitalization, liquidity, and age of banks have a significant impact on the risk-taking of commercial banks in Bangladesh. In the Bangladeshi context, a possible cause may be the inadequate monitoring of MP, which encourages the banking sector of developing countries to assume excessive risk. However, this can be reduced by implementing adequate supervision of the market mechanism.

To the best of the author's knowledge, no other study has been conducted on Bangladesh or any other country in the region which analyzes the impact of monetary policy on banks' risk-taking behavior with consideration of the effect of Basel II. Moreover, the most closely related studies have

been conducted on samples of predominantly large, publicly traded banks. This paper aims to extend the related literature by concentrating on the banking sector consisting of commercial banks that focus primarily on providing loans and advances to the general public or private sector. Its contributions relate to the empirical evidence provided on the association between MP and risk, with implications drawn which have great potential for the authorities in the development of financial stability and suitable policies for improvement of the banking sector in a developing economy such as Bangladesh. The Bangladesh Bank plays an important role as a supervisory authority and is also responsible for the implementation of the country's monetary policy. This study aims to contribute to the ongoing discussion by providing insights into the relationship between monetary policy and the risk-taking behavior of banks in Bangladesh. It is hoped the findings will serve as important input for policymakers, researchers, and academics interested in understanding the impact of policy on such behavior.

The remaining sections are structured in the following manner. Section 2 presents the operational framework of Bangladesh Bank, while Section 3 provides a concise summary of related research. Section 4 explains the methodology, including the data, sampling procedures, variables, econometric model and estimation method. Section 5 outlines the empirical findings and discusses the effect of MP on banks' risk-taking practices, together with the outcomes of the robustness tests conducted. Finally, Section 6 presents the conclusion, suggestions and recommendations.

## 2. Operational framework of Bangladesh Bank (BB)

Bangladesh Bank (BB) acts as the Central Bank of Bangladesh and was established on December 16, 1971 through the enactment of Bangladesh Bank Order 1972–President's Order No. 127 of 1972 (Amended in 2003). In Strategic Plan (2010–2014), the vision of BB was stated as "To develop continually as a forward looking central bank with competent and committed professionals of high ethical standards, conducting monetary management and financial sector supervision to maintain price stability and financial system robustness, supporting rapid broad-based inclusive economic growth, employment generation and poverty eradication in Bangladesh". BB has been undertaking its principal task of formulating and implementing MP to manage the monetary and credit system of the country, with a view to stabilizing domestic monetary value and maintaining a competitive external par value of the Taka in order to foster the growth and development of the country's productive resources. BB designs its MP stance and monetary and credit programs based on macroeconomic updates and outlooks both at home and overseas. The main objectives of the monetary policy of Bangladesh Bank are: (a) price stability, both internal and external; (b) sustainable growth and development; (c) high employment; (d) economic and efficient use of resources; and (e) stability of the financial and payment system. The tools and instruments employed in the implementation of monetary policy in Bangladesh are the bank rate, open market operations (OMO), repurchase agreements (Repo) and reverse repo, and statutory reserve requirements (SLR and CRR).

In the institutional context of Bangladesh, reserve requirements refer to the amount of funds that banks must hold with the central bank as a percentage of their total deposits. The reserve requirement is an MP tool that central banks use to influence money supply and credit conditions in the economy. In Bangladesh, the regulatory authority responsible for formulating and implementing MP isthe country's central bank. The BB formulates its MP to achieve price stability, promote sustainable

economic growth, and maintain a stable external sector. Reserve requirements are one of the tools used to achieve these objectives. The BB Order in 1972 and subsequent amendments outline the legal framework governing reserve requirements in Bangladesh. The central bank has the authority to set reserve ratios and specify the types of deposits subject to reserve requirements.

Bangladesh employs both statutory and cash reserve requirements. Banks maintain statutory reserve requirements (SRR) in the form of liquid assets, and the BB determines the required ratio. Cash reserve requirements (CRR) refer to the percentage of total deposits banks must hold in cash with the central bank. Banks are required to calculate their reserve requirements regularly based on the prescribed ratios. The reserve amount can be maintained as cash or approved liquid assets, and banks report their compliance to the BB. Reserve requirements in Bangladesh are used to manage liquidity in the banking system, influence money supply, and achieve broader MP objectives. By adjusting the reserve ratios, the central bank can impact the lending capacity of banks and control inflationary pressures. The effectiveness of reserve requirements in influencing monetary policy transmission depends on factors such as the banking system's liquidity position, interest rate dynamics, and the overall economic environment. The central bank may adjust reserve requirements to align with its MP stance.

Reserve requirements are often used with other MP tools, such as open market operations and policy interest rates. The coordination of these tools allows the central bank to implement a comprehensive MP strategy. The BB periodically reviews the economic conditions and the effectiveness of its MP tools. Based on the review, adjustments to reserve requirements may be made to address emerging challenges or to support economic stability. Understanding the institutional context of reserve requirements in Bangladesh involves consideration of the legal framework, regulatory authority, objectives, impact on monetary policy, and coordination with other policy tools. It reflects the broader efforts of the central bank to maintain financial stability and promote sustainable economic growth (Bangladesh Bank 2022).

## 3. Literature review

This section specifically examines the various attempts in related research to measure and interpret the MP and risk-taking of financial organizations, together with their influencing factors. However, the interrelationship between MP, risk-taking, and Basel II is receiving increased attention; therefore, studies are highlighted that deal with the relationship between MP and risk-taking, Basel II and risk-taking, and MP and Basel II.

### *3.1. MP and bank risk-taking*

Some studies have examined the effects of MP on banks' willingness to take risks. According to Brana et al. (2019), Chen et al. (2017), de Moraes et al. (2016), Djatche (2019), Fu and Luo (2021), Geng and Zhai (2013) and Wu et al. (2022), loosening MP encourages banks to take more risks. Consequently, there is a negative relationship between MP and bank credit risk. However, Brana et al. (2019) found that the association between the reserve requirement ratio, interest rates and bank risk was nonlinear. They also found that there is a positive relationship between interest rates and return on equity. The nonlinear association between MP and bank risk has also been examined, and it

was found that time and the difference between the current and benchmark interest rates were crucial in establishing the link between MP and banks' risk-taking behavior.

On the other hand, it has also been shown that the MP trend is positively correlated with bank credit risk. Mahrous et al. (2020), for instance, evaluated the impact of MP on the risk-taking of banks in Thailand by employing the inflation targeting procedure rate and quarterly balance sheet data of 13 banks that had operated in the country in the previous ten years. According to their study, there was a positive relationship between the policy rate and the risk-taking of banks, and that exceptionally lengthy, low rates of interest also contributed to increased risk-taking.

Hussain et al. (2021) used RRR and BMLR as MP stances for 67 Chinese commercial banks that were in operation between 2000 and 2012; however, our analysis differs from theirs in a number of aspects. We have shown the CRR and BR to illustrate Bangladesh's MP stance. In an empirical investigation of the risk-taking channel, MP is the key variable and of the greatest importance. A few studies (Bashir et al., 2020; Bui et al., 2021; Dell'Ariccia et al., 2017; Demsetz & Strahan, 1997; Hussain et al., 2021; Naqvi & Pungaliya, 2023; Nguyen & Boateng, 2015; Rahman et al., 2015) have examined the effect of bank-level characteristics (such as size, leverage liquidity, age, and capitalization) on the risk channel. Hussain et al. (2021) considered how market structure, stock market return, adverse external financial positions, and excessive lending affected the willingness to take risks.

### *3.2. Basel II and monetary policy*

Basel II affects the activity of banks and other financial institutions by mandating capital requirements for bank exposures. When a bank extends credit, it incurs a portfolio risk (Dell'Ariccia et al., 2017; Malovaná et al., 2019; Matthys et al., 2020; Ngambou Djatche, 2022). Al-Tamimi (2008) outlines the main findings of a survey of Asian-Pacific nations, which aimed to determine the stage at which Asia-Pacific institutions were in their Basel II preparations. Blunden (2005) investigated the Basel II accord from the perspective of global consumers and claimed that the Revised Structure would provide consumers with more information rather than the banking decision. In addition, Blunden mentions that a large number of regulators were endeavoring to comply with Basel II by the internationally proposed December 2006 deadline.

Some studies have investigated the effect of MP on banks' risk-taking under the Basel Accord. When a central bank raises the federal funds rate, the deposit rate rises. Therefore, the bank keeps less total capital for the following period, as the likelihood that the capital limit will bind next period has decreased. In this instance, the bank decides to keep less overall capital, increasing the likelihood that its loans will be curtailed in the following quarter. Therefore, a tightening of MP diminishes the value of retained capital and reduces a bank's future loan-making potential. This results in a "bank capital accelerator effect", separate from the borrower-side financial accelerator. Banks fully expect that MP will be in force permanently, so this drop in overall capital will last for a considerable period. Moreover, the higher the persistence of MP, the greater the future impact of interest rate rises on banks' total capital. This reduces bank profits, an effect which is more pronounced when banks have limited capital. Therefore, banks' value decreases when the principal bank raises the interest rate. In a fully defined model of general stability, the fall in bank prominence resulting from a contractionary MP would lead to a decline in economic activity through the conventional pathways described by (Bernanke, 2000; Chami & Cosimano, 2010). Such a decline in economic activity results in a further

reduction in future offerings by banks, as they discover an additional cause to reduce total capital at present and in the future. As stated, this is because the possibility that the restriction in capital will bind in the future has decreased. The change in total capital leads to additional losses in banks' profitability and market value. Consequently, the two typical consequences of MP, a rise in interest rates and a decline in economic action, would be magnified by the effect of bank capital.

### *3.3. Basel II and bank risk-taking*

There is a close relationship between Basel II and banks' risk-taking behavior. In order to protect themselves from impending uncertainty or loss, all European banks already keep the same level of statutory capital (i.e., a minimum of 8% of risk-weighted total assets) (Čihák & Schaeck, 2007). In accordance with Basel-II, Bangladeshi banks must keep the Minimum Capital Requirement (MCR) at 10% of all risk-weighted assets (RWA) or Tk. 4.0 billion in capital, whichever is greater. The ratio of adequate capital varies among banks in a given nation based on their size, ownership, or efficacy, despite their compliance with the same capital law. In conformity with Basel II, the risk-weighted assets to total assets (RWATA) ratio accurately predicts the capital adequacy ratio. Risk-weighted assets are all the assets minus loans and advances of banks, market-valued government securities, and cash. A higher ratio indicates a greater need for CAR, which increases risk-taking (Avery & Berger, 1991; Gropp & Heider, 2007; Naceur et al., 2018; Ogunmola et al., 2022). A study conducted by Gondwe et al. (2022) demonstrates that while regulations relating to supervisory authority (Pillar 2) and activity constraints enhance liquidity risk, laws pertaining to capital (Pillar 1) and market discipline (Pillar 3) are advantageous in minimizing solvency risk (i.e. reducing bank stability).

Some studies have considered how Basel II restrictions affect conventional banks. Theoretically, Basel II guidelines can encourage sophisticated banks to focus on low-risk defaulters and unsophisticated ones to focus on high-risk borrowers, as demonstrated by (Altunbas et al., 2012; Hakenes & Schnabel, 2011; Sarkar & Sensarma, 2019), who show that small banks are encouraged to take greater risks due to the competitive advantage of larger ones. Studies have supported the idea that capital requirements encourage banks to maintain more conservative asset ranges (Furlong & Keeley, 1989) and others that support the opposite idea regarding the effect of capital necessities on the risk-taking of banks in general (Chami & Cosimano, 2010; Gopalakrishnan et al., 2021; VanHoose, 2008). In addition, several studies have shown, in a broader context, that raising capital requirements results in a decrease in bank lending (Aiyar et al., 2014; Rubio & Carrasco-Gallego, 2016; Veeramoothoo & Hammoudeh, 2022).

Therefore, it is clear that there are positive and negative relationships between monetary policy and bank risk-taking in different economies. This study will re-explore these relationships with consideration of the Basel II effect. The nonlinear relationship between them will also be tested. To the best of the author's knowledge, this is the first study to examine the relationship between monetary policy and banks' risk-taking behavior together with the effect of Basel II using the two-step generalized method of moments (GMM) panel estimator.

## 4. Methodology

Two options are available for GMM estimation: system GMM and difference GMM. We selected difference GMM by Arellano and Bond (1991), based on the (Blundell et al., 2001)

technique for choosing between the two approaches. The pooled OLS approach and fixed effect method should be used to estimate the auto-regressive model. The fixed effect estimation is a lower-bound estimation, whereas the aggregated OLS estimation for the lagged dependent variable is an upper-bound one. If the difference GMM estimation is too near to, or less than, the fixed effect estimation, indicating that the latter is skewed downward due to insufficient instrumentation, system GMM should be considered. The system GMM is effective in this circumstance, as argued by (Blundell et al., 2001; Bond et al., 2001). Similar techniques were employed by (Özşuca & Akbostancı, 2016), who used a similar estimation to empirically evaluate the risk-taking channel in Turkey. Other research has used difference GMM (Chen & Kao, 2014; Hussain et al., 2021; Kabundi & De Simone, 2020). In our investigation, we used difference GMM in accordance with the methodology.

### *4.1. Data*

This study is mostly based on information originating from three secondary sources: Bangladesh Bank's (BB) website, the annual published reports of 33 Bangladeshi scheduled commercial banks, and the World Bank's World Development Indicators. Accounting measures were used for banks' risk-taking. Risk measures and bank-level control variables were collected from the annual published reports of the banks, MP variables from the BB website, and macro-economic control variables from the World Bank's World Development Indicators.

### *4.2. Sampling technique*

There are currently 61 scheduled banks operating in Bangladesh, comprising six commercial banks run by the government and 43 private commercial banks (PCBs), of which 31 are based on interest and eight on Islamic Shari'ah law. There are also nine foreign commercial banks (FCBs) and three specialized banks that do business in Bangladesh. 16 of the PCBs were omitted because they were recently established. We also excluded the nine FCBs and three specialized banks due to data inaccessibility. Therefore, the sample consisted of 33 Bangladeshi commercial banks. A period of 20 years from 2002 to 2021 was covered. An unbalanced panel of 528 bank-level observations was formed due to the fact that data for all institutions was not available for all the years.

### *4.3. Variable definitions*

#### 4.3.1. Main variables

Risk-taking, MP and Basel II were chosen as the three key variables based on the study aims. Two risk variables were utilized: (i) credit risk, as defined by the ratio of nonperforming loans to total loans (NPLTL); and (ii) stability for insolvency risk, an opposite proxy evaluated by the Z-score (LNZ). In their empirical studies, Hussain et al. (2021) and Zheng et al. (2017) make extensive use of both of these variables. A greater NPLTL value indicates a greater credit risk (Changjun Zheng et al., 2017), while a higher Z-score suggests stronger stability (Hussain et al., 2021). The cash requirement ratio (CRR) and bank rate (BR) were used as proxies to measure MP. In addition, to determine the impact of Basel II on the risk-taking of banks in Bangladesh, we adopted a proxy

variable named Basel II, measured by a dummy variable, with the pre-2010 (dummy) variable equal to one, and zero otherwise.

### 4.3.2. Bank level control variables

Based on previous research, we incorporated a variety of bank-specific control factors into the econometric parameters, including size, liquidity, capitalization, and age, which are supposed to have an impact on the association between MP and banks' risk-taking. Bank size was determined by the natural logarithm of total assets, liquidity as the sum of all loans divided by the sum of all deposits, and the capital adequacy ratio by the ratio of regulatory capital to risk-weighted assets. The age of the bank was the period from its inception to a particular year.

### 4.3.3. Macroeconomic control variables

By Mateev et al. (2021) and Aiyar et al. (2016), we also took into account two macroeconomic factors that could affect the endogenous variables: the growth rate of gross domestic product (GGDP) and the annual rate of inflation (INFR). Table 1 shows a list of the variables including their short form, and the measures used in the study.

**Table 1.** Definition of variables and data sources

| Variables | Symbol | Measures | Source/References |
|---|---|---|---|
| **Risk Measures** | | | |
| Risk Credit Risk | NPL | Non-performing loans as a percentage of total loans | (Akhter, 2023; ElBannan, 2015; C Zheng et al., 2017) |
| Stability | LNZ= Z-Score | Z -Score = (CAR + ROA) /SD (ROA) Here, CAR = Capital adequacy ratio, ROA = Return of asset and SD (ROA) = standard deviation of Return on asset | (Haque, 2019; Moudud-Ul-Huq, 2021; C Zheng et al., 2017) |
| Monetary policy (MP) | CRR | Cash reserve ratio | (Hussain et al., 2021; Roy et al., 2023) |
| | BR | Used as bank/short-term interest rate | (Anwar et al., 2023; Khan et al., 2016) |
| **Bank-level variables** | | | |
| Basel II | BASEL | A dummy equal to 1 for a period before 2010 or 2010 and 0 otherwise. | Author calculation |
| Bank size | SIZE | Total assets as a natural logarithm | (Mohammed et al., 2015; Moudud-Ul-Huq, 2021; Ridwan & Mayapada, 2022) |
| Liquidity | LIQ | Total loan & advances to Total deposits | (Das Gupta et al., 2021; Khan et al., 2016) |
| Capital adequacy | CAR | The ratio of regulatory capital to risk-weighted assets is also known as the ratio of capital adequacy ratio. | (Ridwan & Mayapada, 2022) |
| Bank age | AGE | The period from inception to a particular year | Authors' calculation, (Siddique et al., 2021) |
| **Macro-economic Variables** | | | |
| Growth in GDP | GDP | Annual growth in real Gross Domestic Product | (Akhter, 2023; Rahman et al., 2015) |
| Inflation rate | INFR | Annual rate of inflation | (Akhter, 2023; Khan, 2022) |

Source: Author's compilation using the mentioned sources/references.

In line with the approach of Saif-Alyousfi and Saha (2021) and Hussain et al. (2021), the two-step system generalized method of moments (GMM) developed by Arellano and Bond (1991) and Arellano and Bover (1995) was employed. The aim of employing this approach was to address heteroscedasticity (White test for heteroscedasticity) and autocorrelation (Berusch-Godfrey LM test for autocorrelation) concerns in the data. The accuracy of the model was verified by two standard tests, AR 1 and AR 2, and the Hansen test.

#### 4.3.4. Econometric model

In accordance with the purpose of the study, we employed an empirical econometric model applied in other recent studies, including those of Mateev et al. (2023) and Hussain et al. (2021), and with only minor modifications. Two regressions were used to investigate the various aspects of MP and the risk-taking intention of banks with the help of Basel II. The following regression is displayed by our base model:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 MP_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 LIQ_{i,t} + \beta_5 AGE_{i,t} + \beta_6 CAR_{i,t} + \beta_7 GDP_t + \beta_8 INFR_t + \epsilon_{i,t} \quad (1)$$

This equation represents the cross-sectional dimensions across banks and time by subscripts i and t. Two proxies were used to identify the dependent variable (Y): nonperforming lending (NPL) and the bank Z-score. The independent variables were derived from the lagged dependent variable, MP, which is represented by two proxies (BR and CRR). The regression model also includes four bank-level variables, bank size, capitalization, liquidity, and age, to investigate the potential effects of bank characteristics on risk. GDP is the real growth rate of gross domestic product, and INFR is the annual rate of inflation. The baseline model was augmented by incorporating Basel II, the effect of bank-level variables on risk-taking behavior, and the effect of external liquidity constraints.

Now, the extension incorporates the impact of Basel II on bank risk-taking. The paradigm presented in Equation 1 can be further developed as follows:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 MP_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 LIQ_{i,t} + \beta_5 AGE_{i,t} + \beta_6 CAR_{i,t} + \beta_7 GDP_t + \beta_8 INFR_t + \beta_9 BASEL_t + \epsilon_{i,t} \quad (2)$$

To account for non-linearity between MP and bank risk, and to show the joint effect of MP and Basel II, equations 1 and 2 were further expanded:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 MP_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 LIQ_{i,t} + \beta_5 AGE_{i,t} + \beta_6 CAR_{i,t} + \beta_7 GDP_t + \beta_8 INFR_t + \beta_9 BASEL_t + \beta_{10} BR_{i,t}^2 + \beta_{11} CRR_{i,t}^2 + \beta_{12} BASEL_t * BR_{i,t} + \beta_{13} BASEL_t * CRR_{i,t} + \epsilon_{i,t} \quad (3)$$

## 5. Results and discussion

In this section, a comprehensive overview of the statistics is provided in Table 2, together with the findings of the multicollinearity test in Tables 3 and 4. The experiential results in Tables 5 and 6 were obtained using the two-step difference GMM panel estimator. A Hansen over-identification test was also performed to confirm the credibility of the instruments employed. The applied models are scrutinized by AR (2), which tested the null hypothesis that error terms were not serially correlated. The AR (2) results for all the models used in the study show no second-order serial correlation, as indicated by the p-values.

### *5.1. Descriptive statistics*

Table 2 shows descriptive statistics for the sample of 33 commercial banks operating in Bangladesh, comprising 561 observationsfor the main variables, bank-level variables, and macroeconomic variables. The focus here is primarily on the main variables. Bank risk (measured by NPL) has a mean value of 0.0785752, a standard deviation (SD) of 0.1144728, and a range from 0.0009591 to 1.406547. This indicates that there is a significant degree of variation between banks in terms of non-performing loans. Similarly, the Z-score has a mean value of 1.665862, aSD of 0.641135, and a range of −2.27917 to 3.45657. This variation shows that the risk level differs significantly amongst the banks. The mean values of the MP instruments (cash reserve ratio and bank rates) are 0.0537344 and 4.9110873, respectively. The fact that the standard deviations for the MP instruments are 0.0085567 (CRR) and 0.3574305 (BR) indicates that there are minimal variances in the analysis, which indicates that the MP instruments experienced only minor changes during the study period. However, the lowest values are 0.04 (CRR) and 4.00 (BR), indicating that the MP rates were substantially decreased. The highest levels for both rates, 0.065 (CRR) and 6.00 (BR), indicate that monetary policy rates during the study period were not exceptionally high. The descriptive study demonstrates that during this period, MP rates were relaxed. Before more extensive testing, it may be inappropriate to assert that flexible MP encourages banks to assume excessive risk, despite the fact that the descriptive statistics suggest permissive policy rates.

**Table 2.** Descriptive statistics.

| Variables | No. of obs. | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| NPL | 561 | 0.078575 | 0.114472 | 0.00095 | 1.40654 |
| LNZ | 561 | 1.665862 | 0.641135 | −2.27917 | 3.45657 |
| BR | 561 | 4.910873 | 0.357430 | 4.00000 | 6.00000 |
| CRR | 561 | 0.053734 | 0.008556 | 0.04000 | 0.06500 |
| SIZE | 561 | 11.78162 | 1.082483 | 9.07787 | 14.3077 |
| CAR | 561 | 10.51320 | 10.98609 | −108.490 | 22.3200 |
| LIQ | 561 | 0.851916 | 0.130478 | 0.09717 | 1.33007 |
| AGE | 561 | 21.85740 | 10.50447 | 3.00000 | 50.0000 |
| GDP | 561 | 6.197624 | 1.06443 | 3.44802 | 7.88190 |
| INFR | 561 | 6.785061 | 1.68487 | 3.33256 | 11.3951 |

Source: Authors' calculation.
Notes: Max = Maximum Value, Min = Minimum Value, S.D. = Standard Deviation, and Obs. = Observations.

### *5.2. Panel Test of stationarity*

The unit root test is an important step in determining the stationarity of the variables used to perform the panel data analysis. It helps to identify whether the variables are stationary or not, which is important for accurate analysis and modeling. The panel unit root tests are conducted with Fisher-type test statistics (Table 3). The null hypothesis being tested is that the series contains a unit root and that the null hypothesis is rejected in each case at the 5 percent level, and in 6 out of 10 cases easily rejected at the 1 percent level. Given our results, we reject this hypothesis. From the Table 3 it is seen that the value for these test statistics are (269.3086, 180.033, 162.3282, 121.9412, 284.9496, 144.8984, 108.2052, 104.2391, 469.5710 and 309.8023), and in the next column we see the p-value.

This means there are no unit roots in our panels under the given test conditions. Therefore, we can proceed with the two-step difference GMM.

**Table 3.** Panel test of stationarity.

| Variables | Statistics | Probability |
|---|---|---|
| NPL | 269.3086 | 0.0000 |
| LNZ | 180.0333 | 0.0411 |
| BR | 162.3282 | 0.0320 |
| CRR | 121.9412 | 0.0300 |
| SIZE | 284.9496 | 0.0000 |
| CAR | 144.8984 | 0.0000 |
| LIQ | 108.2052 | 0.0008 |
| AGE | 104.2391 | 0.0251 |
| GDP | 469.5710 | 0.0000 |
| INFR | 309.8023 | 0.0000 |

### *5.3. Correlation analysis*

Considering Pearson's correlation coefficient, Table 4 presents the correlation matrix. Correlation analysis seeks to determine whether or not multicollinearity is a problem. (Kennedy, 2008) asserts that a correlation problem occurs when the correlation coefficient between two independent variables exceeds 0.70. As can be seen in Table 3, SIZE and AGE have the strongest correlation (Pearson's correlation = 0.58). Multicollinearity is therefore not a problem in our research.

**Table 4.** Pearson's correlation coefficients.

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NPLTL | 1.0 | | | | | | | | | | |
| 2 | LNZ | −0.04 | 1.0 | | | | | | | | | |
| 3 | SIZE | −0.08 | 0.19*** | 1.0 | | | | | | | | |
| 4 | CAR | −0.66*** | 0.11*** | 0.27*** | 1.0 | | | | | | | |
| 5 | LIQ | −0.28*** | −0.02 | 0.04 | 0.07 | 1.0 | | | | | | |
| 6 | AGE | 0.34*** | 0.13*** | 0.58*** | −0.08*** | −0.28*** | 1.0 | | | | | |
| 7 | BR | 0.01 | −0.25*** | −0.43*** | −0.09*** | −0.15*** | −0.28*** | −0.32*** | 1.0 | | | |
| 8 | CRR | −0.03 | −0.09** | 0.29*** | −0.09*** | −0.03*** | 0.13*** | 0.50*** | 0.39*** | 1.0 | | |
| 9 | GDP | −0.08 | −0.21*** | −0.10*** | −0.08*** | −0.021 | −0.12*** | −0.07* | 0.17*** | 0.47*** | 1.0 | |
| 10 | INFR | −0.12*** | −0.19*** | −0.26*** | −0.05 | −0.04 | −0.22*** | −0.26*** | 0.11*** | 0.10*** | 0.56*** | 1.0 |

Notes: The total number of observations are 561. *, **, *** denote significance at $p < 0.10$, $p < 0.05$ and $p < 0.01$ (2-tailed) respectively. NPL = Non-performing loans to total loans; LNZ = the return on assets ratio (ROA) plus the CAR divided by the SD of ROA defined as a Z-score is another endogenous variable; CAR = Capital adequacy ratio; ROA = Return on assets; LIQ = Liquidity; AGE = Banks' age from the inception of a bank; BASEL = Basel II; BR = Bank rates; CRR = Cash reserve ratio; GDP = Growth in gross domestic products; INFR = Consumer price index.

The table also shows the correlation between the endogeneous variables (NPLTL, LNZ, BR, and CRR) and the association between the endogeneous, bank level and micro-economic variables. Pearson's correlation co-efficient shows that the connection between MP [both proxies] and risk is negative and significant when risk is measured by LNZ and NPLTL, except BR with NPLTL.

Among the bank level variables, SIZE, CAR, and LIQ have negative impact on NPLTL and a positive impact on LNZ, while AGE has a positive effect on risk [both proxies]. All the bank level control variables have negative impact on BR and CRR, but the association between SIZE, AGE, and CRR is positive. Both macro-level variables (GDP and INFR) have an adverse effect on bank risk. Table 4 also shows that there is a correlation that is very low (less than 0.3) and that some correlations are ambiguous, which suggests that there is a need for regression analysis to have a clear identification of the association among the variables.

### *5.4. Regression analysis*

This section analyzes the above-described equations in which RISK, MP, and CAR are endogenous variables. In this study, the Hausman test was used to observe whether or not simultaneity existed. From the p-value of the Hausman test, we can reject the null hypothesis of no simultaneity among the three variables. On the basis of the p-value of the autocorrelation test, the null hypothesis of no autocorrelation can also be rejected. The null hypothesis of homoscedasticity is rejected at a 5% level of significance when a White test (White, 1980) is employed to investigate cross-sectional heteroscedasticity. Hence, the application of ordinary least squares (OLS) estimation is inappropriate in this situation. To know about endogeneity, autocorrelation, and heteroskedasticity, we relied on GMM estimation. Of the two forms of GMM estimation, thistest supports the application of two-step difference GMM. The following section is divided into two parts for simplicity of discussion. The first part illustrates the effect of MP and Basel II on bank risk-taking as measured by credit risk, while the second part focuses on the effect of MP and Basel II on bank stability, as measured by the Z-score.

#### 5.4.1. The influence of MP and Basel II on risk-taking behavior when credit risk is considered

Regarding the impact of MP and Basel II on bank risk, Table 5 shows the results of the eight regression models. The first two models (M1–M2) describe the base line model, and the second six (M3-M8) the extended model. In model M1, the MP proxy is BR, while in model M2 it is CRR. Basel II is included in models M3 and M4. With reference to Table 5, it can be said that MP, as measured by both BR and CRR, has a significant adverse impact on banks' risk-taking. This suggests that when BR increases, banks' credit risk decreases. The same conclusion can be drawn when CRR increases. A possible reason for this may be the reduction in disbursement due to the increase in BR and CRR, with NPL decreasing as a result. These findings are consistent with those of (de Moraes & de Mendonça, 2019), but contrary to the findings of (Mahrous et al., 2020). These results indicate that a 1% in rise in BR would reduce credit risk by 9.3% for Model 1 and 7.7% for Model 4. It is also indicated that a 1% increase in CRR would reduce credit risk by 92.9% for Model 2 and 54.4% for Model 3. The findings for M1 and M2 are different from those of M3 and M4, which is because of the inclusion of Basel in M3 and M4. The impact of the Basel II regulations on credit risk is negative and highly significant, which suggests that the banks is taking lower credit risk than they were in the period before Basel implementation. A possible reason for this may be the pressure from shareholders to advance fewer loans to mitigate the pressure of Basel II implementation. Among the bank-level control variables, CAR has a significant adverse relationship with credit risk, which reveals that banks with more capital have a lower credit risk. Basel II also concludes the same thing.

These findings are similar to those of (Anani & Owusu, 2023; Hakenes & Schnabel, 2011; Jiang & Yuan, 2022; Sarkar et al., 2019). Other bank-level control variables, for instance AGE and SIZE, have no significant influence on banks' credit risk in models M1–M4. On the other hand, LIQ has a significant negative effect on credit risk in all models, which suggests that banks with more liquidity prefer low credit risk. With regard to macroeconomic variables, GDP has a positive effect on banks' credit risk, while INFR has a negative significant effect, which suggests that when GDP increases, banks' lending also increases. As a result, more loans become non-performing, so credit risk increases, while increases in inflation reduce such risk. The p-value of lagged risk is significant for models M1-M4, which suggests that credit risk demonstrates persistency.

**Table 5.** Impact of MP on bank risk-taking behavior (When Risk= NPL).

| Variables | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 |
|---|---|---|---|---|---|---|---|---|
| NPL(-1) | 0.154*** (21.43) | 0.143*** (23.62) | 0.147*** (24.25) | 0.160*** (20.36 | 0.117*** (55.86) | 0.126*** (17.06) | 0.138*** (11.74) | 0.279*** (7.83) |
| BR | −0.093** (−7.13) | | | −0.077** (−5.81) | | | −0.423*** (−18.55) | |
| $BR^2$ | | | | | 0.164*** (17.37) | | 0.153*** (18.22) | |
| CRR | | −0.929*** (−10.77) | −0.544*** (−7.76) | | | | | −0.545*** (−16.47) |
| $CRR^2$ | | | | | | 8.380*** (10.10) | | 0.110*** (12.32) |
| SIZE | −0.003 (−2.36) | 0.001 (0.47) | 0.014 (−2.25) | −0.003 (−2.12) | −0.001** (−1.1) | 0.001** (−3.16) | −0.006** (−24.52) | −0.001** (−12.53) |
| CAR | −0.004*** (−272.57) | −0.005*** (−155.31) | −0.004*** (−9.62) | −.004*** (−70.50) | −0.005*** (−136.98) | −0.005*** (−57.20) | −0.005*** (−37.15) | −0.005*** (−31.41) |
| LIQ | −0.113*** (−13.54) | −0.141*** (−6.06) | −0.096*** (−100.38) | −.133*** (−15.79) | −0.148*** (−17.01) | −0.159*** (−26.34) | −0.151*** (−28.65) | −0.169*** (−25.05) |
| AGE | 0.002 (10.89) | 0.002 (10.8) | −0.002 (−1.21) | 0.002 (19.66) | 0.002*** (18.33) | 0.002*** (23.84) | 0.002*** (18.62) | 0.003*** (22.52) |
| BASEL | | | −0.016*** (−7.45) | −0.002 (1.93) | | | −0.012*** (−8.23) | −0.014*** (−7.35) |
| BASEL*BR | | | | | | | −0.003*** (−8.55) | |
| BASEL*CRR | | | | | | | | −0.240*** (−16.14) |
| GDP | 0.001 (−0.65) | 0.001 (1.16) | 0.001 (2.72) | −0.001 (−6.65) | 0.017*** (16.31) | 0.001 (0.34) | 0.019*** (6.38) | 0.002 (2.81) |
| INFR | −0.003*** (−8.41) | −0.003*** (−17.62) | −0.002*** (−10.46) | −0.003*** (−9.69) | −0.001*** (−5.32) | −0.002*** (−9.78) | −0.001 (−7.64) | −0.003*** (−9.80) |
| Constant | 0.411*** (11.79) | 0.258** (13.48) | 0.*** (2.09) | 0.360*** (6.33) | 0.438*** (15.15) | 0.233*** (19.89) | 0.307*** (4023) | 0.324*** (3.37) |
| AR(1) p-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| AR(2) p-value | .596 | 0.741 | .467 | 0.565 | .687 | 0.562 | .691 | 0.751 |
| Sargan Test (p-value) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen test (p-value) | 0.875 | 0.476 | 0.880 | 0.989 | 0.954 | 0.876 | 0.959 | 0.988 |
| No. of Obs. | 494 | 494 | 494 | 494 | 494 | 494 | 494 | 494 |
| No. of Banks | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |

Notes: The table displays the two-step difference GMM estimate results of Equation (1). NPL, CAR, and MP are endogenous variables. The NPL (−1) is lagged NPL. BR and CRR are the measures of MP, while BASEL is a dummy variable. SIZE, AGE, CAR, and LIQ are bank level control variables, whereas GDP and INFR are macro-economic control variables. In all Models, credit risk (RISK) is the dependent variable which is measured by NPL to TL. The values enclosed in parenthesis represent t-statistics. *, ** and *** indicate the significance level at the 10%, 5%, & 1% respectively.

We further extended the base line and extended models by including the squared value of BR (M5) and CRR (M6) to observe the non-linear association between MP and risk, and by including the product of BASEL and BR (M7), and BASEL and CRR (M8) to show the joint effect of BASEL and MP, as bank risk is controlled by Basel capital requirements. From models M5 and M6, it can be concluded that there is a significant positive association between credit risks and the square of BR and CRR, which suggests that a non-linear association exists between MP and risk. It can be stated that when BR and CRR increase, credit risk decreases, but after a certain point, further increments in BR and CRR mean the credit risk also increases. From models M7 and M8, it can be said that the joint effect of BASEL and MP is significant and negative; that is, banks' risk-taking behavior is primarily influenced by both BASEL capital requirements and MP in Bangladesh. For models M5-M8, risk is persistent, which means banks with high credit risk in the previous period also face more risk in the current period. The table also reveals that large banks face low credit risk. This is due to their ability for diversification in investment because of their high level of assets. Capital and liquidity have a negative and significant effect on bank risk in all models (M1–M8). Regarding bank age, old banks face more credit risk. The effects of GDP and INFR are similar to the base line and extended models. The p-value of AR (2) indicates that there is no second order serial correlation, while the p-value of the Sargan test suggests that the over-identification restriction is valid.

#### 5.4.2. The influence of MP and Basel II on risk-taking behavior when default risk (stability) is considered

Table 6 shows the results of the two-step difference GMM applied to equations (1) and (2). In models M9, M10, M11, and M12, the default risk measured by LNZ, that is, the logarithm of the Z-score, is employed as the dependent variable as a proxy for bank risk. In models M9 and M12, BR is the measure of MP, while in models M10 and M11 CRR is used. The effect of Basel II is shown in models M11 and M12. Table 6 reveals a positive and statistically significant relationship between LNZ and LNZ (−1), indicating that there was persistence in the stability of banks during the study period, and implying that if a bank is stable in the earlier period, it will also be stable in the present year. According to both MP measures, the table reveals a negative and statistically significant relationship between LNZ and MP, showing that when BR and CRR increase, LNZ decreases, which means that the default risk also increases.

Basel II has no significant impact on bank stability, which suggests that the stability of the economic sector prior to and following the implementation of Basel II is indifferent. Among the bank-level control variables, CAR has a significant positive impact on stability, suggesting that banks with a high level of CAR are more stable than those with a low level. Table 6 also shows that the effects of AGE, LIQ and SIZE on bank stability are not statistically significant, except in three cases. The effect of liquidity on stability is positive and significant when BR is used as a proxy for MP, while the effect is not statistically significant when CRR is used as a proxy. This suggests that banks with more liquidity are more stable than those with low liquidity. With regard to macro-economic variables, GDP and IFR have a negative and significant impact on LNZ, which indicates that as GDP and INFR increase, LNZ decreases, which means that default risk increases.

In accordance with the literature, the models were extended further to observe the non-linear association between MP and bank risk (M13 and M14) and to include the joint effect of Basel II and MP (M15 and M16). as it was introduced to mitigate risk in the banking sector. The results demonstrate a nonlinear connection between MP and the default risk of banks. The relationship

between the squared value of BR and CRR and banks' default risk is positive and significant, which suggests that when BR and CRR increase LNZ first decreases, but after further increments it will in fact increase. This suggests that, due to MP, when BR and CRR increase, banks' default risk first increases, but later decreases [see Models M15 and M16].

**Table 6.** Impact of MP and BASEL II on bank risk-taking behavior (When Risk= LNZ).

| Variables | M9 | M10 | M11 | M12 | M13 | M14 | M15 | M16 |
|---|---|---|---|---|---|---|---|---|
| LNZ(-1) | 0.523*** (24.93) | 0.546*** (34.56) | 0.547*** (26.25) | 0.543*** (24.69) | 0.531*** (26.01) | 0.548*** (34.29) | 0.532*** (18.07) | 0.545*** (21.62) |
| BR | −0.931*** (−4.6) | | | −0.761*** (−4.85) | | | −0.316*** (2.66) | |
| $BR^2$ | | | | | 0.579*** (3.42) | | 0.686*** (−4.15) | |
| CRR | | −4.645*** (−3.5) | −7.966*** (−5.34) | | | | | −15.318 (−0.42) |
| $CRR^2$ | | | | | | 40.815*** (−3.29) | | 161.374 (−0.39) |
| SIZE | 0.031 (1.49) | 0.064 (4.82) | 0.005 (0.2) | −0.001 (−0.03) | 0.027 (1.23) | 0.064*** (4.82) | −0.017 (0.64) | 0.049 (1.43) |
| CAR | 0.018*** (10.11) | 0.016*** (8.9) | 0.017*** (8.32) | 0.018* (8.61) | 0.017*** (7.67) | 0.016*** (8.9) | 0.017*** (7.17) | 0.015*** (6.37) |
| LIQ | −0.170** (2.37) | −0.091 (−0.96) | −0.146 (−1.54) | −0.174 (−1.74) | −0.191** (−1.91) | −0.091 (−0.96) | 0.214** (−1.95) | −0.050 (−0.48) |
| AGE | −0.003 (−2.81) | 0.002* (−2.39) | −0.002 (−2.39) | −0.002 (−2.82) | −0.003*** (−2.91) | −0.002** (−2.39) | −0.003*** (−3.01) | −0.001 (−1.1) |
| BASEL | | | 0.173 (4.99) | 0.090 (3.16) | | | −0.125*** (−0.54) | −1.212** (−1.64) |
| BASEL*BR | | | | | | | 0.029** (0.83) | |
| BASEL*CRR | | | | | | | | 26.674** (1.83) |
| GDP | −0.001* (−.08) | −0.017*** (−2.7) | −0.014* (−1.79) | −0.011 (−1.15) | 0.063*** (2.73) | −0.017*** (−2.7) | 0.050** (1.97) | −0.022 (−1.76) |
| INFR | 0.028*** (3.91) | 0.029*** (−5.17) | 0.029*** (−4.73) | 0.031*** (−5.08) | −0.020*** (−3.45) | 0.029*** (−5.17) | −0.036 (−1.34) | −0.018** (−1.94) |
| Constant | 2.147*** (4.22) | 0.543** (2.46) | 1.339*** (3.69) | 2.250*** (5.21) | 2.290*** (4.57) | 0.429** (2.46) | 0.749 (1.26) | 1.503*** (1.73) |
| AR(1) p-value | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| AR(2) p-value | 0.382 | 0.587 | 0.784 | 0.686 | 0.583 | 0.683 | 0.585 | 0.665 |
| Sargan Test (p-value) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen test (p-value) | 0.782 | 0.786 | 0.711 | 0.710 | 0.741 | 0.786 | 0.669 | 0.689 |
| No. of Obs. | 494 | 494 | 494 | 494 | 494 | 494 | 494 | 494 |
| No. of Banks | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |

Notes: The table displays the two-step difference GMM estimation results of Equation (1) and (2). The endogenous variables are MP, CAR, and LNZ. BR and CRR are the proxies for MP. Bank level control factors include SIZE, CAR, LIQ, and AGE. BASEL is a dummy proxy for BASEL II. Macro-economic control variables include GDP, and IFR. The values enclosed in parenthesis represent t-statistics. *,**, and *** indicate the significance level at 10%, 5%, & 1% respectively.

The table also shows that when the non-linear model and the joint effect of BASEL and MP are considered, the effect of SIZE is significant and negative, which implies that large banks hold lower

LNZ, suggesting that they have more default risk. For models M9-M16, CAR and LIQ are not significant factors in banks' LNZ (default risk). In the extended models (M13–M16), bank AGE has a significant positive impact on LNZ, suggesting that older banks tend to have more LNZ and are consequently more stable. The table also reveals that BASEL and MP have a significant and positive joint impact on bank stability, suggesting that BASEL is not alone in influencing bank stability. Therefore, control mechanisms such as MP are required; through MP, banks hold more LNZ than in the period before Basel II. The effect of macroeconomic variables in the extended models shows consistent results, in line with those in the base line and base line extended models. The p-value of AR (2) shows that there is no serial correlation of the second order, while the p-value of the Sargan test suggests that the over-identification restriction is valid.

In summary, it can be concluded that MP has a nonlinear relationship with bank risk in Bangladesh. This suggests that when BR and CRR increase through MP, bank credit risk and default risk first decrease, but later increase. Lagged risk indicates that banks' risks were persistent during the study period. Among the bank level control variables, the results also reveal that banks with greater capital face low credit risk and that large banks face a lower level of credit and default risk. Apart from Model 1, liquidity is positively important in all the other models. This suggests that banks with more liquidity face a lower level of risk, whereas liquidity is not an important factor in bank stability. Likewise, the outcomes of the macroeconomic variables are striking. In accordance with the results of Changjun Zheng et al. (2017) and Zhou and Tewari (2019), but contrary to those of Brana et al. (2019) and Zins and Weill (2017), higher GGDP raises bank risk because banks spend more during economic expansion, resulting in greater risk. Similarly, this would have negative effects on the Z-score. Due to the availability of funds in debtors' hands, the INFR is substantially and negatively correlated with bank credit risk across all credit risk models. Therefore, inflation reduces the risk of private commercial banks and increases their solvency. In our primary models, we excluded the effect of Basel implementation and the findings are unremarkable. This is because of the absence of the Basel effect, as Basel is a capital-based regulation aimed at mitigating bank risk. But when Basel was included in the extended model, the results are surprising, and it is also evident from the findings that Basel II and MP jointly influence banks' risk-taking behavior in Bangladesh.

### 5.4.3. The nonlinear relationship between MP and risk

Some studies demonstrate a nonlinear and quadratic relationship between MP and risk. Incorporating square and quadratic terms of MP into the regressions reveals this fact. We included a squared term of BR and CRR in the extended models, with the results presented in Tables 5 and 6, to consider the nonlinear relationship between MP and risk (stability). After allowing for nonlinearity and quadratic terms, all the models demonstrate a statistically significant relationship between MP and risk when risk is the dependent variable. The tables show that the squared term of both MP measures exhibits a positive association with credit risk and stability (see Tables 5 and 6). This suggests that when BR and CRR increase, banks first face a lower credit risk, but later this increases. The association between the squared value of BR and CRR and banks' default risk is positive and significant, which suggests that there is a U-shaped relationship between the square of MP measures and bank risk, and that when BR and CRR increase, LNZ first decreases, but after further increments it increases. It could therefore be interpreted that due to MP, when BR and CRR increase, bank default risk first increases, but later decreases [see Model M15 and M16]. This conclusion supports

the U-shaped association proposed by (Haris et al., 2020). Interestingly, the squared value of BR and CRR was included in the extended models (M7, M8, M15 and M16), and both credit risk and stability exhibited persistency. All the bank-level control variables and macroeconomic variables have a significant influence on bank risk-taking behavior in Bangladesh.

### *5.5. Robustness and analysis*

**Table 7.** Impact of MP and BASEL II on Bank Risk-taking behavior using alternative measures.

| Variables | M17 | M18 | M19 | M20 |
|---|---|---|---|---|
| LLP (-1) | 0.912***(293.44) | 0.919***(395) | 0.918***(377.3) | 0.908***(240.65) |
| Spread | −0.279***(−16.86) | −0.416***(−33.15) | 1.480**(6.67) | −2.699***(−6.46) |
| $Spread^2$ | | | −22.502***(−8.49) | 12.930***(3.01) |
| SIZE2 | −0.008***(−15.91) | −0.005***(−13.47) | −0.005***(−11.31) | −0.008***(−17.19) |
| EQTA | −0.008***(−33.49) | −0.008***(−33.09) | −0.008**(−25.98) | −0.007***(−20.6) |
| LIQ | −0.032***(−8.61) | −0.028***(−12.14) | −0.029***(−10.06) | −0.033***(−9.99) |
| AGE | 0.001***(20.49) | 0.001***(13.78) | 0.001***(12.89) | 0.001***(24.71) |
| BASEL | 0.007***(12.27) | | | −0.070***(−10.14) |
| Spread*BASEL | | | | 1.494***(11.36) |
| GDP | 0.001***(3.95) | 0.001***(11.34) | 0.001***(6.2) | 0.001***(4.54) |
| INFR | 0.001***(8.91) | 0.001***(7.39) | 0.001***(9.49) | −0.001***(−2.79) |
| Constant | 0.060***(12.32) | 0.051***(14.7) | 0.014***(2.63) | 0.160***(12.78) |
| AR(1) p-value | 0.005 | 0.006 | 0.007 | 0.005 |
| AR(2) p-value | 0.952 | 0.934 | 0.945 | 0.966 |
| Sargan Test (p-value) | 0.000 | 0.000 | 0.000 | 0.000 |
| Hansen test (p-value) | 0.507 | 0.592 | 0.622 | 0.434 |
| No. of Obs. | 527 | 527 | 527 | 527 |
| No. of Banks | 33 | 33 | 33 | 33 |

Notes: The table displays the two-step difference GMM estimation results of Equation (1) and (2). The endogenous variables are MP, EQTA, and LLP. Spread is the proxy for MP. Bank level control variables include SIZE, CAR, LIQ, and AGE. BASEL is a dummy proxy for BASEL II. Macro-economic control variables include GDP, and INFR. The values enclosed in parenthesis represent t-statistics. *,**, and *** indicate the level of significance at 10%, 5%, and 1% respectively.

In order to assess the robustness of the regression results, the baseline and extended models were modified. We first substituted credit risk with loan loss provision instead of the non-performing loan ratio (LLP) as an alternative risk measure. Second, we used spread as a measure of MP instead of CRR and BR, and third, CAR was replaced with the ratio of shareholders' equity to total assets (EQTTA), as an alternative measure of capitalization. Finally, SIZE2 was used instead of SIZE, measured by the number of bank branches. The regression results are shown in Table 7. All the estimates support our previous findings. We observe that risk is persistent, and that the interaction between MP and LLP is significant and negative, suggesting that an increase in spread reduces bank risk. The squared value of spread exhibits a U-shaped relationship between MP and risk, which supports the previous findings. Therefore, our key findings are similar to previous findings, with a few exceptions; for instance, banks tended to have a greater liquidity risk during the pre-2010 period before Basel II than during the post-2010 period, whereas there was no such correlation for credit risk. The necessity to maximize investor capital in order to produce more revenue than its costs during the Basel II period before 2010, which was supported by depositors, is a valid reason for this. Similarly, the application of EQTA reveals the possible outcome for all the models. Similar to Table 6, the coefficients of the MP variables are virtually identical here. Although the primary regression

findings are different from the coefficient of EQTA for this risk model, the difference is not statistically significant. This evidence indicates that one macroeconomic variable alone does not have a significant impact on bank risk. Almost all the main variables, and all the control variables, and macroeconomic variables exhibit similar signs of associations, which suggests that our model is robust when alternative measures of the different variables were used.

## 6. Concluding remarks and policy implications

This study has investigated the association between bank risk and MP in developing a country, with consideration of the role of Basel II. The most up-to-date comprehensive data from Bangladesh covering the period 2002 to 2021 were used. To account for endogeneity between MP, capital, risk, heteroskedasticity, serial correlation, and cross section dependency, difference GMM was employed in the analysis. The appropriate tests suggest that difference GMM was suitable in our case. The main results show that there was a significant impact of MP on banks' risk-taking, and that the relationship between MP and bank risk is U-shaped, suggesting that banks face low risk when BR and CRR increase, but after a certain point and further increments in BR and CRR, the risk increases. The inclusion of Basel II in the model makes it fit, indicating that MP and Basel II capital regulation jointly effect bank risk. Regarding the effect of Basel II, the results suggest that banks took fewer risks than before its implementation, meaning it was successful in encouraging banks to reduce risk. The findings also reveal that MP, together with Basel II, motivates banks to reduce credit risk and to increase stability (LNZ) compared to the period before Basel II. It can be said that, to control credit risk and to increase stability, Basel II should be followed by a control mechanism such as MP.

With regard to the bank level control variables, bank size has a negative significant influence on both credit risk and stability, suggesting that large banks take on less risk than smaller ones, and that the stability of large banks is lower than that of small banks. As expected, capitalized banks face low credit risk, which is the ultimate objective of Basel capital regulations. Surprisingly, it is suggested that the level of risk taken by a bank does not have a notable impact on its overall stability. In addition, more liquid banks face a low level of credit risk, but liquidity is not an influential factor in bank stability. The positive and significant association between risk and bank age indicates that older banks face more credit risk than younger ones, and that the effect of liquidity on bank stability is not statistically significant. Finally, regarding the macroeconomic variables, the results reveal that economic growth has a positive and significant impact on banks' credit risk, but that inflation has negative significant impact. The effect of GDP on bank stability is negative and significant, while the impact of INFR is positive and significant.

The findings point to extremely beneficial implications for stakeholders such as policymakers, regulators, stockholders, financial analysts, and researchers. We have demonstrated that MP and capital-based Basel regulations are crucial in controlling credit risk. With effective MP and capital-based regulations, banks can be incentivized to take fewer risks, thus maintaining greater capital stability. Second, because Basel II has the potential to affect both banks' internal management policies and market factors, banks should evaluate its multiple implications. Third, Basel II requirements should be enforced and priority given to large banks with inadequate capitalization. Finally, regulators are shown to have a lack of supervisory control over the risk-taking behavior of banks, as the results indicate a clear relationship between market capitalization and risk. Therefore, the study indicates that there is evidence to support the fact that expansionary money supply

stimulates bank lending, while a contractionary monetary policy has the opposite effect. This suggests that changes in money supply can influence bank lending and real sector economic activity in developing countries. Additionally, the findings reveal that high monetary policy rates discourage bank lending in such countries. To overcome these limitations, policymakers need to develop the financial system by removing financial inflexibilities and establishing quality institutional settings. This study also highlights the importance of meeting the minimum capital adequacy ratio, as this is a crucial determinant of bank lending in developing countries such as Bangladesh. Finally, this study shows that a high inflation rate discourages lending in such countries due to the uncertainty and asymmetric lending behavior created by high and volatile inflation.

Future research could be conducted which considers the impact of corporate governance mechanisms on the relationship between MP and banks' risk taking. Research could also include, for example, the influences of ownership structure, ownership concentration, institutions' shareholding, and sponsors' shareholding on the association between bank risk and MP. Further research could also be conducted by considering cross-country data and the effects of Basel III, which is now in force in the banking sector of Bangladesh as well as in other countries.

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**Conflicts of interest**

The authors declare no conflict of interest.

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