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Article

Relationship among cost of financial intermediation, risk, and efficiency: Empirical evidence from Bangladeshi commercial banks

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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Relationship among cost of financial intermediation, risk, and efficiency: Empirical evidence from Bangladeshi commercial banks

Anupam Das Gupta^{1*}, Niluthpaul Sarker² and Mohammad Rifat Rahman³

Abstract: The global financial crisis and stiff market competition enhance risk exposures that raise debate on the cost of financial intermediation and the supremacy of banks' efficiency. This study examines the concurrent effects of bank risk, efficiency and cost of financial intermediation of Bangladeshi commercial banks. The Two-Step System GMM (2GMM) estimators of unbalanced dynamic panel data of 32 commercial banks from 2000 to 2016 addresses key factors rigorously in the light of bank-level, industry-level, and macroeconomic-level phenomenon. Efficiency gains cost the spread of banks' financial intermediation, and risk-taking negatively affects the return. Cost-efficient banks are taking more credit risk; however, more efficiency gains reduce banks' risk substantially. Size (cost of intermediation) of banks positively (inversely) affect the risk-taking (efficiency) behaviour of banks. Market competition enhances the risk and efficiency and reduces banks'



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Photograph of the Corresponding Author
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PUBLIC INTEREST STATEMENT

This study explores the relationship of net interest margin, risk and efficiency of commercial banks in Bangladesh. This study's findings examine that banks with low-interest margins are more efficient than banks with high-interest margins. Again, the risk of banks has a detrimental effect on the net interest margin. In the risk and efficiency relationship, we observe that efficient banks are taking more risk than inefficient counterparts. Moreover, size and market competition have an apparent effect on banks' net interest, risk, and efficiency; and these effects are not similar over time. This research presents the simultaneous relationship between risk, efficiency and intermediation cost of banks as a sample developing country of Bangladesh with size and market competition effect

interest spread. Finally, the Nonlinear effect of size and market competition is heterogeneous on risk, efficiency, and financial intermediation cost that follows a U-shape curve. This study explicitly addresses two issues: simultaneous effect of financial intermediation, bank risk, and efficiency and validated the nonlinear relationship considering size and market competition effect.

Subjects: Finance; Banking; Credit & Credit Institutions; Investment & Securities

Keywords: Cost of financial intermediation; risk; efficiency; GMM estimators; market competition

JEL classifications: C2; D61; G17; G21.

1. Introduction

Commercial banks, the critical matchmakers of fund flow, intermediate capital from surplus to deficit units, and confirm the economic growth with their efficient intermediation (Demirguc-Kunt et al., 2003; Zheng et al., 2018b). However, a growing number of banks enhance the competition that force banks to ensure their efficiency. Numerous studies (Gupta & Moudud-Ul-Huq, 2020; Zheng et al., 2018a) show that the banks' continuous regulatory pressure to control risk for keeping consistent growth is the prime concern of regulators and other stakeholders. Risk and efficiency are a long-debated issue in literature with bidirectional relationship examination (Zheng et al., 2017a, 2018b). The cost of financial intermediation (henceforth CFI), efficiency, and risk concern has examined empirically; but yet to be addressed their inter-dependencies in the literature. Thus, it becomes increasingly essential to delve into relationships among these commercial banks' stimuli, i.e., CFI, risk, and banks' efficiency, to gain new insights. This study investigates the concurrent relationship between the cost of financial intermediation, risk, and efficiency of Bangladeshi commercial banks and examines the intermediating effect of size and market competition.

The term Cost of Financial intermediation (CFI) refers to the net interest margin between the income on loan and advance and cost paid to banks' savers (Al-Jarrah, 2010; Bernanke, 1991). CIF is an increasingly important aspect that needs to address risk and efficiency, particularly in developing countries' perspectives (Al-Jarrah, 2010). Al-Jarrah (2010) argues that the cost of financial intermediation has significantly contributed to improving market competitiveness and mobilizing efficiency in the financial system. Fair market competition will give market power to the highly capitalized and large-sized banks to crammed down the other counterparts and dominate in loan pricing due to their low cost of capital (Brock & Franken, 2002). The landmark initiative of the dealership model by Ho and Saunders (1981) mentions risk, market competition, transaction size, and interest rate fluctuation are significant determinants of the cost of financial intermediation. Therefore, from this debate, it is clear that financial intermediation's cost has a significant association with the market competition, which simultaneously affects banks' loan pricing and risk-taking. Furthermore, in such a condition, efficiency becomes an significant consideration as increasing market competition leads to reduce the investment in information acquisition (Hauswald & Marquez, 2006). Therefore, relationship among the CFI, risk, and efficiency demand the empirical examination having size and market competition effect.

The growing number of banks increase market competition in Bangladesh, especially with banks' inclusion in different generations. Moreover, over time, the increasing trends of bank's size and solid capital base gave the extra pick to old generation banks to deal with competition and regulatory changes in the market. The increasing trend of net-interest margin (see Chart 1), the inconsistent growth of expenditure to income ratio (see Chart 2), and volatility in bank's profit margin (ROA and ROE in Chart 3 and Chart 4 respectively) have a continuous improvement of NPLs (Non-Performing Loans) till 2011, and there-after NPLs moved with a growing tendency. The empirical evidence based on prior literature and numeric figures from the bank performance motivates us to research the bidirectional effect of CFI, risk, and commercial banks efficiency. Moreover, the performance gap between the State-owned Commercial Banks (SCBs) and the Private Commercial Banks (PCBs) clarifies

the relevance of banks' efficiency, risk, and profitability through trend analysis. A synopsis of the performance of the banking industry of Bangladesh is depicting under section 2.

The study is constructed based on the relevant issues to address the following questions: (i) Is there any association among CFI, banks' risk and efficiency? (ii) Do nonlinear and quadratic effects of size and market competition valid in the examination of risk, cost of intermediation and efficiency relationship?

The study encouraged to carry out the research work for the following reasons. Firstly, to shed light on bidirectional intermediation among risk, efficiency, and cost of financial intermediation to evident a new fact regarding Bangladeshi commercial banks. The existing literature does not sufficiently focus on the impact of the cost of financial intermediation in the risk-taking of commercial banks in developing countries like Bangladesh. Moreover, examining the simultaneous relationship of risk, efficiency, and cost of financial intermediation is not observed in the available literature. Secondly, to explore the size and competition effect on risk, efficiency, and cost of financial intermediation. Finally, extending the previous work of Rahman et al. (2018) by adopting performance measure- efficiency and examining the nonlinear and quadratic effect, depicts new insights into the Bangladeshi banking industry.

The rest of the study is organized as follows. Section 2 presents the institutional framework of the banking industry of Bangladesh, and Section 3 describes the relevant literature of the study; Sections 4 illustrates the data, variables description and empirical methodology of the study. Finally, Section 6 presents the empirical results explaining the relationship between risk, efficiency, and cost of financial intermediation with nonlinear and quadratic effects and Section 7 contains the concluding remarks.

2. Banking industry of Bangladesh

Previous studies focus on the developing country context, primarily concentrating on the South Asian region's emerging economies. Undoubtedly, Bangladesh is set its reflexive image in the marketplace due to rapid growth and higher potentiality in the regional economy. Till December 2016, the banking industry has operated with fifty-six (56) schedule banks, consists of six (6) state-owned commercial banks (SCBs), thirty-nine (39) private-commercial banks (PCBs), nine (9) foreign-commercial banks (FCBs) and two (2) development finance institutes (DFIs). The financial market (money market) of Bangladesh is under full supervision and control of Bangladesh Bank as per Bangladesh Bank Order, 1972. In Table 1, it is found that the state-owned commercial banks (SCBs) and private-commercial banks (PCBs) play a significant role in the market in terms of size (number of branches and asset holding) and also in deposits.

From the year 2000 to 2016, it is found that PCBs generate more interest income than SCBs (Chart 1). The reason may be the efficient management of PCB through more inclusion of the ultimate consumers. Furthermore, SCBs are less efficient as they incur more expenditure compared

Table 1. Banking system structure (Year 2016)

(BDT. in billion)

Bank types	Number of Banks	Number of branches	% of industry assets	% of deposits
SCBs	06	3700	26.1	29
PCBs	39	4271	67	63.8
FCBs	09	75	4.5	4.3
DFIs	02	1407	2.5	2.9
Total	56	9453	100	100

Source: Bangladesh Bank annual report.

to their income. The Expenditure-Income Ratio in Chart 2 below shows that PCBs always keep their ratio lower than the industry average. In contrast, SCBs exceed the line in all cases, which indicates their inefficiencies in operation.

Return on Assets (ROA) and Return on Equity (ROE) are widespread measures of profitability. Chart 3 showed that the average ROA of Bangladesh’s banking industry from 2000 to 2016 fluctuates due to immense market pressure. The trend of ROA has drastically fallen in 2012 due to the world economic crisis in 2010. The SCBs performance worsens in contrast with PCBs. Similar results also found in the ROE case (Chart 4), where SCBs confirm their inefficiencies, which finally affect the bottom-line figure.

The non-performing loan ratio (NPLTL) is the ratio between non-performing loans to total loans. Chart 5 below gives fascinating findings that the proper implementation of risk management guidelines (i.e., Basel I, II, and III) gradually reduces the NPLTL. The emergence of capital regulation plays a vital role in keeping the NPLTL minimum. However, PCBs show their efficiencies to maintain lower NPLTL in contrast with SCBs. The reason is that SCBs mainly granted their loans in the unproductive sectors for the welfare of society to keep the political promises of the government.

Chart 1 Net Interest Income

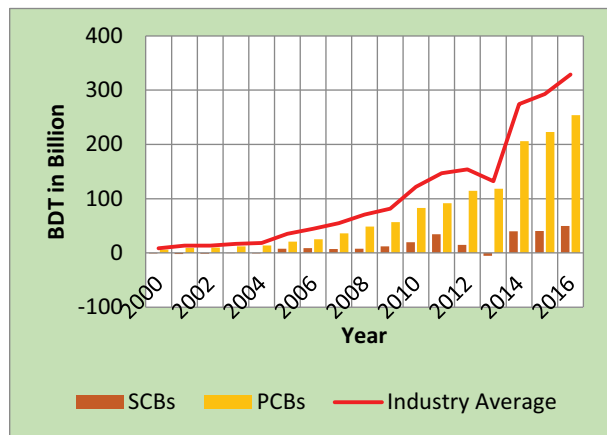


Chart 2 Expenditure-Income Ratio

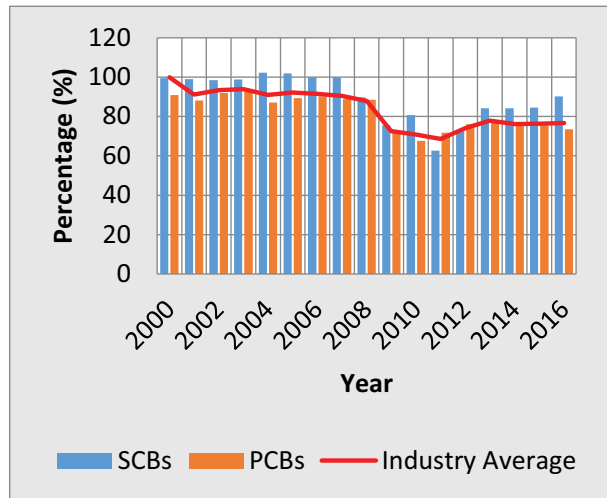


Chart 3 Return on Assets (ROA)

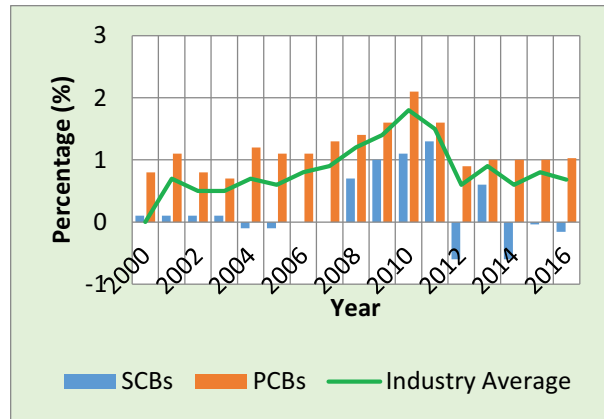
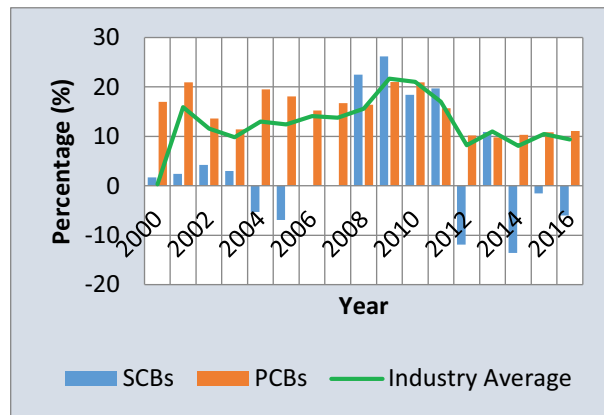


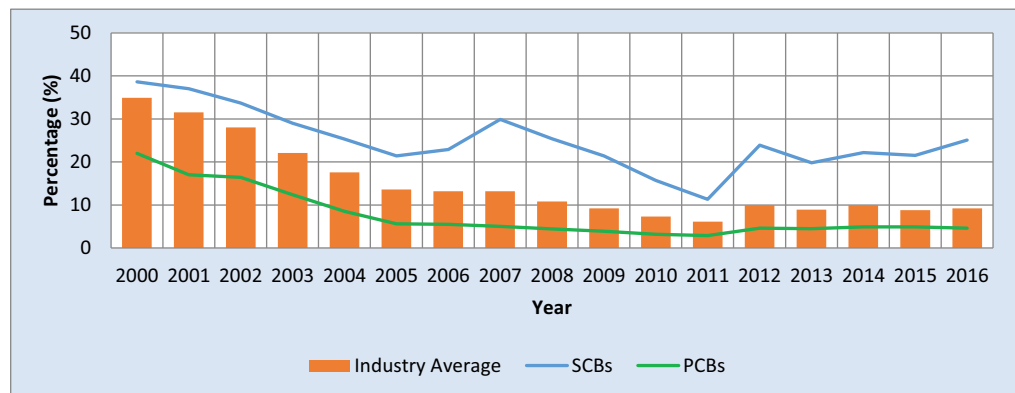
Chart 4 Return on Equity (ROE)



3. Literature review

A comprehensive survey of literature on the cost of financial intermediation, risk, and commercial banks' efficiency is discussed in this section. At first, we investigate the studies relating to the cost of financial intermediation, and in the next, studies explaining the relationship between risk and efficiency are also discussed.

Chart 5 Non-performing loan ratio.



3.1. Literature regarding the cost of financial intermediation

The cost of financial intermediation refers to the benefit derived from the fund mobilization of a bank (Al-Jarrah, 2010). Thus CFI evaluation is related to the profitability and performance of banks. The concept of cost of financial intermediation discussed in the landmark initiative of Ho and Saunders (1981) in their dealership model (Islam & Nishiyama, 2016). Ho and Saunders (1981) argue that the net interest margin derived from banks' intermediacy service. The net interest margin is the gap between the interest charged against loans and advances and the cost incurs against the deposit. The study of Ho and Saunders (1981) pinpoint four factors for the optimum level of cost of financial intermediation. These are the magnitude of banks' risk-taking tendency, market power or competitive condition of the market, transaction size, and interest rate volatility. Extending Ho and Saunders (1981) models, Cruz-García and Fernandez de Guevara (2020) incorporate regulatory capital and deposit insurance as active determinants that positively influence the cost of financial intermediation of OECD countries. They also point out operating cost, market competition, efficiency as determinants of cost of financial intermediation.

However, criticism also moves out, mentioning the limitations of Ho and Saunders (1981) model. Lerner (1981) slated the dealership model due to its failure to address cost inefficiency as a detrimental factor in the cost of financial intermediation. Based on the dealership model's extension, Allen and Santomero (1998) opines that the interest rate spread depends on the loan portfolio's heterogeneity and proper maturity intermediation of deposits. The author has addressed the portfolio effect in the margin determination of interest. Extending the dealership model on European countries, Maudos and Guevara (2004) incorporate the total operating cost and show the significant impact of the cost of intermediation in risk-taking of banks. Angbazo (1997) argues that financial intermediation's benefit reflects both credit risk and interest rate risk premia of commercial banks. However, due to more concentration of short period asset exposures and off-balance sheet hedging instruments, interest margin is mainly affected by banks' credit risk. From the literature, it is apparent that risk is a significant factor in determining the cost of financial intermediation.

Literature digging the determinants of the cost of intermediation of banks is also observed apart from the relationship between risk and cost of financial intermediation. Working on lower-income countries, Poghosyan (2013) addresses the cost of financial intermediation through the net-interest margin. The author shows that the cost of mediation increases with the riskier loan portfolio and size. The inverse relationship between bank capitalization and interest margin is also evident in this study. The author points out that high market power, low level of competition, and institutional weakness play an active role in the higher financial intermediation cost.

From the study of 142 Brazilian banks, Afanasieff et al. (2002) address both bank-level and macro-economic variables as determinants of interest margin spread. The authors address size, opportunity cost, operating cost as banks level variables, output growth, inflation, the market rate of interest, and the volatility of interest rate pointed out as macro-economic variables that affect the net interest margin. Khan and Jalil (2020) depict operating cost, tax, market competition, interest rate risk, and macroeconomic factors like money supply, risk-free return of the market, national saving positive association with cost of financial intermediation of banks. Whereas operational exposure, credit risk, inflation inversely affect the determination of the cost of financial intermediation. Therefore, industry conditions like the market power of banks and macro-economic factors play an active role in determining the cost of financial intermediation. Sirait and Rokhim (2019) point out regulatory capital as a significant determinant of banks' cost of financial intermediation and risk-taking. The authors assert that incremental regulatory capital requirement reduces the risk-taking and cost of financial intermediation of banks.

Consideration of the cost of financial intermediation is also significant in determining the financial institution's sound health and stability. Angori et al. (2019) mention the cost of financial intermediation as a gauge of banks protecting health and stability. They argue that regulatory and institutional settings also significantly affect market competition, efficiency level, risk, and

capitalization. Post arguments of the dealership model say Lerner (1981) justifies the relevance of efficiency in consideration of the cost of financial intermediation.

3.2. Literature regarding risk and efficiency of commercial banks

Although literature stresses a diversified relationship between commercial banks' risk and efficiencies, the general expectation against efficiency enhancement is that banks' risk managing capacity will be accelerated (Zheng et al., 2017a). So, a negative relationship is expected to observe. An empirical investigation of H. T. Phan et al. (2019) on East Asian countries preaches that banks' stability increases with efficiency enhancement. Berger and DeYoung (1997), Deelchand and Padgett (2009b), Fiordelisi et al. (2011), Nguyen and Nghiem (2015), and Kwan and Eisenbeis (1997), among others also point out the inverse association between risk and efficiency. Mentioning efficiency as a significant determinant of credit risk, Berger and DeYoung (1997) opine that administrative cost against loans and advances adversely affect banks' cost efficiency.

Again Kwan and Eisenbeis (1997) and Deelchand and Padgett (2009b) support the moral hazard hypothesis¹ for the adverse rapport between efficiency and risk. Keeping the "Bad Management" hypothesis², Fiordelisi et al. (2011) opine that banks' risk is subject to low cost and revenue efficiency. The "Bad Management" hypothesis is also evident in the study of Partovi and Matousek (2019). The authors stress the inverse effect of non-performing loan over the efficiency of banks. However, the efficiency of banks is not found homogeneous across different ownership structure. Similar outcomes also support the examination of intertemporal relationship risk and efficiency. Saeed et al. (2020) opine that the effect of efficiency on risk-taking is not homogenous across different banks' ownership. They observe a positive impact of efficiency on Islamic banks' risk-taking where inverse association with conventional banks. However, the authors mention capital as a dominant determinant in managing risk of commercial banks.

Investigating Indian banks, Nguyen and Nghiem (2015) pinpoint the technological advancement behind banks' cost efficiency. Salim et al. (2017) point out political interference as one of the significant reasons for loans becoming bad. They comment that although banks' efficiency increases over time, the investment quality decreases due to political interference in the loan approval. Again bad loan is negatively related to the efficiency of banks. Industry-level variables like market competition and macroeconomic condition also mediate the relationship between risk and efficiency of banks. Validating the competition fragility view, Danisman and Demirel (2019) opine that superior market power inversely affects banks' risk-taking tendency. Their study also supports regulatory capital restriction as a risk-mitigating tool. Harimaya and Ozaki (2021) examine the impact of diversification on the efficiency of banks. Opposing the market power, the authors opine that banks' overemphasizing on loan and income concentration efficiency decreases. Therefore, portfolio diversification is playing a significant role in enhancing the efficiency of banks.

Pointing differently, Chen and Lu (2021) focus on macroeconomic and regional disparities in determining the efficiency of commercial banks of China. The authors observe a significant impact of regions and macroeconomic factors like GDP per capita on cost and profit efficiency of commercial banks

Previous literature covers the apparent effect of risk on the cost of financial intermediation. Studies also observed pointing out the relationship between risk and efficiency of banks. However, there is a scarcity of literature addressing the simultaneous examination of the cost of financial intermediation, risk, and commercial banks' efficiency.

To assess the relationship between CFI, risk, and efficiency, the relevant hypotheses are drawn:

H₁: There is an association between the cost of financial intermediation, bank risk-taking, and cost-efficiency.

H₂: There is a nonlinear quadratic effect of size and market competition on the cost of financial intermediation, bank risk-taking, and cost-efficiency.

4. Methodology of the study

Description of Data and Variables

4.1. Data collection and definition of variables

This study composes bank-level variables of 32 commercial banks in Bangladesh collected from the audited financial statements over 2000–2016. After excluding the missing years' data, 480 unbalanced panel observations have taken for the study. The macroeconomic and industry-level variables collected from the World Bank database. In the remaining part of this section, the cost of financial intermediation, risk, and efficiency measures are described. Then the description of other relevant variables is included.

4.2. Definition of Variables

4.2.1. Cost of financial intermediation

In this study, two alternative proxy measures of the cost of financial intermediation are used; the ratio of net interest income to average total assets (CFI_1) and the ratio of net interest income to average earning assets (CFI_2). A higher proportion of these variables refers to the higher cost of financial intermediation and vice versa.

$$\text{Cost of Financial Intermediation}(CFI_1) = \frac{\text{Net interest income}}{\text{Average total assets}}, \text{ and}$$

$$\text{Cost of Financial Intermediation}(CFI_2) = \frac{\text{Net interest income}}{\text{Average earning assets}}$$

4.2.2. Risk measures

Three risk measures opted to address credit risk, stability risk, and total risk of commercial banks.

NPLTL: Following the literature of Gupta and Moudud-Ul-Huq (2020), Zheng et al. (2018b), Farruggio and Uhde (2015), Pan and Wang (2013), and Liang et al. (2013), we have determined the credit risk using the ratio of non-performing loan to total loans and advances (NPLTL) of the sample banks over the period. The higher the ratio of NPLTL, the higher the credit risk, i.e., risk of loan defaults.

$$NPLTL = \frac{\text{Total Non – performing Loan}}{\text{Total Loan}}$$

Z-score: The Z-score addresses stability risk. The ratio of Capital adequacy ratio (CAR) plus return on asset (ROA) to standard deviation of ROA of consecutive three years denotes the Z-score.

$$Z - \text{score} = \frac{(CAR + ROA)}{\delta(ROA)}$$

Following the study of Gupta and Moudud-Ul-Huq (2020), Zheng et al. (2017a), Jeon and Lim (2013), Craig and Dinger (2013), and Abedifar et al. (2013), we also use the Z-score to encounter the stability risk of banks. Z-score is the inverse measure of stability risk. The higher the ratio, the lower the insolvency, and the more banks' stability (Roy, 1952). Detailed measurements explain in Table 2.

LLPTA: Loan loss reserve ratio captures the past performance and expected future performance (Abedifar et al., 2013). Supporting the previous study of Gupta and Moudud-Ul-Huq (2020), Zheng

et al. (2017a), and Abedifar et al. (2013), this study also uses the loan loss provision to total loan (LLPTA) to address the total risk of banks. A higher ratio of LLPTA refers to the high overall risk of banks and vice versa.

$$LLPTL = \frac{\text{TotalLoanLossProvision}}{\text{TotalAssets}}$$

4.2.3. Efficiency measure

Inspiring from the study of A. Kasman and Carvallo (2014), Gupta and Moudud-UI-Huq (2020), and Zheng et al. (2018a), we also use Cost efficiency measure through Stochastic Frontier Analysis (SFA) to represent the efficiency of banks. Using the Software FRONTIER version 4.1 from banks level data, we measure the efficiency cost. The estimation details are explained in Appendix A. Description of dependent and other variables are illustrated in Table 2.

4.3. Empirical research framework

This study opts for the System Generalized Method of Moments (GMM) approach to investigate the panel data estimation in examining the relationship among the cost of intermediation, efficiency, and risk of Bangladesh's banking sector. The unbalanced panel data estimation allows a variety of scope for selecting an appropriate method in statistical approximation. It also supports increasing the number of observations by the multiplication of cross-sections (i) and time periods (t) (Asteriou & Hall, 2007). The simultaneous equations are drawn to judge the "back and forth" causation of variables applies. System GMM suggested by Arellano and Bover (1995) and Blundell and Bond (2000), is applied for our dynamic panel data to address the endogeneity and unobserved heteroskedasticity and autocorrelation problems of the model (Baselga-Pascual et al., 2018; Gupta & Moudud-UI-Huq, 2020; Moudud-UI-Huq et al., 2018; Zheng et al., 2018a). The empirical model of the study is structured as follows:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \sum_{j=3}^4 \beta_j X_{i,j,t} + \sum_{m=5}^6 \beta_m X_{i,m,t} + \sum_{n=7,10,12}^{9,11,15} \beta_n X_{i,n,t} + \varepsilon_{i,t} \quad (1)$$

Where " $Y_{i,t}$ " represents the dependent variables risk, efficiency, and cost of financial intermediation. The subscript "i" refers to the cross-sectional dimension across banks, and subscript j,m,n indicates macro-economic, industry-level, and bank-level control variables, respectively. "t" denotes the time dimension (i.e., t = 2000, 2001, 2002, ... , 2016). One year lagged dependent variable represented by $Y_{i,t-1}$.

The macroeconomic control variables are the growth of gross domestic products (GGDP) and inflation presented by $X_{i,j,t}$. The " $X_{i,m,t}$ " represent the industry level control variables: banking sector development (BSD) and Competition measures (BI) at t period. The $X_{i,n,t}$ present the banks level control variables of bank i at t period. Bank-level control variables are equity to total assets (ETA), size, loan to total assets (LTA) for the risk measures. Size, deposit to total assets (DTA), return on assets (ROA), and off-balance sheet items to total asset (OBSTA) for the efficiency measures; and size, revenue diversification (RD) are used to measure the cost of financial intermediation.

In equation (1), the presence of lagged dependent variables makes the panel dynamic, which will produce a biased and inconsistent estimation of OLS regression in the simultaneous equation. The diagnosis of preliminary test results instigated the method selection of panel data processing. The study has found that the regression estimates are restricted due to the existence of heteroskedasticity (White Test), autocorrelation (Breusch-Godfrey Serial Correlation LM Test) and endogeneity (Durbin-Wu-Hausman test) problem. Moreover, the Hausman specification test (Hausman, 1978) is performed to compare the random effect (RE) estimates with fixed effects (FE), which refers that the null hypothesis is rejected, i.e., the fixed-effect model is appropriate. Therefore, the fixed-effect model with endogeneity in dynamic panel stimulates to use of the system GMM estimates for unbiased and consistent results. The discrepancies in unobserved and bias estimation are significantly addressed by

Table 2. Description of variables of the study

Classification	Variable	Description	Source
Dependent Variables:			
Risk measures	NPLTL	Non-performing loan to total assets (Non-performing loan refers to the classified loans and advances)	Farruggio and Uhde (2015), Liang et al. (2013), Beck et al. (2013), Pan and Wang (2013), Abedifar et al. (2013).
	Z-score	Z-score = $(\frac{CAR+ROA}{\delta(ROA)})$, Where ROA is an annual return on assets, and CAR is the capital adequacy ratio reported in the annual reports. The standard deviation of ROA = $\delta(ROA)$ is calculated over 3-year overlapping periods.	Farruggio and Uhde (2015), Beck et al. (2013), Pan and Wang (2013), Craig and Dinger (2013), Abedifar et al. (2013).
	LLPTA	LLPTA is the ratio of loan loss provision to total assets	Gupta and Moudud-Ul-Huq (2020), Aggarwal and Jacques (2001), Bougategf and Mgdmi (2016).
Efficiency measure-	EFF_C	The efficiency of cost measured through SFA (see Appendix A)	Zheng et al. (2018b), Gupta (2018), Harimaya and Ozaki (2021).
Cost of financial intermediation measures	CFI ₁	Ratio of net interest income to average total assets	Ashraf (2017), Islam and Nishiyama (2016).
	CFI ₂	Ratio of net interest income to average earning assets	Aysen Doyran (2013), Naceur and Kandil (2009)
Independent Variables:			
Industry-level variables:			
	BSD	Banking industry asset to gross domestic product	Gupta and Moudud-Ul-Huq (2020), Moudud-Ul-Huq (2020). Data source: World Bank data: Global Financial Development (web: http://databank.worldbank.org)
	BI	Boone Indicator: Competition proxy; a measure of the degree of competition	Gupta and Moudud-Ul-Huq (2020), Zheng et al. (2017a). Data source: World Bank data: Global Financial Development (web: http://databank.worldbank.org)
Macroeconomic variables:			
	GGDP	The growth of real gross domestic product	Zheng et al. (2017b), Moudud-Ul-Huq (2020). Data source: World Bank data: World development indicators (web: http://databank.worldbank.org)
	Inflation	Inflation, GDP deflator (annual %)	Zheng et al. (2017b), Gupta and Moudud-Ul-Huq (2020). Data source: World Bank data: World development indicators (web: http://databank.worldbank.org)
Bank-level control variables:			
	ETA	Ratio of equity to total assets	Tan and Floros (2013), Lee and Chih (2013), Athanasoglou et al. (2008), Amidu and Hinson (2006), Kwan and Eisenbeis (1997).
	Size	The logarithm of total assets	Goddard et al. (2004), Molyneux and Thornton (1992), Akhavein et al. (1997)
	ROA(%)	Return on assets	Davis and Mathew (2017), Klein and Weill (2017), Javaid (2016), Tan (2016), Djalilov and Piesse (2016), Anarfi et al. (2016).
	LTA	The ratio of total loan and advances to total assets	Zheng et al. (2018a), Yesmin (2018), Zheng et al. (2017a).
	OBSTA	The ratio of total off-balance sheet items to total assets	Zheng et al. (2017b), Gupta (2018), Mongid et al. (2012).
	RD	The ratio of non-interest revenue to total assets	Nguyen and Nghiem (2015) Chaibi and Ftiti (2015) Zheng et al. (2018a).
	DTA	Ratio of deposit to total assets	Gupta (2018), Yesmin (2018), Zheng et al. (2017a)

Source: Authors compilation using the literature/sources mentioned in the fourth column of the table

Table 3. Descriptive statistics of the variable

Variable	Mean	Maximum	Minimum	Std. Dev.
NPLTL	0.0723	0.4459	0.0000	0.0803
Z-score	66.8501	1344.0000	-21.5965	120.2756
LLPTA	0.0171	0.1281	0.0000	0.0193
EFF_C	1.1705	1.8730	1.0079	0.1252
CFI ₁	0.0240	0.0540	-0.0149	0.0110
CFI ₂	0.0275	0.0659	-0.0198	0.0130
ETA	0.0708	0.1543	-0.1294	0.0286
BSD	43.1894	48.1100	27.1900	4.3447
BI	-0.0543	-0.0300	-0.0800	0.0136
GGDP	5.9665	7.1135	3.8331	0.8396
INFLATION	6.1672	8.1646	3.2612	1.4044
SIZE	11.2222	13.9991	8.3667	1.0837
ROA	1.3462	6.0500	-13.5200	1.2722
LTA	0.6597	0.8375	0.3218	0.0849
OBSTA	0.3015	0.6751	0.0298	0.1155
RD	0.0288	0.1011	0.0027	0.0105
DTA	0.8085	0.9354	0.4600	0.0568
Small Bank	34,812	162,376	0.0000	36,634
Large Bank	30,285	886,397	0.0000	108,499

Note(s): This table presents the mean, Standard deviation, minimum, and maximum value of the variables used in regression models. The efficiency of Cost (Eff_cost), Risk (NPLTL, Z-score, LLPTA), and cost of financial intermediation (NIM 1, NIM 2) are the dependent variables, and The Boone Indicator (BI) is used as a proxy measure of competition. All figures are in million USD, whereas applicable. The large bank derives by subtracting average industry assets from the bank's asset, whereas the Small bank calculates by subtracting a particular bank's asset from the average industry assets.

the system GMM approach (Arellano & Bover, 1995; Blundell & Bond, 2000). The first and second-order serial correlation of The Arellano-Bond assumes the null hypothesis that there is no serial correlation. Our test results of second-order serial correlation cannot reject the null hypothesis. Like previous literature of H. T. Phan et al. (2019), Gupta and Moudud-Ul-Huq (2020), Zheng et al. (2018b), and Moudud-Ul-Huq (2020), among others, our test results also observe similar finding of AR(1) and AR (2). Notably, the second-order autocorrelation, AR (2) in residuals, should be statistically insignificant as it removes the time-dependent inconsistent variances from the output. Furthermore, the Hansen test results should be statistically insignificant, which confirms that over-identification restrictions are valid or the instruments are appropriate.

To address the size effect and nonlinear effect of competition, we extend our baseline model. Assuming the heterogeneous behaviour of banks in a competitive environment and size, the extended model is as follows:

$$\begin{aligned}
 Y_{i,t} = & \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 BI_{i,t} + \beta_3 BI_{i,t}^2 + \beta_4 BSD_{i,t} + \sum_{u=5}^6 \beta_u S_{u,i,t} + \sum_{o=7}^9 \beta_o SBI_{i,p,t}^2 \\
 & + \sum_{j=14}^{15} \beta_j X_{i,j,t} + \sum_{n=16,19,21}^{17,20,21} \beta_n X_{i,j,t} + \varepsilon_{i,t}
 \end{aligned}
 \tag{2}$$

Where the variable “ $BI_{i,t}^2$ ” refers to the squared term of competition, and “ $S_{u,i,t}$ ” indicates large and small bank size (Large bank derives by the subtracting average industry assets from the particular bank's asset, whereas Small bank derives by subtracting particular bank's assets from the average industry assets. Large and small banks levelled as *Model I* and *Model II* in extended results.

Table 4. Unit root test (Fisher type ADF)

Variable	At Level		Variable	At Level	
	Statistic	Probability		Statistic	Probability
NPLTL	4.0993	0.000	Inflation	4.0771	0.000
Z-score	9.3484	0.000	ETA	4.9015	0.000
LLPTA	6.9615	0.000	Size	13.8267	0.000
EFF_C	-6.9613	0.000	ROA	5.9244	0.000
CFI1	7.4521	0.000	LTA	8.9324	0.000
CFI2	7.1136	0.000	OBSTA	4.1626	0.000
BSD	27.3479	0.000	RD	4.516	0.000
BI	5.1322	0.000	DTA	10.3505	0.000
GGDP	7.3021	0.000			

Product of size and competition (nonlinear effect of competition) denotes by, “ $S * BI_{i,o,t}$ ” and “ $(S * BI_{i,p,t}^2)$ ”. The large negative coefficients in the Boone indicator indicate that in a highly competitive market (large or small), with the increase of bank size.

5. Empirical results

This section presented the summary statistics (see Table 3) of the variables, and Table 4 explains the Unit root test of the data series. Table 5 and Table 6 show correlation matrix and Variance Inflation Factors (VIF) have also performed to check the variables’ multicollinearity. The following empirical results explained the simultaneous relationship between the cost of financial intermediation, risk, and efficiency are presented in Tables 7–12.

The nonlinear and quadratic effect of size and competition by considering size are discussed in Tables 13–18. Small and large size banks are labelled as Model I and Model II, respectively. All Tables (Tables 7–18) present the regression results of the two-step system GMM (2GMM).

5.1. Descriptive statistics and relevant tests

From the summary statistics of Table 3, we observe the mean values of risk measures are 0.072, 66.85, and 0.017 against NPLTL, Z-score, and LLPTA, respectively. The other two dependent variables’ average value, the efficiency of cost is 1.1705, and cost of financial intermediation CFI₁ is 2.40%, and CFI₂ is 2.75%, respectively. The average CFI values, i.e., net interest margins, are lower than the Latin American 9.85% (Chortareas et al., 2012) and the Asia Pacific economics 3.0% (Fu et al., 2014). The average value of the competition measure (BI) is -0.05, which is lower than the Asian market (BI) -7.50 (Zheng et al., 2017a). It implies that the competition of the Bangladeshi market is lower than the average Asian market. Bangladesh’s average inflation rate is 6.17, which higher than large Asian economic giants, China 2.97 and lower than India 9.16 (Zheng et al., 2017a). However, the mean growth rate of GDP is 5.97, which is comparatively better than the Asian market 5.43 (Soedarmono et al., 2019). Another industry level variable average banking industry asset to gross domestic product (BSD) is 43.19, which shows a good proportion of banking industry assets to GDP and higher than the average of BRICS countries 39.72 (Gupta & Moudud-UI-Huq, 2020). Variables-Small bank and Large bank address banks’ size, showing the average 34,812 and 30,285 million BDT. The average value of equity to total assets is about 0.0708, which implies that Bangladeshi banks lag in capitalization over Asian markets 0.1154 (Soedarmono et al., 2013). The average values of other bank-level control variables ROA, LTA, OBSTA are 1.34, 0.65, 0.30, and RD, DTA are 0.03 and 0.81, respectively.

To check the data stationary, we conduct a panel unit root test for each of the variables. We opt for the Fisher Type Augmented Dickey-Fuller test to address the unit root test for unbalanced panel data to show the data stationary. In Table 4, we observe no probability value is significant at a 1% level of

Table 5. Correlation matrix

	NPLTL	Z-score	LLPTA	CFI ₂	CFI ₁	Eff_C	BSD	ETA	BI	LTA	OBSTA	RD	DTA	GGDP	Inflation	Size	ROA
NPLTL	1																
Z-score	-0.065	1															
LLPTA	.711***	-0.076*	1														
CFI ₂	-.472***	-0.016	-.352***	1													
CFI ₁	-.496***	-0.02	-.367***	.994***	1												
Eff_C	.186***	.120***	.199***	-.354***	-.384***	1											
BSD	-.220***	.130***	-.136***	0.014	0.005	.369***	1										
ETA	-.481***	.090**	-.355***	.346***	.353***	0.001	.230***	1									
BI	0.008	.125***	-0.001	-.182***	-.191***	.348***	.473***	0.004	1								
LTA	-.507***	-.082*	-.297***	.463***	.483***	-.428***	.126***	.238***	-0.072	1							
OBSTA	-.173***	-.146***	-.144***	-0.033	-0.014	-.171***	-0.074	0.059	-0.059	.213***	1						
RD	-0.027	.079*	-0.004	-1.00**	-.083*	.112**	-0.036	.266***	-.227***	-.106**	.199***	1					
DTA	-.135***	-0.032	-.325***	-1.17**	-.113**	0.001	0.017	-.324***	-0.053	0.071	0.023	-.187***	1				
GGDP	-.198***	.107**	-.160***	0.038	0.025	.342***	.419***	.186***	.465***	.164***	-0.004	-0.005	-0.032	1			
Inflation	-.267***	.087*	-.147***	.193***	.177***	.321***	.387***	.376***	-.122***	.187***	-.123***	.164***	-0.059	.456***	1		
Size	.089*	.116**	.163***	-1.12**	-.154***	.724***	.502***	.230***	.339***	-.101**	-.203***	0.036	-.176***	.471***	.565***	1	
ROA	-.397***	-0.034	-.317***	.346***	.370***	-.299***	-.137***	.496***	-.245***	.228***	.146***	.220***	-0.019	-.188***	-0.035	-.288***	1

Note(s): ***, ** Pearson's Correlation is significant at 1%, 5%, and 10% respectively (2-tailed). The efficiency of cost (Eff_C), Risk (NPLTL, Z-score, LLPTA), and cost of financial intermediation (CFI₁, CFI₂) are used as dependent variables in the regression models. The Boone Indicator (BI) is used as a measure of competition.

significance against the Fisher Type Augmented Dickey-Fuller test statistics. It refers that the series data does not possess any unit root.

Table 5 shows Pearson's correlation matrix to determine the relations between dependent and independent variables. The results are given below:

The study conducts the correlation test to check the relationship between the variables, but it is challenging to conclude the independent variables' multicollinearity. Therefore, the study also tests the Variance Inflation Factor (VIF) to address the model's multicollinearity problem. The variance inflation factor (VIF) measures how often one predictor correlates with the other predictors in a model. Higher values indicate that determining the contribution of predictors to a model is complex. For each predictor in a predictive model, a VIF may be calculated. The predictor has a value of 1 if it does not correlate with other variables. The more significant the correlation between the variable and other variables, the higher the value. The value of correlation more than 0.90, and VIF value 10 refers to a very high degree of correlation between independent variables (Thompson et al., 2017).

However, in Table 6, the value of VIF for each variable is below 5, and Pearson correlation coefficients between independent variables in Table 5 don't show high degree correlation, which indicated no significant multicollinearity problems between the independent variables.

5.2. Determinants of risk and examination impact of the cost of financial intermediation and efficiency

Table 7 depicts the effect of cost of financial intermediation and efficiency on the risk of banks along with other variables. In Table 7, we observe that with the increase in the cost of financial intermediation, the risk of banks managed substantially. This result is in line with the finding of (Rahman et al., 2018) and opposes the view of Angbazo (1997) mentions the cost of financial intermediation as a premium of risk-taking.

The negative association of CFI_1 with Z-score in examining the cost of financial intermediation in risk shows that with the increase of net interest margin, the stability reduces having a significant improvement of credit risk-taking and overall bank risk. In efficiency concern, the efficiency of cost is negatively associated with all risk models. This result evident the "Bad Management" hypothesis. Thus, with the increase in cost efficiency, credit risk, stability, and overall bank risk decreases. The market competition measure Boone Indicator (BI) explores that increase market competition reduces the credit risk and overall bank risk significantly. It illustrates that a high degree of market competition reduces the risk-taking tendency of commercial banks. This result is in line with the outcome of Soedarmono et al. (2011) on Asian markets. However, the stability of banks also reduces in the competitive banking industry. As Boone indicators usually bear the negative sign, the sign of the Boone indicators' coefficient will refer to the opposite meaning. Increased asset size induces banks in risk-taking as the coefficient of size shows a positive association with risk. Similar findings depicting a positive association of size and risk is also observed in Zheng et al. (2018a).

In explaining other control variables, we observe that with the increase of capital, banks' risk substantially reduces, and stability increases that depict ETA's negative coefficient in NPLTL, LLPTA model, and positive coefficient of Z-score model. These findings also parallel with Zheng et al. (2017a) and Benes and Kumhof (2015). The industry level variable BSD shows a negative relationship with risk measures. It means that with the development of banking sectors, commercial banks are taking the calculative risk. Due to experience in the industry, the risk handling and managing capacity of banks increases. As debt servicing become more convenient for customers in economic progression (growth of GDP), the risk of banks reduces, and stability increases (Gupta & Moudud-Ul-Huq, 2020). LTA shows the negative, whereas inflation shows a positive association with risk measures. It refers that overall upward price moments of the market make the risk position of banks worse. In contrast, the mobilization of the loan in proportion to total assets reduces the risk significantly.

Table 6. Variance inflation factor

Variable	Dependent Variables					
	Base line equations			Extended results		
	VIF (CFI)	VIF (NPLTL)	VIF (Eff_C)	VIF(CFI)	VIF(NPLTL)	VIF(Eff_C)
Dep(-1)				1.56	1.86	2.16
NPLTL	1.34		1.88	1.57		2.09
Eff_c	2.31	3.16		2.25	2.6	
CFI		1.50	1.50		1.62	1.78
Size	3.42	3.29	2.44			
Large				1.91	1.85	1.9
Small				1.44	1.41	1.45
Inflation	2.80	2.78	2.85	2.19	2.19	2.19
BI	2.48	2.38	2.42	2.88	2.75	2.84
GGDP	1.97	2.01	2.03	1.98	2.01	2.04
BSD	1.85	1.83	1.87	1.93	1.93	1.94
RD	1.12			1.16		
LTA		1.73			1.93	
ETA		1.33			1.44	
ROA			1.42			1.45
DTA			1.13			1.14
OBSTA			1.13			1.19

Source: Authors' Calculation through STATA

5.3. Determinants of efficiency and examination of the impact of the cost of financial intermediation and risk

Table 8 explains the effect of cost of financial intermediation, risk over the efficiency of banks using Equation (1) of the GMM estimator. The coefficients of risk (stability) depict the positive (negative) association with efficiency. It refers that cost-efficient commercial banks are taking more credit risk, and their stability is worse than the cost-inefficient counterparts. Supporting the previous findings of Chortareas et al. (2012), the negative association of CFI₁ with efficiency asserts that efficient banks have a low spread of interest than cost-inefficient counterparts.

The Boone indicator's positive coefficient (BI) depicts that the efficiency of cost decreases in increased market competition. This result is analogous to the finding of H. T. M. Phan et al. (2016). The coefficient of BSD reports a meaningful positive relationship with the efficiency of cost. It means that the efficiency of cost enhances with the development of Bangladesh's banking sector (Gupta, 2018). A significant association with GGDP indicates that in economic progression, the efficiency of cost increases. Again in the rise of the overall market price (Inflation), the efficiency of cost decreases (Zheng et al., 2017a). Increase with assets size, the efficiency of cost decreases that denoted by the coefficient of size. With more dependency on depositm, increase the cost inefficiency of banks signified by the negative coefficient of DTA. This is because banks usually collect deposits short-term basis, but they also invest in long-term investment besides short term. Thus with the maturity gap of asset mobilization, the efficiency of cost decreases. ROA is significantly related to the efficiency of cost. It demonstrates that the profitability of banks provokes the efficiency of cost. With more exposure to non-traditional activities (off-balance sheet exposures), the efficiency of cost decreases.

5.4. Determinants of CFI and examination of the impact of risk and efficiency

Table 9 presents the bidirectional effect of risk and efficiency on the cost of financial intermediation. Supporting the efficiency structure hypothesis, the negative coefficients of efficiency assert

Table 7. Risk equation examining the effect of cost of financial intermediation and efficiency

Variable	NPLTL	Z-score	LLPTA
Dep(-1)	0.547***(32.74)	0.655379***(117.85)	0.545***(39.95)
CFI ₁	-1.837***(-7.73)	-4290.19***(-22.01)	-0.168***(-2.83)
Eff_C	-0.308***(-14.29)	-324.222***(-7.27)	-0.055***(-7.01)
BI	0.231**(2.64)	585.9426***(5.44)	0.100***(7.61)
BSD	-0.002***(-4.92)	-0.622(-1.47)	-0.001***(-9.33)
GGDP	-0.002(-1.08)	5.158037***(3.88)	-0.002***(-5.57)
Inflation	0.0001(0.17)	11.027***(5.63)	0.0004**(2.08)
Size	0.028***(12.32)	11.16575**(2.75)	0.007***(7.89)
LTA	-0.206***(-12.39)	-25.8488(-0.49)	-0.019***(-3.50)
ETA	-0.301***(-9.68)	490.4179***(5.59)	-0.159***(-24.27)
Constant	0.393***(9.09)	340.417***(7.98)	0.063***(6.21)
Hansen Test (P-value)	0.272	0.224	0.120
AR(1) (P-value)	0.011	0.014	0.004
AR(2) (P-value)	0.189	0.100	0.714
Observations	480	480	480

Note: The values in parentheses are t-value; *, **, *** refers to significance at 10 %, 5 %, and 1 % level, respectively. Dependent variables are NPLTL, Z-score, and LLPTA as a proxy measure of Credit risk, Stability risk, and Overall bank risk, respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1 (2) are tests for first (second) order correlation, asymptotically N (0, 1). These test the first-differenced residuals in the system GMM estimation.

that efficiency gains result in low cost of financial intermediation (Chortareas et al., 2012). Risk coefficients are negatively related to the cost of financial intermediation. This result is in line with Chortareas et al. (2012). One of the possible reasons active behind this is that with most investment opportunity utilization, the interest spread reduces substantially. Moreover, financial literacy opposed the massive absorption of extravagant risk in triggering the quality of earnings.

NPLTL model and LLPTA model present the positive association between market competition and the cost of financial intermediation. This result is similar to the finding of Chortareas et al. (2012) and evident the Structure-conduct-performance (SCP)³ argument. The better macroeconomic environment creates an opportunity for higher CFI, depicted by the positive coefficient of GGDP; this is because, in economic progression, default risk reduces, and the average deposit collection cost also reduces since sufficient cash preserved by the corporate and private savers. However, inflation shows a mixed result with the cost of financial intermediation. It asserts a positive association in the Z-score model, whereas negatively related to CFI in the NPLTL model. Higher CFI is associated with bank size. It refers that size fuels banks to gain more interest spreads. This result is the opposite of the finding of Gelos (2009) on Latin American countries. BSD and RD are negatively related to CFI. With the growth of the industry, the opportunity of interest spread reduces as competition increases. Again revenue diversification minimizes the spread of interest margin because non-interest income is the proportion of total operating income that reduces the overemphasize to generate more income on interest (Rahman et al., 2018).

The coefficients of lagged dependent variables are observed positive in all GMM estimates models, confirming the models' dynamic nature and depicting dependent variables are persistently followed from year to year. The value of AR(1) and AR(2) reported in each equation's regression tables validate the instrument of the lagged dependent variable. The Hensen test of J-statistics confirms the validity of the instruments of the models of the study.

Table 8. Efficiency equation examining the effect of risk and cost of financial intermediation

Variable	Eff_C (with NPLTL)	EFF_C(with Z-score)	EFF_C(with LLPTA)
Eff_C (-1)	1.11516***(1815.63)	1.114058***(1099.65)	1.11482***(1756.22)
NPLTL	0.003436***(7.34)		
Z-score		-1.1E-05***(-4.77)	
LLPTA			0.004225*(1.81)
CFI ₁	-0.007431***(3.28)	-0.04085***(-4.57)	-0.01023***(-3.91)
BI	0.003522***(4.32)	0.008297**(2.73)	0.001701**(2.10)
BSD	5.16E-06**(2.47)	1.79E-05*(1.91)	-4.74E-06(-1.66)
GGDP	6.88E-05***(8.47)	0.000114***(3.65)	5.03E-05***(4.89)
Inflation	-4.7E-05***(-6.39)	-0.000079**(2.51)	-6.3E-05***(-6.89)
Size	-0.00038***(-7.82)	-0.00048***(-3.49)	-0.00037***(-8.47)
DTA	-0.0008*(-2.00)	-0.00302***(-2.77)	-0.00153***(-3.38)
ROA	0.000123***(8.47)	0.000186***(11.24)	9.31E-05***(4.86)
OBSTA	-0.00075***(-4.94)	-0.00314***(-7.94)	-0.00082***(-4.44)
Constant	-0.11285***(-177.92)	-0.10717***(-90.13)	-0.11074***(-141.71)
Hansen Test (P-value)	0.242	0.283	0.237
AR(1) (P-value)	0.026	0.058	0.089
AR(2) (P-value)	0.251	0.480	0.245
Observations	480	480	480

Note: The values in parentheses are t-value; *, **, *** refers significance at 10%, 5%, and 1% level respectively. The dependent variable is the efficiency of cost measure through SFA. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1 (2) are tests for first (second) order correlation, asymptotically N (0, 1). These test the first-differenced residuals in the system GMM estimation.

5.5. Robust check

By interchanging the alternative selection of proxy variables, a robustness check of the risk equation is performed. For measuring the cost of financial intermediation, we change the proxy measure CFI₁ to CFI₂ in all models. Table 10 results confirm the validity of the risk equation model's in examining the efficiency and cost of intermediation effect observed in Table 7.

The other robust results observe in Tables 11–12 confirm similar findings present in Tables 8–9, respectively. The only exception is observed in variable inflation in Table 8 with the Z-score model, which is found significant; however, in robust check, it is observed insignificant in Table 11.

5.6. The nonlinear and quadratic effect of size & market competition

Following Gupta and Moudud-Ul-Huq (2020), Kouki and Al-Nasser (2017), S. Kasman and Kasman (2015), and Jeon and Lim (2013), the squared term of Boone Indicator (BI) in equation (2) incorporate to examine the nonlinear effect. We extend the baseline model to delve into the nonlinear relationship between the dependent variables and market competition along with the size effect. Tables 13–18 presents the GMM estimators having a nonlinear impact by using Equation (2).

Table 13 shows the nonlinear effect of size and market competition over the risk of banks. Empirical findings of Table 13 are in line with Gupta and Moudud-Ul-Huq (2020), Tabak et al. (2012) that depict the significant nonlinear effect of competition on risk-taking of banks. The square term of market competition (BI)⁴ describes a significant negative (positive) association with credit and overall risk for large (small) banks and a positive (negative) relationship with stability. This result supports the “competition-stability” (competition-fragility)⁵ view for large (small) banks and is in line with the finding of Gupta and Moudud-Ul-Huq (2020). However, the interim term of size and competition

Table 9. Cost of financial intermediation equation examining the effect of risk and efficiency

Variable	CFI ₁ (with NPLTL)	CFI ₁ (with Z-score)	CFI ₁ (with LLPTA)
CFI ₁ (-1)	0.425***(9.22)	0.481***(11.97)	0.533***(10.17)
NPLTL	-0.050***(-13.42)		
Z-score		-0.0000106(-1.31)	
LLPTA			-0.126***(-7.05)
Eff_C	-0.033***(-3.75)	-0.056***(-8.79)	-0.064***(-6.814)
BI	-0.041**(-2.62)	-0.002(-0.08)	-0.037**(-2.18)
BSD	-0.001***(-8.54)	-0.0003***(-4.69)	-0.001***(-7.14)
GGDP	0.0005**(2.27)	0.001***(4.06)	0.001***(3.10)
Inflation	-0.0004***(-2.90)	0.0004**(2.72)	-0.0001(-0.75)
Size	0.003***(3.57)	0.003***(5.18)	0.005***(6.28)
RD	-0.129***(-6.27)	-0.069***(-3.67)	-0.127***(-6.90)
Constant	0.051***(14.11)	0.051***(13.5)	0.055***(13.43)
Hansen Test (P-value)	0.134	0.115	0.107
AR(1) (P-value)	0.000	0.000	0.000
AR(2) (P-value)	0.310	0.223	0.385
Observations	480	480	480

Note: The values in parentheses are t-value; *, **, *** refers to significance at 10%, 5%, and 1% level respectively. The dependent variable is the cost of financial intermediation. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1 (2) are tests for first (second) order correlation, asymptotically N (0, 1). These test the first-differenced residuals in the system GMM estimation.

Table 10. Equation risk examining the effect of efficiency and cost of intermediation

Variable	NPLTL	Z-score	LLPTA
Dep(-1)	0.549***(31.40)	0.637378***(241.03)	0.545383***(39.97)
CFI ₂	-1.521***(-7.36)	-746.177***(-6.16)	-0.16131***(-3.35)
Eff_C	-0.305***(-13.94)	-73.3607**(-2.48)	-0.0569***(-7.08)
BI	0.229***(2.70)	626.53***(7.13)	0.100449***(7.68)
BSD	-0.001**(-4.96)	0.649018(1.3)	-0.00064***(-9.4)
GGDP	-0.001(-1.07)	2.445059**(2.19)	-0.00148***(-4.92)
Inflation	0.0001(0.33)	9.842193***(8.43)	0.000449**(2.23)
Size	0.028***(14.40)	6.39585**(2.64)	0.007017***(7.94)
LTA	-0.204***(-11.33)	-146.762***(-4.45)	-0.01956***(-3.61)
ETA	-0.290***(-8.60)	210.6766***(4.81)	-0.1581***(-23.64)
Constant	0.372***(9.68)	216.0666***(5.24)	0.063655***(6.28)
Hansen Test (P-value)	0.268	0.242	0.126
AR(1) (P-value)	0.012	0.065	0.004
AR(2) (P-value)	0.201	0.133	0.715
Observations	480	480	480

Note: The values in parentheses are t-value; *, **, *** refers to significance at 10%, 5%, and 1% level respectively. Dependent variables are NPLTL, Z-score, and LLPTA as a proxy measure of Credit risk, Stability risk, and Overall risk, respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1 (2) are tests for first (second) order correlation, asymptotically N (0, 1). These test the first-differenced residuals in the system GMM estimation

Table 11. Efficiency equation examining the effect of risk and cost of financial intermediation

Variable	Eff_C (with NPLTL)	EFF_C(with Z-score)	EFF_C(with LLPTA)
Eff_C (-1)	1.114186***(1590.2)	1.114376***(1174.63)	1.114575***(1763.74)
NPLTL	0.003623***(6.58)		
Z-score		-1.5E-05***(-10.94)	
LLPTA			0.006457***(5.12)
CFI ₂	-0.00747***(-4.1)	-0.03954***(-3.91)	-0.01419***(-5.59)
BI	0.003618***(4.9)	0.0089***(3.72)	0.001597***(2.11)
BSD	6.20E-06***(2.19)	1.48E-05*(1.72)	-7.57E-06(-2.33)
GGDP	0.000101****(8.93)	0.000135*(4.87)	0.000066****(5.76)
Inflation	-2.2E-05***(-3.87)	8.34E-06(0.28)	-6.6E-05***(-8.68)
Size	-0.00035***(-6.38)	-0.00033***(-4.63)	-0.00035***(-7.71)
DTA	-0.00142***(-4.45)	-0.00307**(-2.46)	-0.00161***(-3.63)
ROA	0.000156****(9.15)	0.00019****(9.92)	0.000114****(8.45)
OBSTA	-0.00084***(-4.9)	-0.00317***(-7.73)	-0.0008***(-3.79)
Constant	-0.11164***(-213.2)	-0.10836***(-67.64)	-0.11061***(-160.94)
Hansen Test (P-value)	0.186	0.324	0.209
AR(1) (P-value)	0.082	0.095	0.072
AR(2) (P-value)	0.216	0.905	0.375
Observations	480	480	480

Note: The values in parentheses are t-value; *, **, *** refers to significance at 10%, 5%, and 1% level respectively. The dependent variable is the efficiency of cost measure through SFA. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1 (2) are tests for first (second) order correlation, asymptotically N (0, 1). These test the first-differenced residuals in the system GMM estimation.

Table 12. Cost of financial intermediation equation examining the effect of risk and efficiency

Variable	CFI ₂ (with NPLTL)	CFI ₂ (with Z-score)	CFI ₂ (with LLPTA)
CFI ₂ (-1)	0.447***(9.95)	0.471***(10.07)	0.442***(10.84)
NPLTL	-0.054***(-13.95)		
Z-score		-0.000015**(-2.15)	
LLPTA			-0.142***(-10.76)
Eff_C	-0.043***(-4.53)	-0.070***(-8.76)	-0.067***(-7.30)
BI	-0.050***(-2.79)	0.0002(0.01)	-0.033*(-1.97)
BSD	-0.0006***(-8.71)	-0.0004***(-4.94)	-0.001***(-7.44)
GGDP	0.0006***(2.07)	0.001****(4.51)	0.001****(2.92)
Inflation	-0.0003***(-3.20)	0.0004***(2.40)	-0.0002(-1.18)
Size	0.003****(4.14)	0.004****(5.56)	0.005****(6.60)
RD	-0.152***(-7.79)	-0.095***(-5.27)	-0.119***(-5.61)
Constant	0.057****(14.01)	0.061****(12.66)	0.060****(15.53)
Hansen Test (P-value)	0.139	0.100	0.100
AR(1) (P-value)	0.000	0.000	0.000
AR(2) (P-value)	0.329	0.249	0.412
Observations	480	480	480

Note: The values in parentheses are t-value; *, **, *** refers to significance at 10%, 5%, and 1% level respectively. The dependent variable is the cost of financial intermediation. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1 (2) are tests for first (second) order correlation, asymptotically N (0, 1). These test the first-differenced residuals in the system GMM estimation.

Table 13. Risk equation—Nonlinear effect of size and market competition on risk

Variable	NPLTL		Z-score		LLPTA	
	Model I	Model II	Model I	Model II	Model I	Model II
NPLTL(-1)	0.5761002*** (30.83)	0.6073779*** (31.62)				
Z-score(-1)			0.531084*** (55.62)	0.647739*** (110.05)		
LLPTA(-1)					0.5414168*** (43.40)	0.587497*** (38.78)
CFI ₁	-0.6380638** (-2.68)	-1.012678*** (-4.93)	-4226.31*** (-7.20)	-2759.22*** (-11.35)	0.0670767 (1.34)	0.133039** (2.42)
Eff_C	0.034306* (1.85)	0.0801584*** (4.38)	410.7304*** (4.28)	-222.794*** (-5.11)	0.0355121*** (6.10)	0.050595*** (7.89)
Large	-2.71E-07*** (-14.32)		0.000442 (0.62)		-9.03E-08*** (-9.44)	
Small		4.81E-07*** (2.83)		-0.00163*** (-6.05)		1.01E-07** (2.39)
BI	-0.6211575 (-1.55)	-2.328657*** (-7.9)	-4510.49* (-1.81)	5226.275*** (4.52)	-0.5459561*** (-4.67)	-1.04534*** (-6.35)
BI ²	-8.831444** (-2.60)	-21.58409*** (-9.68)	-42,647.70* (-1.80)	46,186.53*** (4.81)	-5.920515*** (-5.74)	-10.4636*** (-7.59)
Large × BI	-0.0000114*** (-14.27)		0.064695** (2.61)		-3.82E-06*** (-9.20)	
Small × BI		0.0000185** (2.46)		-0.07424*** (-6.39)		4.43E-06** (2.51)
Large × BI ²	-0.0000894*** (-11.31)		0.727755*** (3.37)		-0.0000299*** (-8.58)	
Small × BI ²		0.0001438** (2.06)		-0.74547*** (-6.52)		4.54E-05*** (2.92)
BSD	-0.0016815*** (-4.92)	-0.0015729*** (-3.82)	-2.00842*** (-2.84)	0.293584 (0.30)	-0.000657*** (-6.57)	-0.00073*** (-6.13)
GGDP	-0.0041321*** (-4.39)	-0.0043238*** (-3.06)	0.290244 (0.12)	3.011385 (1.69)	-0.0015355*** (-3.04)	-0.00161** (-2.74)
Inflation	0.0010858** (2.11)	0.0012325** (2.13)	3.625876* (1.78)	8.342811*** (5.27)	0.0002262 (1.03)	8.12E-05 (0.34)
LTA	-0.0895228*** (-3.84)	-0.0355388** (-2.07)	-12.619 (-0.13)	-141.489** (-2.56)	0.0157527*** (2.87)	0.016125*** (3.30)
ETA	-0.2435876*** (-10.82)	-0.1825525*** (-5.89)	377.8504** (2.12)	258.3677*** (4.15)	-0.1314195*** (-15.87)	-0.12986*** (-15.29)
Constant	0.1630917*** (3.55)	0.0206707 (0.43)	-393.125** (-2.22)	480.6397*** (6.36)	-0.0121746 (-1.10)	-0.04066*** (-4.04)
Hansen Test (P-value)	0.305	0.356	0.176	0.382	0.519	0.217
AR(1) (P-value)	0.016	0.017	0.051	0.064	0.004	0.004
AR(2) (P-value)	0.216	0.236	0.160	0.132	0.924	0.996
Observations	480	480	480	480	480	480

Note(s): Empirical results of GMM panel estimator present in the table by using Equation (2). Risk is the dependent variable measured through NPLTL (credit risk), Z-score (Stability risk), LLPTA (overall risk). BI is the competition measures. Size of banks categorized by the small and large size of banks. Small × BI (Large × BI) and Small × BI² (Large × BI²) denotes the quadratic term of size and market competition. The values show in parenthesis are t-values, ***, ** and * indicates significant at 1%, 5% and 10% respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1(2) is tested for the first(second)order correlation, asymptotically N (0,1). These test the first-differenced residuals in the system GMM estimation

Table 14. Efficiency equation—nonlinear effect of size and market competition on efficiency

Variable	Eff_C (with NPLTL)		Eff_C (with Z-score)		Eff_C (with LLPTA)	
	Model I	Model II	Model I	Model II	Model I	Model II
Eff_C (-1)	1.108606*** (1096.68)	1.111475*** (1683.07)	1.108889*** (1187)	1.112765*** (1128.91)	1.109032*** (1140.92)	1.111375*** (1578.86)
NPLTL	0.0020567***(3.95)	0.005444***(9.48)				
Z-score			6.89E-07**(2.34)	-8.07E-06*** (-5.39)		
LLPTA					-0.00284**(-2.50)	0.004375*(1.83)
CFI ₁	0.0063782(1.58)	-0.0059*(-1.73)	-0.00203(-0.73)	-0.03333***(-4.56)	-0.00174(-0.77)	-0.02422***(-6.52)
large	2.45E-08***(9.46)		2.17E-08***(9.36)		2.39E-08***(8.79)	
Small		-1.54E-08*** (-3.29)		-1.44E-08*(-1.98)		-9.64E-09**(-2.26)
BI	-0.0241289*** (-3.92)	0.019321**(2.29)	-0.03262***(-5.45)	-0.00302(-0.16)	-0.03609***(-6.48)	-0.00139(-0.16)
BI ²	-0.2329476*** (-4.39)	0.036579(0.57)	-0.3029***(-5.60)	-0.1136(-0.66)	-0.33993***(-6.69)	-0.13207*(-1.97)
Large × BI	6.29E-07***(10.65)		5.50E-07***(10.18)		6.01E-07***(10.71)	
Small × BI		-3.25E-07*(-1.92)		-4.81E-07(-1.52)		-1.27E-07(-0.83)
Large × BI ²	4.12E-06***(10.74)		3.57E-06***(10.01)		3.97E-06***(11.54)	
Small × BI ²		-4.08E-07(-0.32)		-3.76E-06(-1.35)		8.46E-07(0.73)
BSD	-6.48E-06**(-2.12)	-5.90E-06*(-1.73)	-1.7E-05***(-4.00)	-1.9E-05**(-2.28)	-2.1E-05***(-5.51)	-2.3E-05***(-5.17)
GGDP	0.0000313***(2.86)	8.67E-05***(8.95)	9.25E-06(1.3)	8.54E-05***(4.00)	2.38E-06(0.32)	6.45E-05***(5.13)
Inflation	-0.0000687*** (-5.21)	-0.0001***(-7.66)	-9.7E-05***(-7.84)	-9.4E-05***(-3.66)	-0.0001***(-8.09)	-0.00012***(-9.16)
DTA	-0.0009706** (-2.08)	-0.00044(-1.12)	-0.00173***(-5.12)	-0.00198**(-2.40)	-0.00199***(-5.13)	-0.0017***(-3.77)
ROA	0.0001166***(6.28)	0.000199***(9.62)	8.41E-05***(5.02)	0.000176***(6.34)	7.55E-05***(4.28)	0.000144***(7.18)
OBSTA	-0.000153(-0.69)	-0.00041(-1.43)	-0.00025(-1.61)	-0.00156***(-3.08)	-0.00029*(-1.98)	-0.00102***(-3.31)
Constant	-0.1094461*** (-88.1)	-0.11168*** (-133.78)	-0.10823*** (-110.11)	-0.1102*** (-77.85)	-0.10794*** (-105.67)	-0.10915*** (-128.27)
Hansen Test (P-value)	0.387	0.225	0.373	0.370	0.353	0.253
AR(1) (P-value)	0.029	0.016	0.037	0.058	0.027	0.045
AR(2) (P-value)	0.184	0.259	0.054	0.239	0.100	0.242
Observations	480	480	480	480	480	480

Note(s): Empirical results of GMM panel estimator present in the table by using Equation (2). The cost efficiency is the dependent variable measured through SFA. Risk is measured through NPLTL (credit risk), Z-score (Stability risk), LLPTA (overall risk). BI is the competition measures. Size of banks categorized by the small and large size of banks. Small × BI (Large × BI) and Small × BI² (Large × BI²) denotes the quadratic term of size and market competition. The values show in parenthesis are t-values, ***, ** and * indicates significant at 1%, 5% and 10% respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1(2) is tested for the first(second)order correlation, asymptotically N (0,1). These test the first-differenced residuals in the system GMM estimation

shows the U-shaped shape curve proposed by Martinez-Miera and Repullo (2010). It means that initially, large (small) banks are taking more risk (less), but in the long run, they are taking calculative (more) risk. Banks' stability is leading to the opposite direction of risk of banks for large and small banks.

The relationship between market competition and efficiency portrays the opposite picture that observed with risk. From Table 14, it is noted that with the increase in market competition, the cost efficiency of large banks initially decreases then increases in the long run. Although small banks' efficiency shows a positive association, however, in the long run, no significant relationship is observed. These findings are parallel to the finds of Gupta (2018).

Table 15 summarizes the GMM estimates examining the effect of risk and efficiency over financial intermediation cost with a nonlinear effect of size and competition. The interim and square term of size and competition illustrates that in a competitive market, the interest spread of large (small) banks initially decreases (increases) and subsequently increases (decreases). This is because initially, the risk escalation of large banks reduces the cost of intermediation benefit. In contrast, broad asset exposure gives them extra benefits to adjust the risk and interest spread in a competitive market.

5.7. Robust check of the nonlinear and quadratic effect of size & market competition on risk, efficiency, and cost of financial intermediation

Tables 16–18 reinforce the empirical outcomes of Tables 13–15. Adapting the cost of intermediation measures CFI_2 from CFI_1 , we check the robustness of nonlinear and quadratic models. Few exceptions only observed in the level of significance in a different model. For example, GGDP have found insignificant in Table 13 at the Z-score model, whereas it observed significantly in Table 16 in robust checks.

Thus, the empirical results are plausible, considering few exceptions between the actual results and robust check results.

6. Concluding remarks

Bangladesh's economic growth has not yet reached the projected levels. High margins may stifle savings, investment, and employment, negatively impacting economic growth. The study attempts to explain how efficiency and bank risk-taking behavior affect the cost of intermediation in the developing country context. Although liberalization and financial reforms have reduced intermediation costs due to legislative changes, this may be explained by a rise in the capital requirement, which makes it more expensive for banks, not to mention risk-taking. Furthermore, the findings reveal that efficiency, market concentration, non-performing loans, size, and macroeconomic factors have the greatest economic influence on intermediation. Taking the data together, it's clear that the financial reform failed to accomplish its goal of increasing competition and efficiency across the banking industry, as seen by the variance in bank margins over time. There is a lot of room to lower interest margins in Bangladesh by promoting banking rivalry; therefore, measures to promote competition and efficiency are needed. On the regulatory front, loosening limitations on foreign entry may help reduce intermediation costs. Substantial changes in the country's informational, contractual, and enforcement infrastructure are required to achieve the national goal. Furthermore, the government should encourage banks to participate in markets in order to boost economic growth in the country, as expenditures are passed on to the public at a lower rate.

The banking sector of Bangladesh is tremendously affected by several risk factors that indulge in survival and develop a fragile financial system. Financial intermediation is broadening access to financial services and accelerating economic performance (Levine, 2005). Shreds of evidence of Beck et al. (2007), Demirgüç-Kunt and Levine (2009), and Levine (2005), among others, support that the extent of financial intermediation has a causal effect on poverty reduction, inequality elimination, and ultimately boosting the economic growth. The study conducted by Stiglitz and Weiss (1981) found that credit rationing is prioritized for a higher cost of financial intermediation results in a lower level of credit grant to borrowers. The cost of financial intermediation is higher for lower-income countries (Calice & Zhou, 2018), and hence the lower intermediation spread is driven as a causal factor for financial development. The study found similar results concerning the cost of financial intermediation, which is negatively associated with bank risk and cost-efficiency.

Table 15. Cost of financial intermediation equation—nonlinear effect of size and market competition on the cost of financial intermediation

Variable	CFI ₁ (with NPLTL)		CFI ₁ (with Z-score)		CFI ₁ (with LLPTA)	
	Model I	Model II	Model I	Model II	Model I	Model II
CFI ₁ (-1)	0.5230728*** (12.23)	0.453892*** (10.03)	0.558515*** (12.15)	0.572325*** (13.43)	0.547436*** (15.45)	0.498242*** (12.87)
NPLTL	-0.0418197*** (-8.76)	-0.05209*** (-6.80)				
Z-score			-1.7E-05(-1.31)	-1.4E-05(-1.15)		
LLPTA					-0.07478*** (-5.11)	-0.11642*** (-4.82)
Eff_C	-0.0107975** (-2.05)	-0.01628*** (-4.21)	-0.01968*** (-4.38)	-0.03321*** (-9.22)	-0.02292*** (-5.05)	-0.02972*** (-9.96)
Large	6.84E-09(0.83)		2.21E-08**(2.72)		5.99E-09(0.56)	
Small		3.41E-08(0.71)		-1.22E-07*** (-2.97)		-4.27E-08(-0.95)
BI	0.2726513*** (3.38)	0.258828(1.46)	0.525952***(5.61)	0.941394***(6.13)	0.517095***(7.2)	0.659211***(4.03)
BI ²	2.961034***(3.78)	3.40354**(2.10)	5.242312***(5.83)	9.562024***(6.90)	5.203064***(8.03)	7.109628***(4.89)
large × BI	5.55E-07(1.50)		1.41E-06***(3.91)		4.03E-07(0.81)	
small × BI		6.24E-08(0.03)		-6.91E-06*** (-3.85)		-3.01E-06(-1.43)
large × BI ²	6.42E-06*(1.77)		1.34E-05***(3.32)		4.12E-06(0.81)	
small × BI ²		-2E-05(-0.97)		-8.4E-05***(-4.56)		-5E-05***(-2.38)
BSD	-0.0004905*** (-6.61)	-0.00049*** (-5.72)	-0.00027**(-2.64)	-0.00026**(-2.42)	-0.00037*** (-4.48)	-0.00036*** (-4.46)
GGDP	0.0007591*** (2.82)	0.000618**(2.12)	0.001272***(4.07)	0.001481***(4.49)	0.001042***(3.54)	0.001111***(3.66)
Inflation	-0.0001782(-1.34)	0.000243(1.50)	0.000354(1.49)	0.00062**(2.33)	0.000221(1.57)	0.000581*** (3.09)
RD	-0.1495017*** (-6.69)	-0.1517***(-6.08)	-0.12483*** (-5.60)	-0.10184*** (-4.60)	-0.13533*** (-6.99)	-0.15073*** (-6.14)
Constant	0.0550617*** (8.28)	0.060435*** (8.16)	0.053132*** (9.13)	0.073431*** (10.53)	0.063361*** (8.25)	0.073571*** (11.57)
Hansen Test (P-value)	0.238	0.299	0.252	0.191	0.219	0.241
AR(1) (P-value)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) (P-value)	0.483	0.466	0.423	0.401	0.823	0.783
Observations	480	480	480	480	480	480

Note(s): Empirical results of GMM panel estimator present in the table by using Equation (2). The cost of financial intermediation is the dependent variable measured through Net interest margin to average total assets. Risk is measured through NPLTL (credit risk), Z-score (Stability risk), LLPTA (overall risk). BI is the competition measures. Size of banks categorized by the small and large size of banks. Small × BI (Large × BI) and Small × BI² (Large × BI²) denotes the quadratic term of size and market competition. The values show in parenthesis are t-values, ***, ** and * indicates significant at 1%, 5% and 10% respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1(2) is tested for the first(second)order correlation, asymptotically N (0,1). These test the first-differenced residuals in the system GMM estimation

The cost of intermediation is lower for efficient cost management and inversely associated with risk of banks. Chortareas et al. (2012) opine that efficiency gains cost the low interest spread. It also shows that bank risk has negatively affect cost efficiency because non-performing loan or provisions for default is higher when banks are less efficient. This study also evident the linear and nonlinear impact of size and market competition on risk, efficiency, and cost of financial intermediation. In Bangladesh, most of the commercial banks face similar situations due to lack of

Table 16. Risk equation—Nonlinear effect of size and market competition on risk

Variable	NPLTL		Z-score		LLPTA	
	Model I	Model II	Model I	Model II	Model I	Model II
NPLTL(-1)	0.583457*** (29.51)	0.613974*** (34.51)				
Z-score(-1)			0.531558*** (57.63)	0.648733*** (110.75)		
LLPTA(-1)					0.539388*** (44.42)	0.585533*** (38.54)
CFI ₂	-0.52059*** (-2.86)	-0.76147*** (-5.26)	-3587.81*** (-8.37)	-2349.12*** (-12.89)	0.030783(0.66)	0.08531*(1.95)
Eff_C	0.041095**(2.13)	0.084386***(5.14)	433.7059***(4.98)	-211.976*** (-5.20)	0.034347***(5.90)	0.048869***(7.81)
Large	-2.73E-07*** (-14.23)		0.000221(0.32)		-9.00E-08*** (-9.81)	
Small		4.80E-07***(3.01)		-0.00161*** (-6.06)		1.02E-07**(2.46)
BI	-0.58926(-1.63)	-2.34955*** (-8.43)	-4340.45*(-1.79)	5241.55***(4.85)	-0.53562*** (-4.58)	-1.03691*** (-6.29)
BI ²	-8.52456*** (-2.81)	-21.7841*** (-10.43)	-41,188.3*(-1.79)	46,511.84***(5.11)	-5.80945*** (-5.65)	-10.3766*** (-7.53)
large × BI	-1.2E-05*** (-14.64)		0.056011**(2.4)		-3.81E-06*** (-9.52)	
small × BI		1.85E-05**(2.61)		-0.07323*** (-6.30)		4.55E-06**(2.63)
large × BI ²	-9E-05***(-10.98)		0.649392***(3.25)		-3E-05***(-8.89)	
small × BI ²		0.000146**(2.19)		-0.74568*** (-6357)		4.63E-05***(3.03)
BSD	-0.00172*** (-5.09)	-0.00152*** (-3.73)	-2.05929*** (-3.15)	0.255721(0.27)	-0.00066*** (-6.70)	-0.00074*** (-6.36)
GGDP	-0.00458*** (-3.92)	-0.00424*** (-3.00)	-0.0813(-0.04)	3.100882*(1.81)	-0.0015***(-3.00)	-0.00157***(-2.70)
Inflation	0.00096*(1.82)	0.001236**(2.28)	3.576468*(1.85)	8.657237***(5.68)	0.000232(1.07)	0.000103(0.44)
LTA	-0.07773*** (-3.51)	-0.03936**(-2.29)	-8.3552(-0.10)	-133.717**(-2.65)	0.016229***(3.03)	0.016755***(3.39)
ETA	-0.24359*** (-9.00)	-0.18478*** (-5.94)	351.0286**(2.02)	260.7955***(4.30)	-0.12889*** (-15.31)	-0.12788*** (-15.12)
Constant	0.150984***(3.30)	0.011123(0.24)	-414.033**(-2.51)	461.4371***(6.34)	-0.01067(-0.97)	-0.03817*** (-3.81)
Hansen Test (P-value)	0.334	0.389	0.192	0.389	0.428	0.218
AR(1) (P-value)	0.016	0.017	0.046	0.029	0.003	0.003
AR(2) (P-value)	0.207	0.242	0.150	0.133	0.911	0.985
Observations	480	480	480	480	480	480

Note(s): Empirical results of GMM panel estimator present in the table by using Equation (2). Risk is the dependent variable measured through NPLTL (credit risk), Z-score (Stability risk), LLPTA (overall risk). BI is the competition measures. Size of banks categorized by the small and large size of banks. Small × BI (Large × BI) and Small × BI² (Large × BI²) denotes the quadratic term of size and market competition. The values show in parenthesis are t-values, ***, ** and * indicates significant at 1%, 5% and 10% respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1(2) is tested for the first(second)order correlation, asymptotically N (0,1). These test the first-differenced residuals in the system GMM estimation

Table 17. Efficiency equation—Nonlinear effect of size and market competition on efficiency

Variable	Eff_C (with NPLTL)		Eff_C (with Z-score)		Eff_C (with LLPTA)	
	Model I	Model II	Model I	Model II	Model I	Model II
Eff_C (-1)	1.108525*** (1106.14)	1.111465*** (1813.07)	1.109649*** (1426.69)	1.112646*** (1092.49)	1.110081*** (1332.43)	1.111752*** (1842.39)
NPLTL	0.001624***(3.70)	0.003535***(4.34)				
Z-score			2.73E-07(1.21)	-7.98E-06*** (-5.05)		
LLPTA					-0.00212(-0.85)	-0.00204*(-1.36)
CFI ₂	-0.00028(-0.10)	-0.01562*** (-4.50)	-0.00187(-0.71)	-0.03346*** (-4.83)	-0.0039(-1.62)	-0.03082*** (-8.83)
large	2.33E-08***(8.71)		2.21E-08***(8.06)		2.22E-08***(8.82)	
Small		-1.44E-08*** (-3.31)		-1.49E-08*(-1.95)		-8.83E-09*(-1.84)
BI	-0.0225***(-3.75)	0.01719*(1.99)	-0.03792*** (-8.22)	-0.00135(-0.06)	-0.04009*** (-7.99)	-0.00328(-0.34)
BI ²	-0.221***(-4.29)	0.032547(0.47)	-0.3533***(-8.86)	-0.09233(-0.49)	-0.37826*** (-8.46)	-0.12827*(-1.71)
large × BI	6.06E-07***(9.68)		5.76E-07***(9.20)		5.80E-07***(10.41)	
small × BI		-2.94E-07*(-1.79)		-5.15E-07(-1.54)		-5.09E-08(-0.29)
large × BI ²	4.01E-06***(9.78)		3.83E-06***(9.58)		3.87E-06***(11.26)	
small × BI ²		-4.43E-07(-0.35)		-4.21E-06(-1.39)		1.44E-06(1.11)
BSD	-7.93E-06***(-2.44)	-1E-05***(-2.86)	-2E-05***(-5.39)	-1.8E-05*(-2.03)	-2.2E-05***(-5.83)	-2.1E-05***(-3.34)
GGDP	4.02E-05***(5.12)	0.000086***(7.95)	1.37E-05*(1.90)	9.82E-05***(3.86)	2.44E-06(0.34)	6.82E-05***(4.24)
Inflation	-6.9E-05***(-5.49)	-9.7E-05***(-8.54)	-0.0001*** (-10.28)	-7.9E-05***(-2.90)	-0.00011*** (-9.84)	-0.0001***(-7.49)
DTA	-0.00118*** (-3.16)	-0.00089(-1.61)	-0.00185*** (-5.21)	-0.00211**(-2.45)	-0.00234*** (-6.10)	-0.00223*** (-4.37)
ROA	0.00013***(7.70)	0.000185***(9.16)	9.74E-05***(5.53)	0.000185***(6.29)	0.0001***(5.40)	0.000134***(6.74)
OBSTA	-0.00038**(-2.19)	-0.00072**(-2.41)	-0.00026*(-1.77)	-0.00169*** (-3.21)	-0.0002(-0.90)	-0.00097*** (-3.12)
Constant	-0.10886*** (-99.41)	-0.11069*** (-140.14)	-0.10897*** (-136.39)	-0.11***(-76.28)	-0.10882*** (-100.37)	-0.10903*** (-120.52)
Hansen Test (P-value)	0.352	0.204	0.229	0.369	0.218	0.208
AR(1) (P-value)	0.032	0.053	0.043	0.039	0.036	0.076
AR(2) (P-value)	0.246	0.213	0.132	0.194	0.242	0.211
Observations	480	480	480	480	480	480

Note(s): Empirical results of GMM panel estimator present in the table by using Equation (2). The cost efficiency is the dependent variable measured through SFA. Risk is measured through NPLTL (credit risk), Z-score (Stability risk), LLPTA (overall risk). BI is the competition measures. Size of banks categorized by the small and large size of banks. Small × BI (Large × BI) and Small × BI² (Large × BI²) denotes the quadratic term of size and market competition. The values show in parenthesis are t-values, ***, ** and * indicates significant at 1%, 5% and 10% respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1(2) is tested for the first(second)order correlation, asymptotically N (0,1). These test the first-differenced residuals in the system GMM estimation

proper guidance, monitoring or supervision and above all a deficiency of good intentions. The study suggests that cost efficiency can minimize the intermediation spread as evidenced proved in developed countries (Calice & Zhou, 2018) or else will be responsible for higher risk-taking. The interdependencies should be addressed simultaneously for the steady state of financial market development. Further study can be extended by focusing on cross country data consisting of developing and developed countries to have a comparative picture of the titled study.

Table 18. Cost of financial intermediation equation-Nonlinear effect of size and market competition on the cost of financial intermediation

Variable	CFI ₂ (with NPLTL)		CFI ₂ (with Z-score)		CFI ₂ (with LLPTA)	
	Model I	Model II	Model I	Model II	Model I	Model II
CFI ₂ (-1)	0.552161*** (13.53)	0.4829***(14.04)	0.572356*** (17.37)	0.583095*** (16.68)	0.568889*** (16.64)	0.528448*** (16.15)
NPLTL	-0.04494*** (-7.82)	-0.05736*** (-7.74)				
Z-score			-2.3E-05*(-1.71)	-1.7E-05(-1.25)		
LLPTA					-0.08145*** (-4.32)	-0.1247***(-4.71)
Eff_C	-0.0105(-1.69)	-0.01803*** (-4.00)	-0.02136*** (-4.02)	-0.03759*** (-9.77)	-0.02337***(-4.2)	-0.03352*** (-10.36)
large	1.31E-08(1.50)		3.31E-08***(3.19)		1.44E-08(1.21)	
Small		3.29E-08(0.52)		-1.56E-07*** (-3.24)		-6.86E-08(-1.21)
BI	0.311581***(3.40)	0.339034*(1.72)	0.601913***(5.46)	1.119235***(5.80)	0.583819***(6.29)	0.844732***(4.58)
BI ²	3.405701***(3.93)	4.300601***(2.29)	5.95004***(5.62)	11.33275***(6.54)	5.86072***(7.09)	8.966644***(5.43)
large × BI	9.33E-07***(2.44)		2.05E-06***(4.47)		9.37E-07*(1.8)	
small × BI		-3.95E-07(-0.14)		-8.72E-06*** (-4.29)		-4.38E-06(-1.68)
large × BI ²	1.04E-05***(2.77)		2.02E-05***(3.94)		9.82E-06*(1.86)	
small × BI ²		-2.9E-05(-1.09)		-0.0001***(-5.14)		-6.7E-05**(-2.63)
BSD	-0.00058***(-6.6)	-0.0006***(-6.63)	-0.00032*** (-3.22)	-0.00031*** (-2.79)	-0.00044***(-4.4)	-0.00043*** (-4.51)
GGDP	0.000893***(2.86)	0.000707***(2.06)	0.001459***(3.71)	0.001649***(4.59)	0.001243***(3.76)	0.001211***(3.80)
Inflation	-0.00016(-1.12)	0.000317*(1.73)	0.000484*(1.96)	0.000772****(2.84)	0.000293***(2.11)	0.000707***(4.01)
RD	-0.1814***(-6.83)	-0.17501*** (-6.02)	-0.1466***(-6.04)	-0.12093*** (-4.61)	-0.16254*** (-7.05)	-0.17387*** (-6.57)
Constant	0.060359***(7.37)	0.069943***(9.83)	0.059411***(8.22)	0.084931*** (10.29)	0.068785***(7.27)	0.085698*** (13.00)
Hansen Test (P-value)	0.217	0.316	0.236	0.207	0.213	0.233
AR(1) (P-value)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) (P-value)	0.538	0.524	0.249	0.454	0.879	0.860
Observations	480	480	480	480	480	480

Note(s): Empirical results of GMM panel estimator present in the table by using Equation (2). The cost of financial intermediation is the dependent variable measured through Net interest margin to average earning assets. Risk is measured through NPLTL (credit risk), Z-score (Stability risk), LLPTA (overall risk). BI is the competition measures. Size of banks categorized by the small and large size of banks. Small × BI (Large × BI) and Small × BI² (Large × BI²) denotes the quadratic term of size and market competition. The values show in parenthesis are t-values, ***, ** and * indicates significant at 1%, 5% and 10% respectively. J-statistic refers to the p-value of the Hansen test. The Hansen test's null hypothesis depicts that the instruments used are not correlated with residuals (over-identifying restrictions). Arellano-Bond order 1(2) is tested for the first(second)order correlation, asymptotically N (0,1). These test the first-differenced residuals in the system GMM estimation

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Notes

- 1 Moral hazard hypothesis holds that low capital ratio induces banks to take riskier project resulting increased credit risk in future.
- 2 Bad management hypothesis holds that decrease in cost efficiency leads to an increase in credit risk.
- 3 The Structure-conduct-performance illustrate that market structure has a direct influence on the economic performance of the organization which in turn significantly affect market performance.
- 4 As BI usually bears negative sign, thus, in relationship explanation will need to consider coefficient sign inverse manner. Interactive term is also needed to consider accordingly (Zheng et al., 2017a).
- 5 Competition stability (competition fragility) view hold that increased market competition act behind taking less risk (more risk) that increase the stability (probability of default) of banks (Kabir and Worthington, 2017, Berger et al., 2009).

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Appendix A Determination of Cost Efficiency Using Stochastic Frontier Analysis (SFA)

The stochastic frontier analysis originated by (Aigner et al., 1977) is used to calculate each bank's efficiency based on the production frontier. On this production frontier model, the stochastic cost frontier model was developed (For details, see Kwan and Eisenbeis (1997), Schmidt and Knox Lovell (1979)). According to this methodology, due to inefficiency and random noise, a bank's observed cost is formulated to deviate from the cost-efficient frontier (Deelchand & Padgett, 2009a).

For the nth Bank,

$$\ln TC_n = f(\ln Q_i, \ln P_j) + \varepsilon_n \quad (1A)$$

TC_n represents total operating cost including financial costs; Q_i indicates two outputs, i.e. Q_1 = Gross loans and advances, Q_2 = Other earning assets. P_j stands for three input prices, i.e. P_1 = Price of the fund, the ratio of total interest expenses to total deposit, P_2 = Price of physical capital, which is non-interest expenses to fixed assets P_3 = Price of labour, which is total personnel expenses. ε_n shows the deviation of the actual total cost of a bank from the cost-efficient frontier, and it has two disturbance terms given as below:

$$\varepsilon_n = V_n + U_n$$

Where V_n is the random error term, and we assume that this is independent and identically distributed $N(0, \sigma_v^2)$. U_n represents cost inefficiency and assumed to be distributed independently of V_n and a half-normal distribution, i.e. $N(0, \sigma_u^2)$.

By using the intermediation approach (Sealey & Lindley, 1977) and by following (Deelchand & Padgett, 2009a), we have developed the following multiproduct translog cost function to specify the cost function:

$$\begin{aligned} \ln TC = & \alpha + \sum_i \alpha_i \ln Q_i + \sum_j \beta_j \ln P_j + \frac{1}{2} \sum_i \sum_k \gamma_{ik} \ln Q_i \ln Q_k \\ & + \frac{1}{2} \sum_j \sum_h \delta_{jh} \ln P_j \ln P_h + \sum_i \sum_j \lambda_{ij} \ln Q_i \ln P_j + \varepsilon \end{aligned} \quad (2A)$$

According to Jondrow et al. (1982), the expected value of U_n , on conditional ε_n , represents the cost-inefficiency of bank n (which is defined as C_n).

$$C_n = EU_n / \varepsilon_n = [\sigma \lambda / (1 + \lambda^2)] [\varphi(\varepsilon_n \lambda / \sigma) / \Phi(\varepsilon_n \lambda / \sigma) + \varepsilon_n \lambda / \sigma] \quad (3A)$$

Where λ is the ratio of the standard deviation of U_n to standard deviation of V_n , Φ is the cumulative standard normal density function, and ϕ is the standard normal density function. C_n can be estimated by using **Equation (3A)**.



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